Region One
Vegetation Classification, Mapping, Inventory and Analysis Report

$$\bar{x} = \frac{\sum x}{n}$$

Report 14-17 v2.2 **May 13, 2019**

R1 IM Protocols for Vegetation Data Sampling in Conjunction with LiDAR Point Cloud Acquisition

Contents

Section 1: Overview

This document provides inventory protocols used to collect vegetation data that will be used in conjunction with LiDAR acquisitions. This document is intended to be used with the most recent R1 Common Stand Exam and Inventory and Monitoring Field Guide (R1 CSE/IM Field Guide). All definitions and data collection methods documented in the R1 CSE/IM Field Guide for each attribute listed should be used unless indicated here. Attribute tolerances are specified in the R1 CSE/IM Field Guide, Appendix T, unless stated otherwise below. **If an item is not discussed below, record it exactly as specified for intensive exams in the R1 CSE/IM Field Guide if it is required**.

Data collection will be on a Juniper Systems Allegro personal data recorder using ExamsPDR software. Note: Data recorders (Allegro CX/MX), software, and training are available through the Regional Office.

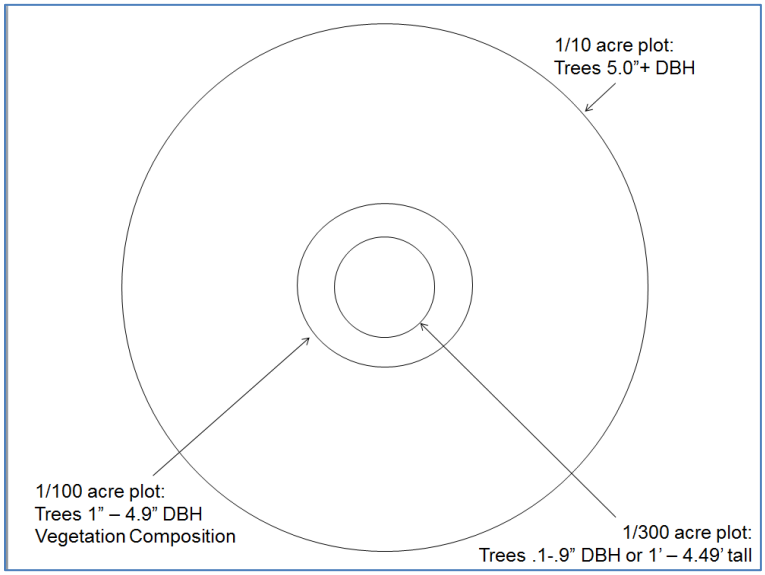
Sample Design

All distances are horizontal distances.

Table 1.1 Sample Design

Population of interest	Size of plot	Radius
All live and dead trees 5.0" DBH and larger	1/10th acre	37.2-foot radius
All live and dead trees 1.0 – 4.9" DBH Vegetation Composition • Shrub, forb, grass cover by lifeform	1/100th acre	11.8-foot radius
All live and dead trees .1 – 0.9" DBH All live trees 1.0' – 4.49' tall	1/300th acre	6.8-foot radius

Figure 1.1 Plot Layout



Section 2: Setting Form

Record all attributes listed. For specific protocols see the most recent R1 CSE Field Guide. All Field Names shown in the table below with an asterisk "*" should be set to enter by default in the Exams template file, so the crew doesn't have to enter these items manually in the field.

Table 2.1: Setting Data Form required attributes

Item	Field Name	Default	Remarks
2.1	Project Name*	LIDAR _____	**Project name must start with LIDAR** in first 5-fields concatenated with a unique description name. Example, for an area called Clear Creek, use a project name like: "LIDAR Clear Creek" Project Name will be set to a default value in the Exams Template File.
2.2	Proclaimed Region*	01	Default in Exams software template file
2.3	Proclaimed National Forest*		Default in Exams software template file
2.4	District*		Default in Exams software template file

Item	Field Name	Default	Remarks
2.5	Location		Three Character (i.e. XYZ) Location Code
2.6	Stand Number		Use the number in the Stand No. Field provided in the Lidar Training data plot locations file. This will be the plot number.
2.7	Owner*	USFS	Default in Exams software template file
2.8	State*		Default in Exams software template file
2.9	County*		Default in Exams software template file
2.10	Administrative Forest *		Default in Exams software template file.
2.11	Date		Enter Date of Inventory
2.12	Photo ID	Not used	
2.13	Exam Level*	3100	Tree: 3, Veg: 1, Down-wood: 0, Surface Cover:0 Default in Exams Template File
2.14	Exam Purpose*	LI	Default in Exams software template file.
2.15	Stratum		Enter the three digit number from the Rastervalu column on your plot spreadsheet.
2.16	Existing Veg Reference	Not used.	
2.17	Existing Veg Composition Type.	Not used.	
2.18	Potential Vegetation Reference*		Required. Default in Exams software template file.
2.19	Potential Vegetation		Required.
2.20	Structure	Not used.	
2.21	Setting Capable Growing Area	Not used.	
2.22	Setting Fuel Model	Not Used.	

