MVP-ES Forest Inventory Phase II Protocol

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Office: MVP

1 Objectives

1.1 Background

A new forest resource survey (forest inventory) for the Mississippi River Project, St. Paul District fee title lands is required. Lands to be surveyed are located between Mississippi River mile 808.5 south of Hastings, MN and river mile 614 near Guttenberg, IA. Generally, these lands are located in the river floodplain and accessible mainly by boat. This type of survey will provide foresters and land managers with the site and stand specific information on diversity, forest health, structure and invasive species needed to make sound management decisions and plans. The forest inventory currently on file no longer reflects current conditions in many areas due to the age of the data and massive changes due to flood events in the last two decades. These lands are owned by the Corps of Engineers and co-managed with the US Fish and Wildlife Service as part of the Upper Mississippi River National Wildlife and Fish Refuge.

1.2 General Objectives

a. Establish forest sample plots and obtain geographic coordinate data for each plot center.
b. Obtain descriptive forest information from each sample plot (i.e. vegetation species composition, heights, stand age, forest health, site conditions, etc.)
c. Obtain a characterization of mid and understory vegetation within the forest.
d. Obtain copies of all forest resource survey data in digital format and in an appropriate computer software package.
e. Identify and document all invasive plant species on sample plots.

2 Methods

2.1 General Sampling Methods

2.1.1 Global Positioning Systems

Use Global Positioning System (GPS) units with field data recording capabilities for Phase II inventory data collection. Used of a data dictionary or pick-list format is necessary to ensure continuity in data collection and should be loaded onto the field data collector prior to any data collection. Prism plot data may be entered on the GPS unit without GPS position as long as a GPS point is created for the fixed plot. Trimble GeoXT 6000 units with inventory data dictionaries are currently being used.

Data may be recorded on paper if available satellites are limited as long as the plot center was marked with a GPS unit. The data could be manually entered later.

2.1.1.1 Coordinate system

GPS coordinates and data will be recorded under the format: Universal Transverse Mercator projection, Zone 15, North American Datum 1983, with units in meters.

2.1.1.2 Data Storage

GPS/Data collection units need to be charged daily and downloaded daily. Data downloads need to be completely backed up daily on a computer. Long term data storage and data delivery to the Government will include redundant digital storage and hard copy printouts of data.

2.1.2 Plot establishment

2.1.2.1 Maps

Maps provided for fieldwork shall display the boundaries of terrestrial areas defined by the latest Upper Midwest Environmental Science Center land cover and Corps fee title. They shall delineate forested and other terrestrial lands referred to in the remainder of this document as "non-forested" lands. Non-forested lands will not be sampled as part of Phase II forest inventory on MVP lands. See definitions below for specific designations of forested versus non-forested land.

2.1.2.2 Sampling grid

Systematic sampling will be employed in forested areas. Plots will be located 5 chains (330 feet) apart thus establishing one plot, on average, for every 2.5 acres. The sampling grid should be pre-determined and created using GIS and loaded onto GPS units prior to initiating fieldwork. To minimize bias, the grid should not be placed in relation to prevailing topographical features.

Plots shall not be arbitrarily relocated in the field, though any points falling outside of the forested sampling area in a non-forested area should be discarded. Points falling within the forested sampling area but near the edge of a non-forested area should be done in place and not relocated further interior to the edge. Any such edge plots will be sampled using a modified technique that is described in the Data Collection section below. If plot centers are located inside of non-forested inclusions and the point is inaccessible, the fixed plot may be recorded as the target plot from the initial GIS layer with a note that this plot location was inaccessible and is non-forested. If plots fall within aquatic inclusions and water depth is greater than 3 feet, the plot should not be measured and AQUATIC should be recorded in the FP_MISC field.

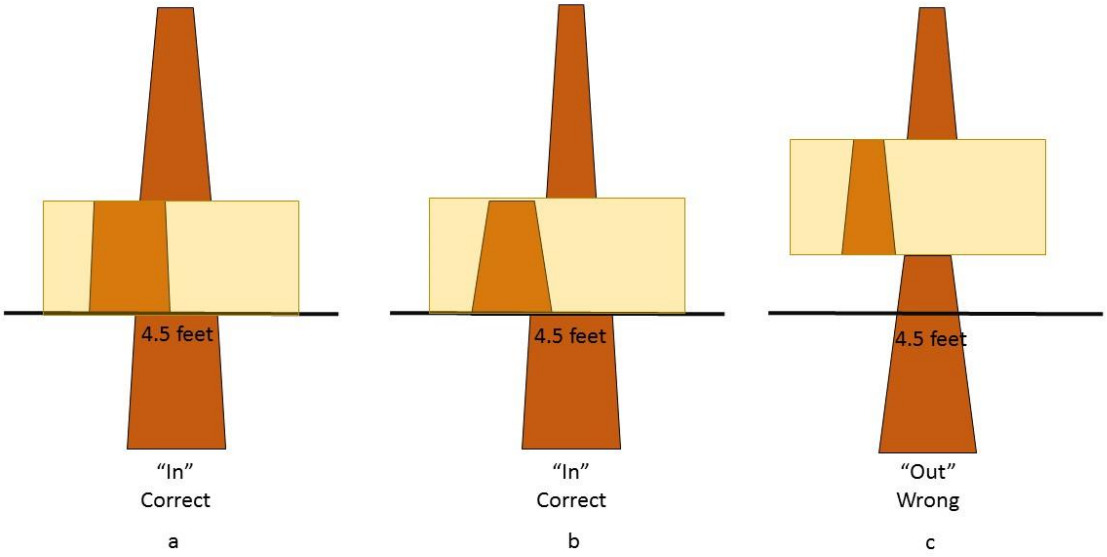
If quality assurance (QA) checks will be conducted on plots, upon locating the plot center in the field, the plot shall be marked and labeled using a brightly colored stake wire flag a minimum of 18" tall, labeled with the plot number. Alternative plot marking techniques may be used. All surveyed plots shall be marked accordingly to facilitate random QA inspections (as described in the Quality Assurance and Standards sections below). This plot center will be the center for the age, prism and fixed plots, as described in the following paragraphs. If QA checks will not be conducted, a temporary plot center shall be used and removed upon completion of the plot survey.

