

5310 – TIMBER CRUISING

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.01 Purpose. This Manual Section provides policies, standards, and guidelines for applying timber cruise measurement systems.

.02 Objectives. The objective of BLM timber cruising is to provide accurate estimates of timber volumes and sometimes values for conducting the Bureau's forest management program.

.03 Authority. (See BLM Manual Section 5300.03.)

.04 Responsibility. (See BLM Manual Section 5300.04.)

.05 Definitions. (Also See Glossary of Terms, BLM Manual Section 5300.)

.06 Policy. Timber cruising must be directed by BLM personnel certified as qualified to cruise timber by the State Director.

.07 Scope and Background. Timber cruising is a linchpin for several Bureau timber management activities including inventory, timberland exchanges, timber sales, and timber trespass. In each case, the accuracy of the timber cruise is basic to accomplishing successfully projects related to the preceding activities. The Bureau has traditionally used cruise sales, also termed lump-sum sales, as the basis for selling timber.

This method of sales makes the accuracy of the cruise especially important. It is not the intent of this Manual Section to provide all that needs to be known to become a proficient timber cruiser. Cruising knowledge is acquired through training and experience (See BLM Manual Section 5300.7). This Manual Section provides some procedural guidance for maintaining uniformity between State Timber Management Programs (See BLM Manual Section 5300.1).

.1 Cruising Systems. Common cruising systems available to Bureau personnel include 100% cruise, 3P cruise, variable radius plot cruise, fixed plot cruise and strip cruise. The procedures discussed in this Manual Section are basic applications of each system. See the Bibliography for additional sources of information on cruising systems. Additionally, check for any State Office Manual Supplements issued in the 5310 Series for guidance on cruising systems.

.11 100% Cruise

A. Cruise Design. Use a topographic map of a project area to plan the location of cruise strips within the area.

1. Cruise Strips. Strips laid out in the field are used to subdivide project areas into uniform widths. Striplines, flag lines, tag lines, or combinations of these are placed at eye height to mark the edge of the strips. Each line should be visible from the next to help minimize the possibility of omission or double counting of trees.

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2. Mark and Cruise. When tree marking and cruising are done concurrently, painted trees may serve as a substitute for cruise strips for marking out areas cruised.
- B. Grading. For States having appraisal systems based on log or tree grades, a minimum of 10% in each species must be grade sampled. The following methods are acceptable for sample grading.
 1. Systematic Selection. Grade every tenth tree in each subsale without biasing the selection of each tenth tree.
 2. Area Selection. Grade every tree that occurs on either edge within 1/10 of the width of the strip.
 3. Change Selection. Grade tree selected by chance through some device, such as colored marbles, coins or dice.
- C. Volume Tables. Refer to BLM State Office Supplement 5300 for information on volume tables.

.12 3P Cruise

- A. Random Numbers. To avoid bias, separate tables of random numbers must be obtained for each sale. Random numbers must be used consecutively. A subset of random numbers cannot be repeated before all the numbers have been used. If the supply of random numbers is expended before the cruise is completed, the same list may be used again, beginning with the first number.
- B. Number of Samples. It is best to over sample, rather than fall short of the number of sample trees needed to obtain an acceptable standard error for the cruise. Since tree populations may differ from precruise estimates, the actual numbers of samples may vary from the expected number. To compensate for variances in sample size, two extra sets of random numbers, one higher and one lower, should be obtained along with the original. If a 3P cruise is producing fewer than expected samples, the cruiser can shift to a set designed to give more samples and vice versa. Whenever, lists of random numbers are changed, establish a new stratum. If 150 samples were estimated to be needed to obtain a satisfactory standard error, 175 should be selected, 25 systematically excluded, and 150 measured. If the 150 does not meet the standard error test, then, additional trees are available for achieving the required standard error.
- C. Cruise Design. The same process is used to plan a 3P sample as for a 100% cruises (see .11A).
- D. Sample Selection. The 3P sample tree selection process must be free from bias. An estimator should not be informed about when the next number is likely to select a sample, since this would bias the selection process. The objective of the estimator is to achieve consistent estimations. An estimator

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who is consistently high or low will obtain greater accuracy than one who is erratically high and low.