Item	Field Name	Default	Remarks
2.23	Setting Elevation		Required. See R1 CSE Field Guide. **Tolerance:** ±100
2.24	Setting Aspect		Required. See R1 CSE Field Guide.
2.25	Setting Slope		Required. See R1 CSE Field Guide.
2.26	Setting Slope Position	Not used.	
2.27	Acres	Not used.	
2.28	Examiner		Required.
2.29	Precision Protocol*	CSE	Default in Exams software template file.
2.30	Radial Growth Interval	Not used.	
2.31	Radial Growth Interval	Not used.	
2.32	Height Growth Interval	Not used.	
2.33	Fuel Photo Reference	Not used.	
2.34	Setting User Code		Leave null unless plot placement has been modified. M = If the plot falls entirely, or partially on a road, move the plot approximately 50 meters from the road to avoid edge effects. H = hazardous plot, new plot was selected because original plot location was hazardous to obtain measurements. When M or H has been entered into the setting user code, enter information on why the code was used in the Setting Remarks Field. **Tolerance:** No Errors

Item	Field Name	Default	Remarks
2.35	Setting Lat Long Reference Datum*	NAD 83	Default in Exams software template file.
2.36	Magnetic Declination*	0	**Magnetic Declination must be set to 0 on the crew's compasses.** Default in Exams software template file.

Section 3: Sample Design Form

Following is the sample design in the default template file for Lidar field data collection.

Tree Form

1/10th acre fixed plot for all trees, live and dead, from 5.0 – 999.99 inches dbh.
1/100th acre fixed plot for all trees, live and dead, from 1.0 – 4.9 inches dbh.
1/300th acre fixed plot for:

- All trees .1 - .9" diameter (greater than 4.5-feet tall)
- All live trees from 1.0 – 4.49 feet tall

Figure 3.1: Tree Sample Design

Tree | Veg. Composition | Ground Surface Cover | Down Woody Material (Brown's Survey)

Meth	ExpFac	Azm	Cond.	SubFiltr	Var	MinV	MaxV	Remarks
FRQ	10.00		---	ALL	DBH	5.00	999.99	
FRQ	100.00		---	ALL	DBH	1.00	4.9	
FRQ	300.00		---	ALL	DBH	0.10	.9	
			OR	LIVE	HGT	1.00	4.49	

Vegetation Composition Sample Design

Vegetation Composition will be measured on a 1/100th acre fixed-radius plot (11.8' radius).

Figure 3.2: Vegetation Composition Sample Design

Default Sample Design Form

Tree | Veg. Composition | Ground Surface Cover | Down Woody Material (Brown's Survey)

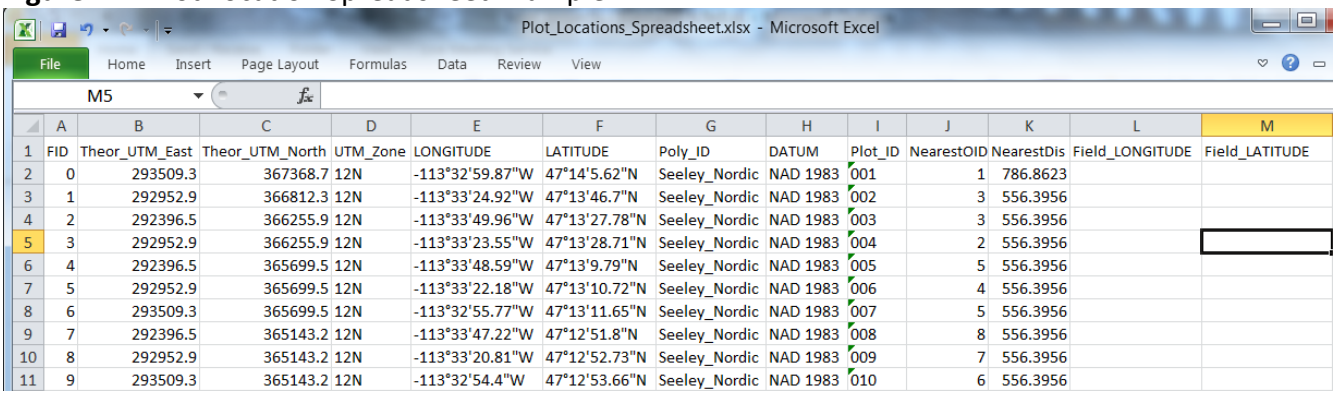
Meth	ExpFac	Azm	Cond.	SubFiltr	Var	MinV	MaxV	Remarks
FRQ	100.00		---	LIVE	CVR	5.00	100.00	Vegetation Composition

