

ATTACHMENT K

BRUSHY MOUNTAIN CARBON PROJECT INVENTORY METHODOLOGY

This document contains specifications for the collection of data in the field for the Brushy Mountain Inventory, as well as the data to be collected and the standards for data collection and processing. The Brushy Mountain Carbon Project includes approximately 16,300 acres of timberland characterized by Douglas-fir, Black Oak, Interior live oak, Ponderosa Pine, Pacific Madrone, and associated conifer and hardwood species. The Project Boundary includes the following GHG emission sources, GHG sinks, and GHG reservoirs (SSRs or Carbon Pools) as defined in table 5.1 of the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011:

- IFM-1 Standing live carbon (carbon in all portions of living trees)
- IFM-3 Standing dead carbon (carbon in all portions of standing dead trees)
- IFM-7 Carbon in in-use forest products
- IFM-8 Forest product carbon in landfills
- IFM-14 Biological emissions/removals from changes in harvesting on forestlands outside the Project Area
- IFM-17 Biological emissions from decomposition of forest products

This Forest Carbon Inventory at its core consists of a systematic sampling of the timber stands found on the Brushy Mountain Forest. Sampling was conducted through the installation of sampling points on a square systematic plot grid 20 chains on a side utilizing a random starting location. A map of the sampling grid is attached. The standard procedures for collecting field measurements are detailed below and are generally aimed at the collection of tree data pertaining to the quantification of the IFM-1 and IFM-3 carbon pools. Carbon in carbon pools IFM7, IFM-8, IFM-14, and IFM-17 are calculated as described in the calculation methodologies section below.

Inventory Methodologies

A description of the inventory methodology for each of the carbon pools listed above is included in the Application under section VII (A) and is included herein by reference. The data collection procedures for IFM-1 and IFM-3 SSRs are described in detail in the attached Brushy Mountain Carbon Project Inventory Specification included as Appendix B.

Calculation Methodologies

A description of the calculation methodologies used to determine metric tons per acre of each of the carbon pools listed above is included in the Application under section VII (B) and is included herein by reference. Included are the analytic methods and biomass equation references used to translate field measurements into volume and biomass carbon estimates.

Data Management Systems and Data Processing

The inventory data gathered by this inventory methodology is entered into an Access database as described in the attached Brushy Mountain Ranch Inventory Plot Data Entry Procedures (Appendix C). Plot data within the database was extensively sorted and queried to look for data entry errors. This process resulted in a final data set for cruise processing. The Access database serves as the repository for inventory data and is accessed by the growth and yield model during growth and yield simulations.

The inventory database is utilized to process the inventory data through the growth and yield model FORSEE, and analyze the modeling outputs. The calculation of volume, biomass and the ultimate conversion to carbon utilizes the inventory data and growth and yield output data and applies the volume formulas and biomass conversion factors described in section VII (B) of the Application as referenced above.

Stratification Methodology

The Brushy Mountain Project Area was stratified based on species composition and relative stocking. The Project Area is dominated by Douglas-fir with varying levels of hardwood species, and other conifer species with Ponderosa pine being the most prevalent other conifer. Stratification was performed post sampling utilizing aerial photos with GIS system polygon overlays. Vegetation strata were verified utilizing historic and current field verification. Boundaries were established utilizing GIS overlays with sample stratification based on plot location within identified vegetation strata polygons. The strata boundaries were digitized into the Brushy Mountain Geographical Information System utilizing orthophoto imagery as a guide. A map of the timber stand boundaries and inventory plot locations is included as Appendix D.

The stratification resulted in the following project acreages:

Table 1: Strata and Plot Summary

Stratum	Acres	Plots
High Stocked DF	4,183.53	98
Mod Stocked DF/PP	1,952.85	36
Mod Stocked DF	6,387.51	134
Low Stocked Mixed	1,598.08	32
Low Stocked Hwd/DF	2,270.09	50
Total	16,392.06	350

The total acreage of each timber stratum was summed and input into the _Stands table in FORSEE for each timber stratum.

Quality Assurance/Quality Control (QA/QC)

Procedures for ensuring quality control are explained in the attached Brushy Mountain Carbon Project Inventory Specifications document under the “Check Cruising” heading. Procedures in verifying the integrity of inventory data are described above.

