WHITE PAPER

USDA Forest Service Pacific Northwest Region Umatilla National Forest

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Calculated Values of Basal Area and Board-Foot Timber Volume for Existing (Known) Values of Canopy Cover[1]

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INTRODUCTION. The USDA Forest Service uses a variety of planning processes, many of which occur at differing scales:

- Bioregional assessments such as the Interior Columbia Basin Ecosystem Management Project (Quigley et al. 1996 and many other citations) cover a broad, regional scale;
- Land and Resource Management Plans (USDA Forest Service 1990) or a national-forest resource inventory (Christensen et al. 2007) result from broad-scale assessment or planning processes;
- Ecosystem Analysis at the Watershed Scale (REO 1995) is an example of mid-scale assessment; and
- Project-scale plans direct implementation of natural resource management activities under the National Environmental Policy Act – an example is the environmental impact statement for the School Fire Salvage Recovery Project (USDA Forest Service 2006).

For planning efforts occurring at a fine or project scale, it is common to have incomplete information when characterizing existing vegetation conditions. To handle incomplete information, vegetation analysts often need to relate a metric for which they have data to another metric for which data is lacking.

Fine-scale, project-level planning often relies on low-resolution data sources derived from remote imagery or interpretation of aerial photography. [Note: White Papers Silv-02, Description of Composite Vegetation Database, and Silv-14, Description of EVG-PI Database, describe low-resolution vegetation data sources in more detail.] Remote sensing data sources generally provide an analyst with canopy cover data for characterizing stand density. For these sources, an analyst seldom has access to basal area or higher-resolution data for characterizing stand density.

[1] White papers are internal reports receiving only limited review. Viewpoints expressed in this paper are those of the author – they may not represent positions of USDA Forest Service.

If fine-scale planning requires that vegetation conditions be characterized by using a metric not available in a database, then an analyst essentially has two choices: acquire additional data by conducting field inventories or by procuring additional imagery, or derive (calculate) a missing metric by relating it to another metric available from the database.

Eight tables provided in this report show how existing (known) amounts of canopy cover were used to calculate corresponding amounts of basal area, and how basal area values were then related to board-foot timber volume for three common tree-size classes. Tables are provided for seven individual tree species, along with a separate table for a 'mixed-conifer' forest type.

METHODOLOGY. Eight tables provided in this white paper present calculated amounts of basal area (ft^2/acre) for existing (known) values of canopy cover.

Calculations used to prepare the tables are based on equations developed during a Blue Mountains elk thermal cover study (Dealy 1985), where 'crown closure' (canopy cover) percentage and basal area (square feet per acre) were sampled for 609 unmanaged stands by using a type A spherical densiometer (to measure canopy cover) and a '10-factor' prism (to measure basal area) at each sample plot.

Studies other than Dealy's (1985) have also found basal area to be correlated with overstory canopy cover, although the relationship is not necessarily consistent across a full range of canopy cover values (Mitchell and Popovich 1997).

Dealy's equations require measured values of basal area (ft^2/acre) as an input variable to calculate canopy cover (percent) as an output result. Since Dealy's equations use basal area as an input, they had to be "reverse solved" to calculate basal area as an output result when canopy cover is used as an input. This reverse solving process was accomplished by using the Goal Seek function in Excel (this function is available from Excel's Tools menu).

Calculated values of basal area were then related to a potential board foot volume per acre by using "volume/basal area ratios" (VBAR). VBAR factors were calculated by Glenn Fischer from Current Vegetation Survey data collected for the Umatilla National Forest, and they are presented by tree species and diameter class (appendix A).

To analyze potential board foot yields, three different size class scenarios were used: a pole size class with a quadratic mean diameter (QMD) of 8", a small size class with a QMD of 12", and a medium size class with a QMD of 16".

The board-foot volumes shown in the tables could be used to estimate potential treatment yields by following a 6-step process:

1. First, select a cover type (species) best representing the stand being evaluated;
2. Then, select a size class for the stand (pole, small, or medium);
3. Then, obtain the stand's existing canopy cover from a vegetation database;
4. Then, use the canopy cover value to look up its corresponding basal area value (use 2nd column for basal area estimates);
5. Then, assume what proportion of the stand's basal area would be removed by a proposed treatment; and
6. Finally, calculate the potential board foot yield by multiplying the removal proportion by the total MBF/Acre value from the table.