Section 4: Plot Data Form

4.A Plot Location Spreadsheet

The plot location spreadsheet will be data acquisition specific, however the following provides an example for managing locations for a project. Coordinates will be supplied for the center stake location for each plot center in latitude/longitude, NAD 1983 in a Plot_Locations_Spreadsheet. The Latitude and Longitude (xx.xxxxxx and –xxx.xxxxxx) columns in the Plot_Locations_Spreadsheet will provide the theoretical locations of the plots. Theoretical locations will be generated for projects to capture the variation in species composition and structure in the project area. The NearestOID column displays the FID of the closest neighbor plot location in the spreadsheet and the NearestDis column displays the distance between the plot location and its nearest neighbor plot location.

Figure 4.1: Plot Location Spreadsheet Example



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	FID	Theor_UTM_East	Theor_UTM_North	UTM_Zone	LONGITUDE	LATITUDE	Poly_ID	DATUM	Plot_ID	NearestOID	NearestDis	Field_LONGITUDE	Field_LATITUDE
2	0	293509.3	367368.7	12N	-113°32'59.87"W	47°14'5.62"N	Seeley_Nordic	NAD 1983	001	1	786.8623		
3	1	292952.9	366812.3	12N	-113°33'24.92"W	47°13'46.7"N	Seeley_Nordic	NAD 1983	002	3	556.3956		
4	2	292396.5	366255.9	12N	-113°33'49.96"W	47°13'27.78"N	Seeley_Nordic	NAD 1983	003	3	556.3956		
5	3	292952.9	366255.9	12N	-113°33'23.55"W	47°13'28.71"N	Seeley_Nordic	NAD 1983	004	2	556.3956		
6	4	292396.5	365699.5	12N	-113°33'48.59"W	47°13'9.79"N	Seeley_Nordic	NAD 1983	005	5	556.3956		
7	5	292952.9	365699.5	12N	-113°33'22.18"W	47°13'10.72"N	Seeley_Nordic	NAD 1983	006	4	556.3956		
8	6	293509.3	365699.5	12N	-113°32'55.77"W	47°13'11.65"N	Seeley_Nordic	NAD 1983	007	5	556.3956		
9	7	292396.5	365143.2	12N	-113°33'47.22"W	47°12'51.8"N	Seeley_Nordic	NAD 1983	008	8	556.3956		
10	8	292952.9	365143.2	12N	-113°33'20.81"W	47°12'52.73"N	Seeley_Nordic	NAD 1983	009	7	556.3956		
11	9	293509.3	365143.2	12N	-113°32'54.4"W	47°12'53.66"N	Seeley_Nordic	NAD 1983	010	6	556.3956		

4.B Finding the Plot Center (GPS Method)

Coordinates will be supplied for the center stake location in Lat/Long, NAD 1983. Each GPS must be set accordingly. Navigate to each plot locating the plot center at the locations indicated in the plot locations spreadsheet.

The accuracy of the GPS coordinates taken at plot center is more important than physically establishing the plot at the UTM *X*/UTM *Y* location provided. If the theoretical plot location falls entirely, or partially on a road, contact the Contracting Officer Representative for an alternate plot. If the theoretical plot location falls in an area that doesn't accurately represent the general stand conditions at the time of the LIDAR acquisition (stand has been thinned since the LIDAR acquisition, edge of a meadow, fire effects, or blowdown) then contact the COR for a replacement plot.

If the crew cannot reach or measure a portion of the plot due to permanent physical conditions or restricted access (e.g. cliffs), then contact the Analysis Team or Contracting Officer Representative for a replacement plot. Record this information in Setting User Code field of the Setting Form (2.34) as indicated.

LiDAR plots need to have more accurate spatial locations than stand exam plots. The target spatial accuracy is 30 centimeters. If this cannot be achieved due to aspect, slope, weather, etc. three meters is an acceptable accuracy, but does start to degrade the value of the data.

