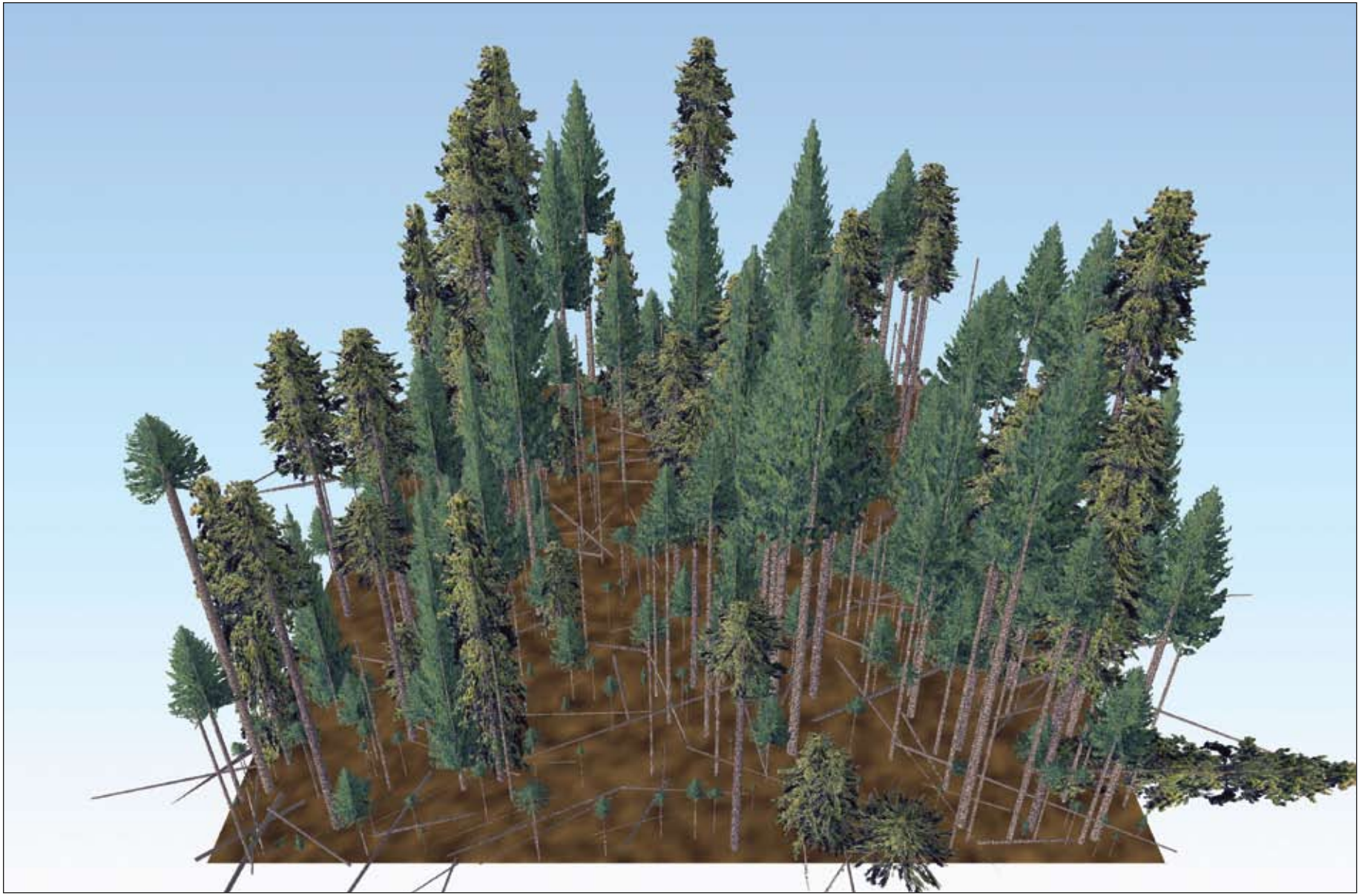
Return to Part C

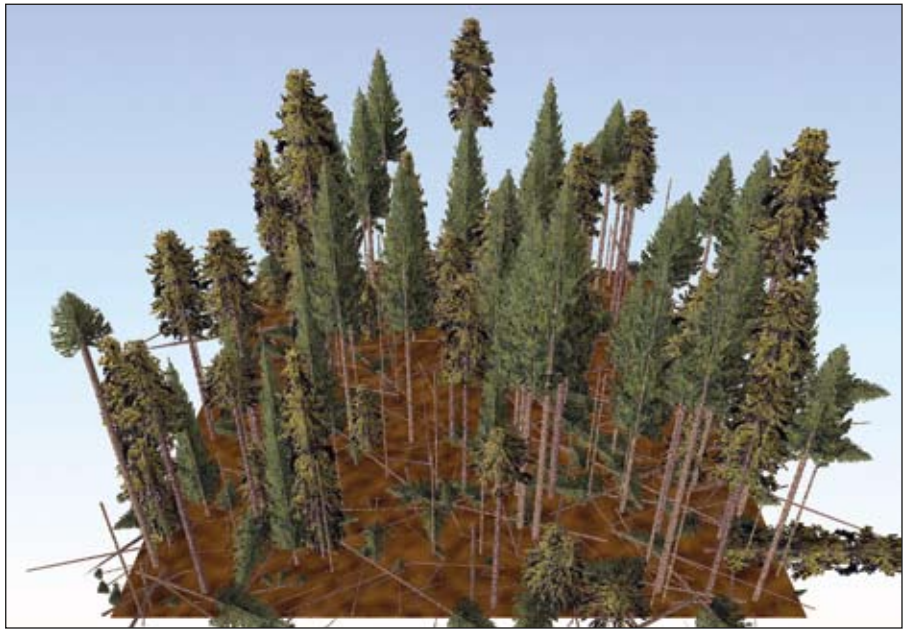


Initial stand conditions

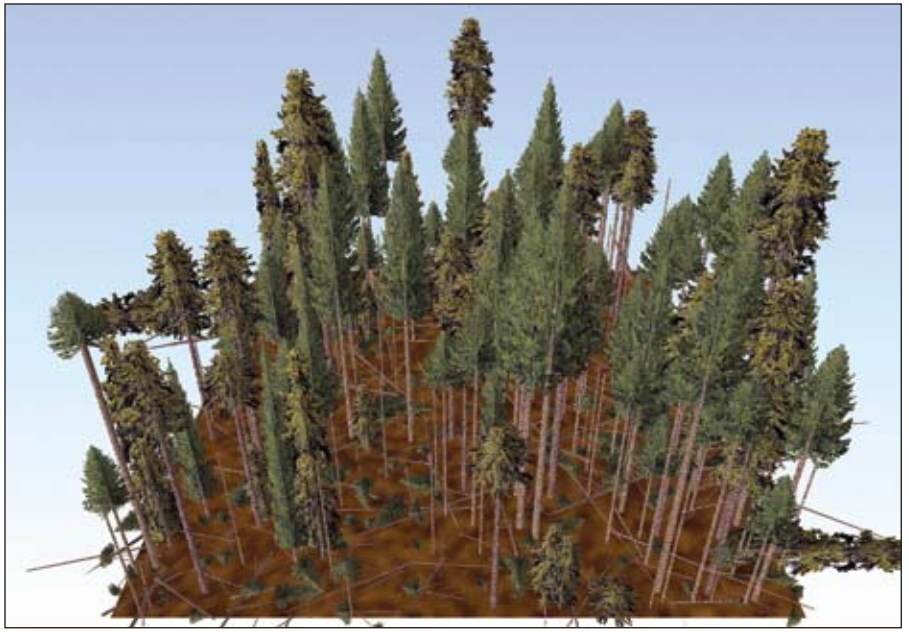
Site: Elevation = 4,700 ft, slope = 30 percent, aspect = 135°.

Species (based on trees per acre): White fir (*Abies concolor*) = 99 percent, ponderosa pine (*Pinus ponderosa*) = 1 percent.

Stand attributes: Stem density = 1,345 tpa, basal area = 246 ft^2/ac, top height = 106 ft, stand density index = 559, quadratic mean diameter = 5.8 in, crown competition factor = 195, canopy cover = 60 percent.

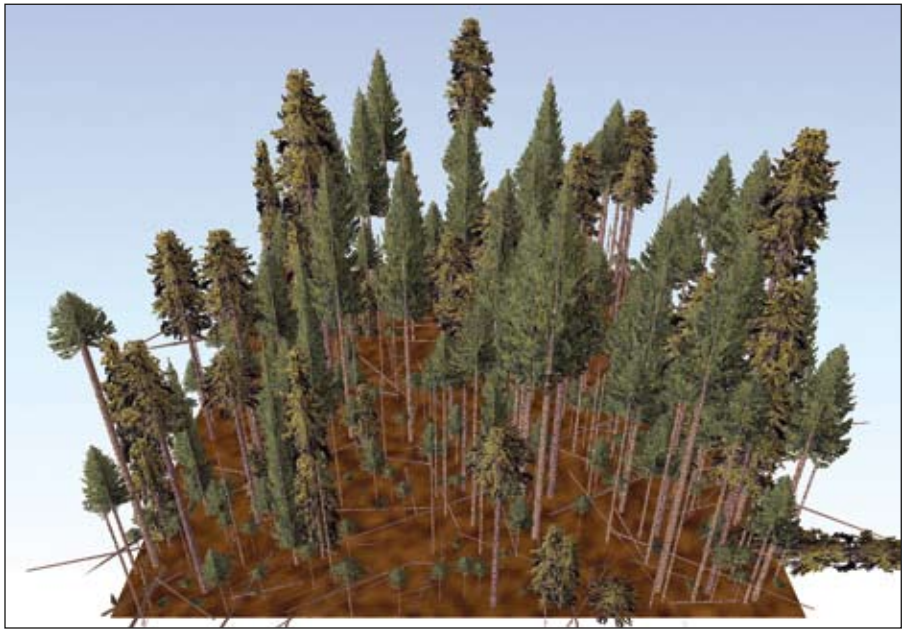


Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit

Thin from below to 200 tpa, 18-in d.b.h. limit



Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This stand has 1,345 trees per acre (tpa) composed of primarily white fir understory with a ponderosa pine overstory. Canopy base height is 4 ft, and canopy bulk density is 0.21 kg/m^3 (0.0131 lb/ft^3), so initial conditions are conducive to passive crown fire and active crown fire spread. Potential flame lengths and mortality are high especially for severe fire weather for which 100-percent basal area mortality is predicted. Woody fuel and duff loadings are high at 30 tons/ac and 20 tons/ac respectively. With no action, canopy base height increases and canopy bulk density decreases as the trees grow and the stand self-thins. Within 10 years, canopy bulk density decreases sufficiently to prevent active crown fire spread, but passive crown fire remains likely for the 50-year projection.