2.1.3 Field Tools

2.1.3.1 Wedge Prism or Angle Gauge

These are optical devices used for estimating basal area and determining "count" trees for the prism plot. Ten basal area factor (10 BAF) tools will be used. If using a wedge prism, the instrument must be held over the plot center and the observer must rotate around the instrument. The prism needs to be directly over plot center. If using an angle gauge, the observer's eye must be positioned over the plot center and the observer rotates at plot center. With the angle gauge, the observer's eye needs to be directly over plot center. If using a prism, IT IS IMPERATIVE THAT THE OBSERVER MAKES THE CALL OF "IN" OR "OUT" BASED ON THE DISPLACEMENT AT 4.5 FEET ONLY, not at any point above or below 4.5 feet. See the example below for proper positioning of the wedge prism to determine whether a tree is

"in" or "out". Image *a* is the usual scenario, neither the top nor the bottom of the bole are displaced in the prism, and the tree is counted in. Image *b* is a less common scenario, but especially important for trees with substantial taper or large trees far from the plot center. Note that in *b*, the bole is NOT displaced at 4.5 feet but IS displaced at the top of the prism. The call of "in" or "out" should be made in this case on whether the tree is displaced at 4.5 feet; since it is not, the tree in image *b* would be called "in" and tallied. If the prism is used incorrectly on the same tree (image *c*), and the reading is taken above 4.5 feet, the tree would be incorrectly called "out" and would not be tallied, even though the diameter at 4.5 feet was large enough for the tree to be "in". Precise use of the prism is imperative.



2.1.3.2 *Clinometer*

This is a hand held instrument for measuring vertical angles to determine tree height. If using a 1:66 clinometer, heights are most easily taken by standing a distance of one chain (66 ft.) from the base of the tree, and recording heights directly from the right-hand scale. If there is no line of sight to the tree top from one chain, then the height can be estimated from a 33 foot standoff by dividing that resulting value by two or from a 132 foot distance by doubling the resulting value. If using a percent scale clinometer, heights may be directly read from the right-hand scale at 100 feet from the height tree. Alternatively, heights may be calculated based on the horizontal distance from the base of the tree and the angle measured by the clinometer.

2.1.3.3 *Compass*

Used to follow directional transect grid lines to determine where plots are established and to identify sampling order.

2.1.3.4 *Loggers tape*

This tape has tree diameter in inches on one side, and the other side measures length in tenths of a foot. This tool will be used to measure standoff distances for clinometer measurements and the DBH of all trees in age plots, as well as the diameter of all large diameter trees or other trees in which other measurement methods will not produce an accurate result.

2.1.3.5 Biltmore stick

A graduated tool for direct reading of tree diameters at breast height. If a Biltmore stick is used, highly asymmetrical trees should be measured on two faces with the average of the two measurements recorded. A Biltmore stick should never be used when the diameter of the tree exceeds the maximum gradation on the stick. In this case, a logger's tape should be used.

2.1.3.6 Increment borer

A hand operated drill with a hollow bit that extracts a wood core from the stem of a tree. An increment borer will be used to determine age and growth ring index for the age plot.

2.1.3.7 Paint sticks

A paint "marker" used to mark trees as they are measured. These tools reduce error by providing evidence that a tree has already been measured.

2.1.4 Definitions

2.1.4.1 Plot

Generic reference for general location where prism, fixed, and possibly age data are collected from.

2.1.4.2 Plot center

The center point referenced/used in collecting prism and fixed data.

2.1.4.3 Prism plot

Variable radius plot where area of the plot is directly proportional to the basal area of the tree it represents. Radius of the plot increases proportionally to the diameter in tree being surveyed.

2.1.4.4 Fixed plot

Fixed radius plot is used to sample trees that are less than the specified breakpoint diameter. Fixed plot is an area of a measured distance from plot center to a defined radius.

2.1.4.5 Age plot

Annual rings are counted to determine the origin of the tree by extracting an increment core from the tree using and increment borer.

2.1.4.6 Count tree

A 10 BAF Wedge Prism or Angle Gauge is used to determine visually whether or not the tree should be sampled and thus considered a "count tree" using standard forestry practices. The "limiting distance" in feet for determining whether a particular tree should be a "count tree" can also be physically determined and measured by multiplying the diameter at breast height in inches by 2.75. If the actual distance to the center of the tree (not the face) from the plot center is less than the "limiting distance", then the tree is a "count tree". In cases of oblong trees, the tree diameter used for calculating limiting distance should be taken with a Biltmore stick on the face of the tree facing plot center.

2.1.4.7 DBH

Diameter at breast height (DBH) which is 4.5 feet off the ground. This is the height at which tree diameter measurements will be taken unless special cases apply. If special cases are encountered, the contractor shall follow all procedures outlined in pages 26 to 36 of the US Forest Service Timber Cruising Handbook, publication number FSH 2409.12, chapter 10[1] to determine the proper location for tree diameter measurements. In instances where an unusual tree is encountered that does not fit into the

[1] Available at: http://www.uky.edu/~jmlhot2/courses/for480/USFS%20Timber%20Cruising%20Handbook.pdf

special cases described in the Timber Cruising Handbook, the contractor may use professional judgment to best determine DBH and should record the tree in the TR_UNUS field described in section e.1.

2.1.4.8 Woody Vegetation

Any perennial vegetation with hardened, lignified stems. This classification includes trees, shrubs and lianas. Perennial herbaceous plants with hardened annual stems should not be classified as woody.