Updating the Inventory

As timber management activities take place on the Brushy Mountain Project Area or disturbance such as fire or mortality resulting from pathogens or other factors occurs, cruise plots installed in 2014 will be relocated and remeasured within areas that have been harvested, treated for hardwood reduction, or subject to disturbance. By 2026, all of the plots installed in 2014 will have been remeasured regardless of whether or not the plot had been harvested, treated for hardwood reduction, or subject to disturbance. On this basis, Brushy Mountain will maintain a forest inventory system that will meet the inventory specifications and requirements contained in Appendix A of the Compliance Offset Protocol U.S. Forest Projects, with plots which are no more than 12 years old.

Updating the Project’s carbon stocks from year to year will involve the following steps:

1. Any newly installed inventory plots will be incorporated into the inventory estimate.
2. Existing inventory plots will be updated using FORSEE as described in the modeling plan.
3. Updating the forest inventory for harvests or disturbances that have occurred during the previous year through the installation of new plots, relocation and re-measurement of existing plots, or adjustments to previous plot data.
4. Where necessary, the inventory update process may result in re-stratification of portions of the timber strata.
5. Inventory updates following harvest or disturbance will be re-measured within 12 months of the harvest or disturbance.

Appendices:

- A. Inventory Change Log
- B. Brushy Mountain Carbon Project Inventory Specification
- C. Brushy Mountain Ranch Inventory Plot Data Entry Procedures
- D. Plot and Strata Map

Appendix A

Brushy Mountain Carbon Project Inventory Change Log

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Appendix B

Brushy Mountain Carbon Project Inventory Specification

Brushy Mountain Carbon Project Inventory Specification

The cruise shall include the CFL Brushy Mountain Tract and Summer Camp Ranch for a total of approximately 16,000 acres. The emphasis of the cruise is to develop timber stand and stock tables at the ownership level, calculate live carbon and standing dead carbon pools, and allow for growth and yield projections to be performed.

The cruise is based on a systematic sample of the ownership, and will include post-cruising stratification. The cruise design will install approximately 400-440 plots on a square systematic plot grid 20 chains on a side.

Plot Documentation and Location: Cruiser will be supplied with maps that show the locations of the plots and plot numbers, air photo maps, and an electronic list of coordinates for plot centers (UTM).

It is the cruiser's responsibility to accurately locate plots within the accuracy tolerances specified (one chain). Plots will be located via a systematic list of GPS coordinates as supplied by CFL and if necessary, due to lack of adequate GPS satellite reception, take-off points established by CFL, and field measurement (hip chain, or electronic device). Handheld GPS equipment will be used to establish plot centers. As needed, plot take-off points will be monumented with black and red striped flagging hung with glo-orange, and a metal tag listing the plot number, and the distance and direction to the plot. The timber cruiser will navigate from the closest and easiest access point to the plot in question using the handheld GPS units. As needed and where it is not possible or practical to establish a road take-off point for a given plot, the plot shall be located based on the last plot cruised on the cruise line.

When navigating to a given plot with the handheld GPS unit, the cruiser will set a "proximity" alarm on the GPS unit. The first time that the GPS unit triggers the proximity alarm, the cruiser shall stop and note the best achievable distance and direction to the plot as indicated by the GPS unit. The cruiser shall then measure the distance to the plot center using a hand compass and steel tape, hip chain or electronic device.

Plots shall be measured where they fall on the systematic grid regardless of roads, watercourses, or unmapped non-timbered areas. The cruise will be based on all acres within the timbered strata including roads and small non-timbered areas. Where plots are located adjacent to mapped non-timber areas, cruise plot locations should be relocated such that the plot is entirely within the timbered type. The plot center shall be moved in the cardinal direction most close to perpendicular to the type boundary.

Plot centers will be documented with a gutter spike (provided by CFL) and flagging (tied to the spike) with the plot number written in rain proof ink. A second long vinyl flag (at

Brushy Mountain Carbon Project Inventory Specification

least 24" in length) with the plot number, date, and cruiser initials written in rain proof ink shall be hung on trees stems or branches over, or nearly over the plot center. The plot number shall be painted on the nearest tree to plot center of sufficient size with orange spray paint. Flagging to establish plot center shall be glow lime green and provided by CFL. A GPS coordinate of the actual plot center shall be recorded.

At each plot center, two plot reference trees will be established for the purpose of relocating the plot center. A reference tree tag shall be placed on each reference tree within 1' of the ground line on the face of the tree which is facing plot center. The plot number shall be scribed on each reference tree tag. Species, azimuth and slope distance from the reference tree to the plot center shall be recorded with the plot data. Reference trees shall be at least 3.5" in diameter and should be located as close as possible at right angles to plot center. A ring shall be painted around the circumference of the reference trees at DBH to identify these trees and the plot in the future. Paint color shall be glo-orange.