Silvicultural and surface fuel treatments—immediate effects

Prescribed fire only increases canopy base height to 16 ft, reduces canopy bulk density to 0.10 kg/m^3 (0.0062 lb/ft^3), and decreases crown fire potential, but snag density doubles. Fuel loadings, potential flame lengths, and basal area mortality are also reduced. All thinning treatments effectively reduce canopy bulk density and increase canopy base height enough to reduce crown fire potential; the greater the thinning, the greater the reduction in fire hazard. Thinning without surface fuel treatments increases surface fuels; the greater the thinning, the greater are activity fuels and potential flame lengths. Pile and burn reduces woody surface fuels in all size classes, decreasing flame length and tree mortality. Prescribed fire reduces surface fuel loading even more, but reduces primarily litter, duff, and fine woody fuels. Woody fuel loading in the larger size classes remains high following prescribed fire, so fuel model 11 remains the predominant model and flame lengths are higher than in the pile and burn treatment.

Silvicultural and surface fuel treatments—long-term effects

Crown fire remains unlikely for the 50-year projection for all combinations of thinning and surface fuel treatments except the 50 tpa treatment, in which greater regeneration causes a decrease in canopy base height allowing for passive crown fire again in 50 years with no surface fuel treatment or with pile and burn, and in 40 years for the prescribed fire treatment. At this time, a second treatment would be necessary to reduce crown fire potential. It may seem contradictory that the treatment with the greatest reduction in surface fuel loading and tree density would have the most fleeting effect on crown fire potential, but this demonstrates the important influence of regeneration on crown fire potential as predicted with FFE. For all other treatments, canopy base height and canopy bulk density increase as the trees grow and the stand self-thins.

Table 21a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	6	4	12	9	8	7
		3–6 in	5	1	7	7	6	5
		6–12 in	7	3	7	7	7	7
		>12 in	12	8	12	12	12	12
		Litter	2	1	4	3	3	3
		Duff	20	14	20	20	20	20
	Flame length (ft)	Moderate	4	3	5	4	4	4
		Severe	5	4	7	6	5	6
	Torching index	Severe	0	41	111	61	56	22
	Crowning index	Severe	14	26	32	23	18	15
	Type of fire	Moderate	Passive	Surface	Surface	Surface	Surface	Surface
		Severe	Active	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	45	10	5	10	14	18
		Severe	100	12	10	13	17	21
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			3	3	2	2
		3–6 in			2	2	2	2
		6–12 in			2	2	2	2
		>12 in			3	3	3	3
		Litter			4	3	3	3
		Duff			18	18	18	18
	Flame length (ft)	Moderate			4	2	2	2
		Severe			5	3	3	3
	Torching index	Severe			63	66	71	71
	Crowning index	Severe			32	23	18	15
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	9	13	14
		Severe			5	10	13	15
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			1	1	1	1
		3–6 in			3	3	2	2
		6–12 in			7	7	7	7
		>12 in			12	12	12	12
		Litter			1	1	1	1
		Duff			4	4	0	0
	Flame length (ft)	Moderate			3	3	3	3
		Severe			4	4	4	4
	Torching index	Severe			92	55	40	47
	Crowning index	Severe			34	26	26	26
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	8	10	10
		Severe			5	9	11	11

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 21b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	6	6	6	6	6	6	4	6	5	4	4	4
		3–6 in	5	7	8	8	8	8	1	5	5	5	5	5
		6–12 in	7	11	15	15	14	14	3	11	13	13	12	11
		>12 in	12	18	23	28	29	30	8	15	21	25	26	24
		Litter	2	3	3	3	3	3	1	2	2	2	2	2
		Duff	20	21	21	21	21	21	14	14	14	15	15	15
	Flame length (ft)	Moderate	4	5	6	6	6	6	3	5	5	6	5	5
		Severe	5	7	8	8	8	8	4	7	7	7	7	7
	Torching index	Severe	0	0	0	0	0	0	41	27	26	29	37	45
	Crowning index	Severe	14	16	18	20	21	23	26	25	24	22	22	21
	Type of fire	Moderate	Passive	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Active	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	222	277	188	164	132	113	440	75	43	23	15	12
		18–29.9 in	25	23	19	13	10	8	27	23	17	10	6	4
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	12	7	4	3	3	3	9	6	4	4	4	4
		3–6 in	7	8	9	8	7	6	7	8	9	8	7	7
		6–12 in	7	12	14	13	12	10	7	12	15	14	12	11
		>12 in	12	17	22	25	25	23	12	17	22	25	26	25
		Litter	4	1	1	2	2	2	3	2	2	2	2	2
		Duff	20	21	21	20	20	20	20	21	21	21	21	21
	Flame length (ft)	Moderate	5	6	6	6	6	5	4	5	6	6	6	5
		Severe	7	8	8	8	7	7	6	7	8	8	8	7
	Torching index	Severe	111	76	76	78	79	0	61	32	33	35	39	43
	Crowning index	Severe	32	31	30	30	29	29	23	22	21	20	19	19
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	143	101	34	19	11	9	144	102	38	24	17	13
		18–29.9 in	24	22	16	10	6	3	24	21	15	10	7	5
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1

Table 21b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	3	4	3	3	3	3	3	4	3	3	4	4
		3–6 in	2	4	5	5	4	4	2	4	5	5	5	4
		6–12 in	2	7	11	10	9	8	2	7	11	10	10	9
		>12 in	3	10	16	19	20	19	3	10	16	19	20	20
		Litter	4	1	1	2	2	2	3	2	2	2	2	2
		Duff	18	18	18	18	18	18	18	18	18	18	18	18
	Flame length (ft)	Moderate	4	3	4	5	4	4	2	3	4	5	5	5
		Severe	5	5	6	6	6	6	3	5	6	6	6	6
	Torching index	Severe	63	120	91	89	90	2	66	64	46	45	48	51
	Crowning index	Severe	32	31	30	30	29	29	23	22	21	20	19	19
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	143	101	35	20	11	10	144	102	35	23	16	14
		18–29.9 in	24	22	15	10	5	3	24	21	15	10	6	4
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	1	3	3	2	3	3	1	4	3	3	3	3
		3–6 in	3	6	6	5	5	5	2	6	6	6	5	5
		6–12 in	7	13	15	13	12	11	7	14	16	15	14	12
		>12 in	12	18	24	27	27	25	12	19	24	28	28	27
		Litter	1	1	1	1	2	2	3	2	2	2	2	2
		Duff	4	4	5	5	5	5	18	4	5	5	5	6
	Flame length (ft)	Moderate	3	5	6	6	5	5	3	5	6	6	6	6
		Severe	4	7	8	8	7	7	4	7	8	8	8	7
	Torching index	Severe	92	79	76	78	0	0	55	32	32	33	36	40
	Crowning index	Severe	34	33	32	31	30	30	26	25	24	22	22	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	103	64	36	26	20	15	119	74	43	28	19	15
		18–29.9 in	27	24	17	10	6	3	27	23	17	11	7	4
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1

Table 21b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	8	6	5	5	5	6	7	6	5	6	6	6
		3–6 in	6	7	8	8	7	7	5	7	8	8	7	7
		6–12 in	7	11	14	14	13	13	7	11	15	14	14	13
		>12 in	12	17	22	26	26	26	12	17	23	26	27	27
		Litter	3	3	3	3	3	3	3	3	3	3	3	3
		Duff	20	21	21	21	21	21	20	21	21	21	21	21
	Flame length (ft)	Moderate	4	5	6	6	6	6	4	5	6	6	6	6
		Severe	5	7	8	8	8	8	6	7	7	8	8	8
	Torching index	Severe	56	28	27	28	30	32	22	17	14	14	18	18
	Crowning index	Severe	18	17	19	20	20	20	15	15	17	18	20	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	145	108	50	32	29	41	159	121	64	50	43	50
		18–29.9 in	24	21	16	11	8	8	25	22	17	12	8	8
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	4	5	5	5	6	2	4	5	5	6	7
		3–6 in	2	4	5	5	5	5	2	4	5	5	5	6
		6–12 in	2	7	11	11	10	10	2	7	11	11	11	11
		>12 in	3	10	16	20	21	22	3	10	16	21	23	23
		Litter	3	3	3	3	3	3	3	3	3	3	3	3
		Duff	18	18	18	19	19	19	18	18	18	19	19	19
	Flame length (ft)	Moderate	2	3	4	5	5	5	2	3	5	5	5	5
		Severe	3	4	6	7	7	7	3	5	6	7	7	7
	Torching index	Severe	71	58	38	38	38	38	71	37	24	22	25	23
	Crowning index	Severe	18	17	19	20	20	21	15	15	17	18	20	22
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	145	108	50	31	31	43	159	121	65	50	43	52
		18–29.9 in	24	21	16	10	8	8	25	22	17	12	8	8
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1

Table 21b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	1	4	4	4	4	4	1	5	4	4	4	4
		3–6 in	2	7	7	6	6	5	2	7	7	6	6	6
		6–12 in	7	14	16	15	14	12	7	14	16	15	14	12
		>12 in	12	19	24	28	28	27	12	19	24	28	28	27
		Litter	1	2	2	2	2	2	1	2	2	2	2	2
		Duff	0	0	1	1	2	2	0	0	1	1	2	2
	Flame length (ft)	Moderate	3	5	6	6	6	6	3	5	6	6	6	6
		Severe	4	7	8	8	8	8	4	7	8	8	8	7
	Torching index	Severe	40	24	25	32	35	39	47	24	24	25	29	33
	Crowning index	Severe	26	25	24	22	22	21	26	25	24	23	22	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	136	75	44	27	20	17	162	75	44	27	20	16
		18–29.9 in	27	23	17	11	7	4	27	23	17	11	6	4
		30–36 in	2	2	2	1	1	1	2	2	2	1	1	1

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 21c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	1,345	1,145	988	863	761	676	127	124	119	113	107	103
	Quadratic mean diameter (in)	5.8	6.4	7.0	7.6	8.2	8.9	5.8	18.3	19.4	20.4	21.5	22.5
	Total volume (ft^3)	8,959	9,333	9,676	9,982	10,238	10,495	8,421	8,761	9,362	9,976	10,437	10,924
	Merchantable volume (ft^3)	8,280	8,584	8,851	9,352	9,717	9,961	8,014	8,321	8,881	9,605	10,125	10,582
	Basal area (ft^2)	246	257	266	274	282	290	217	227	243	259	271	284
	Stand density index	559	561	560	559	559	558	318	327	343	357	367	378
	Canopy closure (percent)	60	60	59	58	58	57	45	46	47	48	48	49
	Crown competition factor	195	193	191	190	189	189	141	145	152	159	163	168
	Canopy base height (ft)	4	5	6	6	6	7	16	18	19	21	24	27
	Canopy bulk density (kg/m^3)	0.21	0.18	0.15	0.14	0.12	0.12	0.10	0.10	0.11	0.12	0.12	0.13

