Elliott State Forest Cruise Report
for Oregon Department of State Lands

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EXECUTIVE SUMMARY

This report presents the results of an intensive cruise of the Common School Fund lands on the Elliott State Forest. The project area included 77,921 net acres, and the cruise was conducted from October 2015 to February 2016. A total of 738 stands were cruised, requiring 18,510 cruise plots. Quality control measures included check cruising of 4% of the plots, as well as multiple office checks for data consistency and integrity. Seventy different cruisers worked on the data collection, and every single cruiser was checked in the field.

The cruise design included stratification by species, size, and stocking. Uncruised stands in a stratum were assigned the average of cruised stands in the stratum. The results of the data compilation show a total of 2.259 billion net board feet, or an average of 28.99 net mbf per acre. The 95% confidence interval on the total volume is plus or minus 1.2%. Douglas-fir comprises 91% of the sawtimber volume, followed by red alder, western hemlock, bigleaf maple, and western redcedar. In the Douglas-fir volume, 61% is in S2 grade or better.

1.0   PROJECT OVERVIEW

1.1   Project Purpose

The 92,000-acre Elliott State Forest includes about 82,500 acres of Common School Fund lands in Coos and Douglas counties in Southwestern Oregon. The forest was created in 1930 to provide long-term funding for Oregon's K-12 public schools and is managed by the Department of Forestry. The purpose of this project is to develop a sound and detailed forest inventory that can be used to develop an appraised value of the timberland and habitat assets on the Common School Fund lands.

1.2   Inventory Goals

There are four primary goals for this inventory project:

- For any cruised stand, attempt to estimate sawtimber volume per acre to within plus or minus 20% at the 80% confidence level.

- For the entire Common School Fund Lands area, attempt to estimate sawtimber volume per acre to within plus or minus 3% at the 95% confidence level.

- In addition to the timber resource, collect stand and tree characteristics useful for characterizing habitat suitability for various wildlife species.

- Provide sufficient detail in the delivered cruise data to support the appraisal effort, including the ability to project stands over time using growth modeling.

1.3   Cruise Project Team – Roles and Responsibilities

This project required the services of several different firms and many cruisers. In general terms, Mason, Bruce & Girard, Inc. (MB&G) provided project oversight, cruise design, cruise maps, final data compilation, and reporting. Stuntzner Engineering & Forestry (Stuntzner) provided field data collection coordination and check cruising, and quality control on delivered data. Two firms, Cougar Environmental and a joint effort between Integrated Resource Management and Rye Tree Services, did the cruising.

1.3.1   Timber Cruisers

In response to ODSL's RPF #141-1161-15 TIMBER CRUISE/FOREST INVENTORY SUPPORT SERVICES which was issued on Wednesday, August 12, 2015, cruising firms submitted proposals to conduct timber cruising services outlined in "Cruise Specifications For Comprehensive Inventory of Common School Fund Lands Of the Elliott State Forest." Two firms were selected, Cougar Environmental, and a joint venture of Integrated Resource Management and Rye Tree Services, hereafter referred to as IRMRTS. After negotiations between ODSL and these two bidders, amendments were made to the cruise specifications. The final Cruising Specifications incorporating these amendments are included in Appendix A of this report. Contracts for timber cruising were signed by Cougar Environmental and IRMRTS on 10/12/2015.

On 10/13/2015, representatives from IRMRTS, Cougar Environmental, Stuntzner and MB&G met in the office and in the woods to review cruising specifications to ensure consistency among the cruisers. A number of items came up that required clarification and a few data fields or data categories were removed from the specification requirements. These changes and clarifications are described in a memo "Clarifications for questions that came up on training day" dated 10/16/2015 (Appendix B).

1.3.2 Field Data Collection Management and Check Cruising

A contract was also awarded to Stuntzner Engineering and Forestry to perform cruise management services. Stuntzner's role was to:

a. Conduct a timber cruiser training and orientation day.

b. Provide field project coordination – This included maintaining communication with cruise contractors, distributing cruise maps, assigning work locations, reporting progress to MB&G, and serving as the liaison between the cruise contractors and MB&G.

c. Conduct cruise data management – This included collecting cruise data from cruise contractors, conducting QA/QC checks, ensuring data were of high quality, and delivering high quality data to the ODSL or MB&G on a regular, scheduled basis during the course of the cruise project.

d. Perform check cruising- conducting, in the field, random checks of contractors' work to ensure data were being collected consistently and accurately, with the goal of checking 3% of the plots completed by every timber cruiser according to the check cruising tolerances and procedure listed in the cruise specifications.

1.3.3 Project Oversight by Mason, Bruce & Girard, Inc.

Mason, Bruce and Girard, Inc. acted as the representative of ODSL throughout the duration of the timber cruise. MBG was responsible for designing the cruise, writing cruise specifications, assigning stand and plot locations to cruisers, making and delivering maps to the cruise contractors and the cruise manager, checking data received from Stuntzner, accepting data from Stuntzer, providing general cruise project oversight and guidance on field protocol issues encountered by Stuntzer, advising the state on the cruise project delivery schedule when needed, reassigning stands when needed, and compiling and reporting the final new inventory for the Elliott State Forest

2.0 CRUISE DESIGN

The cruise design for this project would be described as a stand-based inventory using stratification and double sampling. Every stand was assigned to a stratum as supplied by the Oregon Department of Forestry in their Stand Level Inventory (SLI) system for the Elliott. In the SLI, the stratum is identified by its VEG_LBL, a code indicating the species, tree size, and stocking level for the stand. There were 35 strata in this project.

Budget and time constraints required that a subsample of stands be cruised, so in each stratum a subset of stands was randomly selected for cruising. Realizing that during the final data compilation the un-cruised stands in a stratum would be assigned the stratum average, every attempt was made to secure a subset of stands large enough to provide reliable estimates for the stratum. In the end, 48% of the area was cruised over all strata. From stratum to stratum, the area cruised ranged from 35% to 100%.

A stand selected for cruising could be assigned to have a combination of volume plots and count plots (double sampling), or just volume plots. In a volume plot, all measurements required in the cruise specifications were required to be collected, where as in a count plot, cruisers were only required to tally trees by species. The goal was to achieve an 80% confidence interval of plus or minus 20% on board foot volume in any cruised stand. Stands less than 20 years old were assigned a nominal sample size of 22 volume plots. If a stand was less than 22 acres in size, it was assigned 1 plot for every acre. A stand

greater than 88 acres in size was assigned 1 plot for every 4 acres, so a 100-acre stand would be assigned 25 plots.

Stands 20 years or older were eligible for a combination of count and volume plots. The nominal sample size was a combination of 13 count plots and 13 volume plots.   If the stand was less than 22 acres in size, then the intensity became 1 volume plot for every acre. Stands greater than 110 acres had 1 plot per 4 acres, with an equal number of count and volume plots. In this way, for example, a stand of 140 acres would be assigned 34 plots – 17 count and 17 volume.

3.0   QUALITY CONTROL

3.1   Overview

Quality control in this project was applied at several steps during the data collection and compilation process. The cruise data collection manager (Stuntzner) conducted check cruising, an office data check, and office edits if appropriate. Stuntzer then passed the data to MB&G, which conducted more data checks and again, made edits if they were appropriate. The following sections provide more detail on the check cruising, data checks, and editing prior to compiling the data for reporting purposes.

3.2   Check Cruising

A 4% overall check of the plots completed by the cruisers was completed by the check cruisers. Initial data submissions were checked at a rate of approximately 5%, while later data submissions were checked at a rate of approximately 3%. In total, 759 plots were checked by check cruisers during the term of the field cruising. There were a total of 70 different cruisers who completed the field work for the Elliott cruise. The minimum number of plots completed by a single cruiser was 19 and the maximum completed by a single cruiser was 950. Check cruises were completed on all 70 cruisers who completed work on this project.

The cruise manager maintained a spreadsheet to track the delivery of completed cruise data by the cruise contractors. The tracking spreadsheet computed the average tree count per plot as well as reported the number of site (OS) trees measured in each stand. This spreadsheet also tracked the check cruising of each cruiser in terms of the check cruise scores and the number of checks completed on each cruiser over the course of the project. All Stand, Plot, and Tree table data was compiled in the tracking spreadsheet as the data was delivered by the cruise contractors.

After the delivery of data, prior to looking at the tree data, the cruise manager identified which cruisers were due to have plots checked,   then selected stands and specific plots to field check. Each field check of a cruiser included three plots the cruiser completed in a single stand. If the plots in the chosen stand were a mix of volume plots and count plots, then two volume plots and one count plot were selected to be checked. The cruise manager then compiled the cruiser's data for the three plots into a spreadsheet and assigned it to the check cruiser.

The field check started by locating the plot center using GPS navigation. After locating the plot center, the check cruiser would verify the cruiser's tally of "in" trees taking limiting distance measurements if needed. All necessary data was recorded on trees that a cruiser had called "out", but which the check cruiser deemed "in" the plot. Similarly, the identity of cruiser called "in" trees that the check cruiser deemed "out" was noted. All of the cruiser measurements and log grades were then checked against the values recorded by the cruiser. The check cruiser would record all of their height measurements. Other values were recorded by the check cruiser only if the cruiser's value was not within the allowed tolerances

found in the cruise specifications (Appendix A). In addition, the check cruisers recorded comments to explain any issues found during the check cruise. Upon completion of the check cruise, a check cruise report, as well as a data comparison file, were delivered to the cruise contractor.

Of the 253 checks[1] completed, 94% passed with average penalty point scores under the 18 point limit. For the 6% of the checks which did not pass with an average penalty point score under 18 points, either the data were rejected and the cruise contractor revisited the plots to correct the data, or the stand data were not delivered to MBG for final compiling. Overall, approved data delivered to MBG had an average of only 6.4 penalty points.

3.3   Office Data Check by Stuntzner

Cruise data were received periodically from the cruisers in a database containing four tables (Stand, Plot, Tree, Log). Queries and macros were developed to check the tables and report errors, inconsistencies, incompleteness, etc. consistent with the cruise specifications (Appendix A). The tables were checked in the following sequence. The Stand table was checked against lookup tables of assigned stand numbers and a complete list of BAFs. The Plot table was checked against lookup tables of assigned stand and plot numbers, plot status codes, age structure codes and plot counts.

The Tree table was checked against lookup tables of assigned stand and plot numbers, species codes, group codes and a wide variety of data integrity and logic checks for appropriateness and completeness. This included checks that trees with total height measurements had all additional required measurements, site trees had an age measurement, the tally was consistent with the plot status call (volume and count plots had tree records and blank volume and count plots did not have tree records), MAMU trees were of appropriate species and size with consistent small and large platform entries, the taper diameter was smaller than dbh and the taper height fell within the tolerance range.

The Log table was checked against lookup tables of assigned stand and plot numbers, grade codes, consistency with the Tree table group code and appropriate use of the length "99" (only one occurrence in the last piece in a tree).

Next, logic, consistency and referential integrity crosschecks of the four tables were made. Any issues in the table checks and crosschecks were reported back to the submitting cruiser for correction and a revised database was received and checked. This process continued until no issues arose in checks.

A check cruise protocol was developed for recording extra trees, missed trees, adding in logs for missed trees and dropping logs for extra trees, etc. Check cruise data was received from check cruisers in spreadsheets containing four worksheets corresponding to the four tables in a cruise database (Stand, Plot, Tree, Log). The spreadsheet worksheets were imported into a database containing the original cruise data, queries and macros designed to compare the original cruise data with the check cruise data (see Section V. Check Cruising Procedures in Appendix A. which specifies tolerances and point deductions for field records). The cruise specification tolerances and point deductions were generally clear. Some interpretation and clarification was needed over time to handle tolerance and point deduction issues not specifically addressed in the cruise specifications. One example is the tally on a count plot. If there were two species present and the total tally was correct but the tally by species was not, was it a tally error for both species (extra tree(s) for one species and missed tree(s) for the other) or a species call error, or both a species and tally error? In these cases, a discussion with the check cruise manager and check cruisers

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[1] Each check was for a batch of 3 plots, resulting in a check of 759 plots.

determined how to allocate point deductions. Mostly this did not involve a change in check cruise pass-fail, rather a pass with different point deductions.

A database form was used to format a pdf report summarizing point deductions and calculating the average point deduction across the 3 plots checked in a stand. The check cruise reports were then emailed to the check cruiser for review and follow-up as needed. Occasionally issues in the original check cruise spreadsheets were evident to the check cruiser from the check cruise report resulting in a revised check cruise spreadsheet and a revised report.

Both the original cruise data and the check cruise data checks adapted over time to address emerging issues not foreseen. Some issues showed up in early cruise data and new issues arose as new cruisers started working. Additional issues became evident as data flowed through the original checks, check cruise checks and subsequent MBG checks and check routines were revised to address them as early in the data ebb and flow process as possible.