Plot Card Format: Paper field data forms will follow the format of the attached sample cruise card (to be provided by CFL on Rite-In-The-Rain paper). Cruiser shall fill out all appropriate information on cruise cards while in the field; including plot number, date, cruiser initials. All cruise cards produced within any day shall be completed and "proofed" by the cruiser the same day. Cruiser will be responsible for providing copies of the field data cards to CFL within 1 day of cruising, and providing the cruise data in a digital format within 30 days of cruise completion.

Sampling Method: All plots will be circular fixed plots; plot radius distances will be horizontal distances.

The cruise will consist of three nested circular plots:

1. 1/5th acre (52.7') – Conifers and hardwoods 10.6" DBH and larger.
2. 1/50th acre (16.7') – Conifers and hardwoods 3.6" DBH to 10.5" DBH.
3. 1/100th acre (11.8') – Conifers and hardwoods 1.0" DBH to 3.5" DBH.

Data to be collected:

1. Tree number shall be recorded clockwise from north and painted on the tree above DBH with orange paint (only paint tree numbers on trees in two largest plots as trees smaller than 3.6" DBH are difficult to paint). Record all the trees in the largest plot first then the middle plot and finally the smallest plot. Species Code
2. DBH to the nearest 1/10th inch (paint a horizontal line at DBH location on the uphill side of the tree)..
3. Live crown ratio (LCR) to the nearest 10%
4. Visible defect will be recorded by log position for all conifers which contain at least one 16.5' x 6" dib log

Brushy Mountain Carbon Project Inventory Specification

5. Total height to the nearest foot
6. Merchantable Height – Number of Logs (measured to a 6” DIB top). (WTS
Note: Log heights start at the top of the stump height. [Merch. Ht. data can be noted for each tree on the cruise card.] To be consistent and help check cruisers, logs should be identified within a range per log height, please see table below):

Log Ht.	Height (ft.)	Min (ft.)	Max (ft.)
Log 1	16.5	16	24
Log 2	33.0	25	41
Log 3	49.5	42	57
Log 4	66.0	58	74
Log 5	82.5	75	90
Log 6	99.0	91	107
Log 7	115.5	108	123
Log 8	132.0	124	140
Log 9	148.5	141	156
Log 10	165.0	157	173
Log 11	181.5	174	189
Log 12	198.0	190	206

7. Status Code
8. Conifer and hardwood snag trees if they are at least 5” DBH and 15.0’ in height prior to rounding. Above 15’ height will be recorded to the nearest foot (height to the break, if snag is broken), including decay class.
9. Missing volume by 1/3rd segment of the tree as described below.

Blank Plots

If there are no trees located on any of nested plots, the plot is considered a Blank Plot. Blank Plots are noted on the plot card by including “XX” in the Species column.

Brushy Mountain Carbon Project Inventory Specification

Species Codes:

DF	Douglas-fir	TO	Tanoak
SP	Sugar pine	PM	Madrone
PP	Ponderosa pine	BO	Black oak
WF	White fir	WO	Oregon white oak
IC	Incense cedar	LO	Interior live oak
WH	Western hemlock	CLO	Coast live oak
CX	Other conifer	BM	Bigleaf maple
NM	California nutmeg	CL	California laurel
GP	Gray pine	RA	Red alder
SS	Sargent cypress	CB	California buckeye
XX	Blank Plot	GC	Golden chinkapin
		HX	Other hardwood*

*Include the species of each “Other hardwood” in the note field.

Diameter at Breast Height:

Measure DBH at 4.5 feet above ground on the uphill side of tree perpendicular to angle of the tree. On leaning or pistol butt trees, measure 4.5 feet along the stem, not vertical distance. For trees where there is no good ground level to measure from, figure where a faller would cut the tree, and measure DBH 3.5 feet above that stump height.

Diameter is recorded to the nearest 0.1”. If the diameter reading is not exactly on a tenth, record the DBH to the next lower one-tenth inch. Paint a horizontal line at the DBH location on the uphill side of the tree.

Live Crown Ratio:

Estimate live crown ratio, in percent, on all trees on the plot. Visually estimate the percentage of the total length of the tree bole that is covered by live crown, to the nearest 10 percent. In trees with uneven crown length, average the two most different sides of the tree.

Visible Defect:

Estimate defect for all merchantable conifer trees by 16-foot log segment. A merchantable conifer tree is any tree that will make at least one 16.5' x 6" dib log.