As an example of the 6-step estimation procedure, assume the following:

1. Ponderosa pine stand with a small size class and 60% canopy cover.
2. App. half of stand stocking is to be removed in a thinning treatment.

Treatment yield for this scenario would then be estimated as:

11.6 total MBF/Acre (from small size class column and 60% canopy cover line in table 1 for PP) × .5 (removal proportion) = 5.8 MBF/Acre for this treatment (assuming a proportional thinning removing trees in roughly equal proportions from all merchantable size classes).

CAUTIONS AND CAVEATS.

Dealy's (1985) sample included unmanaged stands only (defined as no evidence of timber harvest), so his mature-stand dataset did not include a wide range of basal areas.

I suspect that calculated basal area values shown in gray cells for each table (tables 1-8) might be beyond the effective range of his equation for these tree species. But my supposition has not been tested in a field setting. However, I recommend use the 'gray-cell' portions of tables 1-8 with caution or after validation!

Dealy (1985) used a 'type A' spherical densiometer (Dealy 1960, Lemmon 1956, Strickler 1959) to collect his forest canopy cover measurements. Research in northeastern Oregon examining use of densiometers found they can overestimate canopy cover significantly and are apparently insensitive to substantial variations in forest cover (Cook et al. 1995). Another research report corroborates this finding because it concluded that spherical densiometers may be unsuitable for estimating canopy cover for many applications in forest ecology (Bunnell and Vales 1990).

Table 1: Calculated basal area and board-foot timber volume values for ponderosa pine.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	12.26	1.01	1.28	1.65
25	16.32	1.34	1.71	2.20
30	21.60	1.78	2.26	2.91
35	28.51	2.34	2.98	3.84
40	37.52	3.08	3.93	5.05
45	49.28	4.05	5.16	6.64
50	64.63	5.31	6.76	8.71
55	84.68	6.96	8.86	11.41
60	110.84	9.11	11.60	14.93
65	144.99	11.92	15.18	19.53
70	189.59	15.59	19.84	25.54
75	247.79	20.37	25.93	33.38
80	323.77	26.62	33.89	43.62
85	422.94	34.77	44.27	56.98
90	552.41	45.42	57.82	74.42
95	721.42	59.32	75.50	97.19

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 2: Calculated basal area and board-foot timber volume values for Douglas-fir.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	2.71	0.27	0.31	0.38
25	4.06	0.40	0.47	0.57
30	5.88	0.58	0.67	0.83
35	8.37	0.83	0.96	1.18
40	11.75	1.16	1.35	1.65
45	16.36	1.62	1.88	2.30
50	22.63	2.24	2.60	3.18
55	31.16	3.08	3.58	4.38
60	42.79	4.23	4.91	6.02
65	58.60	5.79	6.72	8.24
70	80.13	7.92	9.19	11.27
75	109.44	10.82	12.55	15.39
80	149.34	14.76	17.13	21.01
85	203.65	20.13	23.36	28.65
90	277.58	27.44	31.84	39.05
95	378.22	37.38	43.39	53.20

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 3: Calculated basal area and board-foot timber volume values for grand fir.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	3.11	0.28	0.37	0.47
25	4.43	0.40	0.53	0.67
30	6.16	0.55	0.73	0.93
35	8.44	0.76	1.00	1.27
40	11.45	1.03	1.36	1.73
45	15.42	1.39	1.83	2.33
50	20.66	1.86	2.45	3.12
55	27.57	2.48	3.27	4.16
60	36.68	3.30	4.35	5.54
65	48.70	4.38	5.78	7.35
70	64.55	5.81	7.66	9.75
75	85.45	7.69	10.14	12.90
80	113.02	10.17	13.41	17.06
85	149.38	13.44	17.73	22.55
90	197.34	17.75	23.42	29.80
95	260.60	23.44	30.93	39.35