Periodically batches of cruise data that passed check cruising were assembled in database tables (Stand, Plot, Tree, Log) for submission to MBG. Check cruise data replaced original cruise data in this assembly with one exception. There were a few instances where the original cruise failed the check cruise and the stand was re-cruised but not re-checked. In this case, the re-cruised data only was submitted. Further data and referential integrity checks were made in the assembly process, focusing on issues that had arisen in previous batches submitted to MBG.

3.4 Data Editing by Stuntzner

A batch of cruise data assembled for submission to MBG was first submitted to the check cruiser to scrutinize. Some spot issues were corrected by the check cruiser, generally relating to log grades. A list of global changes, generally relating to log grades, were received from the check cruiser and applied via queries to the Log table. Once these global changes were made, the database was zipped and emailed to MBG where further checking was performed as described in the following sections. Issues in the submission batch were received from MBG, corrected, and a revised batch submitted. This process iterated until no further issues needed to be addressed. Many of these issues related to check cruise data that replaced the original cruise data.

3.5 Office Data Check by MB&G

MBG received large batches of data from Stuntzner every couple of weeks. Upon receipt of a batch of data, MBG appended the new data to a data checking database which contained all data received to date. The new data was run through a module that runs 63 queries that check for data integrity, data limits, and completeness. If errors were found, MB&G detailed the errors in a memo or email to Stuntzner. Then, Stuntzner would re-submit the corrected data. MBG would recheck the data, and send notification when the data was clean, free of errors and ready to be accepted.

3.6 Data Editing by MB&G

There were a few edits that did not require resubmission by Stuntzer and could be made by MB&G after conferring with Stuntzner. An example would be when there was a plot listed as CB (count blank), VB (volume blank), or DP (dropped plot) but had tree records. If Stuntzer verified that the tree data was valid, MBG would change the status to the appropriate status, CP (count plot) or VP (volume plot). Other edits are described here:

3.6.1 Retention Trees (RT)

Based on a review of data in younger stands that contained a "1" in the third digit of the timber type including 1D1L, 1W1L or DX1L, therefore indicating that it was an early or mid-seral with stands that ranged from seedlings to <8" in DBH, it appeared that some cruisers were not utilizing the RT (retention tree) tree group code for the large trees. Therefore, MBG reviewed all cruised stands with this sort of vegetation label to check for stands in which there was a clear break in the diameters of cruised tree between young size (i.e. 1-8"), and larger (24"+) remaining overstory trees. If there was clear break in tree size, and the larger trees were recorded as tree group "..", MBG changed these ".." trees to tree group "RT."

3.6.2 Marbled Murrelet (MAMU) Trees

MBG corrected trees which were called potential marbled murrelet trees (MAMU=Y), but which did not meet the specified dimensions of a MAMU trees. These trees were presumably called MAMU trees because they contained a potential marbled murrelet platforms, but since they did not meet the definition of a MAMU tree because it was a hardwood tree, or less than 24" DBH, or less than 33' tall, or dead, MBG, changed the code to MAMU=N, and changed platform counts to 0.

3.6.3 Observed Site (OS) Trees

During Check cruising, Stuntzner noted that cruisers were coring trees that were too big to be accurately cored with the size of increment borers the cruisers were carrying. They observed some of the cores next to the tree, and it was clear that the core did not hit the pith of the tree, and therefore, the cruisers were estimating the number of rings to the center of the tree to estimate overall age. Stuntzner recommended that 36" dbh was a reasonable cutoff above which trees should not be considered valid for age measurement. MB&G directed Stuntzner to submit all OS trees as called by the cruiser so the amount of attempted site index trees could be reviewed. Later, MBG changed any OS tree larger than 36" to ".." and this data was not used in calculating site index of the stand.

4.0 DATA COMPILATION

4.1 Appending to Tables

After data was accepted from Stuntzer, and checking and necessary edits completed, the four data tables, Stand, Plot, Tree and Log, were copied to an MBGTools database used for compiling the data. Data from Stand was appended to the ADMIN table. ADMIN also contains gross, net, and proposed acreages calculated by MBG based off of ODSL's SLI data, and additional data from the ODF SLI database including ODF's site index information, birth years and Vegetation labels. Data from Plot was appended to SAMPLEPOINTS, which included a record for every plot where data was recorded, including no tally plots. If a plot was dropped, it does not have any record in the delivered database. Data from both Plot (BAF) and Tree were appended to CRUISERECS, and data from Log was appended to CRUISELOGS. Please note that CRUISELOGS contains all logs as called by cruisers, or later edited by Stuntzner, whereas LogList contains this data amended to take into account cruiser called graded and defects, but merchandizer calculated lengths.

4.2 Taper Equation

MBG used the SIS taper system, region 1 to model the tapers, and thus volumes of the trees. SIS was chosen because it contains equations for most of the species found in the Elliott State Forest, and it handles large trees well. SIS is particular in that it only accepts ratio's of taper diameter, DIA1:DBH less

than or equal to 0.9. Most measured DIA1:DBH ratio's are less than 0.9, but some exceed 0.9. On these trees, we updated the DIA1 to DIA1=0.9(DBH).

4.3   Dubbed Heights

We predicted total tree height on the volume plots when height was not measured using MBGTools' standard height dubbing equation:

$$Height = 4.5 + a0 * Exp(a1 * Dbha2)$$

During cruise data compilation, measured total height and dbh are extracted from the cruise records, grouped by sample group, then by species and component code. The observed tree heights are used to fit the height prediction function, and the resulting equation is used to predict the missing tree heights. If the R2 of the resulting regression is less than 40%, or if the sample size is less than 4, a regional height prediction equation is employed.

Trees with a broken top of course had the height to the broken top recorded, but no "total height". Total height (to the imaginary tip of the tree) is needed in order to feed the taper function. To predict total heights on broken topped trees, we temporarily changed the BT trees to normal ".." trees so that the model would use the measured total heights within the ".." component code to predict total height and volume of broken topped trees as if they were whole. Then, these trees were switched back to a BT component code, and the HT2 (height to broken top) was used as a stopper height in calculating these trees' volume.

All snags' (SN) heights were estimated, not measured by cruisers. All observed site trees (OS) had a measured height. All trees which had a defect that affected height (DE), had their total height measured by the cruiser. Trees less than 4.6" DBH recorded in the 1/200th acre plot were grouped by 1" diameter classes by species, and the average height of a species' diameter class was estimated by the cruiser. Therefore, trees in groups SN, OS, DE and small trees had cruiser called heights, not dubbed heights.

4.4   Accounting for Defect and Breakage

Through their experience in the Elliott State Forest in past projects and during the check cruising effort, Stuntzner noted that trees of different sizes should have different amounts of hidden defect and breakage applied to them during compiling. The assumption is that larger trees have more hidden defect, and when felled, their tops would break at a larger top diameter and be left in the woods. Therefore, the estimated volume of the broken off top should not be included in the net merchandized volume. The DBH breaks used for all tree species to apply various hidden defect percentages as well as the minimum top diameter (assumed point of breakage) are shown in Table 1 below:

Table 1. Elliott Conifer Species Factors for Hidden Defect & Breakage

Class Code	Min DBH		Max DBH	Estimated Form Factor	Min Cruise TD	Hidden Defect
1	4.60	-	19.99	89%	5.0	2%
2	20.00	-	29.99	88%	9.0	3%
3	30.00	-	39.99	88%	12.0	4%
4	40.00	-	49.99	87%	15.0	5%
5	50.00	-	59.99	86%	18.0	5%
6	60.00	-	100.0	85%	23.0	5%
Note: Breakage TD Based on using 40% of 16' Form Diameter Rule						

To apply these minimum top diameter inside bark and hidden defect values, we created six databases which contained mutually exclusive ranges of diameters of trees in CRUISERECS, and merchandized each one. For example, Database2 contained all species of trees in the DBH size range of 20 to 29.99 inches, and the trees were merchandized to a 9" diameter inside bark and a hidden defect of 3% defect was applied. This defect was in addition to the cruiser called defect per log.

4.5   Top Logs

Cruisers were directed to record log length (with a default of 36'), grade and percent defect on all trees which contained at least one log, up to a 6" top. Many of the trees in the Elliott State Forest are very tall (200'+), and determining if minimum top diameters and minimum log lengths necessary to satisfy the log specifications for the top portions of trees was onerous. Therefore, for the top portion of the tree, above the estimated 6" top, cruisers were directed to record the log with a length of 99', but record the grade and defect in the same manner as the lower logs. During compiling, MBG used the merchandizer to take measured or dubbed heights, and the SIS taper to determine the number and length of logs present in the cruiser called 99' log. Then, the cruiser called grades and defects were applied to these merchandizer determined log lengths. The results of this process may be seen by comparing the CRUISELOGS table which contains the raw data, and LogList, which contains the cruisers called lower log and their lengths, as well as the merchandized top logs.

4.6   Reassigning Log Grades

Based on observations from check cruising, Stuntzner noted that while some cruisers did well at grading logs, others were not as experienced and made inaccurate log calls. Logs were called whose small end diameter did not satisfy diameter specifications described in the *Official Rules for the following Log Scaling and Grading Bureaus: Columbia River, Northern California, Pacific Rim, Southern Oregon, Yamhill*. To correct these grade calls, we updated the grade on any log whose dimensions did not match the required sizes according to the conifer (Table 2) and hardwood (Table 3) grade change tables below.

Table 2. Conifer Log call grade changed based on small end diameter inside bark and volume limits

Cruiser Called Grade		Diameter Inside Bark Class Breaks in Inches						Volume Break
	>=30	>=24 and <30	>=16 and <24	>=12 and <16	>=6 and <12	>=4.6 and <6	or <50BF
V1	V1	V3	SM	S2	S3	S4	S4
V2	V2	V3	SM	S2	S3	S4	S4
V3	V3	V3	SM	S2	S3	S4	S4
SM	V3	V3	SM	S2	S3	S4	S4
S2	S2	S2	S2	S2	S3	S4	S4
S3	S3	S3	S3	S3	S3	S4	S4
S4	S3	S3	S3	S3	S3	S4	S4
S1	S1	V3	SM	S2	S3	S4	S4
00	S2	S2	S2	S2	S3	S4	S4

Table 3. Conifer Log call grade changed based on small end diameter inside bark and volume limits

Cruiser Called Grade	Diameter Inside Bark Class Breaks in Inches		
	>=12	>=10 and <12	>=4.6 and <10
S2	S2	S3	S4
S1	S2	S3	S4
S3	S3	S3	S4
S4	S4	S4	S4
SM	S2	S3	S4
S5	S5	S5	S5
V3	S2	S3	S4
00	S4	S4	S4

4.7   Cruise Expansion

Once the compiling and merchandizing was complete, MBG expanded the cruise results to the rest of the stands within the ODSL ownership of the Elliott State Forest. Forty-eight vegetation labels were present in the SLI inventory and eight of these are non-timbered types. Of the 40 remaining vegetation label types, 35 were covered in the cruise, which means that five vegetation label types representing eight stands were not cruised. MBG selected the closest vegetation label represented in the cruise based on the definitions of vegetation label provided by ODSL, a comparison of tree species, size and tpa distributions within the SLI and cruised stands, and a review of the aerial imagery for these types. The breakdowns of these un-cruised types and their re-assigned vegetation label used in the cruise expansion are shown in Table 3.

4.8   Reported Acres

In order to calculate net acres, MBG used the FishPresenceStreams data layer received in June 2015 from ODF along with the 2014ElliottSLIpoly shapefile received at that time. MBG assigned the buffer widths shown in Table 4, based on the current FPA rules. Streams are buffered by the widths shown and then the acreage within the stream and road buffers are removed from the inventory acres to calculate net acres.

These net acres are used for total volume calculations reported in the results section, as well as the stand1liner.

Table 4. Buffer and Total Riparian Management Area Width for Current FPA Rules

Size/Fish Presence (from the desc_class field)	Buffer Width (ft)	Total RMA (ft)
Large - Fish	100	200
Large - Nonfish	70	140
Large - Unknown	70	140
Medium - Fish	70	140
Medium - Nonfish	50	100
Small - Fish	50	100
Small - Nonfish - Perennial	20	40

In order to estimate the effect of the proposed new FPA rules on riparian management area (RMA) acreage we used the buffer widths shown in the Table 5. Medium Fish streams increased from a 70 foot to an 80 foot buffer and Small Fish streams increased from a 50 foot to a 60 foot buffer. The affected buffers are shown in bold. Using the same stand and stream data layers and methods as above, these new stream buffers were removed from the inventory to generate "Proposed net acres".

Table 5. Buffer and Total RMA Width for Proposed FPA Rules.