2.1.4.9 Forested area

An area dominated by trees and defined as a forest, willow or cottonwood community type in USGS land cover layers. Specifically, to be considered forested, an area must:

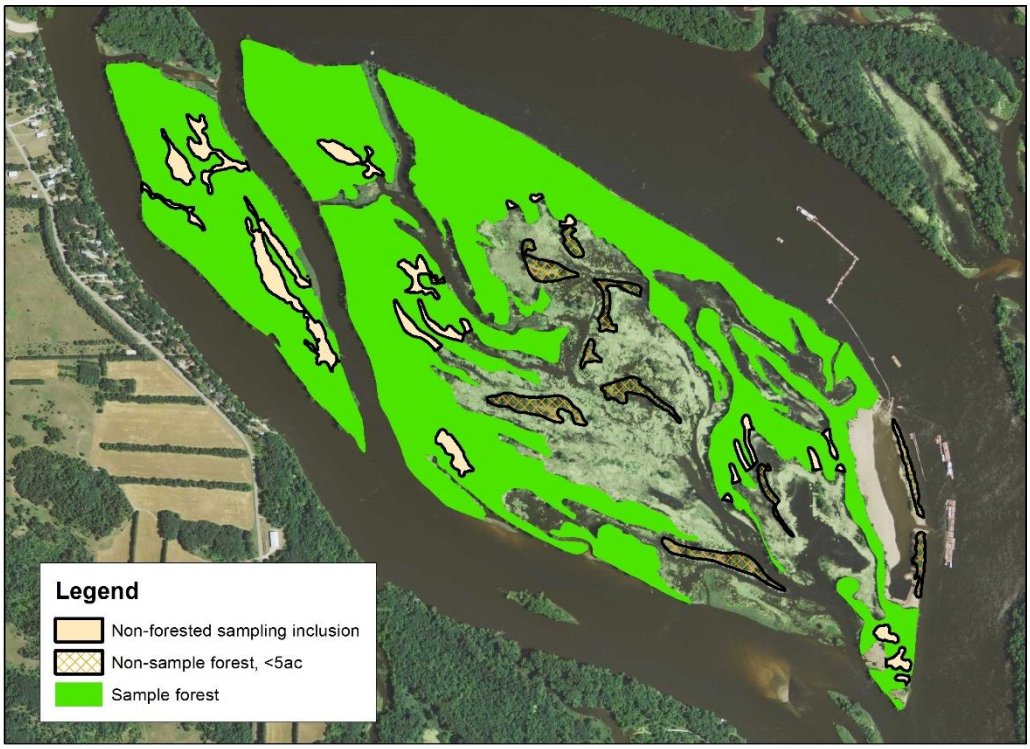
1. Be a minimum of 5 contiguous acres of forested cover. Isolated patches of forest smaller than 5 acres should not be considered forested for the purposes of Phase II forest inventory.
2. Be more than 75 feet from an adjacent forest edge across an intervening non-forested area

2.1.4.10 Non-forested area

Non-forested lands are defined as dominated by herbaceous and/or non-willow multiple fork shrub species and greater than 5 acres in size. Areas dominated by willow will be considered forested. To be non-forested for the purposes of Phase II forest inventory an area must:

1. Be a minimum of 5 contiguous acres of non-forested cover. Isolated patches of non-forest cover smaller than 5 acre that occur within a forested areas should be sampled as inclusions within that forested area and no special methods should be used to account for edge.
2. If a contiguous feature (i.e. a bay), the separation between adjacent forest edges should be greater than 75 feet. In cases where the separation in less than 75 feet, the area should be considered an inclusion as above and sampled as forested area up to the point at which separation becomes greater than 75 feet. At this point, sampling should include corrections for forest edge sampling, except:

If a contiguous, flowing water feature > 3 feet deep (i.e. a slough) completely bisects two adjacent forested areas, it should be considered non-forested regardless of width or area and protocols outlined below should be used to account for edge in both of the adjacent forested areas.



2.1.5 Data Collection

The data collection is split into three categories. These are listed as separate features in the Trimble data dictionary and labeled as: "Prism Plot", "Fixed Plot", and "Age Plot". Each plot location shall include the collection of prism and fixed plot data. Every 5th forested plot shall also include the collection of age data. This is regardless of what sampling area the plots are in (the counting towards the increment of the 5th plot doesn't start over at a new sampling area or new day).

2.1.5.1 Prism Plot

The prism data is intended to capture information on the overstory canopy and includes data on count trees in the variable radius plot using a 10 BAF prism or angle gauge. The plot center established as defined above for fixed and prism plots will be used as the prism plot center. All count trees within the plot will be tallied. Trees should be tallied in a clockwise direction, starting with the first tree east of due north (0^o). Each tally tree shall be marked with a paint stick. The first tree tallied shall be marked with three vertical slashes using an orange paint stick at 4.5 feet. Every subsequent count tree should be marked with a single vertical slash as 4.5 feet. The tree to be used for a TR_HT measurement (see Fixed Plot section below) should be marked with a single vertical blue slash at 4.5 feet. Every age tree (see Age Plot section below) should be marked with a vertical and horizontal blue slash in the form of a cross (+). This is the only tree in the plot that shall be marked with a blue rather than an orange paint stick. Slashes should be made in such a way that they are visible from the plot center, but not so large that they are visible from a much greater distance. The data for each "count" tree will be individually recorded in a separate point feature on the GPS unit. The GPS point does not need to be collected directly at the count tree but must be collected within the vicinity of the plot center.

The following data will be collected for every "count" tree at the plot location. Plots with no count trees shall be documented by recording a Prism feature and selecting "no tree" for the tree species. Prism plot center will coincide with the similarly numbered fixed plot. Trees on the "border" of the variable radius plot (where it can't be visually determined whether they are in or out) shall be included in every second instance. Any trees that are measured as borderline trees shall be noted accordingly in the TR_BDWK field described below[2].

If a fixed plot center falls within the forested sampling area but adjacent to an area defined as non-forested, the prism plot shall be measured as a walkthrough plot[3]. Any trees between the fixed plot center and the forest edge that are closer to the forest edge than to the plot center shall be noted according to the procedure described in the TR_BDWK field (explained below). Any trees that are closer to the fixed plot center than the forest edge, or which are not between the fixed plot center and the forest edge, shall be tallied normally (see figure 5, shown below). The determination of distance between the tally tree and the plot center should be measured only in very rare circumstances. In most cases, an ocular estimate will be sufficient. In cases where it is unclear whether the tree is closer to the plot center or the forest edge, a determination of whether the tree should be tallied as a walkthrough tree may be made by pacing from the plot center to the tree, then pacing from the tree to the forest edge. If the number of paces between the tree and the plot center is greater than the number of paces between the tree and the forest edge, the tree would be recorded as a walkthrough tree in the TR_BDWK field. Otherwise, no additional data needs to be recorded for the tree. The Contractor does not need to complete any additional processing with the walkthrough information. In summary analyses conducted by the Government, trees recorded as walkthrough trees will be double counted to correct for bias introduced by plots that incorporate a large area outside of the forested sampling area.