- E. Sample Marking. Each sample tree must be well marked with the sample tree number prominently displayed by tree marking paint (above and below stump height) and flagging which contrasts with the color of surrounding vegetation.
- F. Cruise Map. A map is required to show the location of 3P sample trees in relation to cruise strips and topographic features, i.e., streams and ridges. An accurate map is needed to allow the cruiser, a check cruiser, or prospective purchaser to locate the sample trees for measurement. When the sample trees are to be felled, bucked and scaled, the felling and bucking crew and the scaler need a map to find the sample trees.
- G. Cruise Notes. Before the cruise begins, the cruiser must set up the cruise notes to account for strata within the cruise. Separate stratum are established for cutting units, right-of-way, species, green timber, salvage timber, and when random number lists are changed (see .12B). It is also expedient when sampling defective timber to set up a separate stratum for trees which are near culls. This becomes more important if the selected sample trees are to be felled, bucked, and scaled. Stratification not only provides administrative information, but also helps to minimize the combined standard error.
- H. Sample Tree Measurement. Because each sample tree volume is expanded, it is especially important that same tree volume estimates be accurate.

.13 Variable Radius Plot Cruise

- A. Acreage Computation. Under this method of timber sampling, the acreage of the area to be cruised must be measured accurately. Since the products of variable radius plot cruising, e.g., number of trees and volumes, are computed on a per acre basis, inaccurate acreage for the cruise area applied to the cruise volumes results in an inaccurate cruise.
- B. Cruise Design. The line-plot method is used to establish the location of plot centers for a variable radius plot cruise. A topographical map of the cruise area is required to lay out the grid system formed by the lines and plot locations. It is permissible to use a compass and pacing to establish plot centers on the line in the field. A person other than the cruiser should locate the plot centers.
- C. Sampling Device. Any type of device which subtends a critical angle, such as an angle gauge, relaskop, wedge prism, etc., is acceptable for selecting samples. Whichever device is used the basal area factor must be verified.
- D. Cruise Notes. Separate subsales must be established for cutting units, rights of way, species, green timber and salvage timber.

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- E. **Volume – Basal Area Ratio (V-BAR).** The cruiser must verify that the volume table used to construct the chosen V-BAR table is compatible with the BLM measurement standard.

.14 Fixed Radius Plot Cruise

- A. Acreage Computation. As with variable radius plot cruising (see .13A), an accurate acreage measure is necessary to achieve an accurate cruise estimate of the total volume.
- B. Cruise Design. The line-plot method, used for variable radius plot cruising (see .13B) is also used with the fixed radius plot.
- C. Sample Design. The most commonly used fixed radius plots used by BLM are ¼ acre, 1/5 acre, and 1/10 acre plots.
- D. Cruise Notes. Separate subsales must be established for cutting units, rights-of-way, species, green timber, and salvage timber.

.15 Strip Cruises

- A. Acreage Computation. An accurate acreage measure is needed to expand volumes from strip cruises to obtain an accurate estimate of total volume.
- B. Cruise Design. Cruise strips should be located on a topographic map of the project area so as to obtain a representative sample. The length of cruise strips can be paced and used to compute expansion factors needed for estimating the total volume for the cruise area.
- C. Sample Design. The width chosen for the cruise strips must be within a manageable limit.

.2 Cruise System Selection. The following guidelines must be used to select a suitable timber cruise measurement system that will achieve the desired measurement result.

.21 Timber Trespass Measurement. Refer to BLM State Office Manual Supplement 5310 for timber measurement systems approved by the State Director.

.22 Timber Sales, Timberland Disposal, or Timberland Exchange Measurement. Refer to BLM State Office Manual Supplement 5310 for timber cruise measurement systems approved by the State Director.

.23 Forest Inventory Timber Measurement. The State Director approves the cruise system to be used for forest inventory.

.24 Precruise Timber Measurement. Any measurement system, including strip cruising, can be used for precruise of a timber tract.

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.3 Timber Cruise Data. Field data must be recorded in an orderly and legible fashion on notebook pages which will not deteriorate when exposed to moisture. A properly arranged cruise book not only minimizes possible transposing errors, but also presents a professional appearance. A complete set of field notes must be filed in the project folder.

.31 Notebook Organization. At a minimum, notebook pages must have the following information:

A. Page Headings. Include the cruiser's name, cruise dates, and the legal description of the tract. Identify volume table specifications.

.32 Data Entries. Record data neatly so that if someone other than the cruiser needs to interpret the notes, they can do so readily. An efficient tally method is a combination of dots and lines demonstrated on Illustrations 1, 2, and 3.

.33 Designated Timber. Threes included in the timber cruise must be plainly marked by paint or enclosed within a readily discernible boundary prior to the cruise. This precaution aids in precluding any possible conflicts between the Federal government and its clients concerning designated timber within a project.

.34 Subsales. Subsales provide a means for dividing a timber cruise into components. Separate field notes are kept for each subsale. Subsales are set up for the following categories of timber to provide input for timber volume computations which are summarized in the timber cruise report.