FPASize/FishPresence	Buffer Width (ft)	Total RMA (ft)
Large - Fish	100	200
Large - Nonfish	70	140
Large - Unknown	70	140
Medium - Fish	**80**	**160**
Medium - Nonfish	50	100
Small - Fish	**60**	**120**
Small - Nonfish - Perennial	20	40

4.9   Site Index

During training day discussions, all parties agreed that in older stands, with multiple cohorts, finding an appropriate tree to determine site index would be difficult because it is unlikely that that a tree small enough to core had grown up free of over story competition which is required by the cruise specifications:

Site index trees should be dominant or co-dominant, showing no evidence of crown damage, disease, sweep, crook, forking, or prolonged suppression. There should be no evidence of past suppression or release based on examination of tree rings (i.e., growth rings should display a gradual decrease in width throughout the life of the tree).

In these older, largely natural stands, it is very rare to find a tree that has not been suppressed at some point in its life.

Any stand that has a "4" or "5" in the third digit of the VEG_LBL represents an older stand with larger trees (mean size of 40 largest trees per acre >= 20" DBH). The likelihood of finding a suitable site tree in these older stands is questionable. However, site index data in these stands was computed, and compared with the SLI site index values for the same stands. Averaged across these stands, the cruise SI was 8' less than the average SLI value. Therefore, MBG decided to report the site index data for all stands that had at least three site index trees less than 36" DBH measured.

MBG used King's site index equation to compute Douglas fir site index, Wiley's site index to compute western hemlock site index, and Harrington and Curtis's site index equation for red alder. We computed site index using these formulas, then averaged the site index measurement within a stand. Sometimes, cruisers measured more than one species in a stand. If red alder was measured along with western hemlock or Douglas fir, we dropped the red alder and only calculated average site index if at least 3 western hemlock or Douglas fir remained. If the two species present were Douglas fir and western hemlock, we used the data and converted the computed SI of minority species to the other species using the following formulas:

$$WHSI = -0.432 + 0.899DFSI$$

$$DFSI = (WHSI + 0.432) \times 1.11235$$

In these cases, the site species reported is the species that had the majority of the site index trees in the stand, and to which the minority species' site index was converted. Using these criteria, MBG was able to calculate site index for 449 stands.

The delivered database also contains the ODSL site index information in the ADMIN table in the following fields: ODSL_SiteSpp, ODSL_SitePhy, ODSL_SiteInd. ODSL_SitePhy is the physical site index, and ODSL_SiteInd is presumably the measured, expressed site index, more appropriate for comparison with the reported cruise site index (SiteIndex, SiteSpp).

4.10   Marbled Murrelet Information (MAMU)

Cruisers collected data on habitat features important to marbled murrelet (MAMU) including the presence of mistletoe brooms in trees and therefore the distribution of mistletoe infection throughout the stand, and the number of small (<8" diameter) and large (>=8") potential marbled murrelet platforms on trees meeting the definitions of a potential marbled murrelet tree described in the cruise specifications (Appendix A). This is provided in raw format in the MAMUinfo table. This table contains every tree in the volume plots as these were the only places where the MAMU info was collected. This table contains StandID, PlotID, TreeID so that the trees and their marbled murrelet information can be related back to CURRDATA for other tree level data.

5.0 RESULTS

At the completion of cruising and check cruising, 738 stands were submitted and accepted by MBG (Table 6). One-hundred and forty seven plots (0.79% of total) were dropped due to safety concerns, landing on an incorrectly mapped road, or landing outside of a stand (stand lines on map do not match vegetation boundaries on the ground).

Table 6. Breakdown of accepted stands, and number of plots by plot status and cruiser

Cruiser	Number of Stands	Status	Number of Plots
Cougar Environmental	479	count blank	97
		count plot	5,388
		dropped plot	78
		volume blank	296
		volume plot	6,514
IRMRTS	259	count blank	43
		count plot	2,442
		dropped plot	69
		volume blank	61
		volume plot	3,522
SUMS	**738**		**18,510**

Stands were cruised in 35 of the 40 forested vegetation types on the Elliott State Forest. These stands represent 38.64% of the stands, and 48.12% of the 77,921 net acres in the Elliott State Forest (Table 7).

Table 7. Acres Cruised by VEG_LBL

VEG_LBL	Sum of Net Acres in Elliott	Number of stands in VEG_LBL in Elliott	Percent of Total Elliott Net Acres in VEG_LBL	Net Acres Cruised in VEG-LBL	Number of stands in VEG_LBL Cruised	% of Stands in VEG-LBL Cruised	% of Net Acres in VEG-LBL Cruised	Percent of Total Elliott Net Acres Cruised within Strata
1H1L	19	1	0.02	19	1	100	100	0.02
OT2L	23	1	0.03	23	1	100	100	0.03
OT3L	25	1	0.03	25	1	100	100	0.03
1H3L	36	1	0.05	36	1	100	100	0.05
HX3L	57	3	0.07	38	2	67	67	0.05
1W1L	40	1	0.05	40	1	100	100	0.05
OT5H	51	1	0.07	51	1	100	100	0.07
1H3H	106	8	0.14	59	1	13	55	0.08
OT4H	77	2	0.10	68	1	50	88	0.09
HX1L	72	2	0.09	72	2	100	100	0.09
WX4H	110	5	0.14	84	2	40	76	0.11
HX4L	85	4	0.11	85	4	100	100	0.11
1H4H	87	1	0.11	87	1	100	100	0.11
HX2H	117	4	0.15	105	3	75	90	0.14
HX2L	209	8	0.27	124	4	50	59	0.16
WX3H	154	5	0.20	128	3	60	83	0.16
OT1L	386	9	0.50	157	3	33	41	0.20
1D4L	410	12	0.53	291	7	58	71	0.37
HX4H	696	16	0.89	389	7	44	56	0.50
DX4L	1,024	27	1.31	442	11	41	43	0.57
1D3L	608	16	0.78	534	9	56	88	0.69
DX3L	1,318	22	1.69	561	10	45	43	0.72
HX3H	1,431	34	1.84	645	13	38	45	0.83
1D1L	4,497	120	5.77	1,571	36	30	35	2.02
DX2H	3,065	115	3.93	1,645	47	41	54	2.11
DX5H	3,724	72	4.78	2,082	38	53	56	2.67
DX2L	3,359	94	4.31	2,114	46	49	63	2.71
1D2H	3,890	83	4.99	2,142	42	51	55	2.75
DX1L	5,987	148	7.68	2,208	46	31	37	2.83
1D3H	4,070	91	5.22	2,674	40	44	66	3.43
1D2L	5,153	115	6.61	2,697	53	46	52	3.46
DX3H	4,879	123	6.26	2,826	50	41	58	3.63
1D5H	6,838	126	8.78	2,997	50	40	44	3.85
1D4H	9,574	192	12.29	4,260	75	39	44	5.47
DX4H	15,180	413	19.48	6,213	126	31	41	7.97
1H2H	43	2	0.05	-	0	-	-	0.00
1H2L	67	2	0.09	-	0	-	-	0.00
1W4H	8	1	0.01	-	0	-	-	0.00
DX5L	74	2	0.10	-	0	-	-	0.00
HX5H	12	1	0.02	-	0	-	-	0.00
XC1N	124	4	0.16	-	0	-	-	0.00
XG1N	44	2	0.06	-	0	-	-	0.00
XG2L	39	3	0.05	-	0	-	-	0.00
XR1N	8	3	0.01	-	0	-	-	0.00
XS2L	40	4	0.05	-	0	-	-	0.00
XS3H	39	1	0.05	-	0	-	-	0.00
XS3L	61	8	0.08	-	0	-	-	0.00
XW2L	6	1	0.01	-	0	-	-	0.00
SUMS	**77,921**	**1910**	**100.00**	**37,493**	**738**	**38.64**		**48.12**

Tables 8, 9 and 10 show the total volume in Mbf, percent total volume and Mbf per acre respectively for log grades for the top three tree species found on the Elliott State Forest, Douglas fir, western hemlock and red alder. For Douglas fir and western hemlock, a majority of the volume exists in S2 and S3 log grades. Significant volume also exists in the V3 (peeler 3) log grade for Douglas fir. S4 is the most abundant log grade for red alder.

Table 8. Total volume (Mbf) by grade for the top three species.[2]

	V2	V3	S1	S2	S3	S4	SM/S5 for RA	Total
DF	1,633	228,642	549	1,013,717	526,073	138,368	112,355	2,021,336
WH	-	1,391	376	31,901	26,854	8,153	395	69,070
RA	-	-	-	7,792	16,456	47,076	244	71,569

Table 9. Total percent of volume by grade for the top three species.

	V2	V3	S1	S2	S3	S4	SM/S5 for RA	Total
DF	0%	11%	0%	50%	26%	7%	6%	100%
WH	0%	2%	1%	46%	39%	12%	1%	100%
RA	0%	0%	0%	11%	23%	66%	0%	100%

Table 10. Total volume per acre by grade for the top three species.

	V2	V3	S1	S2	S3	S4	SM/S5 for RA	Total
DF	0.0	2.9	0.0	13.0	6.8	1.8	1.4	25.9
WH	-	0.0	0.0	0.4	0.3	0.1	0.0	0.9
RA	-	-	-	0.1	0.2	0.6	0.0	0.9

The summary statistics are shown for all species present in the Elliott State forest in table 11. This table also shows an average of 28,995 net board feet per acre across the forest. Overall, there is approximately 2.26 billion net board feet of timber in the Elliott State forest.

In 738 cruised stands, the cruise statistics were less than or equal to the +/- 20% allowable error at the 80% confidence level 82% of the time, so the project was quite successful at achieving the first bulleted goal of the inventory effort. The cruise also exceeded the second goal of the inventory which was to estimate sawtimber volume per acre to within plus or minus 3% at the 95% confidence level; we actually achieved a narrower 95% confidence interval of +/- 1.21%.

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[2] The total volumes by species in this table do not include all log grades, and thus are not equal to the total volumes by species in Table 11, which does include all log grades.

Table 11. Summary statistics for all species cruised on the Elliott State forest.

Summary Statistics By Species
Elliott Common School Fund Lands 2016

Stand ID	Species	Per Acre Values				Stem CuFt	Merch Cu Ft		Board Feet		Stand Totals	
		Trees	Basal Area	QMD	SDI		Gross	Net	Gross	Net	MBF Gross	MBF Net
All Stands Combined												
	DF	146	176	14.9	238	6,581	6,009	5,309	29,942	26,333	2,333,157.0	2,051,922.1
	WH	15	8	9.8	12	273	248	215	1,043	902	81,278.1	70,293.9
	RC	3	2	11.8	3	68	63	49	279	211	21,744.8	16,420.4
	SS	0	0	16.8	0	13	12	10	58	47	4,542.0	3,673.8
	GF	0	0	29.2	0	1	1	0	3	3	220.2	198.7
	PC	0	0	9.3	0	1	1	1	2	2	187.8	151.4
	PY	0	0	7.7	0	1	0	0	1	0	47.2	31.4
	LP	0	0	14.1	0	0	0	0	0	0	5.1	5.0
	CX	0	0	17.1	0	0	0	0	0	0	0.0	0.0
	RA	40	19	9.3	32	466	392	300	1,352	1,041	105,329.1	81,093.5
	BM	11	6	9.6	9	128	115	81	381	269	29,669.5	20,922.9
	BC	0	0	6.9	0	0	0	0	1	0	53.6	33.4
	OA	0	0	3.9	0	0	0	0	1	1	70.3	66.8
	OM	20	6	7.6	11	118	93	61	258	174	20,112.2	13,570.0
	PD	0	0	4.8	0	1	0	0	1	0	44.1	20.3
	PM	3	0	2.6	0	2	1	1	4	2	325.0	186.2
	CA	7	0	3.4	1	6	2	1	6	4	450.5	330.6
	CH	2	0	3.0	0	1	0	0	1	1	106.5	86.4
	GC	0	0	5.9	0	1	1	0	2	1	137.4	90.8
	TO	0	0	3.9	0	1	0	0	1	1	89.7	67.7
	WI	0	0	12.3	0	0	0	0	0	0	12.7	10.9
	WO	0	0	14.9	0	0	0	0	0	0	5.1	2.7
	HX	5	0	2.7	0	2	1	1	4	2	291.3	172.1
	XX	1	0	6.1	0	0	0	0	1	0	64.1	19.5
		254	219	12.6	307	7,665	6,941	6,031	33,341	28,995	2,597,943	2,259,371

Number of Stands   1,910
Total Acres   77,921.5
Based On Net Acres

APPENDIX A

Cruise Specifications

Cruise Specifications
For Comprehensive Inventory of
Common School Fund Lands
Of the Elliott State Forest

Section I. Overview

A. Project Purpose

The 92,000-acre Elliott State Forest includes about 84,000 acres of Common School Fund lands in Coos and Douglas counties in Southwestern Oregon. The forest was created in 1930 to provide long-term funding for Oregon's K-12 public schools and is managed by the Department of Forestry. The purpose of this project is develop a sound and detailed forest inventory that can be used to develop an appraised value of the timberland and habitat assets on the Common School Fund lands.