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[2] TR_BDWK was added in 2017 to better track trees designated as borderline or on plot edges.

[3] The theoretical basis for walkthrough plots for variable radius sampling can be found at http://www.fs.fed.us/ne/newtown_square/publications/other_publishers/ne_2004_ducey001p.pdf

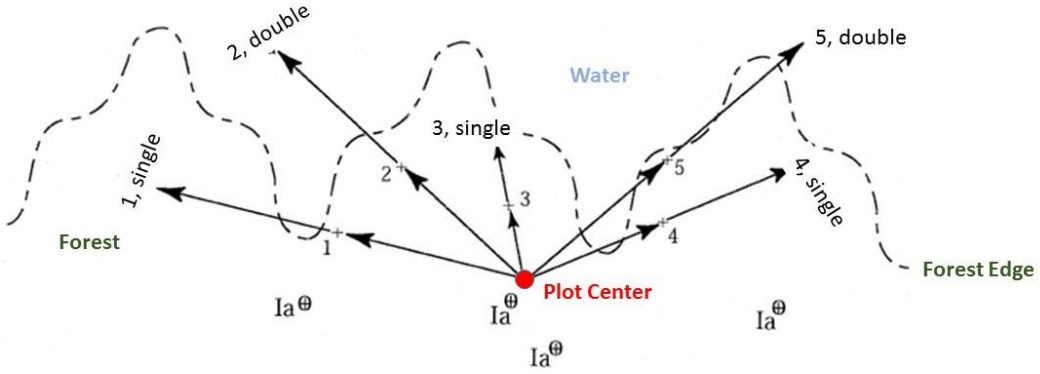


Figure 5. Graphic illustration of the walkthrough method. Five sample objects (+), lying close to the boundary, have been tallied from a sample point (*). The arrows indicate the layout of the walk-through points for each object; the outcome on the key in Table 1 is indicated for each walkthrough point. Objects 1, 3, and 4 are tallied normally; objects 2 and 5 are double-tallied. Four objects (⊕) lie "close to the boundary" but in positions where they would be single-tallied, and no measurements would be needed.

PL_NUM - Plot number for each prism plot should coincide with fixed plot numbering. All "count" trees within an individual plot will have same plot numbering.

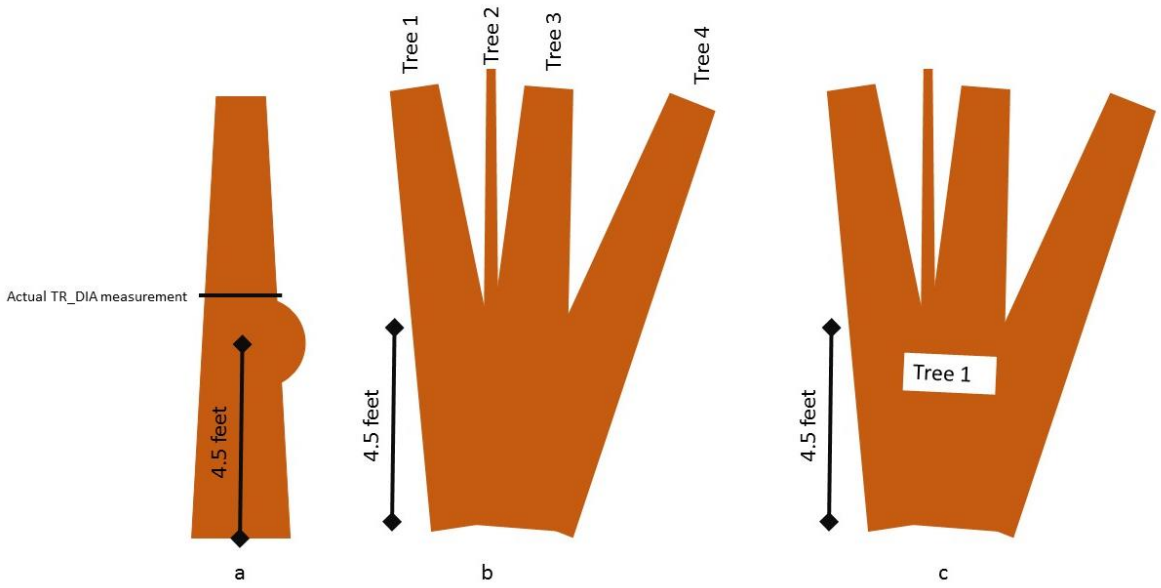
TR_SP - Tree species of "count" tree selected from menu pick list of standard USDA plant codes. If there are no count trees in the plot, select "no trees" in this field. If a tree is dead and the species cannot be determined, the TR_SP should be recorded as "Unknown".

TR_BDWK – Designation of "in" borderline trees (**brdr**) and/or walkthrough (**walk**) trees for double-counting (**bdwk** for both borderline and walkthrough). This field will default to blank. The objective of this field is to facilitate QA procedures and to allow for post-processing of walkthrough trees. All trees that are counted as "in" but fit the criteria for borderline must be indicated as "brdr" in this field; all trees that should be double counted as walkthrough trees should be recorded as "walk" in this field.

TR_DIA - Measurement of tree diameter at breast height (DBH), 4.5 feet from ground, to the nearest inch. Tools that may be used include: diameter tape, logger tape, or Biltmore stick. The US Forest Service timber cruise handbook provides protocols on the measurement of unusual situations or problem trees (see footnote 1 on page 5). If there are no count trees in the plot, select zero for this field.