Table 21c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	1,345	50	149	145	141	137	132	100	147	142	135	129	124
	Quadratic mean diameter (in)	5.8	26.0	15.6	16.2	16.9	17.6	18.2	20.1	17.2	18.1	19.1	19.9	20.8
	Total volume (ft^3)	8,959	7,789	8,025	8,522	9,001	9,419	9,825	8,996	9,330	9,964	10,466	10,927	11,370
	Merchantable volume (ft^3)	8,280	7,600	7,829	8,318	8,774	9,176	9,595	8,654	8,969	9,607	10,067	10,656	11,069
	Basal area (ft^2)	246	184	196	208	219	230	240	220	238	255	267	279	291
	Stand density index	559	232	302	315	327	337	347	306	352	369	379	390	400
	Canopy cover (percent)	60	35	35	36	37	38	39	44	45	46	47	47	48
	Crown competition factor	195	111	116	122	127	132	138	139	147	154	159	164	168
	Canopy base height (ft)	4	44	48	48	48	47	5	21	22	24	25	26	27
	Canopy bulk density (kg/m^3)	0.21	0.07	0.08	0.08	0.08	0.08	0.09	0.11	0.12	0.13	0.13	0.14	0.14
Pile and burn	Trees per acre	1,345	50	199	194	188	184	178	100	173	169	162	155	149
	Quadratic mean diameter (in)	5.8	26.0	13.5	14.1	14.6	15.2	15.8	20.1	15.9	16.7	17.5	18.3	19.1
	Total volume (ft^3)	8,959	7,789	8,025	8,532	9,011	9,469	9,878	8,996	9,330	10,038	10,598	11,082	11,548
	Merchantable volume (ft^3)	8,280	7,600	7,829	8,327	8,784	9,224	9,644	8,654	8,969	9,677	10,192	10,799	11,243
	Basal area (ft^2)	246	184	196	208	220	231	241	220	238	257	271	284	296
	Stand density index	559	232	320	334	347	360	370	306	364	385	398	409	420
	Canopy cover (percent)	60	35	35	36	37	38	40	44	45	47	47	48	49
	Crown competition factor	195	111	116	122	127	133	140	139	147	155	161	166	171
	Canopy base height (ft)	4	44	48	48	48	47	5	21	22	24	25	26	27
	Canopy bulk density (kg/m^3)	0.21	0.07	0.08	0.08	0.08	0.08	0.09	0.11	0.12	0.13	0.14	0.14	0.15
Prescribed fire	Trees per acre	1,345	50	346	340	329	316	306	100	227	218	208	199	191
	Quadratic mean diameter (in)	5.8	26.0	9.9	10.4	10.8	11.3	11.8	20.1	13.2	13.9	14.7	15.3	16.0
	Total volume (ft^3)	8,959	7,417	7,641	8,158	8,598	8,991	9,403	8,297	8,597	9,174	9,677	10,131	10,575
	Merchantable volume (ft^3)	8,280	7,238	7,455	7,962	8,377	8,763	9,181	8,026	8,313	8,900	9,368	9,881	10,305
	Basal area (ft^2)	246	184	187	199	210	220	231	220	217	231	244	255	267
	Stand density index	559	232	343	360	373	384	397	306	356	372	384	395	407
	Canopy cover (percent)	60	35	34	35	36	39	40	44	41	42	43	44	44
	Crown competition factor	195	111	111	117	122	132	140	139	132	139	144	149	154
	Canopy base height (ft)	4	44	48	48	48	4	5	21	22	24	25	26	28
	Canopy bulk density (kg/m^3)	0.21	0.07	0.07	0.08	0.08	0.08	0.08	0.10	0.10	0.11	0.12	0.12	0.13

Table 21c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	1,345	200	216	199	188	171	150	300	301	272	245	220	190
	Quadratic mean diameter (in)	5.8	14.7	14.9	15.9	16.9	18.0	19.2	12.2	12.6	13.7	14.7	15.8	17.0
	Total volume (ft^3)	8,959	9,348	9,688	10,219	10,835	11,158	11,182	9,245	9,592	10,136	10,576	10,899	10,948
	Merchantable volume (ft^3)	8,280	8,684	8,965	9,434	10,237	10,763	10,798	8,535	8,817	9,241	9,846	10,394	10,416
	Basal area (ft^2)	246	237	260	275	292	301	301	243	263	278	290	299	301
	Stand density index	559	372	407	419	435	437	426	412	439	450	457	458	447
	Canopy cover (percent)	60	52	54	54	55	55	53	57	58	58	58	57	56
	Crown competition factor	195	163	174	179	185	187	182	180	187	191	193	194	189
	Canopy base height (ft)	4	15	18	20	21	22	23	12	13	14	15	17	17
	Canopy bulk density (kg/m^3)	0.21	0.15	0.16	0.14	0.14	0.13	0.13	0.20	0.19	0.17	0.15	0.13	0.12
Pile and burn	Trees per acre	1,345	200	229	211	200	181	158	300	314	284	256	230	198
	Quadratic mean diameter (in)	5.8	14.7	14.4	15.5	16.4	17.5	18.7	12.2	12.4	13.4	14.4	15.5	16.7
	Total volume (ft^3)	8,959	9,348	9,688	10,243	10,871	11,162	11,189	9,245	9,592	10,140	10,589	10,946	10,982
	Merchantable volume (ft^3)	8,280	8,684	8,965	9,454	10,271	10,768	10,807	8,535	8,817	9,244	9,858	10,452	10,458
	Basal area (ft^2)	246	237	260	275	293	301	301	243	263	278	291	301	301
	Stand density index	559	372	412	425	442	442	431	412	443	454	461	464	451
	Canopy cover (percent)	60	52	54	55	55	55	53	57	58	58	58	58	56
	Crown competition factor	195	163	174	179	186	187	182	180	187	191	194	195	189
	Canopy base height (ft)	4	15	18	20	21	22	23	12	13	14	15	17	17
	Canopy bulk density (kg/m^3)	0.21	0.15	0.16	0.14	0.14	0.13	0.13	0.20	0.19	0.17	0.15	0.13	0.12
Prescribed fire	Trees per acre	1,345	200	189	181	171	163	156	300	190	182	173	164	157
	Quadratic mean diameter (in)	5.8	14.7	14.8	15.7	16.6	17.4	18.2	12.2	14.7	15.6	16.5	17.3	18.1
	Total volume (ft^3)	8,959	8,428	8,755	9,361	9,896	10,371	10,834	8,403	8,724	9,345	9,876	10,374	10,855
	Merchantable volume (ft^3)	8,280	8,024	8,319	8,887	9,503	10,070	10,520	8,017	8,319	8,899	9,472	10,066	10,517
	Basal area (ft^2)	246	237	226	242	256	269	282	243	225	241	255	268	282
	Stand density index	559	372	355	372	385	397	408	412	354	371	384	396	408
	Canopy cover (percent)	60	52	45	46	47	48	48	57	45	46	47	48	48
	Crown competition factor	195	163	143	150	156	161	166	180	142	150	155	161	166
	Canopy base height (ft)	4	15	18	20	24	25	26	18	18	20	21	22	23
	Canopy bulk density (kg/m^3)	0.21	0.10	0.10	0.11	0.12	0.12	0.12	0.10	0.10	0.11	0.12	0.12	0.12

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 21d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*		*Percent*		
None	1	10	74	12	26					10	67	9	30	2	4		
	10	12	66	10	34					10	52	12	48				
	20	12	98	13	2					12	68	10	32				
	30	12	87	13	13					12	75	10	25				
	40	12	85	13	15					12	71	10	29				
	50	12	86	13	14					12	64	10	36				

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		*Percent*
None	1	14	89	11	11					14	62	11	38				
	10	12	69	10	31					12	67	10	33				
	20	12	80	10	20					12	83	10	17				
	30	12	77	10	23					12	87	10	13				
	40	12	67	10	33					12	82	10	18				
	`50	12	55	10	45					12	73	10	27				
Pile and burn	1	2	61	10	39					9	74	10	21	2	6		
	10	10	91	6	8	9	1			10	98	9	2				
	20	10	72	12	28					10	68	12	32				
	30	10	65	12	35					10	57	12	43				
	40	10	68	12	32					10	56	12	44				
	50	10	75	12	25					10	60	12	40				
Prescribed fire	1	11	64	2	20	10	16			11	67	10	17	2	9	9	8
	10	10	55	12	45					12	56	10	44				
	20	12	67	10	33					12	81	10	19				
	30	12	71	10	29					12	87	10	13				
	40	12	66	10	34					12	83	10	17				
	50	12	54	10	46					12	73	10	27				

Table 21d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*		*Percent*		*Percent*		*Percent*		*Percent*		
None	1	11	61	14	39					10	69	12	31				
	10	12	62	10	38					12	65	10	35				
	20	12	89	10	11					12	92	10	8				
	30	12	95	10	5					12	97	13	3				
	40	12	96	10	4					12	95	13	5				
	50	12	97	10	3					12	94	13	6				
Pile and burn	1	9	94	10	6					9	100						
	10	10	100							10	95	12	5				
	20	10	59	12	41					10	54	12	46				
	30	12	56	10	44					12	65	10	35				
	40	12	62	10	38					12	73	10	27				
	50	12	69	10	31					12	80	10	20				
Prescribed fire	1	11	66	10	16	9	15	2	3	10	83	9	14	2	3		
	10	12	63	10	37					12	67	10	33				
	20	12	85	10	15					12	86	10	14				
	30	12	92	10	8					12	92	10	8				
	40	12	89	10	11					12	88	10	12				
	50	12	80	10	20					12	78	10	22				

tpa = trees per acre, d.b.h. = diameter at breast height.