B. Inventory Goals

There are four primary goals for this inventory project:

- For any cruised stand, attempt to estimate sawtimber volume per acre to within plus or minus 20% at the 80% confidence level.
- For the entire Common School Fund Lands area, attempt to estimate sawtimber volume per acre to within plus or minus 3% at the 95% confidence level.
- In addition to the timber resource, collect stand and tree characteristics useful for characterizing habitat suitability for various wildlife species.
- Provide sufficient detail in the delivered cruise data to support the appraisal effort, including the ability to project stands over time using growth modeling.

C. Inventory Design

This project will employ double sampling, so a combination of volume (measure) plots and count plots will be used. In the stands greater than or equal to 20 years old, every stand 10 acres or larger will be cruised. In stands less than 20 years old, a subset of stands have been selected for cruising.

Concentric (nested) plots will be used. A variable radius plot will share the same plot center as a fixed radius 1/200th acre plot for smaller trees.

The number of stands selected for cruising and the numbers of count and volume plots are shown in the following table.

Age Class	Stands to Cruise	Cruise Acres	Volume Plots	Count Plots	Avg. Acres/ Plot
< 20 years	57	2,407	1,195	0	2.0
>= 20 years	1,486	69,056	20,375	15,696	1.9
Total	1,543	71,463	21,570	15,696	1.9

D. Purpose of this Manual.

This manual is intended to describe specifications for the timber cruise data collection and delivery of the data in a standard format.   The appendices detail how to conduct the measurements required. This manual also describes the check cruising procedure and criteria used to pass or fail a cruiser based on the accuracy of his/her measurements.

Section II. Cruise Preparation

A. Map Preparation

An essential step in the preparation for cruising is the development of maps to aid in logistical planning and travel to each cruise plot. Two types of maps will be supplied to the cruise contractor. The first is a vicinity map, showing stand locations, roads, ownership boundaries, etc., to aid in navigating to the stand. The second is a stand map showing individual plot locations, and whether the plot is a count plot or a volume plot. GPS coordinates, which specify count or volume plot, will also be supplied to the cruising contractor to aid in plot location.

B. Plot Distribution

A systematic grid of plots with a random starting point will be mapped on each stand to be cruised. Plots are only assigned in the net area of a stand, and therefore, should not occur in SMZs or on mapped roads. Because only roads and streams and their surrounding buffer area are excluded from net area, it is likely that several of the plots will wholly or partially fall on a non-forested area such as an unmapped stream, meadow, cliff etc. This means that skid trails, springs, creeks, rock outcrops and other features are included in the net acres, and that cruise plots which may fall on or near these features are valid for obtaining estimates of average volume, basal area, and trees per acre.

C. Role of the Cruise Manager

The cruise manager, responsible for the overall conduct of the cruise project, will supply contractors with the following:

- List of stands and plots to cruise.
- Vicinity map showing plot locations, road networks, ownerships, etc.
- Directions for obtaining gate keys and recommendations for best access routes.
- Local maps for each set of plots showing access, topography, and plot locations.

- Copies of this Cruise Specifications document describing the data to be collected.
- An orientation session (for all cruisers) to review specifications, answer questions, and ensure consistency between cruisers.
- A reminder to the cruise contractor that check cruising will be conducted by an independent third party.
- A thorough explanation of the check cruising grading system and thresholds of point values which determine plot acceptance or failure.

D. Completion of Cruise

All cruise data must be submitted to the Cruise Manager by February 15, 2016.   The data must have undergone a quality review before being submitted.

Section III: Plot Monumentation, Design and Procedure

A. Plot Location

Predetermined plot locations will be loaded into a highly accurate handheld GPS unit. Navigate to the GPS location with the handheld GPS until you are within 15 feet of the plot location. Then, stop and let the GPS locate you more precisely. If the direction and azimuth changes, follow the new direction and azimuth.

In the event of a weak satellite signal or loss of battery power in the GPS unit, be prepared to locate the plot as close to the mapped location as possible using a compass and pacing or other means of measurement.

B. Field Maps

On the stand map, draw direction of travel from the road to a plot, and between plots that cruisers traveled between on foot. Record any important insect and disease areas, forest management activities or concerns, or anything else of note. A cruiser traversing a forested area represents an important opportunity for "eyes on the ground" to gather information about the area's general forest conditions. Locating oneself on the map, and then writing a comment assigned to that point on a map, or noting by using GPS coordinates/waypoints in the cruiser notes, is very important because information is not useful unless it is tied to a specific area. The maximum amount of characters allowed in the comment column in the data collection application is only 30 characters, so the maps are where longer notes about stand or plot conditions should be recorded.

C. Determining if a Plot Location is Valid in Plot Establishment
1. Dealing With Cruise Plots on the Edge of Property
    a. Use your best judgment based on available photos and maps to determine whether you are on the edge of a stand line. Do <u>not</u> take steps to *avoid* sampling on or near

the edge. Moving a plot location back along the line of travel to avoid the edge is <u>not</u> an acceptable practice.

    b. If you determine the point center for the plot is outside of a stand line, do not take the plot.

    c. If the plot center is near the edge of the stand line, establish the plot and use the mirage method to determine tree count for the side of the plot that lies over the edge of the stand boundary. (Appendix A).

2. Dealing With Plots In or Near a Stream

    a. In the Elliott State Forest net acres do not include road and stream buffers. If these areas have <u>not</u> been delineated as distinct from the forest, then their area is included in the forest and a plot could be mapped in them. Any plots falling in or near an un-buffered stream or riparian area are valid, and trees qualifying for tally on the <u>plot should be recorded</u>.

3. Dealing With Plots <u>On</u> or <u>Near</u> a Road

    a. In the Elliott State Forest, roads and associated buffers are removed, so net acres do not include mapped roads. Therefore, any plots where the plot center falls on a mapped road or mapped road buffer should <u>not</u> be taken.

    d. Plot centers that fall near the road or mapped road buffer, should be installed where they fall. If the plot center is near the edge of the property line, establish the plot and use the mirage method to determine tree count for the portion of the plot that lies over the edge of the property boundary. (Appendix A).

D. Plot Monumentation

After navigating to the plot center location, establish the plot by firmly shoving a stick into the ground at plot center. Tie pink flagging to this stick and record: Stand #, Plot #, Cruiser Initials and Date on the flag. Near plot center tie a long piece of flagging at or above eye level for help in identifying the plot during check cruising. Flag the first tree recorded in the variable radius plot.

E. Plot GPS

If a plot is moved or offset from its intended location, place your GPS at plot center and start recording the location of your plot. Get an average from at least 20 locations before recording the location of the new plot. If the GPS signal is poor, walk to a nearby opening in the canopy and offset the plot location. If there is no way to get a good GPS signal, hang a lot of flagging, make a note on the cruise map, and explain what occurred in the "notes/comments" column at the plot level.

F. Variable Radius Plots and Basal Area Factors:

A variable radius plot will be used. Each plot will be a full circle sweep, sighting trees at DBH. The "prism sweep" should proceed from due north in a clockwise manner and all "in" trees will be recorded in the order they are encountered. Every tree (both conifers and hardwoods) 4.6" DBH and larger will be tallied.

The Basal Area Factor (BAF) should be chosen for the stand by the cruiser such that an average of 5 to 8 trees will be tallied per plot. The choice of the appropriate BAF can be found by taking the expected basal area per acre for the stand and dividing it by 6.5 (expected per plot tree count). For example, if the expected basal area in the stand is 110 square feet, an appropriate BAF would be 110/6.5, or approximately 17. Tools for conducting variable radius cruising will usually have a 20 BAF as an option, which would be close enough. Prism factors can vary between 10-90 BAF.

The "5 to 8 trees per plot" rule is simply a guideline for cost-efficient cruising. Unbiased estimates of the basal area and volume per acre can be obtained using BAFs either higher or lower than the BAF indicated by the rule, but the result may be more work than is necessary on the plots (due to a small BAF), or a larger than desired confidence interval on the estimate of volume (due to using a very large BAF).

The same BAF is to be used for all plots in a stand. If the cruiser selects a BAF, tries it on a few plots and then decides to change the BAF, the first few plots must be redone with the new BAF.

Basal area factors (BAF) and their associated plot radius factors (PRF) for limiting distance calculations.

BAF	PRF		BAF	PRF
10.0	2.750		40.0	1.375
17.78	2.0625		46.94	1.2692
20.0	1.9445		54.44	1.1786
22.50	1.8333		62.50	1.100
25.15	1.7342		71.11	1.0312
27.78	1.650		80.27	0.9706
33.61	1.500		90.0	0.9167
Limiting Distance = DBH * PRF				

G. Borderline Trees

If a tree is not obviously in or out of a plot, the cruiser will measure <u>horizontal</u> distance from plot center to the estimated center (pith) of the tree at DBH. The limiting distance should be calculated using the plot radius factor (PRF) corresponding to the appropriate BAF (Table 1). Multiply the PRF by DBH to the nearest tenth of an inch to calculate the limiting distance. If the calculated limiting distance is greater than or equal to the distance from plot center to the center of the tree, then the tree is considered an "in" tree**.**

All borderline trees measured by the cruiser should be flagged, with the measured diameter and distance from plot center to estimated pith of the tree written on the flag. On "in" trees, record the distance you measured in the notes column for that tree, i.e. HD=18.3.

H. Fixed Radius Plots:

An objective of this cruise is to be able to grow stands into the future, so data on smaller, understory trees will be measured in a fixed radius plot centered on the same plot center as the

variable radius plot. The small circular plot is used to tally trees < 4.6" DBH, and the variable radius plot is used to tally trees greater than or equal to 4.6" DBH. A nested 1/200th acre circular plot will be used (radius = 8.33 feet or 8 feet 4 inches). The fixed radius plot must be mutually exclusive of the BAF plot. The threshold DBH separates the two, and no trees are tallied in both plots; tally once on BAF or once on fixed radius.

I. Stand Level Data

Summary of data to be collected at stand level

Item	Frequency	Comments
StandID	Every stand	Enter all digits as they appear on the map, do not shorten.
CRU	Every stand	Enter your initials (First, Middle, Last)
BAF	Every Stand	Enter the BAF used throughout the whole stand. Enter the number exactly as it appears on the above basal area factor table, do not round digits.
Comments	As needed	Enter information about stand as needed. This field should not be used to record notes about unusual stand conditions, as it only allows 30 characters. That information should be indicated on the cruise maps.

Stand (StandID)

Record the number of the Stand.

Cruiser ID (*CRU*)

Record your cruiser initials that were assigned at the beginning of the project. Please use a three character set of initials to help us keep unique cruiser identifications.

BAF (BAF)

Record the basal area factor that is used on every plot in the stand.

Comments

Record any stand level comments (maximum of 30 characters).

J. Plot Level Data

Summary Table of Data to be collected at the plot level

Item	Frequency	Notes
Stand Number	Every Plot	This is auto-filled in the handheld based on what was entered at the STAND level.
CRU	Every Plot	This is auto-filled in the handheld based on what was entered at the STAND level.
Plot Number	Every Plot	Unique Plot Number from cruise map. You will be unable to enter the character signifying C or M. Numbers only.
Plot Status	Every Plot	VP for a volume plot with trees, VB for a blank (no trees) volume plot; CP for a count plot with trees, CB for a blank (no trees) count plot.
Age Structure	Every Plot	Record the code corresponding to the age structure of the forest on the plot
Plot Stocking ID	Every Plot	Record the plot stocking structure code from the corresponding table
New GPS Latitude	Moved plots	Record a new latitude with all decimals only if plot was moved (record reason in Comments)
New GPS Longitude	Moved plots	Record a new latitude with all decimals only if plot was moved
Date	Every Plot	Date the plot was completed.
Plot Comment	Every Plot as needed	Brief notes about dropped, moved, or aberrant plots, field only contains 30 character

**Plot Number (*PlotID)*

Plots will be numbered 1-X, where X is the total number of plots on the project.

Plot Status (Status)

- VP = A volume plot with trees (live or dead) on it.
- VB = A blank (no tally) volume plot.
- CP = A count plot with live trees on it.
- CB = A blank (no tally) count plot including a plot which contains only dead trees.

Age Structure (AgeStrID)

Examine the age (size) structure of the surrounding forest, including the plot. Record the age structure code (1, 2 or 3).