- A. Green or Salvaged Timber. Live or dead trees are tallied by species and by cutting unit. Green and salvage subsales make it possible to tailor recovery factors to account for recovery differences. Additionally, green and salvage timber volumes are needed to compute percent salvage for the timber sale notice (see BLM Manual Section 5430; Illustration 9, Page 1).
- B. Timber Types. Similar Timber types are tallied by species and by cutting unit. Grouping age or size classes allows the selection of recovery factors to account for recovery differences.
- C. Tree Form. Timber having similar taper are tallied by species and by cutting unit. Separate taper subsales make it possible to assign proper form classes.
- D. Cutting Units and Rights-of-Way. Provided separate subsales have not been established for the preceding purposes, cutting units and rights-of-way are tallied separately by species. Summaries of subsales comprising cutting units or rights-of-way are used for Exhibit "B" of the timber sale contract (see BLM Manual Section 5424, Illustration 1, Page 5) and Timber Cutting and Yarding Inspection Report (see BLM Manual Section 5462, Illustration 12, page 1).

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E. Species. Provided subsales have not been established for the preceding purpose, tree species are tallied separately. Timber volumes by species are used in the ensuing BLM Manual Sections.

1. Appraisal of Forest products (9350)
2. Preparation of Contracts and Exhibits (5424)
3. Advertisement (5430)
4. Conduct of Sale (5440)

.4 Timber Cruise Data Processing

.41 Subsale Summary Sheet. Regardless of the data processing method, prepare a subsale summary sheet. This summary sheet lists the cutting unit of rights-of-way, species, and whether the trees are green or salvage (see Illustration 4). A subsale summary sheet is the same as a transmittal memorandum usually used to request an automated data processing run.

.42 BLM Automated Data Processing. The Oregon State Office has main frame compute capability to process timber cruise data from Washington, Oregon and California. Information on the types of available timber cruise programs and directions for their use can be obtained from the Oregon State Office.

.43 Other Automated Data Processing. Bureau offices, outside of California, Oregon and Washington, may arrange to procure data processing from other sources, provided that the other volume computation programs are compatible with BLM measurement standards (See BLM Manual Sections 5300.11B and 5300.11E).

.44 Manual Data Processing. Manual Data Processing. Manually processed cruises must be accomplished in a manner which facilitates checking for mathematical accuracy and which displays cruise volume data for the timber cruise report (See Illustration 5).

.5 Timber Cruise Report. The cruise report is the source of timber statistics used for appraisals to estimate both timber volumes and values (See Illustration 6).

.51 Subsales: The subsales displayed on the timber cruise report must correspond to the subsales listed on the subsale summary sheet (see .44).

.52 Subsale Summaries. Each subsale summary at a minimum, providing the following information:

- A. Net Merchantable Volume
- B. Gross Merchantable Volume (optional)

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- C. Gross Volume
- D. Number of Trees
- E. Number of 16-Foot Logs (optional)
- F. Realization Value (optional)
- G. Sample Error (for sample cruises)

.53 Species and Sales Summaries. At a minimum, species and sale summaries provide the following:

- A. Net Merchantable Volume
- B. Gross Merchantable Volume
- C. Gross Volume
- D. Number of Trees
- E. Number of 16-Foot Logs (optional)
- F. Realization Value (optional)
- G. Percent of Volume by Log grade (optional)
- H. Sample Error (for sample cruises)

.54 Filing Requirement. The timber cruise report or a copy of the report must be filed in the project folder.

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Illustration 1

Field Tally Sheet - Graded & Cull Logs

DISTRICT Eugene : 205 7W 5 COMP. SALE NO. _____
 TRACT NO. _____ SALE NAME _____ SUBSALE NO. _____
 DATE 11-17-80 SPEC. CODE NO. _____
 SPECIES Green D. fir AREA NO. Unit 3 P. C. _____
 NO. OF TREES _____ CRUISER Tim Burr J & B I-3 _____

GRADED LOGS 4-4

DBH-HT	1	2	3	4	5	6	7	8	9	10	11	12	Notes
1 12-1	6												①
2 16-4	5	6	6	6									①
3 20-4	5	-	6	-									①
4 28-6	5	-	-	-	-	6							①
5 36-8	3	-	5	-	-	-	-	7					①
6 36-8	3	5	-	-	-	-	-	7					①
7 40-8	3	-	5	-	-	-	-	7					②
8													
9													
10													
	1	2	3	4	5	6	7	8	9	10	11	12	
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													