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 4: Calculated basal area and board-foot timber volume values for western larch.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	8.20	1.13	1.32	1.57
25	11.12	1.53	1.79	2.13
30	14.96	2.06	2.41	2.87
35	20.03	2.76	3.23	3.84
40	26.69	3.68	4.30	5.12
45	35.47	4.89	5.71	6.81
50	47.04	6.48	7.58	9.03
55	62.27	8.58	10.03	11.95
60	82.33	11.35	13.26	15.80
65	108.76	14.99	17.52	20.87
70	143.56	19.78	23.12	27.55
75	189.40	26.10	30.51	36.34
80	249.78	34.42	40.23	47.93
85	329.30	45.38	53.04	63.18
90	434.04	59.81	69.91	83.28
95	571.97	78.82	92.13	109.74

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 5: Calculated basal area and board-foot timber volume values for lodgepole pine.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	8.20	1.15	1.31	1.57
25	11.12	1.56	1.77	2.13
30	14.96	2.10	2.39	2.87
35	20.03	2.81	3.19	3.84
40	26.69	3.74	4.26	5.12
45	35.47	4.97	5.66	6.81
50	47.04	6.59	7.50	9.03
55	62.27	8.72	9.93	11.95
60	82.33	11.53	13.14	15.80
65	108.76	15.24	17.35	20.88
70	143.56	20.11	22.90	27.56
75	189.40	26.53	30.22	36.36
80	249.78	34.99	39.85	47.95
85	329.30	46.13	52.54	63.21
90	434.04	60.80	69.25	83.31
95	571.97	80.13	91.25	109.79

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 6: Calculated basal area and board-foot timber volume values for Engelmann spruce.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	3.15	0.33	0.42	0.51
25	4.52	0.48	0.61	0.74
30	6.33	0.67	0.85	1.03
35	8.75	0.92	1.17	1.43
40	11.96	1.26	1.60	1.95
45	16.22	1.71	2.17	2.65
50	21.89	2.31	2.93	3.57
55	29.42	3.10	3.94	4.80
60	39.44	4.16	5.28	6.43
65	52.75	5.56	7.07	8.61
70	70.44	7.43	9.44	11.49
75	93.96	9.91	12.59	15.33
80	125.21	13.20	16.77	20.43
85	166.76	17.58	22.34	27.21
90	221.98	23.40	29.73	36.22
95	295.36	31.14	39.56	48.19

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 7: Calculated basal area and board-foot timber volume values for subalpine fir.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	3.15	0.27	0.32	0.41
25	4.52	0.39	0.46	0.59
30	6.33	0.55	0.65	0.83
35	8.75	0.76	0.90	1.14
40	11.96	1.04	1.23	1.56
45	16.22	1.41	1.66	2.11
50	21.89	1.90	2.24	2.85
55	29.42	2.55	3.02	3.84
60	39.44	3.42	4.04	5.14
65	52.75	4.58	5.41	6.88
70	70.44	6.11	7.22	9.18
75	93.96	8.16	9.63	12.25
80	125.21	10.87	12.83	16.32
85	166.76	14.48	17.09	21.74
90	221.98	19.27	22.75	28.93
95	295.36	25.64	30.27	38.50

Sources/Notes: Refer to cautions and caveats section (p. 3) for an explanation of gray cells.

Table 8: Calculated basal area and board-foot timber volume values for the mixed-conifer type.

Existing (known) Canopy cover %	Calculated Basal Area (Ft^2/Ac)	Pole Size Class: 8" DBH; 82.2 BF/SF (MBF/Acre)	Small Size Class: 12" DBH; 104.7 BF/SF (MBF/Acre)	Medium Size Class: 16" DBH; 134.7 BF/SF (MBF/Acre)
20	12.26	1.01	1.28	1.65
25	16.32	1.34	1.71	2.20
30	21.60	1.78	2.26	2.91
35	28.51	2.34	2.98	3.84
40	37.52	3.08	3.93	5.05
45	49.28	4.05	5.16	6.64
50	47.04	6.48	7.58	9.03
55	62.27	8.58	10.03	11.95
60	82.33	11.35	13.26	15.80
65	58.60	5.79	6.72	8.24
70	80.13	7.92	9.19	11.27
75	109.44	10.82	12.55	15.39
80	149.34	14.76	17.13	21.01
85	149.38	13.44	17.73	22.55
90	197.34	17.75	23.42	29.80
95	260.60	23.44	30.93	39.35

Sources/Notes: 20-45% lines came from ponderosa pine table; 50-60% lines came from western larch table; 65-80% lines from Douglas-fir table; and 85-95% lines from grand fir table.