1. Even-aged one story: one prominent canopy layer with similar DBH Classes (A)
2. Even-aged two story: two prominent canopy layers with dissimilar DBH Classes (B)
3. Uneven-aged (all aged): an even distribution of age classes where no age class is a real majority or minority (C)
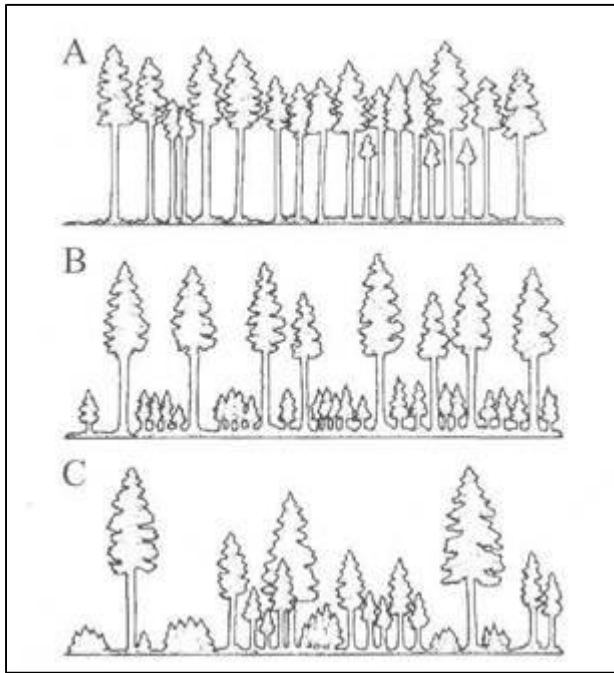
Plot Stocking (PStkID)

Record the plot stocking category.
1. Stocked/Forested: The plot is forest production ground with at least one tree.
2. Non-Stocked/Forested: The plot is forest production ground currently with no trees.
3. Non-forested: The plot is non-forest land that may be a meadow, rock outcrop, water, gravel pit, road/landing (not netted out in GIS).

GPSLat/GPSLong (NewGPSLat/NewGPSLong)

Only fill in this field if the plot needed to be moved for some reason. If so, record the new coordinates in decimal degrees. Do not round GPS coordinates.

Cruise Date (CrsDate)

Date of the completed field cruise (mm/dd/yyyy).

Comments (Comment)

Provide comments regarding any significant issues which a forester/check cruiser should be aware of on the plot (Maximum of 30 characters). If additional characters are needed, please make notes on the cruise map.

Section IV. Tree Measurement Instructions

A. Trees to Tally

This section describes which trees to tally in the plot. It does not matter if the fixed radius or variable radius trees are recorded first, but all trees from the variable radius plot should be grouped together, and all trees from the fixed radius plot should be grouped together. Begin tallying trees at an azimuth of 1 degree from plot center and continue clockwise around each sub-plot. Flag the first tree.

Tallying trees on the Count Plot

No tree measurements are made on the count plots. Simply record the number of live tally trees >= 4.6" DBH by species on the variable radius plot. The 1/200th acre fixed radius plot is not established on the count plots.

Tallying trees in the 1/200th acre Volume plot

Live trees between 0.5" and 4.6" DBH are sampled within the 1/200th acre fixed area plot. Sampled trees in this plot are referred to as 'tally saplings.' Acceptable tally saplings in this plot are defined as all live trees. The only data that needs to be recorded for these trees are species, DBH, and average total height. Trees can be grouped into 1" diameter classes by species according to the table below.

Size breaks for 1" diameter classes on the 1/200th acre plot

Diameter Class (in)	breaks
1	0.6" to 1.5" DBH
2	1.6" to 2.5" DBH
3	2.6" to 3.5" DBH
4	3.6" to 4.5" DBH

Tallying trees in the variable radius Volume plot:

Tally all standing trees >=4.6" DBH including dead trees

Definition of a live, standing tree

Trees are alive if they have **any** living parts (leaves, buds, cambium) at or above the point of diameter measurement (for trees taller than breast height). Trees that have been temporarily defoliated are still alive.

Definition of a dead, standing tree

To qualify as a dead tally tree, it must have a bole which has an unbroken ACTUAL LENGTH of at least 4.5 feet that is self-supported. The tree must be greater than 4.6" DBH, and appear to have been dead 5 years or less. If a tree is recently dead (<5 years), but meets the size requirements of a snag, it should still be considered a dead tree.

Definition of a Snag
A tree that is dead and has been so for greater than 5 years. The tree must be at minimum 10"
DBH and 10' height to tally.

B. Data at the Tree Level

Note: If the plot is a blank count (CB) or blank volume (VB) plot, it is not necessary to enter any
data on the tree or log level, nor to even advance to these screens.

Summary of data to be collected at the tree level on volume plots

Item	Frequency	Notes
Tree #	Every tree	Flag first tree
Species	Every tree	2-character code
Tree Group	Every Tree; variable radius plots only	See Table below
Tally	Every Tree	Auto-fills to 1, enter 2 on edge plot duplicate tree
DBH	Every tree	Nearest one-tenth of an inch (Appendix B). To facilitate check cruising, make a mark on the tree <u>directly at</u> the DBH measurement using a paint stick, lumber crayon, chalk stick, or something similar.
Total height	at least 1st and 3rd trees, per species, on each plot (make sure to cover the range of diameters, heights and species throughout the stand) and all trees with broken tops or defect that impacts the total height; estimate snag height; in 1/200th acre plots, estimate an average height for every species by 1" DBH class entry	Nearest 1.0 ft.
Live crown ratio	On every tree where total height is recorded; variable radius plots only	Nearest 10% ocular estimate
Upper stem diameter	On every tree where total height is recorded; variable radius plots only	Diameter outside bark to nearest 1.0 inches, corresponding to the Upper Stem Height.
Upper stem height	On every tree where total height is recorded; variable radius plots only	Height to the nearest 1.0 foot that corresponds to 25% to 35% of the total tree height.
Crown Class	On every tree where total height is recorded; variable radius plots only	Use codes illustrated in picture to designate the trees position in the canopy
Tree age	5 trees per stand, for trees where total height is recorded; only on trees that meet requirements for a site index tree (defined below)	measured at breast height, species preference order is DF,WH, RA; these should be trees suitable for estimating site index
Mistletoe	On every tree on the variable radius plot	Yes/No identifier
Murrelet Platform Tree	Every Live Tree =>24" DBH	Yes/No identifier; does this tree appear to have platforms suitable for marbled murrelet? All trees under 24" should say No
Small MAMU platforms	Every tree with MAMU = "YES"	Binned number of potential platforms >=4" and less than 8" in diameter, located 33' or more off of the ground, record midpoint of bin following table
Large MAMU platforms	Every tree with MAMU = "YES"	Count of number of potential platforms >=8" in diameter, located 33' or more off of the ground

Item	Frequency	Notes
Comments	As needed	Field only allows 30 characters

Tree record number (TreeNum)

Record a code to uniquely identify each tree in the variable radius plot. In general, work clockwise from azimuth 1° to 360°, and work outwards from plot center to plot perimeter. Numbers should be consecutive and start with 1. Flag the first tree that you record on the plot. Trees from the 1/200th acre plot should be grouped together and ordered in the same clockwise manner as the variable radius plot. It does not matter if the fixed radius or variable radius trees are recorded first, but all trees from the variable radius plot should be grouped together, and all trees from the fixed radius plot should be grouped together. If a tree needs to be added or deleted, ensure that the numbers are continuous (no repeats or skips) upon finishing the plot.

Species (*Sp*)

Record the species for each tree. Use the following species codes.

SPECIES	SPNAME		SPECIES	SPNAME
AC	Alaska Cedar		OM	Oregon Myrtle
AF	Subalpine Fir		PC	Port Orford Cedar
BC	Black Cottonwood		PD	Pacific Dogwood
BM	Bigleaf Maple		PM	Pacific Madrone
BO	California Black oak		PP	Ponderosa Pine
CA	Cascara		PY	Pacific Yew
CH	Cherry		RA	Red Alder
CX	Misc. Conifers		RC	Western Red Cedar
DF	Douglas-fir		SF	Pacific Silver Fir
GC	Golden Chinquapin		SP	Sugar Pine
GF	Grand Fir		SS	Sitka Spruce
HX	Misc. Hardwoods		TO	Tanoak
IC	Incense Cedar		WF	White Fir
JP	Jeffrey Pine		WH	Western Hemlock
KP	Knobcone Pine		WI	Willow
LO	Canyon Live Oak		WL	Western Larch
LP	Lodgepole Pine		WO	Oregon White Oak
NF	Noble fir		WP	Western White Pine
OA	Oregon Ash		XX	Unknown Species

Tree Group (*Gp*)

Record tree group, which is available for indicating a special sub-class of trees tallied within a given species. The default is 'live' tree ("**..**"). Some of the Tree Group codes are used to govern merchandizing options during cruise data processing. Others are used to designate special wildlife.

Tree Group ID	Tree Group Name	Tree Group Description
..	Live Tree (default)	Live, acceptable tree or seedling.
BT	Broken top tree	Live tree with a broken top.
C.	Cull tree	Live tree, but entire tree is cull (100% volume deduction due to defect)
D.	Dead tree	Dead tree >= 4.6" DBH. Dead for 5 or less years.
DE	Defect tree that impacts Height	Tree with defect that impacts the total height of the tree compared to a non-defective tree of similar size.
M.	Marginal tree	Live, unacceptable trees that are not expected to grow or to survive for ten years due to physical damage, disease, insect, or other defect. Marginal trees are not indicated by current competitive position alone.
OS	Observed site tree	Live tree suitable for determining site index.
RT	Retention tree	Live, overstory retention or wildlife tree left after harvest with no plans for future harvest.
SN	Snag	A tree that is dead and has been so for greater than 5 years. 10" DBH and 10' height minimum to tally.

Diameter at breast height (*DBH*)

Record DBH to the nearest 0.1 inch for all trees observed as "IN" on the variable radius volume plot. Unless a special situation is encountered, measure DBH at 4.5 feet above the ground line on the uphill side of the tree. **Round each measurement to the nearest 0.1 inch**. For example, a reading between 3.6 and 3.7 that could be approximated at 3.68 inches is recorded as 3.7 inches. When measuring 4.5 feet above the ground, it is not necessary to remove litter; however, measure below any large woody debris (e.g., down logs or branches) that may be at the base of the tree. See Appendix B for explanation of proper use of diameter tapes and points of measurement for DBH.

To facilitate check cruising, make a mark on the tree directly at the DBH measurement using a paint stick, lumber crayon, chalk stick, or something similar.

Total Tree Height (*tHt*)

At least 30 trees spanning the range of species and diameters should be measured for height in each stand. As a guideline for selecting trees to satisfy the desired measure population, measure height on the first and third trees of each species. However, a cruiser can modify this routine and select trees to sample the range of diameter, height and species. All height measurements should be recorded as total height (not merchantable height) from root collar to terminal bud to the nearest foot. See Appendix D for description of total height measurements.

- Broken Top Trees- Height to the broken top should be recorded in the **total tree height (tHt)** field, and recorded as **Tree Group** = BT.

- Defect trees- record total height if the defect impacts the height growth of the tree. Record this in the **(tHt)** field and record **Tree Group** = DE. It is not required that you take a total height on every tree with defect, just those where the defect has impacted the growth of the tree in total height. The purpose of this group code is to remove these trees from the height dubbing routine for other live, healthy trees.
- Small Trees in 1/200th acre plot-Estimate the average height for each diameter class/species combination entry
- Snags- Estimate, rather than measure snag height.

Live Crown Ratio (Crn)

Record live crown ratio in increments of 10% on all trees where total height is recorded, on the variable radius plots. Visually "balance" lopsided crowns so that the live-crown base is as if all sides have crown. See Appendix C for an explanation of estimating live crown ratio.

Upper Stem Diameter (TaperDia)

Record the diameter at the upper stem height.

Upper Stem Height (TaperHT)

Record the height above ground to the nearest foot at a point that is 25% to 35% of the total height of the tree. This is intended to give the cruiser some flexibility in picking a point on the tree for recording the upper stem diameter.