GPS Receiver Requirements. Plot center must be recorded with sub-meter accuracy. This will require using a survey grade GPS unit. Use a GPS receiver capable of obtaining the stated accuracy of ± 1 meters or less in the horizontal dimension.

Note: Some Trimble models capable of sub-meter accuracy include the GeoXT and XH models. Trimble "Juno" model does not support sub-meter accuracy. GPS units used for typical field use and navigation (e.g. Garmin, Magellan) are generally not accurate enough.

All GPS data must use the following format for Lat/Long coordinates:

- Geodetic Datum – NAD83
- Geographic System – Latitude/Longitude (Lat/Long)

Acquiring GPS Coordinates for the PC. Use a bipod/tripod with bull's-eye level and remote antennae on the GPS unit. Set unit directly over plot center. Let the GPS collect points for the entire time that field data is collected. Note: this can make measuring distance from plot center to trees slightly more difficult, but not impossible. *See Trimble GeoXH operating instructions in Appendix A of this document.*

The GPS unit precision is controlled by what is termed "Positional Dilution of Precision (PDOP)". Lower values indicate lower precision. This initially should be set to a value of 2. The GPS can have difficulty finding satellites under dense canopies and on steep, north facing slopes. In general, GPS units have less difficulty finding satellites early in the day than later in the day. If, after 30 minutes of sampling, the unit fails to see enough satellites to sample points, you can increase the PDOP to 4. This will reduce the precision constraint and increase the likelihood of collecting a point. Periodically monitor the GPS unit to ensure that it is sampling waypoints. You should try to collect a minimum of 300 sample points. If, after completing the plot sampling, you are unable to collect 300 sample points, you can further increase the PDOP to 5 and collect a minimum of 50 points. NOTE that sampling success is strongly dependent on time of day and the position of satellites in the sky. If you are still unable to collect the required points, further increase the PDOP to 6 and wait until the minimum 50 points have been collected.

Record PC geographic coordinate information on the plot form, Item 4.2.1 and 4.2.2.

❖ **Tolerance (Finding the PC):**

- Estimated Horizontal Error (acquiring PC coordinates): ± 1 meters. Under difficult conditions this accuracy may not be possible

***NOTE: Do not delete files from the Trimble! The actual data files from the Trimble unit are needed for post-processing because they contain more decimal places than are recorded in the PDR providing more accurate location information.**

4.C Plot Measurements

Follow the procedures indicated in Section 4 of the R1 CSE Field Guide for the Plot Data Form unless indicated otherwise below. Field number, name, and size (digit/character width) are as defined in the R1 CSE Field Guide. Enter all plot data items into Exams software. If an attribute is listed in the R1 CSE Field Guide but not listed here, do not record the attribute.

Item	Attribute	Remarks
4.1	Plot Number	Use the pre-assigned plot number. If the plot number needs to be edited within Exams software, use the Option button on the Plot Data Form to edit the default plot number.
4.2.1	Plot Latitude	Enter the plot latitude acquired in the field at the PC **Tolerance:** ± 1 meter
4.2.2	Plot Longitude	Enter the plot longitude acquired in the field at the PC **Tolerance:** ± 1 meter
4.4	Plot Aspect	Required. Note, due to only 1 plot being installed per stand, Plot Aspect is the same as recorded on the Setting Form Aspect field.
4.5	Plot Slope	Required. Note, due to only 1 plot being installed per stand, Plot Slope is the same as recorded on the Setting Form Slope field.
4.11	Plot Potential Vegetation	Required. Note, due to only 1 plot being installed per stand, Plot Potential Vegetation is the same as recorded on the Setting Form Potential Vegetation field. **Tolerance:** accurate to series, understory union and Forest/District phase
4.12	Plot Fuel Model	Not Used
4.16	Plot History	If an activity has occurred within the 1/10 acre plot record the appropriate code.

Section 5: Tree Data Form

Follow the protocols indicated in section 5 of the *R1 Common Stand Exam and Inventory and Monitoring Field Guide* for the Tree Data Form unless indicated otherwise below. If an attribute is not listed in this table, then it is not recorded.