APPENDIX A: TREE VOLUMES BY SPECIES AND DIAMETER CLASS

SPECIES	DIAMETER	CUBIC FEET	BOARD FEET	BF/CF	BF VOLUME/SF	CF VOLUME/SF
DOUGLAS-FIR (BASIS: 5,604 TREES)	8	6.5	34.5	5.31	98.84	18.62
	10	11.8	55.6	4.71	101.94	21.64
	12	19.3	90.1	4.67	114.72	24.57
	14	28.5	138.2	4.85	129.28	26.66
	16	39.8	196.4	4.93	140.67	28.51
	18	54.2	278.3	5.13	157.49	30.67
	20	69.7	373.6	5.36	171.25	31.95
	22	87.3	486.7	5.58	184.37	33.07
	24	109.6	632.5	5.77	201.34	34.89
	26	130.6	779.5	5.97	211.42	35.42
	28	156.1	955.3	6.12	223.41	36.51
	30	183.9	1155.3	6.28	235.36	37.46
	32	223.7	1444.5	6.46	258.64	40.05
	34	247.8	1632.0	6.59	258.85	39.30
	36	285.5	1930.8	6.76	273.16	40.39
	38	329.9	2233.3	6.77	283.57	41.89
	40	332.5	2254.1	6.78	258.31	38.10
	42	386.0	2616.4	6.78	271.95	40.12
	44	444.0	3017.9	6.80	285.81	42.05
	46	490.3	3368.1	6.87	291.85	42.48
	48	528.6	3660.8	6.93	291.33	42.07
	50	571.9	4006.1	7.00	293.81	41.94
LODGEPOLE PINE (BASIS: 1,043 TREES)	6	3.9	18.9	4.90	96.26	19.66
	8	9.0	48.9	5.43	140.09	25.78
	10	15.8	76.2	4.82	139.71	28.97
	12	25.1	125.3	4.99	159.54	31.96
	14	36.3	183.3	5.05	171.47	33.96
	16	51.0	268.0	5.25	191.95	36.53
	18	66.8	372.5	5.58	210.80	37.80
	20	84.0	477.6	5.69	218.92	38.50
	22	104.6	631.3	6.04	239.15	39.63
	24	132.0	835.6	6.33	265.99	42.02
SUBALPINE FIR (BASIS: 977 TREES)	8	5.8	30.3	5.22	86.81	16.62
	10	11.1	53.5	4.82	98.09	20.35
	12	17.9	80.5	4.50	102.50	22.79
	14	26.9	129.7	4.82	121.33	25.16
	16	37.4	182.0	4.87	130.35	26.79
	18	50.4	355.0	7.04	200.89	28.52
	20	64.7	342.8	5.30	157.13	29.66
	22	77.4	421.2	5.44	159.56	29.32
	24	98.7	548.1	5.55	174.47	31.42
	26	103.9	600.8	5.78	162.96	28.18
	28	146.2	883.3	6.04	206.57	34.19