Crown Class (*CrnCls*)

Record the crown position of every tally tree in the variable radius plot where total height is recorded. In multi-aged stands, call the crown class by comparing trees within canopy tier. Classes consist of:

- Emergent (EM)
- Dominant (DO)
- Co-Dominant (CD)
- Intermediate (IN)
- Suppressed (SU)
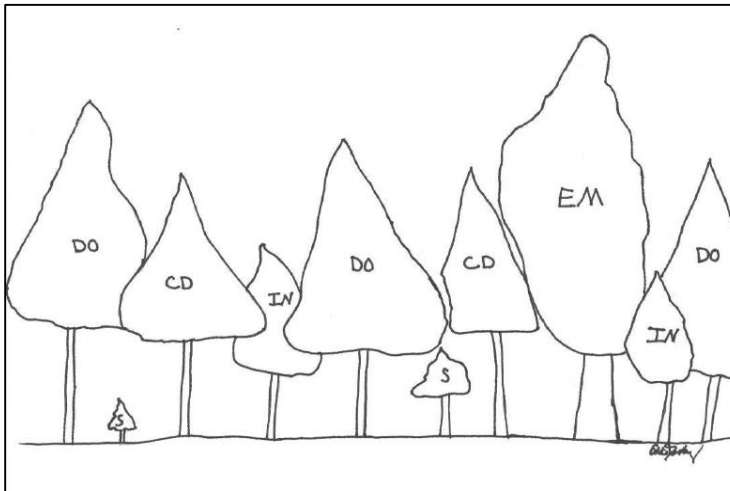
Tree Age (BH*Age*)

Tree age should be recorded for five trees per stand to determine the site index of the plot.

Site Index - Site index trees should be dominant or co-dominant, showing no evidence of crown damage, disease, sweep, crook, forking, or prolonged suppression. There should be no evidence of past suppression or release based on examination of tree rings (i.e., growth rings should display a gradual decrease in width throughout the life of the tree). On the suitable site index trees of the predominant species (DF = Douglas-fir or WH=western hemlock if present, RA=Red Alder if the plot is purely red alder) in each stand, record species, breast-height age and total height in the **Tree Age (Age)** and **Total Tree Height (tHt)** columns, respectively. It is highly preferred that all site index trees within a stand are the same species. It is required that site index trees are located on the plot (either count or measure plot). If a suitable tree does not exist on the plot, then you do you do not need to collect site measurements. Site index trees should be well dispersed throughout the stand. Off plot site trees are not allowed as part of this project. Record the species, group code, height, live crown ratio, upper stem height, upper stem diameter and age. For trees used for determining site index, record **Tree Group (Gp)** = OS.

After counting the rings, tie a piece of flagging around the core and leave at the base of the tree (on the uphill side) for potential check-cruising evaluation. Do not insert the core back into the tree.

Note: There are some very large trees in this forest, so plan ahead to carry a suitable sized borer which will allow you to hit the pith of the dominant or co-dominant sized trees in the stand.

Mistletoe Broom (MTB)

Examine the tree from as many sides a possible to look for recognizable mistletoe brooms. Record a Yes or No (Y/N) if the tree has a recognizable mistletoe broom.

Potential Marbled Murrelet Platform Tree (MAMU)

Record a Yes or No (Y/N) if the tree is a potential Marbled Murrelet platform tree.

Every large (=>24" DBH) *live* conifer tree's crown should be searched for potential marbled murrelet platforms. A potential marbled murrelet platform is defined as:

> A relatively flat surface at least 4 inches in diameter and 33 ft. high in the live crown of a coniferous tree. Platforms can be created by a wide branch, moss, or lichen covering a branch, mistletoe, witches brooms, other deformities, or structures such as squirrel nests (Mack et al. 2003)

If the tree meets these criteria assign a Yes; if no potential platforms are found in the tree, assign a No.

Number of MAMU Platforms <8" in diameter (SmallPlat)

If the tree meets the definition of a potential marbled murrelet platform tree, count the number of >=4" but <8" diameter platforms located 33' or more off of the ground. Assume a single branch can only have one platform on it. Bin counts into the following categories by assigning the midpoint of each class:

Bins for numbers of small (>=4" and <8" diameter) platforms	Midpoint of Bin to record
0	0
1-5	3
6-10	8
11-15	13
16-20	18
21-25	23
26-30	28
31-35	33
36-40	38
41+	40

Number of MAMU Platforms >=8" in diameter (LargePlat)

Count the number of potential platforms that are >=8" in diameter located 33' or more off of the ground, and record the actual number counted. Assume a single branch can have only one platform.

Comments (Comment)

Provide comments regarding any significant issues which a forester/remeasurement cruiser should be aware of on the tree (Maximum of 30 characters). If additional characters are needed, please make notes on the cruise map.

C. Log Level Data

Every tree that meets the minimum log grade specifications needs to have log segment information recorded. We are requiring both log grade and % defect by segment in order to satisfy both inventory and market cruise requirements.

Summary of data to be collected at the Log level

Item	Frequency	Notes
Segment #	Every Log segment	Continuous numbering starting with 1, which is the butt log.
Grade	Every Log segment	Record grade based on Log Scaling and Grading Bureaus standards
Log length	Every Log segment	length of log to nearest foot for all logs except the top log, enter 99 for the top log
Defect	Every Log segment	% volume deduction by log segment, to nearest 5%; estimate visible defect only
Comments	As needed	Field only allows 30 characters

Segment Number (*Piece*)

Segment or piece number starting from the stump and moving up the tree (i.e. butt log = 1).

Grade (*Grade*)

Each log segment will be assigned a grade using the criteria described in the January 1, 2011 edition of the *Official Rules for the following Log Scaling and Grading Bureaus: Columbia River, Northern California, Pacific Rim, Southern Oregon, Yamhill. Northwest Log Rules Eastside and Westside Log Scaling Handbook*. Use the following table for coding:

Log Grade	Code
Cull	C0
Pulp	P0
Utility	U0
Special Cull (includes wormy red cedar)	QS
Special Mill	SM
#1 Sawmill	S1
#2 Sawmill	S2
#3 Sawmill	S3
#4 Sawmill	S4
#5 Sawmill	S5
#6 Sawmill	S6
#1 Peeler	V1
#2 Peeler	V2
#3 Peeler	V3

Log Length (*Length*)

Record the length in feet of each segment. Segments are variable in length. The expectation is that the cruiser will specify log lengths as appropriate for the grade; minimum log lengths will vary with the grade. The preferred log length is 36', and the minimum log length is 12'.

Record grade, length and defect for every log, except the top log. For the top log, record grade and defect, and enter "99" for the length. The merchandizer will calculate the length of the last log.

Log Deduction (*Defect*)

Record defect deductions for each tallied segment in 5-percent (%) volume increments from 0 – 100%. This is in addition to the log grade calls.

Note: If a whole tree receives a Group code of cull (C.) or snag (SN), it is not necessary to enter log grade information or defect.

Section V. Check Cruising Procedures

Quality is best achieved through a comprehensive initial training session, and through continuous check cruising, to ensure that data are collected consistently and accurately throughout the duration of the project. Check cruising will be done intensely early in the project to identify and remedy any training deficiencies before they become a problem, and will be conducted periodically throughout the remainder of the cruising project to ensure quality standards are always being met. Check cruising is to be used as a teaching tool to ensure that the cruise instructions, measurement standards and other protocols are understood and that work is consistent from cruiser to cruiser.

Cruisers are not told when their work will be checked, and understand that their work may be checked at any time. An independent check cruiser will visit a subset of plots measured by each cruiser, complete all measurements and compare his/her results with the data originally recorded. The following point deductions will apply for all "out of tolerance" measurements.

Stands being check cruised will be assessed based on a batch of three plots per stand. If a stand with a combination of volume plots and count plots is being checked, the check cruiser will select a group of plots that includes 2 volume plots and 1 count plot.

Check cruise tolerances for Count Plots

Measurement	Plot/Tree/Log Level	Tolerance (+/-)	Point Deduction
Missed/Added Tree	Tree	None	6 points
Tree species	Tree	None	4 points

Check cruise tolerances for Volume Plots

Measurement	Plot/Tree/Log Level	Tolerance (+/-)	Point Deduction
Plot Status	Plot	None	2 points
Age Structure	Plot	None	2 points
Plot Stocking	Plot	None	2 points
Missed/Added Tree*	Tree	None	5 points
Tree species	Tree	None	3 points
Tree Group	Tree	None	2 points
DBH (for trees up to 19.9")	Tree	+/- 0.5"	3 points
DBH (from 20.0" to 29.9")	Tree	+/- 1.0"	3 points
DBH (from 30.0" to 44.9")	Tree	+/- 1.5"	3 points
DBH (from 45.0" to 59.9")	Tree	+/- 2.0"	3 points
DBH (greater than 60.0")	Tree	+/- 2.5"	3 points
Total tree height	Tree	+/- 9%	2 points
Crown ratio	Tree	+/- 10%	1 point
Upper stem height	Tree	+/- 5%	2 points
Upper stem diameter	Tree	+/- 2.0"	2 points
Crown class	Tree	None	1 point
Tree age at breast height	Tree	+/-3 years on trees < 20 years old; +/- 5 years on trees 20 to 50; +/- 10 years 51+..	1 point
Mistletoe broom presence	Tree	None	1 point

Measurement	Plot/Tree/Log Level	Tolerance (+/-)	Point Deduction
Potential Marbled Murrelet Tree	Tree	None	1 point
Small MAMU Platforms	Tree	+/- 1 bin***	0.5 point
Large MAMU Platforms	Tree	+/- 1 large platform***	0.5 point
Log Data for a single tree	Tree		0,1,2,or 3 points
Log Length	Log	+/- 4'	1 point**
Log Grade	Log	None	1 point**
% Defect	Log	+/- 10%	1 point**

*A missed or added tree will have a maximum deduction of 5 points; the penalty for all other measurements will not apply.

** The point values shown for log length, grade, and % defect are intended as guidelines for the check cruiser's score with regard to log data for the tree. The largest number of penalty points for disagreements about log data for a single tree is 3.

*** If a cruiser did not see any MAMU platforms and called an N for Potential Marbled Murrelet Tree, they will not be double penalized for recording 0 for Small MAMU Platforms, nor for recording 0 for Large MAMU Platforms.

The total point deduction will be calculated on each plot in the 3-plot batch. Then, the simple average of the point deduction is calculated across the three plot batch, which yields the total point deduction in the stand. If the average point deduction is < 18.0 points, then the stand passes. In the example below, three plots were checked and had a point deduction of 15, 18, and 7 points. The average point deduction in the stand = 13.3. Since 13.3 points is < 18.0 points, the stand passes.

Example Check Cruising Analysis

Stand	Plot	Plot and Tree Penalties
1	1	15.0
1	2	18.0
1	3	7.0
Average Penalty		13.3

Check cruising is part of a larger quality control effort, which also includes the following:

- *Sufficient training* of all cruise contractors and as many cruisers as possible at the start of a project to ensure that the cruise instructions, measurement standards, log defecting, and other protocols are understood, and that work will be consistent

from cruiser to cruiser. Since not all cruisers will be at the initial group training session, it is imperative that cruise contracts train each cruiser to these specifications when they start cruising.

- *Actions in the event of substandard work* by any cruiser, may include, but are not limited to:
    - Remedial training of cruisers in which cruiser and check cruiser will return to the plots in question.
    - Original cruiser will return to cruised plots to redo all measurements.
    - Removal of a cruiser from the project.

Work that is deemed unacceptable will require the check cruiser to decide how much of the cruiser's work must be discarded and redone. To minimize the likelihood of rejecting a large amount of work, check cruising will be done frequently, and results will be shared with the cruiser in a timely manner. Initially 10% of each cruiser's plots should be checked. If work is found to be consistently satisfactory, this may be reduced to a level that yields a final checked proportion of 3% of each cruiser's plots.

In addition to check cruising, a number of other quality control checks will be completed, including:

1. Total height measurement distribution across species and DBH range.
2. Total number of height trees recorded in each stand.
3. Total number of site index trees recorded in each stand.

Please note that the pass/fail score calculated above is not the final determining factor in assessing a cruisers work. For example, a cruiser may receive a passing grade, but may be consistently measuring the DBH of trees incorrectly. This would be flagged and brought to the cruiser's attention.

Section VI. Delivery of Data from Contractor to Cruise Manager

The cruising contractor will deliver the raw cruise data to the Cruise Manager after running error checks and making corrections. The goal for the contractor should be to deliver clean (no errors) data to the Cruise Manager within 5 days of completing a stand, but delivery within 2 days is preferred. Only data from wholly completed stands should be submitted to the Cruise Manager. Maps with direction of travel noted and reason for and identity of dropped plots, as well as any stand level notes explaining unusual situations should accompany the raw data delivery.

Data must be delivered to the Cruise Manager in an Access database consisting of 4 tables – Stand, Plot, Tree, and Log. MB&G is providing a template database that must be used to submit all final data.

Section VII. References

Mack, D.E., W.P. Ritchie, S.K, Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer. 2003. *Methods for surveying marbled murrelets in forests: A revised protocol for land management and research.* Pacific Seabird Group Technical Publication Number 2.

Section VIII. Appendices

A. Edge Plot Procedures

Use the Mirage method any time possible. If going outside of the stand to establish mirrored plot center in impossible due to some hazard (i.e. a cliff, a water boundary, etc.), or if you are unable to monument the mirrored center (because it would fall in a road or bedrock), then the walkthrough method is acceptable. In both cases, flag the stand boundary where the plot would extended beyond it.