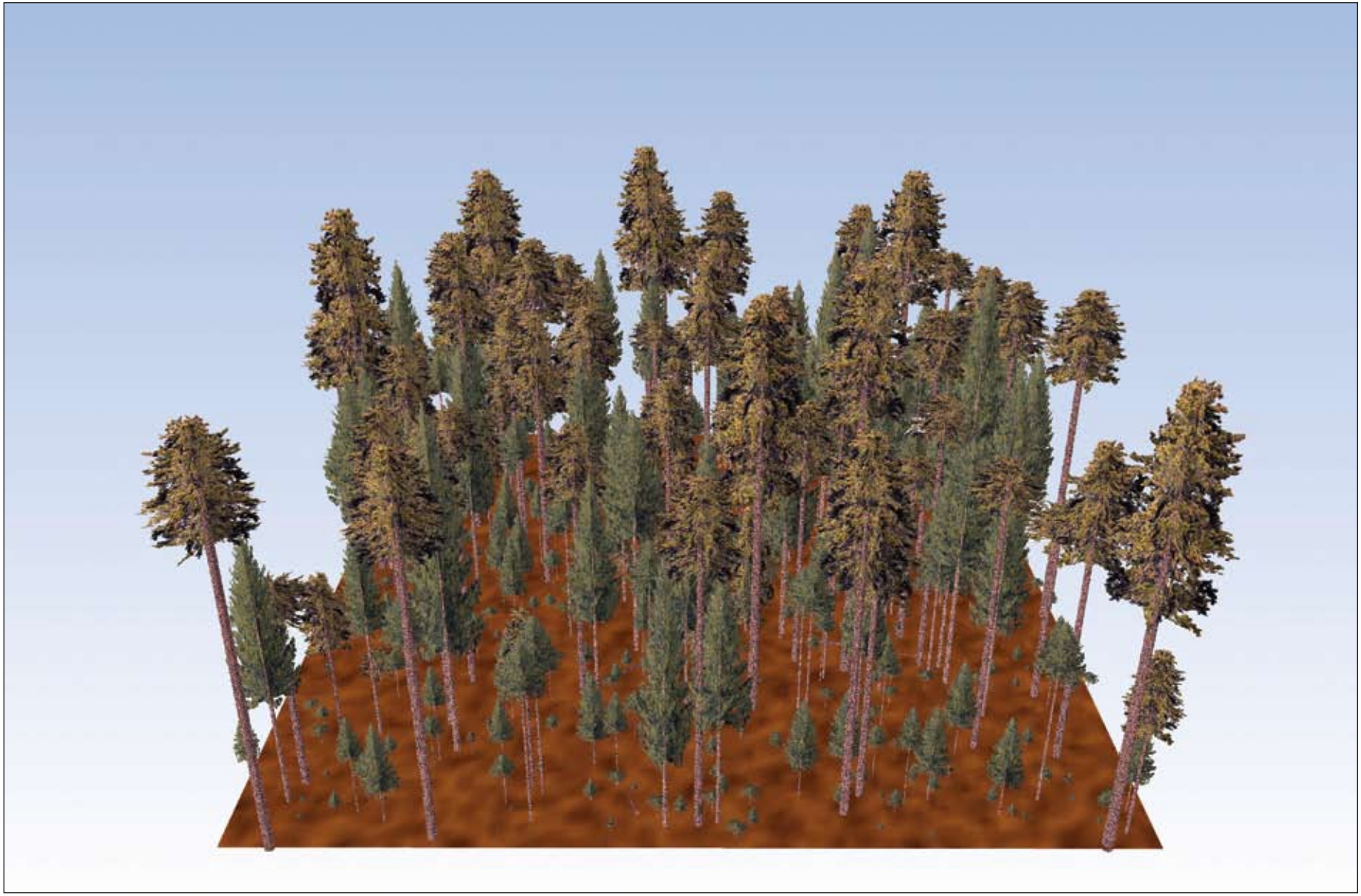
Table 21e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	*°F*	*Percent*					
Severe—98th percentile	14	90	3	5	8	15	50	100
Moderate—75th percentile	9	71	5	8	11	24	125	150

Table 21f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

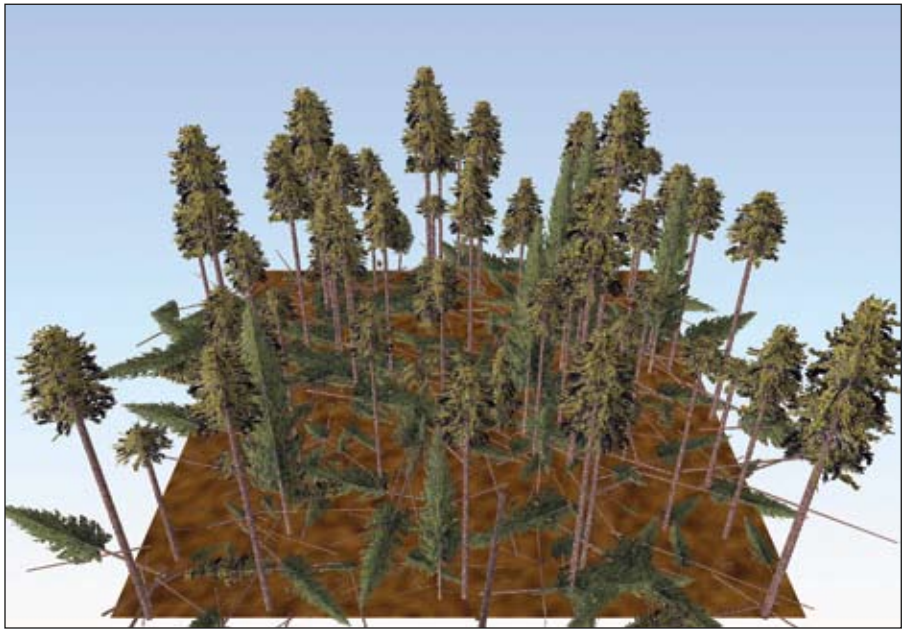


Initial stand conditions

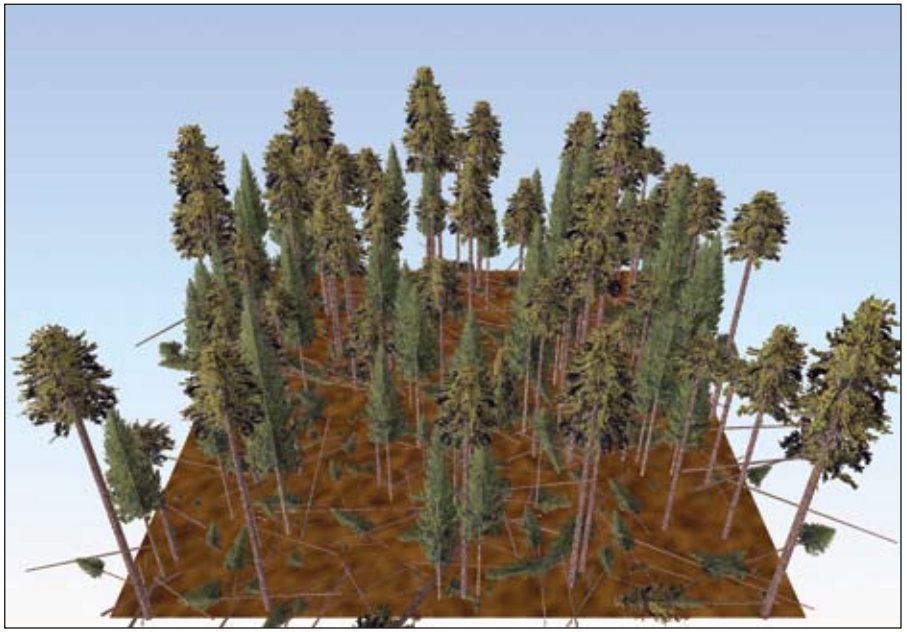
Site: Elevation = 5,300 ft, slope = 20 percent, aspect = 180°.

Species (based on trees per acre): White fir (*Abies concolor*) = 83 percent, ponderosa pine (*Pinus ponderosa*) = 11 percent, lodgepole pine (*Pinus contorta*) = 6 percent.

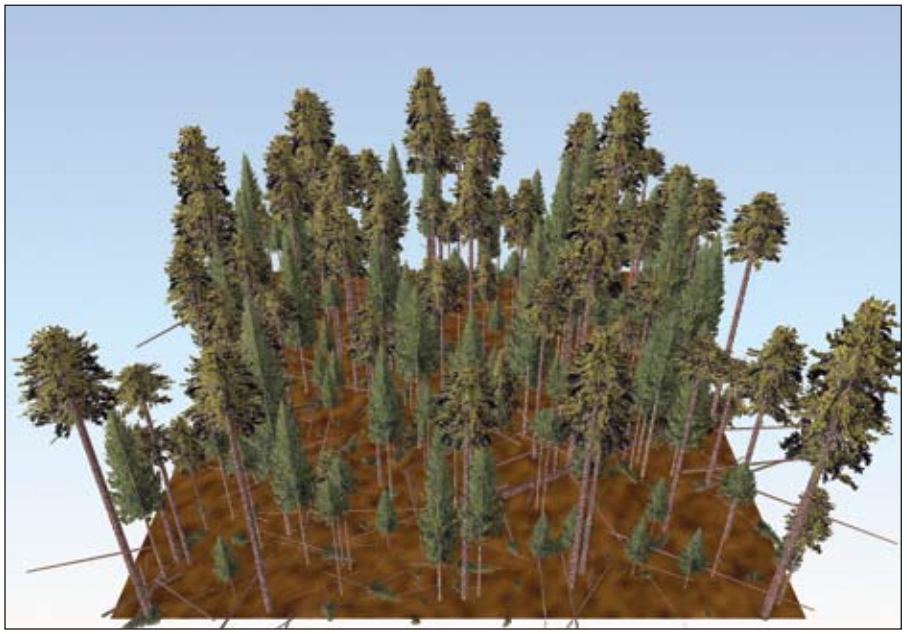
Stand attributes: Stem density = 947 tpa, basal area = 252 ft^2/ac, top height = 91 ft, stand density index = 532, quadratic mean diameter = 7.0 in, crown competition factor = 215, canopy cover = 62 percent.