APPENDIX A: TREE VOLUMES BY SPECIES AND DIAMETER CLASS

SPECIES	DIAMETER	CUBIC FEET	BOARD FEET	BF/CF	BF VOLUME/SF	CF VOLUME/SF
GRAND FIR (BASIS: 5,936 TREES)	8	6.0	31.4	5.23	89.96	17.19
	10	11.5	55.1	4.79	101.03	21.09
	12	19.7	93.2	4.73	118.67	25.08
	14	29.8	146.9	4.93	137.42	27.88
	16	41.9	210.8	5.03	150.98	30.01
	18	57.7	303.3	5.26	171.64	32.65
	20	74.2	406.0	5.47	186.10	34.01
	22	93.8	530.6	5.66	201.00	35.53
	24	114.0	664.5	5.83	211.52	36.29
	26	140.0	851.4	6.08	230.93	37.97
	28	165.1	1025.6	6.21	239.85	38.61
	30	205.9	1321.4	6.42	269.20	41.95
	32	230.6	1499.5	6.50	268.49	41.29
	34	262.6	1738.4	6.62	275.73	41.65
	36	304.1	2070.2	6.81	292.88	43.02
	38	341.4	2339.4	6.85	297.04	43.35
	40	379.0	2628.9	6.94	301.26	43.43
	42	435.3	3031.2	6.96	315.07	45.25
	44	478.0	3327.8	6.96	315.16	45.27
	46	505.8	3565.2	7.05	308.93	43.83
	48	583.4	4056.9	6.95	322.85	46.43
	50	620.9	4376.4	7.05	320.97	45.54
	52	703.2	5028.9	7.15	341.00	47.68
ENGELMANN SPRUCE (BASIS: 1,638 TREES)	8	6.8	36.8	5.41	105.43	19.48
	10	12.9	62.5	4.84	114.59	23.65
	12	22.1	105.2	4.76	133.95	28.14
	14	31.8	156.9	4.93	146.77	29.75
	16	45.0	227.8	5.06	163.15	32.23
	18	60.8	315.6	5.19	178.60	34.41
	20	79.2	437.1	5.52	200.36	36.30
	22	93.7	523.0	5.58	198.13	35.50
	24	119.1	692.0	5.81	220.28	37.91
	26	140.0	839.6	6.00	227.72	37.97
	28	168.7	1046.0	6.20	244.62	39.45
	30	198.7	1255.8	6.32	255.84	40.48
	32	229.2	1470.8	6.42	263.35	41.04
	34	266.5	1759.2	6.60	279.02	42.27
	36	288.0	1924.1	6.68	272.21	40.74
	38	355.4	2433.8	6.85	309.03	45.13
	40	378.2	2596.0	6.86	297.49	43.34
	42	424.4	2969.8	7.00	308.68	44.11
	44	517.5	3620.0	7.00	342.84	49.01

APPENDIX A: TREE VOLUMES BY SPECIES AND DIAMETER CLASS

Species	Diameter	Cubic Feet	Board Feet	BF/CF	BF Volume/SF	CF Volume/SF
PONDEROSA PINE (BASIS: 3,352 TREES)	8	5.6	28.7	5.13	82.22	16.04
	10	11.0	50.6	4.60	92.78	20.17
	12	17.9	82.2	4.59	104.66	22.79
	14	26.7	127.2	4.76	118.99	24.98
	16	38.6	188.1	4.87	134.72	27.65
	18	52.4	268.5	5.12	151.94	29.65
	20	68.2	365.2	5.35	167.40	31.26
	22	92.5	525.9	5.69	199.22	35.04
	24	115.8	686.4	5.93	218.49	36.86
	26	138.3	842.1	6.09	228.40	37.51
	28	168.6	1060.1	6.29	247.92	39.43
	30	200.0	1281.3	6.41	261.03	40.74
	32	242.5	1607.1	6.63	287.76	43.42
	34	281.9	1923.7	6.82	305.12	44.71
	36	316.8	2163.6	6.83	306.10	44.82
	38	362.3	2498.9	6.90	317.30	46.00
	40	410.0	2841.6	6.93	325.63	46.98
	42	461.6	3177.9	6.88	330.31	47.98
	44	534.9	3718.5	6.95	352.17	50.66
	46	544.4	3773.6	6.93	326.98	47.17
	48	620.9	4392.4	7.07	349.55	49.41
	50	733.7	5354.8	7.30	392.72	53.81
WESTERN LARCH (BASIS: 1,843 TREES)	8	8.6	48.1	5.59	137.80	24.64
	10	15.7	78.8	5.02	144.48	28.79
	12	25.8	126.5	4.90	161.07	32.85
	14	37.0	187.2	5.06	175.12	34.61
	16	51.7	267.9	5.18	191.87	37.03
	18	68.0	362.7	5.33	205.25	38.48
	20	87.5	490.1	5.60	224.65	40.11
	22	109.9	639.8	5.82	242.37	41.63
	24	138.3	831.9	6.02	264.81	44.02
	26	157.1	982.8	6.26	266.57	42.61
	28	193.0	1229.7	6.37	287.59	45.14
	30	235.0	1535.6	6.53	312.84	47.88
	32	253.1	1684.7	6.66	301.65	45.32
	34	302.7	2073.3	6.85	328.84	48.01
	36	341.6	2360.0	6.91	333.88	48.33
	38	389.8	2737.9	7.02	347.64	49.49
	40	417.3	2953.7	7.08	338.48	47.82
	42	465.6	3263.1	7.01	339.17	48.39