Mirage Method

- Let B = Distance from the plot center to the boundary.

- If the maximum limiting distance for all trees in the plot is > (2*B), then walk distance B perpendicularly beyond the stand boundary and establish a temporary plot center.

- Sample trees in the original stand from the plot or point center (light and dark green colored trees on the fixed radius and variable radius plots in the following diagrams).

- Count all trees again which are in at the temporary plot or point center (light green colored trees on the fixed radius and variable radius plots in the following diagrams) and add them to the original tree tally.

Note that while another plot center was established, it is only temporary and does not increase the number of plots in the stand.

23
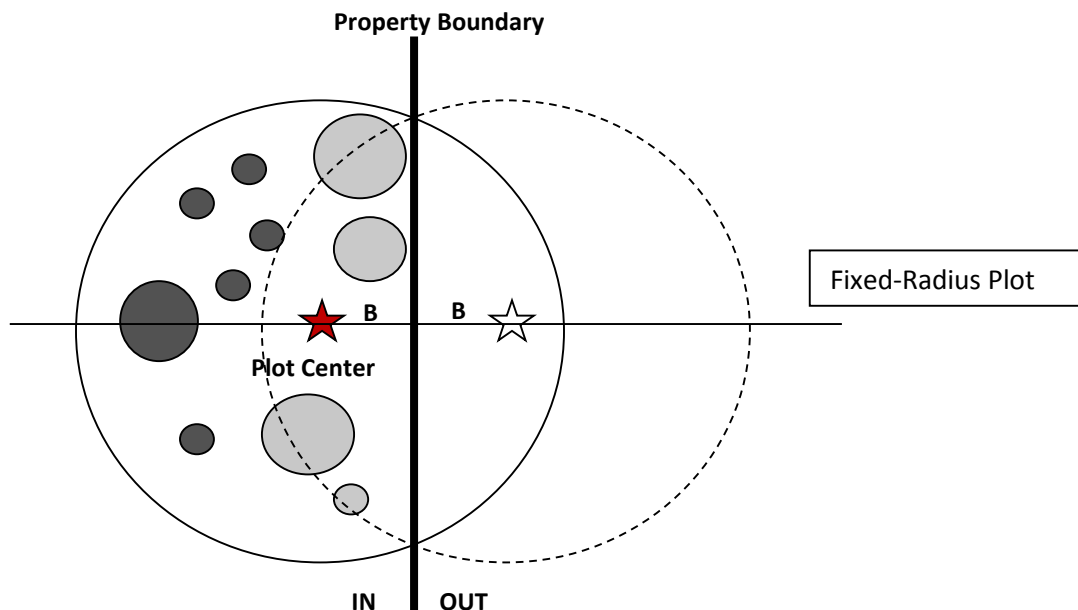
The Walkthrough Method

Establish the plot exactly where the plot center falls and measure and record all trees falling in the plot that are inside the stand boundary.

For any "in" tree, measure the distance ("d" in Figure 1 below) from the sample point to the tree.

Duplicate the distance, "d", on the other side of the tree towards the stand boundary.

If you are outside the stand boundary at the end of this duplicated distance, record the tree twice. If you are inside the stand boundary at the end of this duplicated distance, record the tree once.

The "Walkthrough" Method

Equal distance "through" tree is outside tract, so record it twice

Tract Boundary

Tree Circle

Tree

Sample Point inside the tract.
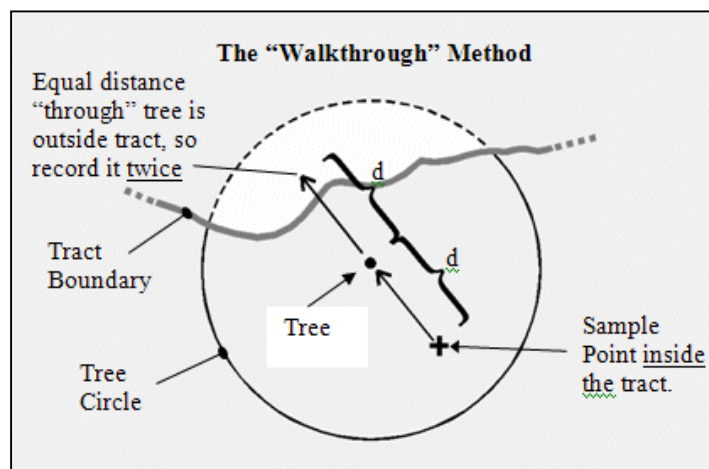
B. DBH Measurements

1. Proper Use of a Diameter Tape

Optional method if left handed

Correct Method

4.5'
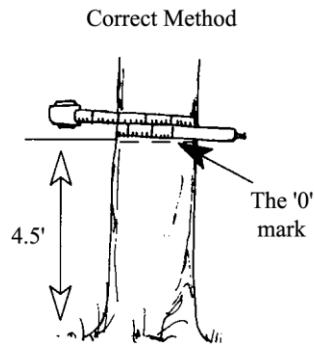
The '0' mark

End of tape (with the '0' mark or hook) crossed under.

4.5'
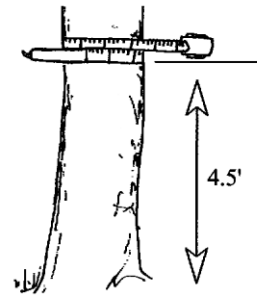
End of tape crossed under. (Be careful - reading will be made from upside down d-tape marks.)

Press the tape firmly against the tree. Do not pull it out at a tangent to the tree at the point of measurement.

Correct

Incorrect

4.5'

Correct

Incorrect

4.5'

Correct

4.5'
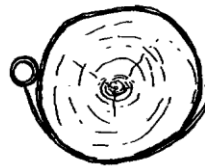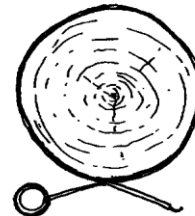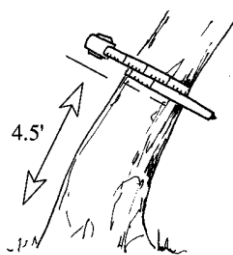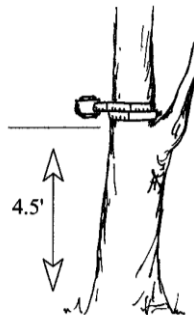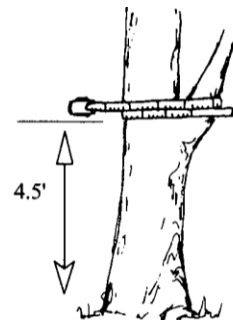
Incorrect

Tape must be at right angles to lean of tree.

Do not place tape at abnormal location on bole of tree.

Point of Measurement for DBH

DBH

4.5'

Tree on slope

DBH

4.5'

Tree on level ground

Diameter Point

4.5'

Tree deformed at DBH by
swelling or crook. Take
DBH above deformation.

Diameter Point

4.5'

**Tree with branch
at 4.5 feet**

4.5'

Diameter Point

Windthrown tree

DBH

4.5'

Leaning tree

DBH

1.5'

3' or
more

Bottleneck tree

4.5'

Adjust diameter tape to normally rounded position to allow for the missing catface portion.

Tree with a catface

-If you can see light between the two stems, at DBH, measure as two separate trees.

-If you cannot see light between the two stems, at DBH, measure as one tree.

4.5'

Crotch

DBH

4.5'

4.5' or higher

Tree forked at 4.5 feet or higher. Record as one tree and consider only the main fork. Take DBH below the swell of the fork.
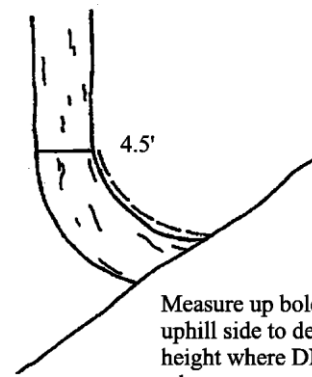

Diameter Point

Diameter Point

4.5'
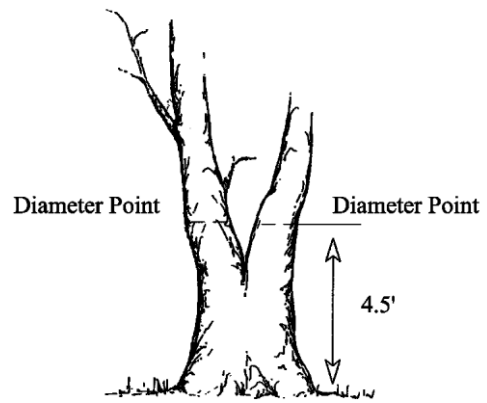
Tree forked below 4.5 feet. Record each fork that is "in" as a separate tree. Measure diameter at 4.5 feet.

Point of diameter measurement

4.5 feet
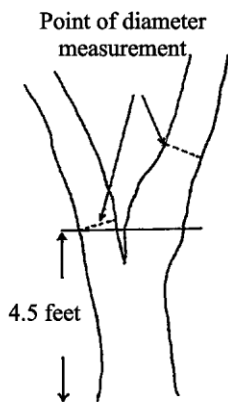
Measuring abnormal diameters on forked trees
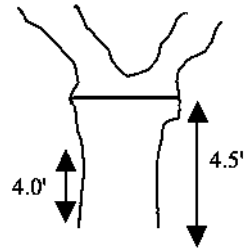
Diameter on abnormal fork

4.5'

Measure up bole of tree on uphill side to determine height where DBH should be taken

Diameter on pistol butt tree

27

4.5'
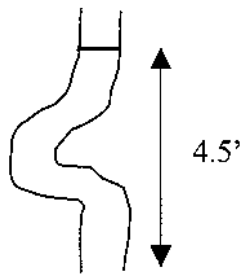
DBH measurement for a
pistol butt shaped tree

4.0'   4.5'

Tree forked at DBH. Unable to get a
DBH tape through crotch. Take DBH
below the swell of the fork.

C. Live Crown Ratio

Live crown ratio, in percent, is the length of the live crown divided by tree height. Live crown length is assessed from the uppermost live leader or branch to the lowest live branch. Visually adjust large openings in the crown or lopsided crowns by transferring lower branches to fill in the holes. Compressing the live crown length because the crown appears "sparse" or contains "unhealthy" foliage is not appropriate. Crown ratio is the portion of the tree bole supporting live, healthy foliage and is expressed as a percent of the actual tree height. The distance between A and B is the existing crown length.
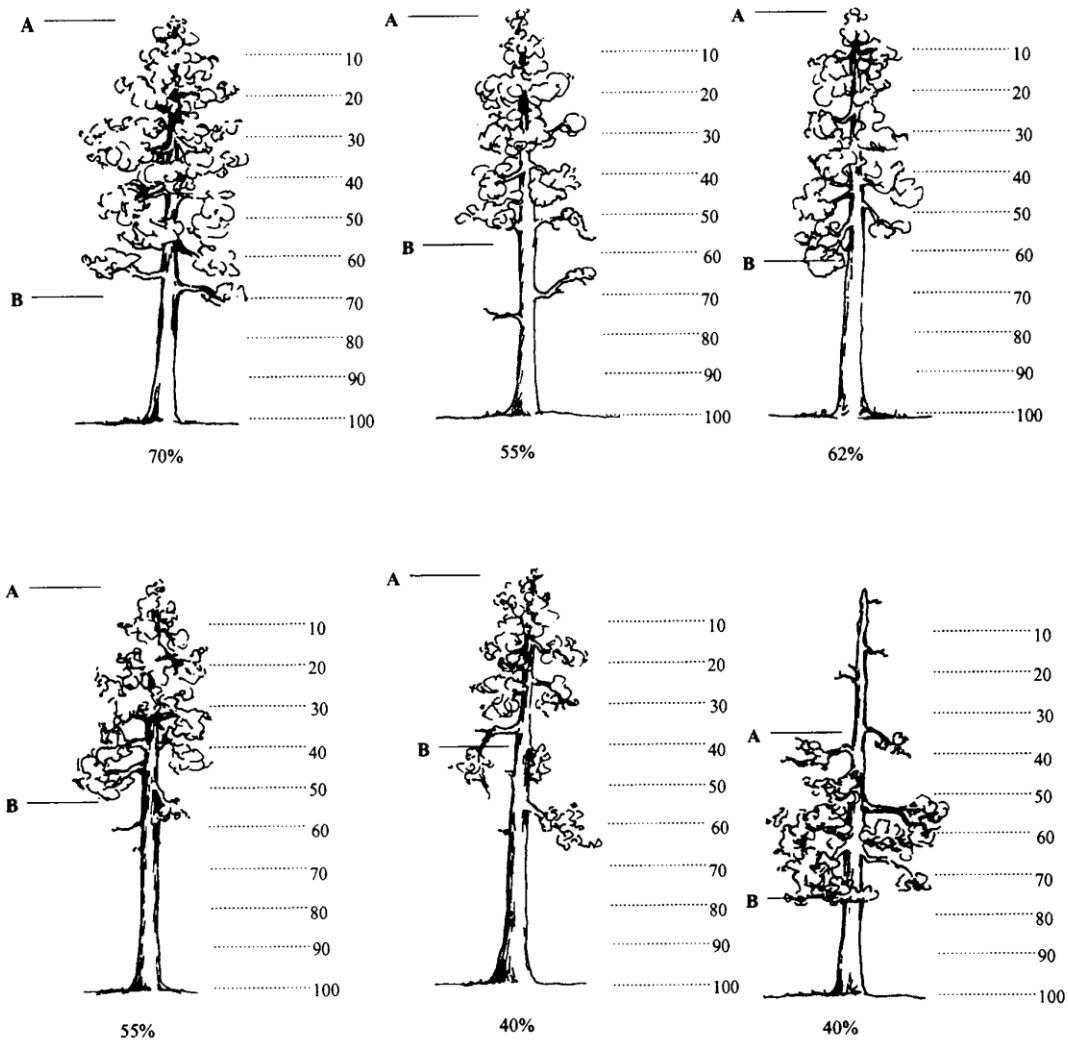
D. Measuring Total Height

Total tree height can be measured using several different angle measurement devices but is normally done with a Relaskop or Suunto Clinometer while cruising. A simplified field procedure is outlined as follows:

1. Tape away from the center of the tree until the percent scale registers less than 100 when sighted at the top of the tree.