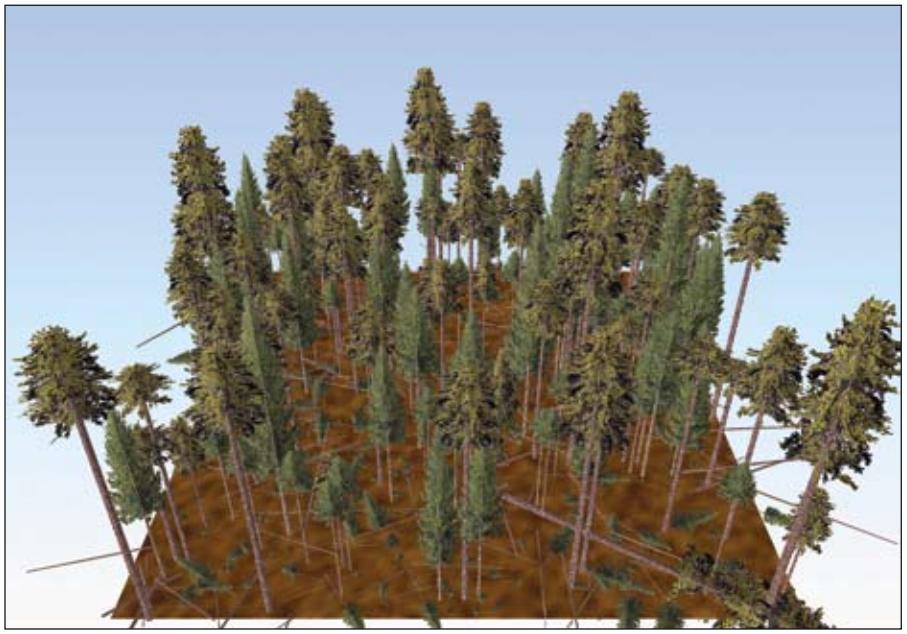
Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit



Thin from below to 200 tpa, 18-in d.b.h. limit



Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This stand has 947 trees per acre (tpa) composed primarily of white fir understory with ponderosa pine and lodgepole pine overstory. Canopy bulk density is 0.13 kg/m^3 (0.0081 lb/ft^3), and canopy base height is 3 ft, so ladder fuels are sufficient to enable passive crown fire but not active crown fire under severe fire weather. Potential tree mortality under severe weather is 83 percent. Woody surface fuel loading is 15 tons/ac, and duff and litter loading is 12 tons/ac. With no action, surface fuels accumulate and flame lengths increase over time, and canopy base height increases only slightly with tree growth and self-thinning, so passive crown fire remains likely for the duration of the 50-year projection for severe fire weather. For moderate fire weather, the predicted fire type is surface fire for the 50-year projection.

Silvicultural and surface fuel treatments—immediate effects

Prescribed fire only increases canopy base height and reduces canopy bulk density and surface fuel loading, so crown fire potential decreases, but many snags are created that contribute to surface fuel loading in the future. All thinning treatments increase canopy base height, but the lower density treatments (50 and 100 tpa) increase canopy base height to a much greater extent than the higher density treatments (200 and 300 tpa) and also reduce canopy bulk density. The lower density treatments generate greater activity fuels and cause higher potential flame lengths. The pile and burn, and to a greater extent the prescribed fire surface fuel treatments, reduce activity fuels and potential flame lengths. In the 50 tpa treatment, fuel model 6 is the predominant model used, so flame lengths are predicted to be higher than initial conditions regardless of surface fuel treatment.

Silvicultural and surface fuel treatments—long-term effects

Canopy base height continues to increase as trees grow in the 100, 200, and 300 tpa treatments, and regeneration is not sufficient to affect canopy base height, so crown fire potential remains low for the duration of the 50-year projection. Canopy base height also increases over time in the prescribed fire only treatment, and surface fire is predicted for 50 years. Regeneration is highest in the 50 tpa treatment so canopy base height declines in 40 or 50 years, at which time a second treatment would be necessary to prevent passive crown fire. Surface fuel loading and potential flame lengths remain fairly stable over time in stands treated with a pile and burn or prescribed fire treatment. All thinning prescriptions reduce canopy bulk density sufficiently that active crown fire remains unlikely for the 50-year projection.

Table 22a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	5	4	12	9	6	5
		3–6 in	1	0	3	3	2	2
		6–12 in	2	1	2	2	2	2
		>12 in	7	5	7	7	7	7
		Litter	2	1	4	3	2	2
		Duff	10	7	10	10	10	10
	Flame length (ft)	Moderate	2	2	4	3	2	2
		Severe	3	3	5	3	3	3
	Torching index	Severe	7	35	254	209	26	16
	Crowning index	Severe	22	30	52	32	22	22
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	16	12	5	9	14	16
		Severe	83	12	5	9	15	17
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			3	2	2	2
		3–6 in			1	1	1	0
		6–12 in			0	0	0	0
		>12 in			2	2	2	2
		Litter			3	3	2	2
		Duff			9	9	9	9
	Flame length (ft)	Moderate			3	2	2	2
		Severe			5	3	2	2
	Torching index	Severe			76	130	55	32
	Crowning index	Severe			52	32	22	22
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	9	14	16
		Severe			5	9	15	16
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			1	1	1	1
		3–6 in			1	1	1	1
		6–12 in			2	2	2	2
		>12 in			7	7	7	7
		Litter			0	1	1	1
		Duff			0	0	0	0
	Flame length (ft)	Moderate			3	2	2	2
		Severe			5	3	3	2
	Torching index	Severe			72	103	121	49
	Crowning index	Severe			55	37	30	30
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	8	11	12
		Severe			6	8	11	12

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 22b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	5	5	5	5	5	5	4	5	4	4	3	3
		3–6 in	1	2	2	3	3	4	0	3	3	3	3	3
		6–12 in	2	2	3	4	5	6	1	5	6	6	6	6
		>12 in	7	7	7	8	9	9	5	6	7	7	8	8
		Litter	2	3	3	3	3	3	1	2	2	2	2	2
		Duff	10	10	10	10	11	11	7	7	7	7	8	8
	Flame length (ft)	Moderate	2	2	2	2	2	3	2	2	2	2	2	2
		Severe	3	3	3	4	4	4	3	4	4	4	4	4
	Torching index	Severe	7	7	10	9	13	12	35	45	74	100	116	129
	Crowning index	Severe	22	22	22	21	20	19	30	31	28	26	24	24
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Passive	Passive	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	76	100	100	89	81	73	266	39	18	12	13	12
		18–29.9 in	1	1	2	3	4	4	3	3	2	2	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	12	6	3	2	2	2	9	5	4	3	3	3
		3–6 in	3	3	3	3	3	3	3	3	3	3	3	3
		6–12 in	2	2	2	2	2	2	2	2	2	3	3	3
		>12 in	7	7	7	6	6	6	7	7	7	7	7	7
		Litter	4	1	1	1	1	1	3	2	2	2	2	2
		Duff	10	10	10	10	10	10	10	10	10	10	10	10
	Flame length (ft)	Moderate	4	3	4	4	3	3	3	2	2	2	2	2
		Severe	5	5	5	5	5	5	3	4	3	3	3	3
	Torching index	Severe	254	125	122	111	108	8	209	101	114	122	123	122
	Crowning index	Severe	52	51	50	49	49	49	32	28	26	26	25	25
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	36	26	10	6	6	6	38	28	12	9	11	11
		18–29.9 in	1	1	1	2	2	2	1	1	1	1	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 22b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	3	2	2	2	2	2	2	3	3	3	3	3
		3–6 in	1	1	1	1	2	2	1	1	1	2	2	2
		6–12 in	0	1	1	2	1	1	0	1	2	2	2	2
		>12 in	2	2	3	3	3	4	2	2	3	4	4	4
		Litter	3	1	1	1	1	1	3	2	2	2	2	2
		Duff	9	9	9	9	9	9	9	9	9	9	9	9
	Flame length (ft)	Moderate	3	4	4	4	3	3	2	2	2	2	2	2
		Severe	5	6	5	5	5	5	3	3	3	3	3	3
	Torching index	Severe	76	114	107	106	105	9	130	160	153	157	154	146
	Crowning index	Severe	52	51	50	49	49	48	32	28	26	26	25	25
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	36	26	11	7	7	7	38	28	13	6	9	10
		18–29.9 in	1	1	1	1	2	2	1	1	1	1	1	1
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	1	2	2	2	2	2	1	3	3	2	2	3
		3–6 in	1	1	2	2	2	2	1	2	2	2	2	2
		6–12 in	2	2	3	3	2	2	2	3	5	5	4	4
		>12 in	7	7	8	8	8	7	7	8	9	9	9	8
		Litter	0	1	1	1	1	1	3	1	1	2	2	2
		Duff	0	0	0	0	1	1	9	0	0	1	1	1
	Flame length (ft)	Moderate	3	4	4	4	3	3	2	3	2	2	2	2
		Severe	5	6	6	5	5	4	3	4	4	3	3	3
	Torching index	Severe	72	121	125	119	6	9	103	84	100	108	113	113
	Crowning index	Severe	55	53	52	51	51	50	37	32	30	29	29	28
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	35	25	15	11	11	10	53	38	17	11	12	12
		18–29.9 in	3	3	2	2	2	2	3	3	2	2	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 22b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	6	5	5	4	4	5	5	5	5	4	5	5
		3–6 in	2	2	3	3	3	3	2	2	2	3	3	4
		6–12 in	2	2	3	4	4	5	2	2	3	4	4	5
		>12 in	7	7	7	8	8	8	7	7	7	7	7	9
		Litter	2	2	2	2	2	2	2	2	2	2	2	2
		Duff	10	10	10	10	10	11	10	10	10	10	11	11
	Flame length (ft)	Moderate	2	2	2	2	2	2	2	2	2	2	2	3
		Severe	3	3	3	3	3	4	3	3	3	3	4	4
	Torching index	Severe	26	54	78	93	111	118	16	16	16	16	14	12
	Crowning index	Severe	22	24	24	23	21	21	22	22	22	21	21	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive
	Hard snags (stems/ac)	0–17.9 in	51	42	28	18	17	32	48	43	30	26	46	50
		18–29.9 in	1	1	2	2	2	4	1	1	1	2	4	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	4	4	4	4	5	2	4	4	4	5	5
		3–6 in	1	1	2	2	2	3	0	1	1	2	2	3
		6–12 in	0	1	2	3	4	4	0	1	2	3	4	5
		>12 in	2	3	4	4	5	6	2	2	3	4	5	6
		Litter	2	2	2	2	2	2	2	2	2	3	2	2
		Duff	9	9	9	9	9	10	9	9	9	9	9	10
	Flame length (ft)	Moderate	2	2	2	2	2	2	2	2	2	2	2	2
		Severe	2	3	3	3	3	3	2	2	3	3	3	4
	Torching index	Severe	55	75	87	99	114	122	32	27	21	20	16	13
	Crowning index	Severe	22	24	24	23	21	21	22	22	22	21	22	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	51	42	28	18	17	34	48	43	29	28	48	51
		18–29.9 in	1	1	2	2	2	4	1	1	1	2	4	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 22b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	1	4	3	3	3	3	1	4	3	3	3	3
		3–6 in	1	3	3	3	3	3	1	3	3	3	3	3
		6–12 in	2	6	7	6	6	6	2	6	7	7	6	6
		>12 in	7	8	9	9	9	8	7	8	9	9	9	9
		Litter	1	2	2	2	2	2	1	2	2	2	2	2
		Duff	0	0	1	1	1	1	0	0	1	1	1	1
	Flame length (ft)	Moderate	2	2	3	2	2	2	2	3	3	2	2	2
		Severe	3	4	4	4	4	4	2	4	4	4	4	4
	Torching index	Severe	121	93	74	87	97	114	49	45	71	85	101	115
	Crowning index	Severe	30	30	29	27	26	25	30	30	29	27	26	25
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	70	39	17	12	14	14	92	40	20	14	15	14
		18–29.9 in	3	3	2	2	2	2	3	3	2	2	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 22c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	947	865	785	712	647	588	150	148	144	139	133	128
	Quadratic mean diameter (in)	7.0	7.4	7.9	8.4	8.9	9.4	7.0	16.7	17.3	18.0	18.7	19.4
	Total volume (ft^3)	8,192	8,636	8,916	9,194	9,466	9,756	7,383	7,664	8,125	8,489	8,854	9,222
	Merchantable volume (ft^3)	7,490	7,848	8,325	8,611	8,782	9,084	6,979	7,197	7,771	8,141	8,467	8,748
	Basal area (ft^2)	252	262	268	274	280	285	218	224	237	246	255	264
	Stand density index	532	539	538	538	537	535	329	336	349	357	365	373
	Canopy closure (percent)	62	62	62	61	61	61	50	50	51	52	52	53
	Crown competition factor	215	218	219	219	218	218	163	167	173	178	182	186
	Canopy base height (ft)	3	3	4	4	5	5	9	15	24	32	37	41
	Canopy bulk density (kg/m^3)	0.13	0.12	0.13	0.13	0.14	0.15	0.08	0.08	0.09	0.10	0.11	0.11