Sources/Notes: Compiled by Glenn Fischer from Current Vegetation Survey (CVS) data for Umatilla National Forest. Values are an average of all live trees in a diameter class. BF/CF is a board foot/cubic foot ratio. "BF Volume/SF" and "CF Volume/SF" refer to the board foot or cubic foot volume, respectively, per square foot of basal area; calculated as: Board Feet (or CF)/(Diameter^2 × .005454).

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APPENDIX: SILVICULTURE WHITE PAPERS

White papers are internal reports, and they are produced with a consistent formatting and numbering scheme – all papers dealing with Silviculture, for example, are placed in a silviculture series (Silv) and numbered sequentially. Generally, white papers receive only limited review and, in some instances pertaining to highly technical or narrowly focused topics, the papers may receive no technical peer review at all. For papers that receive no review, the viewpoints and perspectives expressed in the paper are those of the author only, and do not necessarily represent agency positions of the Umatilla National Forest or the USDA Forest Service.

Large or important papers, such as two papers discussing active management considerations for dry and moist forests (white papers Silv-4 and Silv-7, respectively), receive extensive review comparable to what would occur for a research station general technical report (but they don't receive blind peer review, a process often used for journal articles).

White papers are designed to address a variety of objectives:

(1) They guide how a methodology, model, or procedure is used by practitioners on the Umatilla National Forest (to ensure consistency from one unit, or project, to another).

(2) Papers are often prepared to address ongoing and recurring needs; some papers have existed for more than 20 years and still receive high use, indicating that the need (or issue) has long standing – an example is white paper #1 describing the Forest's big-tree program, which has operated continuously for 25 years.

(3) Papers are sometimes prepared to address emerging or controversial issues, such as management of moist forests, elk thermal cover, or aspen forest in the Blue Mountains. These papers help establish a foundation of relevant literature, concepts, and principles that continuously evolve as an issue matures, and hence they may experience many iterations through time. [But also note that some papers have not changed since their initial development, in which case they reflect historical concepts or procedures.]

(4) Papers synthesize science viewed as particularly relevant to geographical and management contexts for the Umatilla National Forest. This is considered to be the Forest's self-selected 'best available science' (BAS), realizing that non-agency commenters would generally have a different conception of what constitutes BAS – like beauty, BAS is in the eye of the beholder.

(5) The objective of some papers is to locate and summarize the science germane to a particular topic or issue, including obscure sources such as master's theses or Ph.D. dissertations. In other instances, a paper may be designed to wade through an overwhelming amount of published science (dry-forest management), and then synthesize sources viewed as being most relevant to a local context.

(6) White papers function as a citable literature source for methodologies, models, and procedures used during environmental analysis – by citing a white paper, specialist reports can include less verbiage describing analytical databases, techniques, and so forth, some of which change little (if at all) from one planning effort to another.

(7) White papers are often used to describe how a map, database, or other product was developed. In this situation, the white paper functions as a 'user's guide' for the new product. Examples include papers dealing with historical products: (a) historical fire extents for the Tucannon watershed (WP Silv-21); (b) an 1880s map developed from General Land Office survey notes (WP Silv-41); and (c) a

description of historical mapping sources (24 separate items) available from the Forest's history website (WP Silv-23).