Missing Volume:

Record missing gross volume for each 1/3rd portion of the tree, bottom, middle, and top. For trees with broken tops, estimate the total height including the missing top section before estimating the height of each 1/3rd segment of the tree. If the broken top is the only missing portion of the tree, record nothing for missing volume as the cruise compiler will estimate the missing portions based on a regressed total tree height. Record missing volume to the nearest 10 percent by segment for any tree with missing volume. If any portion of the tree is missing, record the missing volume for each 1/3rd segment of the tree. For example if 20% of the bottom 1/3rd, and 100% of the middle 1/3rd is missing, record 20-100-0 for the tree.

Total Height:

Total height to the nearest foot will be measured for all trees on each plot (Measure total height from the ground (uphill side of the tree) to the highest point on top of the tree (highest branch) unless it is broken then measure to the break in the stem, unless a new leader has developed then measure to the height of the new leader). Trees with broken tops will have the condition of the top noted in the Status Code column (broken [BT], broken and recovered [RL], dead [DT]). Height to the nearest foot will be recorded for each tree that has a broken top.

Status Codes:

BT	Broken top
FT	Forked top
RL	Recovered leader
DT	Dead top
SN	Snag

Snag Decay Class:

Each snag recorded on a given plot shall have its decay class recorded. These decay classes are generally described as follows:

- Class 0 Tree has recently died with leaves intact.
- Class 1 Leaves mostly still attached, intact bark, fine twigs, and branches.
- Class 2 Leaves mostly gone, fine branches mostly gone, bark loose and starting to fall off.
- Class 3 A few large branches or stubs remain, bark falling off in large patches, softwood sloughing is evident.
- Class 4 Highly decomposed, no branches, little bark, broken off top.
- Class 5 Mostly decomposed, no branches, very little bark, broken off close to the ground.

Brushy Mountain Carbon Project Inventory Specification

Check Cruising: A minimum of five percent of plots will be check cruised. Each plot check cruised will receive either a pass or fail grade. The basis for pass or fail will be individual plot measurements for a given plot as compared to the check cruiser. Plot data shall be proofed daily and provided to CFL for check cruising within 3 days of cruising. CFL will randomly select plots to be checked as plot data is received from cruiser. All check cruise reports should be provided to cruiser in a timely manner and no later than 3 days from receipt of plot data from cruiser.

The following tolerances will be used to determine if a cruiser passes or fails the quality control check on any one plot:

Measurement	Tolerance, + / - of check measurement
Tree count on 1/5 th , and 1/50 th acre plot only including snags	None.
Species	None.
Total height	±10% or 10' whichever is less, on each tree.
DBH 1/5 th acre plot	±0.3" for trees less than 24" DBH ±0.5" for conifer trees and ±1" for hardwood trees 24" DBH or greater
DBH 1/50 th and 1/100 th acre plots	±0.3" for all trees
Live crown ratio	20%.
Plot location	Within one chain of mapped location
Tree count on 1/100 th – acre plot	±20% within each species class

The cruiser's work will be considered acceptable if the following is met:

1. The cruise design was followed.
2. The plot card is correctly filled out
3. A minimum score of 86% is achieved using the Check Cruise Worksheet (the worksheet generates a score by evaluating all data on a plot and considers data that misses the cruise tolerances)

If 2 or more plots measured by the same cruiser on the same day fail the check cruising criteria, then in addition to the failed plots, all plots measured on the day of measurement of the last failed plot by the same cruiser will have to be remeasured in their entirety.

Remarks:

Record descriptive information for a particular tree, notes about measurements, or other observations.

Special Circumstances:

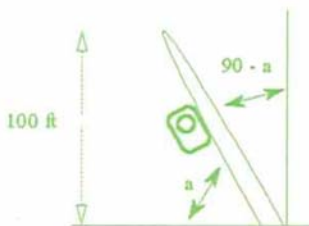
DBH: Trees with irregularities at DBH shall be measured just above the irregularity. For trees with a fork near DBH, the tree shall be treated as two trees if the fork occurs below DBH, and as a single tree if the fork occurs above DBH. As the plots are fixed area plots, trees are considered on the plot if the center of the tree at ground level is within the fixed plot radius. If it is not possible to get a DBH it can be estimated by the cruiser and noted in the remarks section that the tree (use the tree “line number on the cruise card,” to identify the tree) was estimated.