Table 22c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	947	55	153	150	146	143	140	100	147	144	139	134	130
	Quadratic mean diameter (in)	7.0	23.4	14.2	14.5	14.9	15.3	15.7	19.6	16.6	17.2	17.8	18.5	19.1
	Total volume (ft^3)	8,192	5,961	6,088	6,301	6,512	6,736	6,945	7,540	7,775	8,215	8,549	8,879	9,196
	Merchantable volume (ft^3)	7,490	5,820	5,944	6,153	6,387	6,599	6,773	7,321	7,532	7,996	8,326	8,671	8,939
	Basal area (ft^2)	252	163	167	173	178	183	189	210	221	233	242	250	258
	Stand density index	532	213	268	273	279	284	289	295	332	344	352	360	367
	Canopy cover (percent)	62	36	36	37	37	38	39	46	47	48	48	49	49
	Crown competition factor	215	117	120	123	126	131	135	151	156	162	166	170	174
	Canopy base height (ft)	3	54	54	54	51	52	5	28	35	38	39	39	39
	Canopy bulk density (kg/m^3)	0.13	0.04	0.04	0.04	0.04	0.04	0.04	0.08	0.09	0.10	0.10	0.10	0.11
Pile and burn	Trees per acre	947	55	203	199	194	190	185	100	173	169	166	160	155
	Quadratic mean diameter (in)	7.0	23.4	12.3	12.6	13.0	13.3	13.7	19.6	15.3	15.9	16.4	17.0	17.6
	Total volume (ft^3)	8,192	5,961	6,088	6,300	6,520	6,735	6,960	7,540	7,775	8,186	8,609	8,980	9,317
	Merchantable volume (ft^3)	7,490	5,820	5,944	6,153	6,391	6,599	6,789	7,321	7,532	7,969	8,383	8,769	9,057
	Basal area (ft^2)	252	163	167	173	178	184	189	210	221	232	243	253	262
	Stand density index	532	213	283	289	295	301	307	295	343	354	367	376	384
	Canopy cover (percent)	62	36	36	37	37	38	40	46	47	48	49	49	50
	Crown competition factor	215	117	120	123	126	131	137	151	156	162	168	172	177
	Canopy base height (ft)	3	54	54	51	51	52	5	28	35	38	39	39	39
	Canopy bulk density (kg/m^3)	0.13	0.04	0.04	0.04	0.04	0.04	0.04	0.08	0.09	0.10	0.10	0.11	0.11
Prescribed fire	Trees per acre	947	55	351	342	335	327	319	100	233	229	221	214	207
	Quadratic mean diameter (in)	7.0	23.4	9.1	9.4	9.7	10.0	10.2	19.6	12.5	13.0	13.5	14.0	14.5
	Total volume (ft^3)	8,192	5,691	5,814	6,014	6,223	6,454	6,664	6,883	7,085	7,489	7,800	8,126	8,435
	Merchantable volume (ft^3)	7,490	5,557	5,678	5,878	6,103	6,320	6,494	6,690	6,873	7,298	7,600	7,937	8,207
	Basal area (ft^2)	252	163	160	165	170	176	183	210	200	211	219	228	236
	Stand density index	532	213	303	310	317	324	332	295	335	348	357	365	374
	Canopy cover (percent)	62	36	35	36	37	39	41	46	43	44	45	46	46
	Crown competition factor	215	117	115	117	121	131	146	151	141	147	151	156	160
	Canopy base height (ft)	3	55	55	54	54	4	5	29	35	38	38	39	39
	Canopy bulk density (kg/m^3)	0.13	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.08	0.08	0.08	0.09	0.09

Table 22c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	947	200	211	199	191	183	166	300	308	291	274	242	214
	Quadratic mean diameter (in)	7.0	15.0	14.9	15.6	16.3	17.0	17.8	12.4	12.5	13.2	13.9	14.8	15.7
	Total volume (ft^3)	8,192	8,257	8,559	8,957	9,438	9,915	9,999	8,444	8,749	9,222	9,669	9,785	9,901
	Merchantable volume (ft^3)	7,490	7,655	7,876	8,455	8,910	9,323	9,425	7,751	7,954	8,600	9,027	9,091	9,131
	Basal area (ft^2)	252	245	254	264	276	288	288	250	264	276	288	288	288
	Stand density index	532	383	399	406	418	429	420	422	443	454	464	453	442
	Canopy cover (percent)	62	56	57	57	58	58	57	59	60	60	61	60	58
	Crown competition factor	215	189	192	195	201	206	203	203	209	214	219	214	210
	Canopy base height (ft)	3	9	16	23	27	32	36	5	5	5	5	5	5
	Canopy bulk density (kg/m^3)	0.13	0.13	0.11	0.11	0.12	0.13	0.13	0.13	0.12	0.12	0.13	0.13	0.13
Pile and burn	Trees per acre	947	200	224	210	202	194	175	300	321	304	286	251	223
	Quadratic mean diameter (in)	7.0	15.0	14.4	15.2	15.8	16.5	17.4	12.4	12.3	12.9	13.6	14.5	15.4
	Total volume (ft^3)	8,192	8,257	8,559	8,955	9,440	9,917	10,001	8,444	8,749	9,243	9,677	9,783	9,906
	Merchantable volume (ft^3)	7,490	7,655	7,876	8,453	8,912	9,324	9,424	7,751	7,954	8,618	9,033	9,082	9,134
	Basal area (ft^2)	252	245	254	264	277	288	288	250	264	277	288	288	288
	Stand density index	532	383	404	411	423	433	424	422	446	459	468	456	445
	Canopy cover (percent)	62	56	57	57	58	58	57	59	60	61	61	60	58
	Crown competition factor	215	189	192	195	201	206	203	203	209	215	219	214	210
	Canopy base height (ft)	3	9	16	23	27	32	36	5	5	5	5	5	5
	Canopy bulk density (kg/m^3)	0.13	0.13	0.11	0.11	0.12	0.13	0.13	0.13	0.12	0.12	0.13	0.13	0.13
Prescribed fire	Trees per acre	947	200	206	202	195	188	181	300	223	217	208	201	194
	Quadratic mean diameter (in)	7.0	15.0	14.1	14.6	15.2	15.9	16.5	12.4	13.6	14.1	14.7	15.3	15.9
	Total volume (ft^3)	8,192	7,369	7,642	8,136	8,555	8,972	9,380	7,385	7,660	8,119	8,518	8,917	9,351
	Merchantable volume (ft^3)	7,490	6,982	7,201	7,797	8,206	8,602	9,037	6,981	7,201	7,760	8,144	8,518	8,906
	Basal area (ft^2)	252	245	223	236	247	258	268	250	224	236	247	257	268
	Stand density index	532	383	357	372	384	394	404	422	364	378	388	399	409
	Canopy cover (percent)	62	56	50	51	52	52	53	59	50	51	52	53	53
	Crown competition factor	215	189	164	171	177	181	187	203	166	173	178	183	189
	Canopy base height (ft)	3	25	31	24	28	31	36	9	15	23	27	32	36
	Canopy bulk density (kg/m^3)	0.13	0.08	0.08	0.09	0.10	0.10	0.11	0.08	0.08	0.09	0.10	0.10	0.11

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 22d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		Percent						Percent		Percent				
None	1	9	54	10	46					9	83	10	17				
	10	9	50	10	50					10	68	9	32				
	20	10	66	9	34					10	66	9	34				
	30	10	75	9	25					10	61	9	39				
	40	10	87	9	13					10	60	9	40				
	50	10	98	9	2					10	61	9	39				

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		Percent		Percent				Percent		Percent		Percent		
None	1	11	61	14	39					11	96	14	4				
	10	10	53	6	42	9	5			10	53	9	47				
	20	6	62	10	27	9	12			9	60	10	40				
	30	6	68	9	19	10	14			9	69	10	31				
	40	6	64	9	28	10	8			9	69	10	31				
	`50	6	58	9	36	10	6			9	66	10	34				
Pile and burn	1	2	73	10	21	9	6			9	100						
	10	6	89	9	11					9	100						
	20	6	84	9	16					9	94	10	6				
	30	6	76	9	24					9	93	10	7				
	40	6	65	9	35					9	91	10	9				
	50	6	55	9	45					9	87	10	13				
Prescribed fire	1	2	100							9	74	2	26				
	10	6	94	10	6					9	55	10	34	6	10		
	20	6	83	10	13	9	5			9	52	10	45	6	3		
	30	6	71	9	16	10	13			9	57	10	43				
	40	6	53	9	36	10	11			9	60	10	40				
	50	9	54	6	38	10	9			9	60	10	40				

Table 22d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*				
None	1	11	63	9	37					10	51	9	49				
	10	10	56	9	44					9	51	10	49				
	20	10	61	9	39					10	53	9	47				
	30	10	61	9	39					10	54	9	46				
	40	10	64	9	36					10	70	9	30				
	50	10	78	9	22					10	95	9	5				
Pile and burn	1	9	100							9	100						
	10	9	89	10	11					9	93	10	7				
	20	9	71	10	29					9	77	10	23				
	30	9	66	10	34					9	71	10	29				
	40	9	58	10	42					9	51	10	49				
	50	10	58	9	42					10	75	9	25				
Prescribed fire	1	9	100							9	100						
	10	10	67	9	33					10	71	9	29				
	20	10	72	9	28					10	73	9	27				
	30	10	68	9	32					10	71	9	29				
	40	10	65	9	35					10	69	9	31				
	50	10	66	9	34					10	68	9	32				

tpa = trees per acre, d.b.h. = diameter at breast height.