TR_UNUS – Designation for a tree as a tree with a particularly unusual diameter that requires a professional judgment call on where to take the diameter and/or on whether a tree should be measured as a single stem or as multiple stems. The default value is blank. If the professional judgment call is on location of diameter only, "yes" should be selected for the tree with an unusual diameter only. If the judgment call is on the number of stems in a clump, "yes" should be selected for each of the stems in the clump. For example, in the figure below, in example *a*, there would be one tree with a designation of "yes" for TREE_UNUS. In example *b* and *c*, an individual could make a judgment call that there are either four trees (*b*) or one tree (*c*), since the tree splits at 4.5 feet. If it is determined that there are four trees (*b*), there should be four records in the data file and each record should be recorded as "yes" for TREE_UNUS. If is determined that there is only a single tree (*c*), there should only be one record in the data file and this record should be recorded as "yes" for TREE_UNUS. There is no accuracy assessment

for this field; it will instead be used to help compare trees during the QA process.



TR_CL – Tree canopy class menu pick list to include: dominant (**D:** top of tree's canopy extends above the general canopy of surrounding trees), co-dominant (**CD:** top of canopy is at roughly the same height as the general canopy and the tree has a wide area of unshaded leaf area at the top), intermediate (**I:** top of canopy is at the same height of or slightly below the height of the general canopy and the tree receives some sunlight, but only a small amount, from above), suppressed (**S:** top of canopy is completely below the bottom of the general canopy of co-dominant trees). If there are no count trees in the plot, select "no trees" in this field. The canopy class for dead trees or trees with broken tops should be the current position of the highest point of the tree relative to the main canopy.

TR_HLTH – Tree health menu pick list to include: vigorous (**V)**, stressed (**S)**, significant decline (**SD**), and dead (described further below). In 2016, the "dead" field will have multiple options to assess the mortality agent. If there are no count trees in the plot, select "no trees" in this field. Numerous factors are used to determine tree health. Crown dieback is the single most important factor to consider. The presence of epicormic branching may be used as a component in defining the health class, however, different tree species produce epicormic branches in response to different environmental triggers and epicormic branching is not necessarily an indication of stress or significant decline. Vines should only be considered if they are having a substantial impact on crown health and structure. The classes are defined as follows. Healthy: tree has a vigorous canopy with no dieback, minimal epicormic branching, and no significant disease. Stressed: tree has one of the following factors: dieback comprising of less than 50% or more of the canopy, epicormic branching, defoliation, or significant vine competition. Significant decline: tree has one or more of the following: dieback comprising 50% or more of the canopy, significant epicormic branching, significant defoliation, broken top or major vine competition. Dead: tree is a standing stem with no live foliage or live branches. The dead tree options for 2016 will be: Dead-insect/disease **(D-ID)**, Dead-beaver **(D-B)**, Dead-storm **(D-S)**, Dead-other (**D-O;** Dead-other should be used for any tree for which a specific mortality agent can be identified but when that mortality agent doesn't fit into the three previous categories), Dead-unknown (**D-U;** Dead-unknown should be used when the mortality agent cannot be identified). There will be no stand-alone option for dead; one of these five options must be chosen.

TR_MISC – Miscellaneous comments may be added as necessary allowing up to 60 characters to be entered.

TR_CREW – Select crew leader from pick list. Crew leader's initials will be populated in database.

TR_DATE – GPS automatically populates current date.

TR-TIME – GPS automatically populates current time.

2.1.5.2 Fixed Plot

A GPS point will be collected at plot center.

PL_NUM – Plot number starts at one each day for each individual GPS unit. Fixed plot numbers will automatically populate as fixed plots are conducted throughout the day using the Trimble data dictionary.

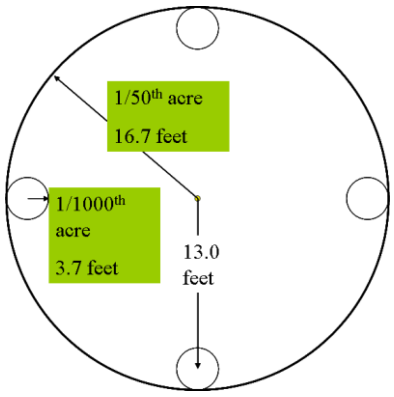
OV_CLSR – Overstory closure will be determined through means of ocular estimation in increments of 10 percent for trees in coverage area over the 16.7 ft. radius understory plot.

OV_HT – Overstory height is the measurement of co-dominant canopy layer using a clinometer within plot area. A single tree at each fixed plot should be measured for height; this tree should be a tree that was selected as an "in" tree in the prism plot, does not have substantial lean, and should be representative of the average height of the co-dominant canopy layer.

UND_HT – Understory height is the average height of **tree** species (not including shrubs) in an area inside 16.7 feet from plot center. Heights are categorized in feet from a pick list: 2-5, 5-10, 10-15, 15-20, 25-30, 30-35, 35-40, 40-45, 45-50, >50. Trees need to be greater than 2 feet tall to be recognized as understory. Tree cover less than 2 feet tall may be documented under ground cover or notable.

UND_COV[4] – Understory coverage noting presence/absence of trees greater than or equal to 2 feet tall and less than or equal to 4 inches DBH in 1/50 acre plot (16.7 radial feet from plot center) and four 1/1000th acre plots (3.7 radial feet) in cardinal directions at 13 feet from plot center (see diagram). Possible scores consist of 0 (no trees in 1/50th acre plot) to 5 (trees in each of small plots and 1/50th acre plot). One point for any regenerating tree stem within 1/50th acre plot and one point for each cardinal direction plot with regeneration present. If regeneration is present in any one cardinal direction plot and no where else in the plot, it will still receive a 2 score (one for 1/50th acre and one for cardinal direction).

UND_COV_50[5] – Understory coverage noting presence/absence of trees greater than or equal to 2 feet tall and less than or equal to 4 inches DBH in 1/50 acre plot (16.7 radial feet from plot center). Possible values are 0 (trees absent in 1/50th ac plot) or 1 (1 or more trees present in 1/50th ac plot).



UND_COV_1000[5] – Understory coverage noting presence/absence of trees greater than or equal to 2 feet tall and less than or equal to 4 inches DBH in four 1/1000th acre plots (3.7 radial feet) in cardinal directions at 13 feet from plot center (see diagram). Possible scores consist of 0 (no trees in 1/1000th acre plot) to 4 (trees in each of the 1/1000th acre plot), with one point for each 1/1000th ac. plot containing 1 or more tree seedlings or saplings.