The reference for determining if a tree is off or on the plot is the point where the tree meets the ground. Trees leaning away from plot center are on the plot in question if the center of the base of the tree, and not the tree’s DBH is within the plot radius.

Leaning Trees: Total height on slightly leaning trees (less than 15 degrees) shall be measured perpendicular to the lean of the tree. Severely leaning trees (15 degrees or more) shall be measured perpendicular to the lean with the vertical distance from the ground to the tip of the tree, and the angle of the tree lean to the nearest 5 degrees recorded in the “Remarks” column. The cruiser may additionally estimate the trees height using the heights of similar diameter trees that are standing upright. Severely leaning tree heights are not subject to penalties by check cruisers.

A) Slope Correction Factor Method:

1. Measure vertical height to tree tip from a point perpendicular to tree lean.
2. Measure angle of tree lean, reading from the side of clinometer (in Degrees).
3. Subtract the degree reading from 90°
4. Find slope correction factor for step 3 angle.
5. Multiply vertical height by slope correction factor.



EXAMPLE:

Vertical height = 100 ft. Clinometer reading = 61° ($a = 61$)
 $90^{\circ} - 61^{\circ} = 29^{\circ}$ Slope Correction Factor for $29^{\circ} = 1.14$
Corrected height = $100 * 1.14 = \underline{114 \text{ ft}}$

Measurement Tools:

Tree heights shall be measured using laser hypsometers, DBH shall be measured with steel diameter tapes, plot diameters shall be determined utilizing steel tapes while correcting for slope. Slope shall be determined with a Relaskop or clinometer.

Appendix C

Brushy Mountain Ranch Inventory Plot Data Entry Procedures

Brushy Mountain Ranch Inventory

Plot Data Entry Procedures

1. Cruise cards are ordered as they are received from the cruisers. A page number is added to the lower left corner of each card. A copy of the cards with this page number is made and used for the basis of data entry. Data entry cards are stored in a binder with a copy of the completed data entry form.
2. Open the "Select Plot to View" form in the "Brushy_Carbon_2014.mdb" Access database found at L:\CFL\Brushy Mountain\Inventory.
3. Type the plot number ("Plot" on the field card) in the StandId field and hit the enter key to move through the other data in the plot header.
4. Irregularities in the header data should be noted in the Data Entry Note field.
5. To begin entering the tree data, click in the upper left most cell in the TREE DATA portion of the form and type the Tree No.s from 1 to the total number of trees on the plot in the Tree# column. Then enter the remaining data by column from left to right. It is more efficient to enter data by moving up and down the columns, rather than across columns for each tree.
6. Snags are recorded with "SN" in the status column followed by the decay class. SN1 is a snag with decay class 1. Record SN in the Status column, and 1 in the DC (Decay Class) column. Record zero for LCR for all snags.
7. Enter Log Ht and defect by log position data as recorded on the field card. This data is not used for the carbon inventory, but must be entered properly. WTS cruisers include a line through log position columns if the data is the same as the cell to the left of the line. Record the value in the cell to the left of the line for all columns through which the line passes up to the recorded log Ht.
8. Leaning trees have the lean in degrees recorded in the Remarks column. Enter the lean from the Remarks column to the nearest 5 degrees in the Lean column.
9. Missing volume is recorded in the Remarks column on the field card, and in the B1/3, M1/3, and T1/3 columns in the database. Missing volume is recorded to the nearest 10 percent by segment for any tree with missing volume. If any portion of the tree is missing, the missing volume for each 1/3rd segment of the tree is recorded. For example if 20% of the bottom 1/3rd, and 100% of the middle 1/3rd is missing, 20-100-0 is recorded for the tree. The B1/3, M1/3, and T1/3 columns default to zero, separate the recorded data into the respective columns.
10. Record all of the data in the Remarks column of the card into the Note column in the form, even if the data is recorded elsewhere on the form with the exception of 0-0-0 data included for trees without missing volume.