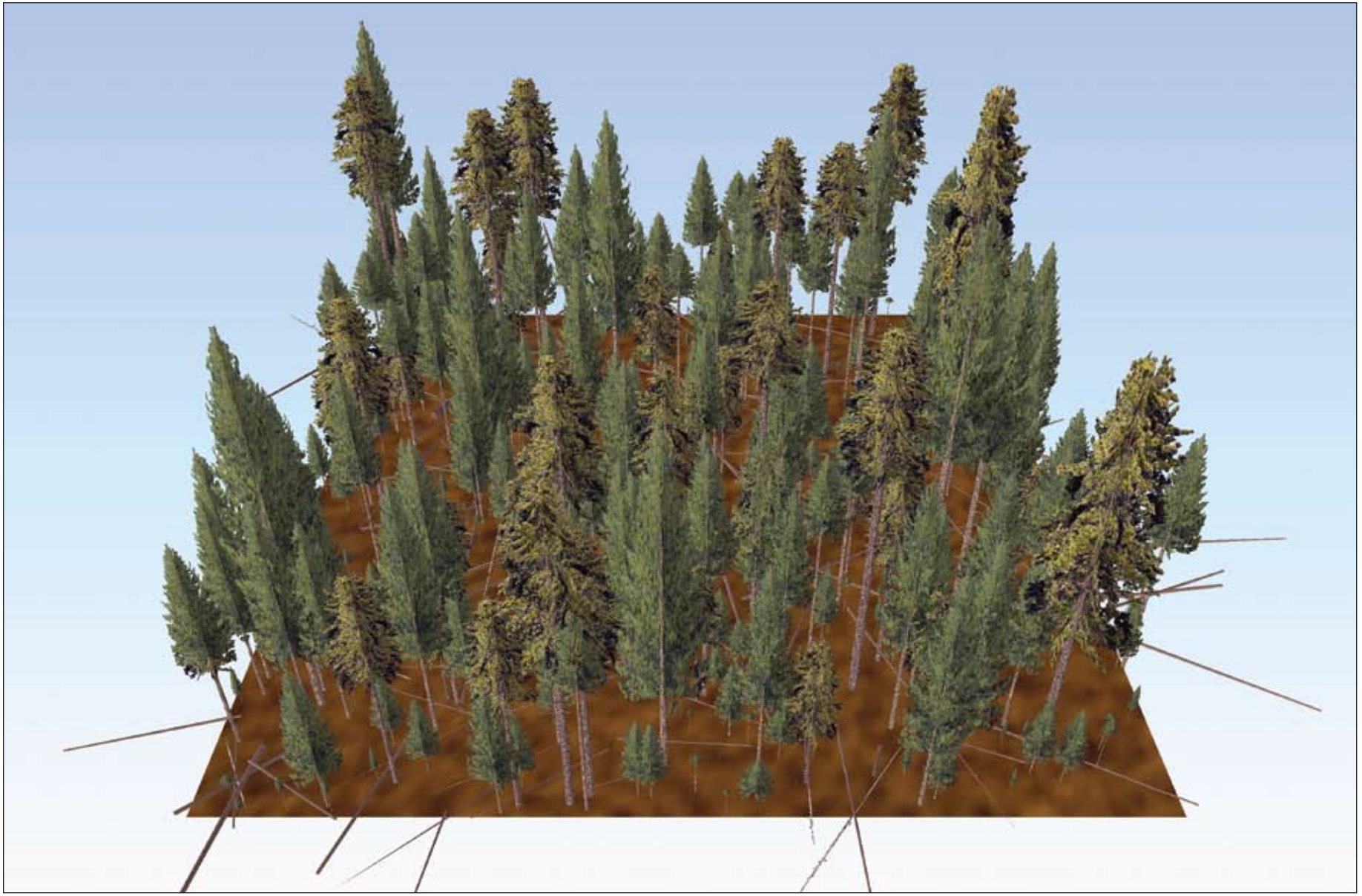
Table 22e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	*°F*	*Percent*					
Severe—98th percentile	14	90	3	5	8	15	50	100
Moderate—75th percentile	9	71	5	8	11	24	125	150

Table 22f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

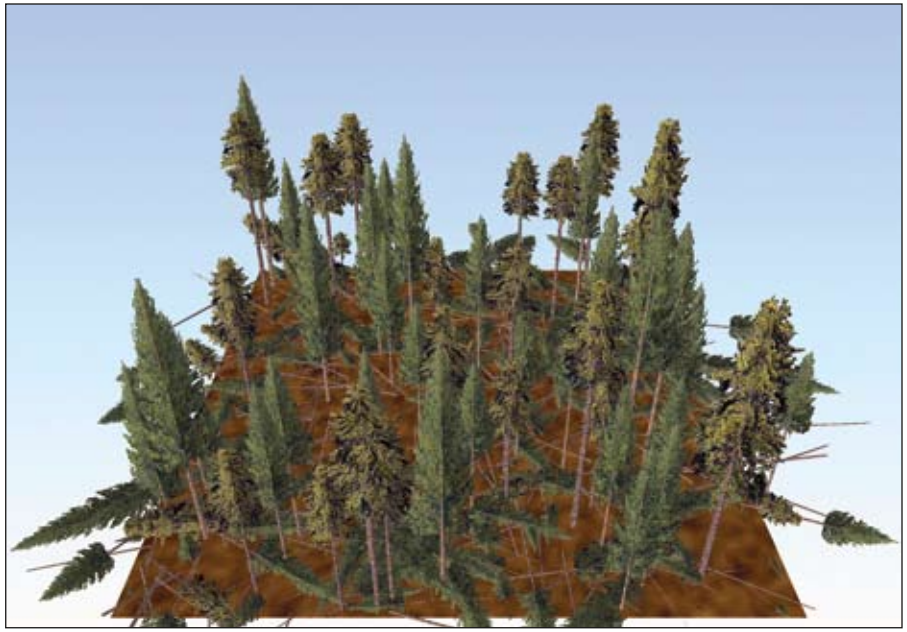


Initial stand conditions

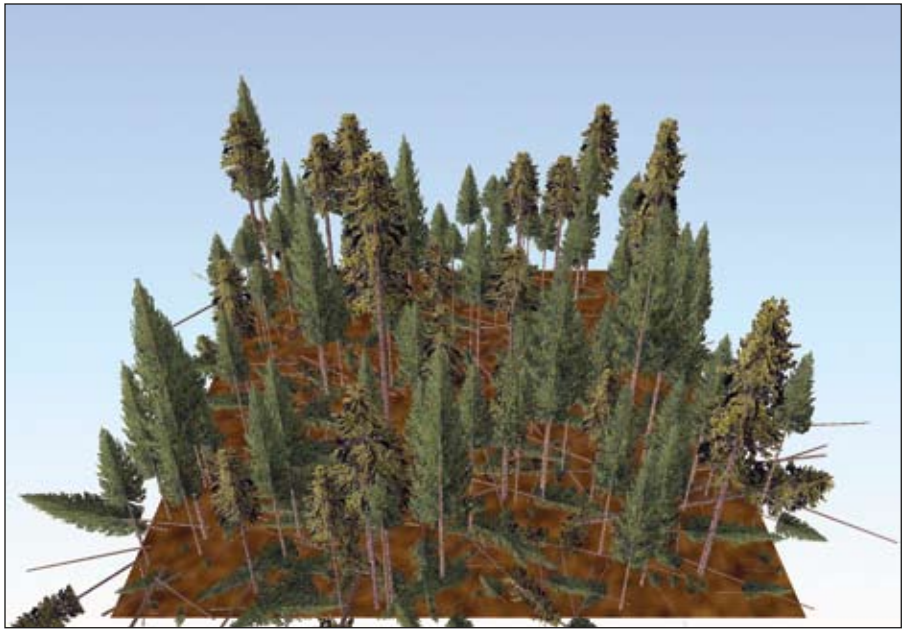
Site: Elevation = 5,000 ft, slope = 35 percent, aspect = 270°.

Species (based on trees per acre): White fir (*Abies concolor)* = 93 percent, ponderosa pine (*Pinus ponderosa*) = 7 percent.

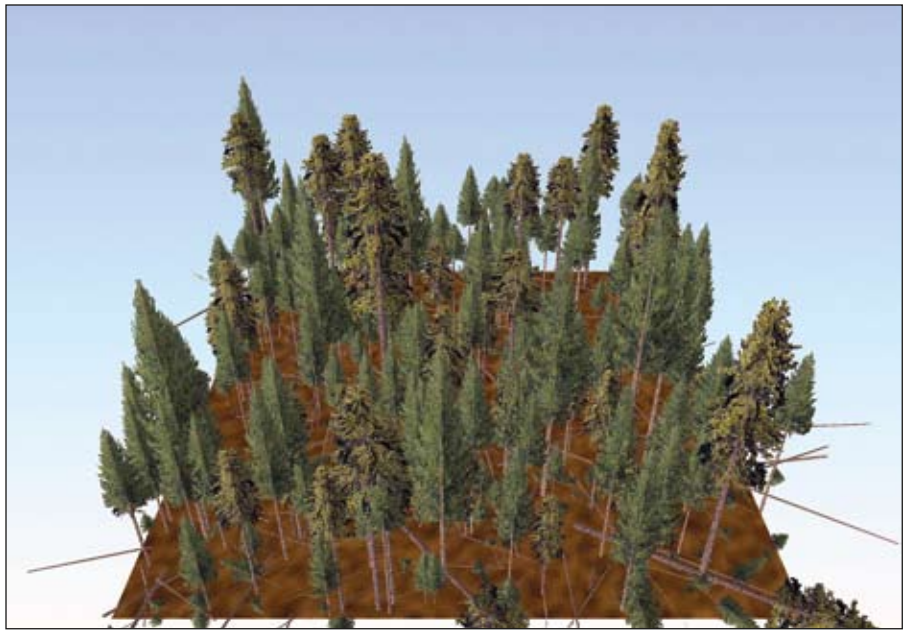
Stand attributes: Stem density = 544 tpa, basal area = 167 ft^2/ac, top height = 84 ft, stand density index = 344, quadratic mean diameter = 7.5 in, crown competition factor = 153, canopy cover = 55 percent.