[4] UND_COV was used through 2016 for the 1/50th and 1/1000th acre plot. It was removed in 2017 and the value was split into the following two fields, UND_COV_50 and UND_COV_1000 to represent each plot size independently.
[5] UND_COV_50 and UND_COV_1000 were both added in 2017 to replace UND_COV.

UND_SP1[6] – Understory species 1 referencing most dominant woody species (including trees, shrubs and vines) from menu pick list of woody vegetation greater than or equal to 2 feet tall but less than or equal to 4 inches in diameter within 1/50th acre plot. Values recorded as USDA species codes. Poison ivy (*Toxidedron radican*s) is an exception and should not be included as a woody species but as a ground species (GRD_SP).

UND_SP2 – Understory species referencing 2nd most dominant woody species (including trees, shrubs and vines) from menu pick list of woody vegetation greater than or equal to 2 feet tall but less than or equal to less than 4 inches in diameter within 1/50th acre plot. Values recorded as USDA species codes. Poison ivy (*Toxidedron radican*s) is an exception and should not be included as a woody species but as a ground species (GRD_SP).

UND_SP3 - Understory species referencing 3rd most dominant woody species (including trees, shrubs and vines) from menu pick list of woody vegetation greater than or equal to 2 feet tall but less than or equal to less than 4 inches in diameter within 1/50th acre plot. Values recorded as USDA species codes. Poison ivy (*Toxidedron radican*s) is an exception and should not be included as a woody species but as a ground species (GRD_SP).

GRD_SP1[7] – Dominant herbaceous species within 1/50th acre plot. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

GRD_SP2 – Second most dominant herbaceous species within 1/50th acre plot. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

GRD_SP3 – Third most dominant herbaceous species within 1/50th acre plot. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

NOT_SP1[8] – Notable species 1 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical floodplain forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

NOT_SP2 – Notable species 2 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical floodplain forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

NOT_SP3 – Notable species 3 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical floodplain forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

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[6] It is acceptable for the Understory Species fields to be left blank if there are no woody understory species within the 1/50th ac. plot area.

[7] It is acceptable for the Ground Species fields to be left blank if there are no herbaceous species within the 1/50th ac. plot area.

[8] It is acceptable for the Notable Species fields to be left blank if there are no notable species within the 1/50th ac. plot area.

NOT_SP4 – Notable species 4 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical floodplain forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

NOT_SP5 – Notable species 5 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical floodplain forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort, family.

FP_MISC – Fixed plot miscellaneous comments may be added as necessary. There is space to allow for 60 characters to be entered as necessary. Enter codes from list that other stakeholders would like people conducting inventory to document in the fixed plots as the occasion occurs.

FP_Crew – Select crew leader from pick list. Crew leader's initials will be populated in database.

FP_Date – GPS automatically populates current date.

FP-Time – GPS automatically populates current time.

2.1.5.3 Age Plot

Data on aged tree should be collected every 5th plot with a GPS location taken 3 to 6 feet away from the tree. Trees selected as age trees should be representative of the trees in the plot area and should be a dominant or co-dominant canopy tree. No trees with signs of past suppression should be used and trees should not be selected specifically on the ease of reading rings.

PL_NUM – Plot number coinciding with prism plot number.

AGE_SP – Species of aged tree.

AGE_DIA – Diameter measured at breast height to nearest tenth of an inch using a diameter tape. See definitions above for determining DBH.

AGE_ORIG – Origin year of tree will be recorded. This should be calculated as the current year minus ring count on tree core minus 3 years to account for growth to DBH.

AGE_GRW – The total number of rings in the outer inch of the core, excluding bark, should be counted and recorded to index growth rates.

AGE_MISC – Allows for up to 60 characters to be entered as necessary.

AGE_CREW – Select crew leader from pick list. Crew leader's initials will be populated in database.

AGE_DATE - GPS automatically populates current date.

AGE_TIME - GPS automatically populates current time.

2.2 Quality Standards and Assurance

2.2.1 Procedures

2.2.1.1 QA Inspections

It is advised to implement QA inspections based upon a comparison of field data with QA collected field data on up to 10% of sampled plots. A comparison should be made of field data with QA data to determine whether field data meets established quality standards (defined below). The plot center, marked as described in the Plot Establishment section above, will be used as the plot center for random QA inspections and all surveyed plots shall be marked accordingly. **THE LABELED PIN FLAG OR ALTERNATIVE MARKER WILL BE ASSUMED IN ALL CASES TO BE THE ACCURATE PLOT CENTER AND QA DATA WILL BE COLLECTED BASED ON THIS ASSUMPTION.** Any error identified in the determination of in/out trees by the QA inspection will therefore be assumed to be due to the field crews not utilizing proper protocol for holding the BAF tool in relation to the plot center. For each QA plot, the QA inspector will complete a field QA data sheet. This QA sheet will be folded over in the field to allow the inspector to complete the plot without being influenced by field crew results. The sheet will then be opened to compare field crew and inspector results in the field, allowing for any discrepancies to be noted. After completing all QA plots for a set of completed inventory points, the inspector will assess field crew accuracy using a modification of the US Forest Service scorecard for performance checks of qualified timber cruisers in the Forest Service Timber Cruising Handbook (FSH 2409.12)[9].

2.2.1.2 QA Assessment

Accuracy will be determined by first tallying the number of incorrect values (defined as values outside of the allowable error/deviation for various fields defined in tables a, b and c below) from the field crew's data for each recorded field against inspector recorded values for the same plot. The error for each field will then be multiplied by a weight (ranging from 0 to 1, see table d below) to calculate a "total error". The total error will then be expressed as a percentage of the possible correct values for each field.

Individual plot accuracy will be calculated as the average % correct for all fields in a given plot. The final All Plot % Correct Value, which will be the number used by the inspector to determine performance accuracy, will be calculated as the average % Correct for all individual fixed plots and prism plots. Because each fixed plot has only a single record for multiple prism plot records, all individual plot % correct values associated with fixed plots will be weighted to account for 10% of the final penalty while the individual plot % correct values for each prism plot summary will be weighted at 90%. All Plot % Correct Values of 90% or greater will be accepted as satisfactory performance without penalty. If the All Plot % Correct value falls below 90%, re-measurement of all plots should be considered as an option.