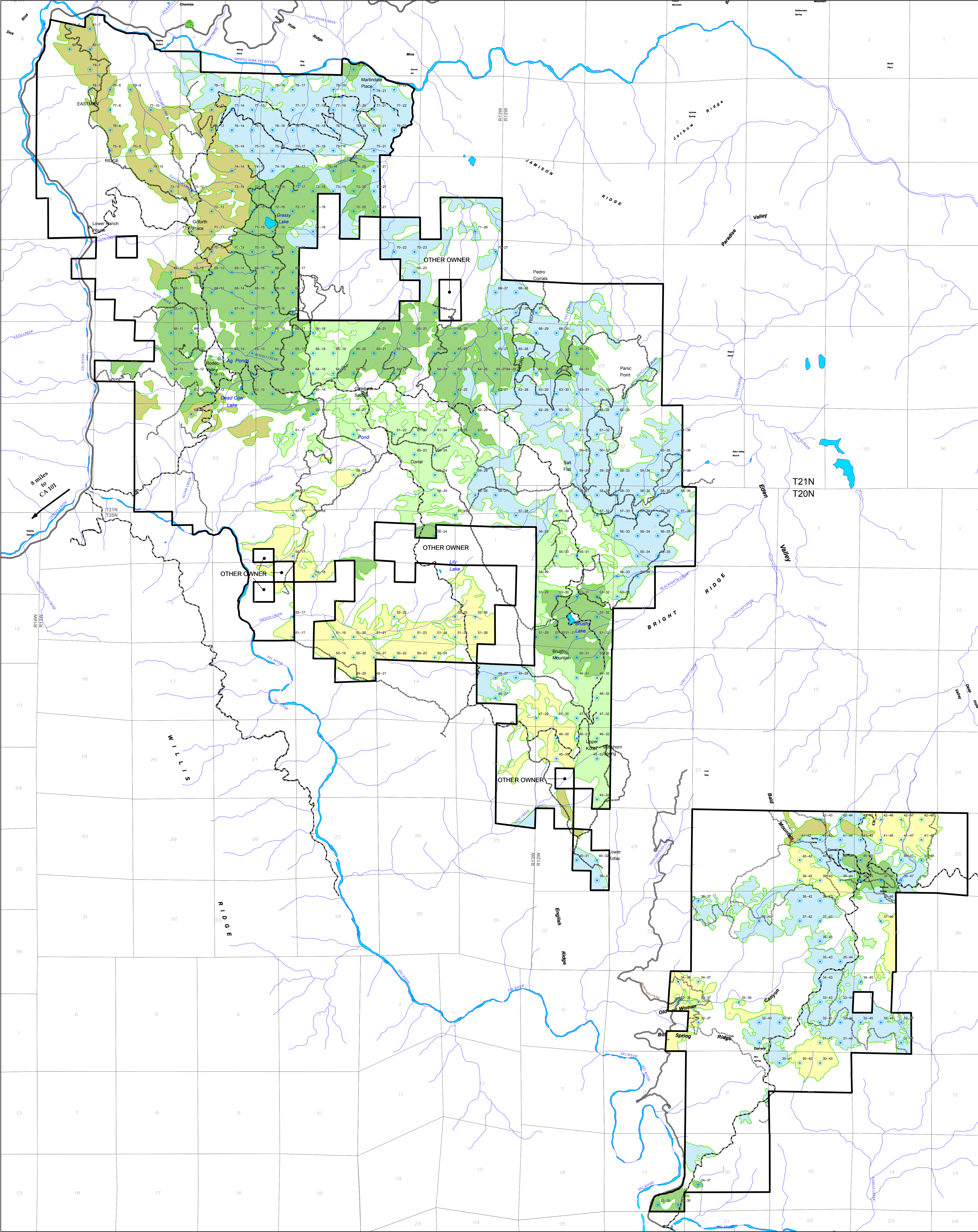
11. If there is a problem reading the data for a tree, or if the data entered differs from the data on the cruise card, describe the issue in the Entry Note column for the tree in question.
12. When data entry is complete, the person entering the card shall write the word "Entered", the date entered, and their initials in the upper right corner of the card in the box where the word "Remarks" is found.

Data Review

1. Data review begins with a visual review of the plot card and the data entered. Check that data is entered in the appropriate column, and in the appropriate order.
2. Save a PDF of the completed plot card with the StandId as the file name into the following directory on the server:
L:\CFL\Brushy Mountain\Inventory\Plotcards\Final_Plot_Cards
3. Print a hard copy of the PDF and place it in the Data Entry binder opposite the field card.
4. Review the printed card against the field card. Make any corrections, then reprint the completed card.

Appendix D

Plot and Strata Map



BRUSHY MOUNTAIN PROJECT INVENTORY PLOT AND STRATA MAP

September 15, 2014
Version 1.0D

- Property Boundary
- Project Area
- Inventory Plot

- Strata**
- High Stocked DF
 - Mod Stocked DF
 - Mod Stocked DF/PP
 - Low Stocked Mixed
 - Low Stocked Hwd/DF

- Roads**
- Public
 - Mainline
 - Seasonal