The following papers are available from the Forest's website: Silviculture White Papers

Paper #	Title
1	Big tree program
2	Description of composite vegetation database
3	Range of variation recommendations for dry, moist, and cold forests
4	Active management of Blue Mountains dry forests: Silvicultural considerations
5	Site productivity estimates for upland forest plant associations of Blue and Ochoco Mountains
6	Blue Mountains fire regimes
7	Active management of Blue Mountains moist forests: Silvicultural considerations
8	Keys for identifying forest series and plant associations of Blue and Ochoco Mountains
9	Is elk thermal cover ecologically sustainable?
10	A stage is a stage is a stage…or is it? Successional stages, structural stages, seral stages
11	Blue Mountains vegetation chronology
12	Calculated values of basal area and board-foot timber volume for existing (known) values of canopy cover
13	Created opening, minimum stocking, and reforestation standards from Umatilla National Forest Land and Resource Management Plan
14	Description of EVG-PI database
15	Determining green-tree replacements for snags: A process paper
16	Douglas-fir tussock moth: A briefing paper
17	Fact sheet: Forest Service trust funds
18	Fire regime condition class queries
19	Forest health notes for an Interior Columbia Basin Ecosystem Management Project field trip on July 30, 1998 (handout)
20	Height-diameter equations for tree species of Blue and Wallowa Mountains
21	Historical fires in headwaters portion of Tucannon River watershed
22	Range of variation recommendations for insect and disease susceptibility
23	Historical vegetation mapping
24	How to measure a big tree
25	Important Blue Mountains insects and diseases
26	Is this stand overstocked? An environmental education activity
27	Mechanized timber harvest: Some ecosystem management considerations
28	Common plants of south-central Blue Mountains (Malheur National Forest)
29	Potential natural vegetation of Umatilla National Forest
30	Potential vegetation mapping chronology
31	Probability of tree mortality as related to fire-caused crown scorch
32	Review of "Integrated scientific assessment for ecosystem management in the interior Columbia basin, and portions of the Klamath and Great basins" – Forest vegetation
33	Silviculture facts

Paper #	Title
34	Silvicultural activities: Description and terminology
35	Site potential tree height estimates for Pomeroy and Walla Walla Ranger Districts
36	Stand density protocol for mid-scale assessments
37	Stand density thresholds as related to crown-fire susceptibility
38	Umatilla National Forest Land and Resource Management Plan: Forestry direction
39	Updates of maximum stand density index and site index for Blue Mountains variant of Forest Vegetation Simulator
40	Competing vegetation analysis for southern portion of Tower Fire area
41	Using General Land Office survey notes to characterize historical vegetation conditions for Umatilla National Forest
42	Life history traits for common Blue Mountains conifer trees
43	Timber volume reductions associated with green-tree snag replacements
44	Density management field exercise
45	Climate change and carbon sequestration: Vegetation management considerations
46	Knutson-Vandenberg (K-V) program
47	Active management of quaking aspen plant communities in northern Blue Mountains: Regeneration ecology and silvicultural considerations
48	Tower Fire…then and now. Using camera points to monitor postfire recovery
49	How to prepare a silvicultural prescription for uneven-aged management
50	Stand density conditions for Umatilla National Forest: A range of variation analysis
51	Restoration opportunities for upland forest environments of Umatilla National Forest
52	New perspectives in riparian management: Why might we want to consider active management for certain portions of riparian habitat conservation areas?
53	Eastside Screens chronology
54	Using mathematics in forestry: An environmental education activity
55	Silviculture certification: Tips, tools, and trip-ups
56	Vegetation polygon mapping and classification standards: Malheur, Umatilla, and Wallowa-Whitman National Forests
57	State of vegetation databases for Malheur, Umatilla, and Wallowa-Whitman National Forests
58	Seral status for tree species of Blue and Ochoco Mountains

REVISION HISTORY

January 2014: minor formatting and text edits were made throughout the document, and a new appendix was added describing the white paper system, including a list of available white papers.