Determining the correct number of Total Trees: For the total number of trees measured (Total Trees, table a. below), the possible number correct will be the inspector's tree count. If the field crew's tree count is greater than or less then the inspector's tree count, the number of trees' difference will be the number incorrect. If in any case the field crew's tree count varies by more than 25% from the Government's tree count, the % correct for the tree count field will be assigned as 0%. If the tree count varies by more than 40% from the Government's tree count, the average % correct for that entire plot will be assigned a 0%, regardless of the values in the other fields.

(2.a) Exceptions for borderline trees: If both the field crew's and the inspector's tree count includes borderline trees the field crew's tree count may be ±1 the inspector's tree count without

[9] This reference is available at: http://www.fs.fed.us/fmsc/measure/handbooks/index.shtml. Within the first link for the Timber Cruising Handbook, the guidance for check cruises is provided in section 62.1 and the scorecard is shown in 62.1 – Exhibit 01 of the link 2409.12,60.rtf.

being considered incorrect. If the field crew's tree count with borderline trees exceeds ±1, the remaining difference will be considered an incorrect tree count.

(2.b) Exceptions for unusual trees (TR_UNUS designated as "Yes"): In instances where the field crew identifies a tree with as an unusual tree (as defined above), the Inspector will assess accuracy based on the field crew's tree measurement. For example, assuming a professional judgment call is merited, if the field crew determines that a clump with a fork at 4.5 feet is four trees and the inspector determines that the clump is a single tree, the inspector will re-measure the clump as the number of trees tallied by the field crew and will assess accuracy based on those measurements.

Determining the potential number of correct values: With the exception of Total Trees, error for individual fields will only be assessed for trees measured by both the inspector and the field crew. Thus, if the inspector measures fewer trees, the Inspector number of trees will be used as a basis for the number of correct answers. If the field crew measures fewer trees, the field crew's number will be used as a basis for the number of correct answers.

Allowable error tables: Tables showing the allowable error for each field are provided below for a. Prism, b. Fixed and c. Age plots. Inspector determinations of measurement accuracy will be based on these allowable deviations and the weighting of the individual fields in table d.

3 Variables

Field	Field Name	Type	Allowable entries/data format	Entry	Maximum Allowable Error/Deviation From Government Measurement
a. Prism plot					
PL_NUM	Plot number	numeric (integer)	Integer between 1 and 10,000	required	none
TR_SP	Tree species	text	USDA plant code	required	none - COE and contractor USDA code must match
TR_BDWK[1]	Tree borderline/ walkthrough	text	B, W or <Null>	as needed	n/a
TR_DIA	Tree diameter	numeric (integer)	Integer between 1 and 100	required	+/- 1 inch
TR_UNUS[1]	Tree judgement call	text	Y or <Null>	as needed	n/a
TR_CL	Tree canopy class	text	D, CD, I, S	required	+/- 1 class
TR_HLTH	Tree health	text	V, S, SD, D[2], D-ID[1], D-B[1], D-S[1], D-O[1], D-U[1]	required	+/- 1 class
TR_MISC	Miscellan-eous	text (up to 60 characters)	Variable	as needed	n/a
TR_CREW	Crew	text	First and last initials of crew separated by an underscore	required	none
TR_DATE	Date	date	mm/dd/yyyy	required	none
TR_TIME	Time	time	hh:mm	required	n/a
b. Fixed plot					
PL_NUM	Plot number	numeric (integer)	Integer between 1 and 10,000	Required	none

Field	Field Name	Type	Allowable entries/data format	Entry	Maximum Allowable Error/Deviation From Government Measurement
OV_CLSR	overstory closure	numeric (integer)	0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100	Required	+/- 10 %
OV_HT	overstory height	numeric (integer)	Integer between 1 and 150	Required	+/- 5 feet
UND_HT	understory height	numeric (integer)	2-5, 5-10, 10-15, 15-20, 25-30, 30-35, 35-40, 40-45, 45-50, >50	Required	+/- 1 class
UND_COV[2]	understory cover, 1/50 ac. plot and 4 1/1000 ac plots	numeric (integer)	0, 1, 2, 3, 4, 5	Required	+/- 1
UND_COV[1]_50	understory cover, 1/50 ac. plot	numeric (integer)	0, 1	Required	none
UND_COV_1000[1]	understory cover, 1/1000ac. plot	numeric (integer)	0, 1, 2, 3, 4	Required	+/- 1
UND_SP1	understory species1	text	USDA plant code	Required	must be noted in Gov't UND_SP1, UND_SP2 or UND_SP3 - same USDA code
UND_SP2	understory species2	text	USDA plant code	as needed	none - same species and USDA code
UND_SP3	understory species3	text	USDA plant code	as needed	none - same species and USDA code
GRD_SP1	herbaceous species1	text	USDA plant code	Required	none - same species and USDA code
GRD_SP2	herbaceous species2	text	USDA plant code	as needed	none - same species and USDA code
GRD_SP3	herbaceous species3	text	USDA plant code	as needed	none - same species and USDA code
NOT_SP1	notable species1	text	USDA plant code	as needed	none - same species and USDA code
NOT_SP2	notable species2	text	USDA plant code	as needed	none - same species and USDA code
NOT_SP3	notable species3	text	USDA plant code	as needed	none - same species and USDA code
NOT_SP4	notable species4	text	USDA plant code	as needed	none - same species and USDA code
NOT_SP5	notable species5	text	USDA plant code	as needed	none - same species and USDA code
FP_MISC	Miscellaneous	text (up to 60 characters)	Variable	optional	n/a
FP_CREW	Crew	text	First and last initials of crew separated by an underscore	required	none
FP_DATE	Date	date	mm/dd/yyyy	required	none
FP_TIME	Time	time	hh:mm	required	n/a
c. Age plot					
PL_NUM	Plot number	numeric (integer)	Integer between 1 and 10,000	Required	none
AGE_SP	species	text	USDA plant code	Required	none - same species and USDA code
AGE_DIA	diameter	numeric (integer)	Integer between 1 and 100	Required	+/- 0.2 inches
AGE_HT	age tree height	numeric (integer)	Integer between 1 and 150	Required	+/- 5 feet
AGE_ORIG	year of origin	numeric (integer))	Date (yyyy) formated as a	Required	+/- 5 years