2. Determine the horizontal distance to the tree. If only the slope distance is known, horizontal distance can be calculated as follows:

   Find the slope angle by shooting at eye level on the tree with the Suunto or Relaskop. Multiply the cosine of the angle (often on the back of a Suunto) by the slope distance to get the horizontal distance. For example, if the taped slope distance is 83.5' the slope and the angle is 26º,

$$\text{Horizontal distance} = 83.5 * \text{COS } 26º$$
$$= 83.5 * 0.90$$
$$= 75'$$

   Horizontal distance calculation is available with the handheld data recorder.

3. Determine readings to the top of the tree and at the base and add the absolute value of each of the readings if they are opposite in sign; subtract them if they are both the same sign.

4. Determine total height by dividing the horizontal distance from the tree by 100 and multiplying the quotient by the sum of the readings for the tree. The same process is employed when using the chain scale except the horizontal distance from the tree is divided by 66, and then multiplied by the sum of the readings (chain scale readings.) Height calculations based on slope distance, slope, and height readings are available with the data recorders.

   For example, if
   > Horizontal distance to the tree = 75', and
   > Sum of the readings (chain scale) to the base and top of the tree = 82, then
   > Total tree height = 75/66 * 82 = 93.18 = 93'

   An obvious advantage can be realized by taking the readings at 100' or 50' (horizontal distance) when using a percent scale and at 66' or 33' (horizontal distance) when using a chain scale angle measurement.

   Readings to the top of a leaning tree should be made, to the best of the cruiser's judgment, to a point where the top of the tree would be if it was a straight standing tree. Also, care should be taken when shooting the top measurement on the tree. Focusing on an outside branch tip instead of the top leader will give an inaccurate height measurement.

   Multiple topped trees should have an estimated top recorded as if the top had not become multiple topped or bole broken.

Total Tree Height - To determine total tree height, measure from the base of the tree on the high ground side to the tip of the tree leader. Measure the height from a point uphill or on the same contour line as the tree. Record the total tree height to the nearest foot.
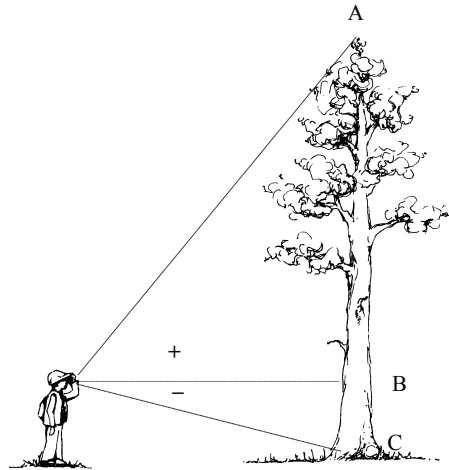
Height for Leaning Trees - Trees leaning 25% (about 15°) or more from vertical require the following special height measuring technique.

Procedure: Locate point on ground directly under tip of leaning tree. Measure height **A B**. Measure horizontal distance **B C**. Determine actual tree height (**A C**) using either the Pythagorean theory for right triangles where:

$$\text{Tree Height} = \sqrt{AB^2 + BC^2}$$

Example: Measured height (AB) = 120'
Horizontal distance (BC) = 40'

Corrected tree height = $\sqrt{120^2 + 40^2}$ = 126.49 feet

Height for Trees with Forked Tops

If tree forks below DBH, treat as two trees and measure height of each stem from base of tree to tip of tree.

If the fork crotch occurs at or above 4.5 feet on high ground side, the tree is treated as a single tree. Measure height of the tallest fork.
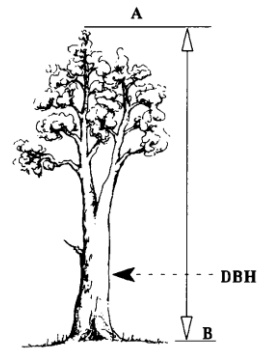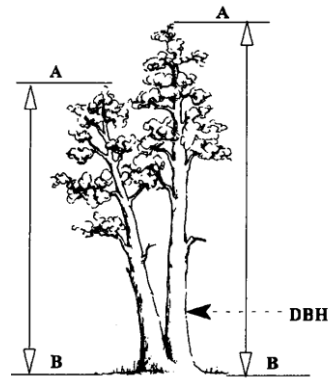
APPENDIX B

Clarifications to Cruise Specifications

MEMO

Date: October 16, 2015
From: Cliff Barnhart, Cruise Manager for Elliott Timber Cruise
To: Cruise Contractors and all Cruisers

Subject: Clarifications for questions that came up on training day

The following clarifications are provided for the Elliott timber cruising project for questions that arose during our training day, October 13th. These are clarifications to the Cruise Specifications to cover ambiguities found and to provide clearer direction for how the cruisers are to record plot data so as to provide consistency among cruisers.

1. For consistency, ignore the PU grade code, and use either C0 or U0 instead as appropriate. A C0 is a complete cull that does not include at least 50% sound material for making chips. A U0 includes at least 50% sound chips.

2. It is not expected that cruisers will be able to distinguish QS (Special Cull) log segments from external characteristics and that this grade of log will likely be called a U0 by the cruisers. Being able to determine if a cedar is wormy and should receive a QS code is also not expected from external characteristics.

3. We do not expect that a #2 Peeler grade (V2) will be found very often, if at all, on the Elliott timber that is less than 200 years of age. The depth of clear lumber will not typically be adequate to make this grade. It will take a high quality old-growth tree before a V1 or V2 grade should be considered.

4. Upper bole logs on the older timber which are up in the large diameter limbed crown should receive a S3 or S4 log grade with appropriate "rough-cut" defect deductions. So that all of the cruisers are consistent, I would expect to typically see around a 30% defect call on these rough log segments. Do not call these log segments a U0 just based on the large limbs. Also, only defect for the diameter deduction due to being "rough-cut", not the breakage factor.

5. Cruisers will not account for any breakage in their segment grading or defect calls. All breakage will be accounted for in the cruise compiling in the hidden defect and breakage factor.

6. No taper is needed on BT or DE trees.

7. If a D. tree has a broken top, call it a snag and write BT in the tree level comments. This means that all D. trees are >=4.6" dbh, have been dead five years or less and have unbroken tops. Also, snags, are now defined as a tree dead longer than 5 years that are greater than 10" dbh and 10' tall, **OR a tree dead less than 5 years that is >=4.6" dbh with a broken top**.

8. No need to grade D. trees.

9. SN group trees do not need crown ratio or crown class data.

10. It is okay for the 1st or 3rd tree measured for height to be a Dead tree if it does not have a broken out top.

11. It is okay to measure a site tree on a count plot. Enter the site tree as its own line of data with a tally of 1. The rest of the trees (for that species) in the count plot should be a separate entry; the tally of which should not include the site tree.

12. All of the measurements required for site trees in the manual should be recorded on site trees in volume plots. On site trees located on count plots, breast height age, dbh, total height, and crown class are required.

13. In old stands like the one we visited for the training day, where all younger trees that are suitable for Kings Site Index have likely been suppressed at some point, it is okay to not take any site index (OS) trees if they cannot be located. If none, or less than the required number of OS trees are measured, a note explaining stand conditions that prevented finding a suitable OS tree should be written on the maps and on the stand comments.

14. Collection of data for the Plot Stocking field is not required. Leaving this field blank on all plots will not be a point deduction on the check cruises.

15. A regenerated clear cut with trees less than 1" at dbh should be a called a VP (volume plot) for plot status , but should have no tree records shown.

16. Maps only need to be turned in if there is a note on them. Nothing of note=no map.

17. If a cruiser calls a plot non-stocked and the check cruiser finds an "in" tree, they will only miss 5 points for the missed tree, not the additional 2 for the incorrect plot status call.

18. No plots should be moved. Therefore, the use of the GPSLat/GPSLong field is not needed.

19. Add DP for dropped plot to plot status. It is important that these dropped plots are still indicated on a map, as well as the reason for dropping noted. These maps should be turned in to Stuntzner when the data is turned in.

20. Plots dropped due to safety concerns may cause a bias in the sample of the stand (for example, dropping a plot on a rock outcrop which is not stocked with timber). Therefore, if a plot falls in a rocky ledge that is unsafe to travel to or occupy by the Cruiser, and the Cruiser can look into the location where the plot is supposed to be located and see that it would be a plot with no trees, the Cruiser can then record the plot as a no tally count plot. The cruiser should hang a flag as close the plot as they can

safely get and write on the flag the plot number along with the bearing and distance to the observed plot center. The Cruiser will also note in the plot level notes the bearing and distance to the actual plot center from the flagging placed on the ground, and that the plot center was not monumented.

21. When assessing the age structure for a plot, visually assess the stand surrounding the plot in roughly a 100' circle as a guide.

22. Live crown ratio asks for LIVE crown. Therefore, if a tree is dead, its live crown ration is 0%. Appendix C states that "crown ratio is the portion of the tree bole supporting live healthy foliage and is expressed as a percentage of actual tree height". Estimate the length of crown from the bottom to the top of live foliage (using the balancing method described in appendix C), and convert into a percentage of actual tree height. While height to broken top point is recorded as total height for these trees, the crown ratio estimation should be made using the actual total height.

23. Please record all dead tree crown classes as suppressed.

24. Please evaluate broken tree crown class just as you would with live trees by comparing the trees crown with other trees in the same tier of the canopy.

APPENDIX C

Steps to Merchandizing a Tree

Example:

We consider the following tree in CRUISERECS:

StandID	PointID	TreeID	Species	DBH	TotalHt
83	20503	1	DF	38.5	236

The cruiser called the following logs which can be seen in CRUISELOGS:

LogNum	Length	FieldCode	Defect
1	36	V3	10
2	36	V3	0
3	36	V3	15
4	36	S2	25
5	99	S3	30

Because the tree has 30 ≤ DBH < 40 inches, all logs to be merchantable must have top diameters greater than 12 inches. We use top diameter of 12 inches to merchandize and use the prescribed 4% hidden defect and arrive at the following logs:

LogID	Length	Grade	Dib
1	36	V3	31
2	36	V3	27
3	36	V3	23
4	36	S2	18
5	31	S3	12

We note the merchandizer made the top log 31 feet – the length in which the top diameter was scaled at 12 inches. The grade is then updated if it does not meet the standards of top (small end) diameter. In this case, the third log is updated from V3 to SM since the top diameter has 16 ≤ TopDib < 24 inches.

LogID	Length	Grade	Dib
1	36	V3	31
2	36	V3	27
3	36	SM	23
4	36	S2	18
5	31	S3	12

We now look at the volume of this tree. The logs have gross and net board foot volumes:

Dib	Length	BvG	BvN	Percent Defect
31	36	1480	1272.8	14
27	36	1230	1180.8	4
23	36	750	607.5	19
18	36	420	298.2	29
12	31	150	99	34
Total		4030	3458.3	

We note the defect is the cruiser called defect plus the hidden 4 percent defect.

The record in CURRDATA has the volume of the tree as the sum of the volumes from its logs:

StandID	PointID	TreeID	TPA	Species	DBH	TotalHt	BFVolG	BFVolN
83	20503	1	0.763768	DF	38.5	236	4030.00	3458.30