Field Tally Sheet - Ungraded Cull Logs

DISTRICT Eugene TRACT NO. 205-7W-5 COMP. SALE NO. _____
 TRACT NO. _____ SALE NAME _____ SUBSALE NO. _____
 DATE 11-17-80 SPEC. CODE NO. _____
 SPECIES Green D. fir AREA NO. Unit 3 P. C. _____
 NO. OF TREES _____ CHUISER Tim Burr J & B I-3 _____

UNGRADED CULL LOGS

COM-NT	NO. OF LOGS	1	2	3	4	5	6	7	8	9	10	11	12
1	12-1 <input checked="" type="checkbox"/> ⑩												
2	-2 1: ⑤												
3	-3 " ②												
4	16-2 " ①												
5	-3 L ⑥												
6	-4 " ③												
7	20-3 " ①												
8	-4 1: ⑤												
9	-5 L ⑥												
10	24-5 " ①												
11	-6 L ⑥												
12	-7 " ④												
13	28-6 " ③												
14	-7 " ①												
15	-8 " ②												
16	32-6 " ②												
17	-7 <input checked="" type="checkbox"/> ③												
18	-8 " ①												
19	36-7 " ②												
20	-8 <input checked="" type="checkbox"/> L ⑦												
21	-9 L ⑦												
22	40-7 " ②												
	8 <input checked="" type="checkbox"/> L ②												
	9 <input checked="" type="checkbox"/> L ②												

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Field Tally Sheet - DBH & Total Height

Cruiser - Tim Burr
Date - 12-5-80
T. 15S., R. 7W., Sec. 17
Species - Green Lodgepole pine
Area - Unit #1

Numbers of trees

DBH	Total Height						
	40	50	60	70	80	90	100
8	:: (3)	· (1)					
10		:: (3)					
12		:: (4)	" (2)				
14		· (1)	□ (7)	" (2)			
16			· (1)	▣ (9)	" (2)		
18				" (2)	▣ (11)	" (2)	
20						r. (6)	:: (3)
22						:: (3)	:: (5)

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Illustration 4

<u>Subsale Summary Sheet</u>			
			Date <u>12-10-80</u>
Units	Subsale Number	Species	Number of Trees
15-7-17 (Unit #1)	1	Gr. Lodgepole pine	66
" "	2	Sal. Lodgepole pine	110
" "	3	Gr. Engelmann spruce	83
" "	4	Sal. Engelmann spruce	270
15-7-17 (R/W)	5	Gr. Lodgepole pine	113
15-7-17 (Unit #2)	6	Gr. Lodgepole pine	43
" "	7	Sal. Lodgepole pine	24
" "	8	Gr. Engelmann spruce	33
Total			742

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Illustration 5

Volume Computations							
Subsale Number	DBH	Total Height	Volume Per Tree	Number of Trees	Gross Volume	Recovery Factor	Net Volume
1	8	40	23	3	69		
1	22	100	548	5	2,740		
				66	16,951	.95	16,103
2	8	40	23	8	184		
2	20	90	427	7	2,989		
				110	26,400	.80	21,120
3	10	60	57	5	285		
3	24	110	735	4	2,940		
				83	21,995	.95	20,895
4	8	40	18	11	198		
4	18	100	360	4	1,440		
				270	59,400	.80	47,520
5	12	80	131	17	2,227		
5	24	110	713	2	1,426		
				113	31,640	.95	30,058
6	10	80	89	16	1,424		
6	26	120	909	1	909		
				43	10,320	.95	9,804
7	8	70	46	19	874		
7	24	110	713	8	5,704		
				24	6,013	.80	4,810
8	10	60	57	3	171		
8	24	110	735	2	1,470		
				33	7,425	.95	7,054

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Illustration 6

<u>Timber Cruise Report</u>				
				Date <u>12-15-80</u>
<u>Subsale Number</u>	<u>Number of Trees</u>	<u>Gross Volume</u>	<u>Net Volume</u>	<u>Realization Value/MBF</u>
1	66	16,951	16,103	
2	110	26,400	21,120	
3	83	21,995	20,895	
4	270	59,400	47,520	
Subtotal	529	124,746	105,638	
5	113	31,640	30,058	
Subtotal	113	31,640	30,058	
6	43	10,320	9,804	
7	24	6,013	4,810	
8	33	7,425	7,054	
Subtotal	100	23,758	21,668	
<u>Species Totals</u>				
Lodgepole pine	356	91,324	81,895	268.15
Engelmann spruce	386	88,820	75,465	268.15
<u>Sale Totals</u>				
	742	180,144	157,360	

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