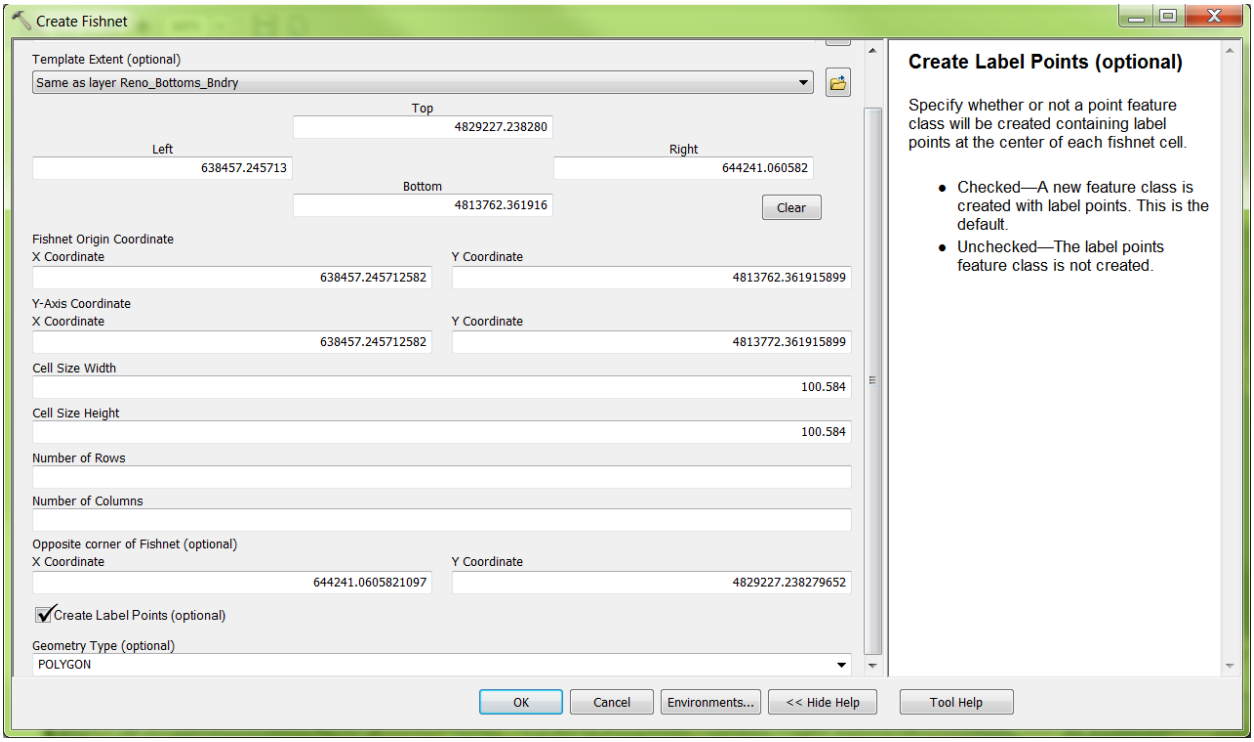
Field	Field Name	Type	Allowable entries/data format	Entry	Maximum Allowable Error/Deviation From Government Measurement
			numeric field		
AGE_GRW	growth rate	numeric (integer)	Integer between 1 and 50	Required	+/- 1 ring
AGE_MISC	misc	text (up to 60 characters)	Variable	optional	n/a
AGE_CREW	Crew	menu- initials of crew separated by an underscore	First and last initials of crew separated by an underscore	required	none
AGE_DATE	date	date	mm/dd/yyyy	required	none
AGE_TIME	time	time	hh:mm	required	n/a

[1] Added in 2017 field season

[2] Removed following 2016 field season

Appendix A: Plot Establishment Procedures

1. If inventory points from previous inventories are available and correspond to a 330 foot spacing, those points should be used. If not, used the procedure below to create new points.
2. Load layer with outermost boundaries of sampling area (e.g. pool boundaries for COE district, refuge boundaries for FWS district, etc.).
3. Create fishnet grid using the "Create Fishnet" tool. Template extent should be the layer loaded in step 1. The grid size should be at 100.584 meters (equivalent to a 330 foot spacing), entered for both "cell size width" and "cell size height". Each grid cell will represent 2.5 acres, which is the target spacing for inventory plots. IT IS CRITICAL THAT THE "CREATE LABEL POINTS" BOX IS CHECKED; this will be the actual point location for inventory points. Geometry type of "Polygon" is recommended, since this may be used as a 2.5 acre reference grid if desired.



4. Is a layer is available that shows forested landcover (based on USGS Landcover) within the desired ownership?
    a. Yes. Load this layer and go on to 5.
    b. No. Load USGS Landcover and ownership layers (e.g. LUAP). Open the properties window for the USGS Landcover layer, and in the "Definition Query" box, set the layer to display only features that are identified as forest in the 7N definition (CLASS_7_N = 'Forest').
    c. If multiple owners are included in the ownership layer, open the properties window for the ownership layer and in the "Definition Query" box, set the layer to display only features in the specific ownership of interest ("OWNER" = 'U.S. Fish and Wildlife Service').
    d. Using the Intersect tool, intersect the USGS Landcover and ownership layers to create a new layer that includes only forested areas in the desired ownership.

    e. Select all in the new layer, and use the Select by location option in the Selection dropdown to select only grid points within the new layer.
    f. Start an editing session on the point grid layer. Open the attribute table for the point layer, click on the "Switch Selection" button to change the selection to all points outside of the forested areas, and click delete to remove those points.
    g. These are your target sampling points.
5. Determine target sampling areas based on forested landcover (USGS Landcover 7N = Forest) and land ownership. Stand boundaries may be used if available and if they accurately follow ownership and landcover boundaries.
    a. Open landcover attribute table and use "Select by Attribute" to select only forest landcover.
    b. Use the "Select by location" tool in the Selection drop down menu to