Tree Form:

Record all required fields in above referenced field guide. Additional specifics listed below:

R1 CSE Field Guide Item No.	Field	When Required
5.1	Plot Number	Defaulted by Exams software.
5.2	Tag ID Number	Defaulted by Exams software.
5.3	Tree Status	All trees
5.4	Growth Sample Tree	Record G for all GST trees. Follow selection protocols as stated in the *R1 CSE/IM Field Guide.*
5.6	Tree Species	All trees
5.7	Tree Count	Group non-GST trees that are less than 1" DBH by Height Groups using Grouping Criteria as stated in *R1 CSE/IM Field Guide.*
5.9	DBH	• All trees 1.0" DBH+ • Seedling/sapling groups if ≥ 4.5 feet tall and less than 1.0" in diameter
5.10	Height	Record for all GST trees, all trees with broken/missing tops, all trees < 4.5' tall, and all seedling/sapling groups.
5.11	Height to Crown	Required for GST trees. See protocols in *R1 CSE/IM Field Guide.*
5.12	Radial Growth	Required for GST trees with 3.0"+ DBH
5.14	Height Growth	Required for GST trees < 3.0" DBH.
5.15	Tree Age	Required for all GST trees. Follow protocols in *R1 CSE/IM Field Guide.*
5.16	Crown Ratio	All live trees and seedling/sapling groups
5.17	Crown Class	All live trees and seedling/sapling groups
5.20	Snag Decay Class	All dead trees .1 inch DBH and larger
5.22	Tree Damage Category	Required when damage present.
5.23	Tree Damage Agent	Required when damage present.
5.25	Tree Damage Severity	Required when damage present.
5.29	Tree Distance	Record the horizontal distance from PC (center point of the plot) to the center of the bole (pith) of the tree to the nearest .1 foot for all trees 3.0" and larger
5.30	Tree Azimuth	Record azimuth from the plot center to the center of where the tree comes out of the ground, to the nearest degree, for all trees 3.0" and larger. NOTE: be sure that declination is set to 0 as indicated in the Magnetic Declination field on the Setting Form.

Section 6: Vegetation Composition

Vegetation composition Cover by Lifeform Form will be collected on the 1/100th acre plot. Collect cover by Lifeform and by specified height classes for Trees and Shrubs. Follow protocols in the most recent R1 CSE Field Guide.

Cover by Lifeform | Cover by Species and Layer | Cover by Spec

Life Form	Layer	Code	Cvr%
Trees		TOT	*
	Hgt >= 6.1 ft	TOV	*
	Hgt < 6.1 ft	TSA	*
Shrubs		TOS	*
	Hgt >= 6.1 ft	ST	*
	1.6 ft <= Hgt <= 6.0 ft	SM	*
	Hgt < 1.6 ft	SL	*
Forbs		TOF	*
Graminoids		TOG	*

Note: radius of a circle that is 5% on a 1/100th acre plot is 2.6'. Radius of a circle that is 1% on a 1/100th acre plot is 1.2'.

Literature Cited

Region 1 Common Stand Exam and Inventory and Monitoring Field Guide. Region 1 Vegetation, Classification, Mapping, Inventory, and Analysis Report #15-02. 2015. http://fsweb.r1.fs.fed.us/forest/inv/cse_exams/guides.shtml

Appendix A: Acquiring Latitude and Longitude Coordinates with a Trimble GeoXH

Turn GPS on by holding down the green power button. Wait while Windows Mobile loads. Use the stylus to click GPS in the lower right corner of the screen. Terrasync will load.

Changing the PDOP:
Select Status in the dropdown menu in the upper left corner of the screen. Select **Skyplot** in the second dropdown menu. Start by selecting a PDOP value of 2 on the slider at the bottom of the screen. Gradually move the slider toward **Productivity** as needed until sample points are being collected, or a PDOP of 6 is reached with a minimum of 50 sample points.

Capture the point location:
Select **Data** in the upper dropdown menu. Select **New** in the second dropdown menu. Leave the default file type, location, and dictionary. Name the file **lidarxxx** (xxx = plot #). Click the **Create** button. In the Antenna Height pop-up window, set the height to 1.000 ft if the GPS is on the ground. Otherwise measure the distance from the ground to the base of the antenna and enter the correct distance. Make sure the **Point_generic** feature is highlighted. Don't click the **Create** button until the GPS is positioned and will not be moved. You will see the number of satellites and sample points in the top line of the window. When you are done collecting data points, click **OK** to save the data. Click **OK** again to confirm.

Lat/Long Coordinates:
Select **Map** in the upper dropdown menu. A small **x** will be shown on the screen. Click the center of the **x** with the stylus. If the lat/long coordinates box contains the text **point_generic**, those are the coordinates of the location that you just collected. Enter these values into the PDR. To increase the size of the x, select the magnifying glass with the plus symbol in the arrow dropdown menu under Map. This may make clicking the center of the x easier.

***NOTE: Do not delete files from the Trimble! The actual data files from the Trimble unit are needed for post-processing.** The .ssf files will be transferred from the trimble unit to a computer and differentially corrected in Pathfinder Office.