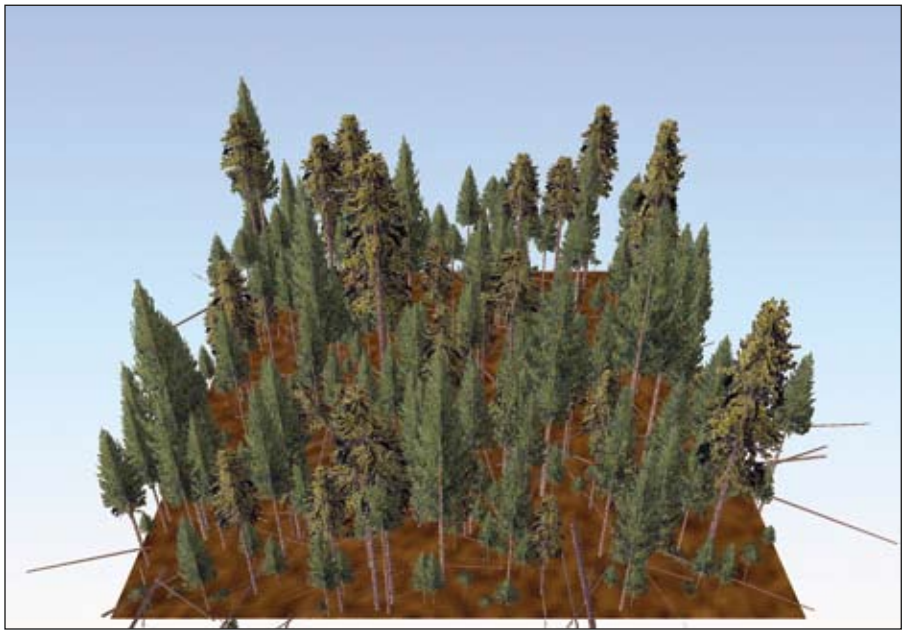
Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit



Thin from below to 200 tpa, 18-in d.b.h. limit



Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This stand has 544 trees per acre (tpa) composed of primarily white fir understory with ponderosa pine overstory. Canopy base height is 3 ft and canopy bulk density 0.14 kg/m^3 (0.0087 lb/ft^3), so there is high potential for passive crown fire and tree mortality but low potential for active crown fire spread under severe fire weather. Wood loading is 10 tons/ac, and litter and duff loading is 11 tons/ac. With no action, canopy base height will increase as trees grow and the stand self-thins, but flame lengths also increase as surface fuels accumulate, so crown fire potential remains essentially the same with passive crown fire likely. Canopy bulk density does not change for the 50-year projection, so the potential for active crown fire spread remains low.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment reduces tree density, which increases canopy base height enough to reduce crown fire potential, but it creates many more snags. This treatment also reduces woody surface fuels in all size classes, but potential flame lengths increase because conditions change from predominantly fuel model 9 to predominantly fuel model 2, suggesting that grass fuels drive fire behavior following the prescribed fire. This may or may not be true depending on the site. Thinning to 50 or 100 tpa greatly increases canopy base height and reduces canopy bulk density, thereby decreasing crown fire potential, but these treatments create high surface fuel loadings and increase potential flame lengths (fuel models change from predominantly 9 to predominantly 11). Thinning to 200 or 300 tpa is not sufficient to increase canopy base height, so these treatments have little effect on crown fire potential, but potential flame lengths remain low because removing fewer trees generates less activity fuels. The prescribed fire fuel treatment further decreases crown fire potential because fire-caused mortality of smaller trees further increases canopy base height. The pile and burn treatment reduces woody fuel loading to below initial conditions, and the prescribed fire treatment reduces woody fuel loading even more and consumes most of the duff layer, but these surface fuel treatments increase potential flame lengths because the more open stands with low woody fuel loading are characterized by fuel model 2. Again, grass fuels may or may not increase flame lengths depending on the site. Grass fuels are not tracked in FFE, so these results should be interpreted with caution.

Silvicultural and surface fuel treatments—long-term effects

Reductions in crown fire potential last for 30 years in the 50 tpa treatment, but then regeneration lowers canopy base height making passive crown fire likely again; at this time, another treatment would be necessary to prevent passive crown fire. In the 100 tpa treatment, the influence of regeneration on canopy base height and crown fire potential depends on the surface fuel treatment with the greatest regeneration occurring in the prescribed fire treatment. In the 200 and 300 tpa treatments, regeneration is low and canopy base height increases over time as the stand self-thins and crowns rise, so after 50 years, crown fire remains unlikely except in the prescribed fire treatment in which passive crown fire becomes likely again in 40 years.

Table 23a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	4	3	10	7	5	4
		3–6 in	3	0	4	4	3	3
		6–12 in	2	1	2	2	2	2
		>12 in	1	1	1	1	1	1
		Litter	2	1	4	3	3	2
		Duff	9	6	9	9	9	9
	Flame length (ft)	Moderate	2	3	3	3	2	2
		Severe	3	5	4	4	3	3
	Torching index	Severe	5	17	141	70	3	4
	Crowning index	Severe	19	25	43	22	19	19
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate	24	19	11	17	22	24
		Severe	98	31	11	17	97	98
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			3	2	2	1
		3–6 in			1	1	1	1
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			4	3	2	2
		Duff			8	8	8	8
	Flame length (ft)	Moderate			4	4	2	2
		Severe			7	6	3	3
	Torching index	Severe			33	49	11	11
	Crowning index	Severe			43	22	19	19
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate			11	17	22	23
		Severe			37	37	94	90
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			1	1	1	1
		3–6 in			2	2	1	1
		6–12 in			2	2	2	2
		>12 in			1	1	1	1
		Litter			1	1	1	1
		Duff			0	0	0	0
	Flame length (ft)	Moderate			4	4	4	3
		Severe			7	6	5	5
	Torching index	Severe			34	37	39	19
	Crowning index	Severe			50	29	25	25
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			10	15	19	19
		Severe			38	43	35	31

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 23b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	4	5	6	6	6	6	3	5	4	4	4	4
		3–6 in	3	3	4	5	5	6	0	3	3	3	4	4
		6–12 in	2	2	4	6	8	9	1	6	6	6	6	7
		>12 in	1	2	4	5	7	10	1	2	4	5	7	8
		Litter	2	3	3	3	3	3	1	2	2	2	2	2
		Duff	9	9	10	10	10	10	6	7	7	7	7	7
	Flame length (ft)	Moderate	2	3	3	3	4	4	3	3	3	3	3	3
		Severe	3	4	4	4	5	6	5	5	5	4	4	5
	Torching index	Severe	5	8	9	11	2	6	17	14	23	27	34	43
	Crowning index	Severe	19	19	19	19	19	19	25	24	23	23	21	19
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	72	100	95	87	89	79	131	18	20	22	22	22
		18–29.9 in	5	6	7	7	7	6	6	6	6	6	6	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	10	5	3	2	2	2	7	5	3	3	3	3
		3–6 in	4	3	4	4	4	3	4	3	4	4	4	4
		6–12 in	2	2	2	2	2	2	2	2	2	2	3	3
		>12 in	1	2	3	4	6	7	1	2	3	4	6	7
		Litter	4	1	1	1	1	1	3	2	2	2	2	2
		Duff	9	9	9	9	9	9	9	9	9	10	10	10
	Flame length (ft)	Moderate	3	5	5	5	5	5	3	4	4	4	4	3
		Severe	4	7	7	7	7	6	4	6	5	5	5	5
	Torching index	Severe	141	64	65	0	7	12	70	70	72	73	75	14
	Crowning index	Severe	43	40	38	37	35	34	22	22	22	22	21	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	18	14	11	13	13	13	19	17	12	16	18	17
		18–29.9 in	5	6	6	6	6	5	5	6	6	6	6	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 23b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	3	3	2	2	2	2	2	3	3	3	3	3
		3–6 in	1	1	2	2	2	2	1	1	2	2	2	2
		6–12 in	1	1	1	1	1	2	1	1	1	2	2	3
		>12 in	0	1	3	4	5	6	0	1	2	4	5	7
		Litter	4	1	1	1	1	1	3	2	2	2	2	2
		Duff	8	8	8	8	8	8	8	8	8	8	9	9
	Flame length (ft)	Moderate	4	5	5	5	5	5	4	4	4	4	3	3
		Severe	7	7	7	7	7	6	6	6	6	5	5	5
	Torching index	Severe	33	50	51	0	6	12	49	66	70	71	7	12
	Crowning index	Severe	43	40	38	37	35	34	22	22	22	22	21	20
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	18	14	12	15	15	15	19	17	15	19	19	17
		18–29.9 in	5	6	6	6	6	5	5	6	6	6	6	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	1	2	2	2	2	2	1	3	2	2	2	3
		3–6 in	2	2	2	3	3	3	1	3	3	3	3	3
		6–12 in	2	3	3	3	3	3	2	5	5	5	5	5
		>12 in	1	3	4	6	7	8	1	3	4	5	7	8
		Litter	1	1	1	1	1	1	3	1	1	1	2	2
		Duff	0	0	0	1	1	1	8	0	0	1	1	1
	Flame length (ft)	Moderate	4	5	5	5	5	4	4	5	5	4	4	4
		Severe	7	7	7	7	6	5	6	7	6	6	6	5
	Torching index	Severe	34	49	60	0	8	12	37	69	74	0	7	10
	Crowning index	Severe	50	46	44	42	27	23	29	28	28	27	26	26
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	23	17	16	19	19	19	33	18	16	20	20	30
		18–29.9 in	6	6	7	6	6	5	6	6	6	6	6	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 23b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	5	5	5	5	6	6	4	5	6	6	6	6
		3–6 in	3	3	4	4	5	5	3	3	4	4	5	6
		6–12 in	2	2	3	5	7	9	2	2	3	5	8	10
		>12 in	1	2	3	5	7	9	1	2	3	5	7	10
		Litter	3	2	2	2	2	2	2	3	3	3	2	2
		Duff	9	9	10	10	10	10	9	9	10	10	10	10
	Flame length (ft)	Moderate	2	3	3	3	3	4	2	2	3	3	4	4
		Severe	3	4	4	4	5	6	3	3	4	5	5	6
	Torching index	Severe	3	16	28	38	45	41	4	19	22	25	26	21
	Crowning index	Severe	19	19	18	19	19	19	19	18	19	20	19	19
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	33	32	33	53	58	50	31	33	73	78	70	58
		18–29.9 in	5	6	6	7	7	6	5	6	6	7	7	6
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	4	5	5	6	6	1	4	5	6	6	6
		3–6 in	1	1	2	3	4	4	1	1	2	3	4	5
		6–12 in	1	1	2	4	6	8	1	1	2	4	7	9
		>12 in	0	1	3	4	6	9	0	1	3	4	7	9
		Litter	2	2	2	2	2	2	2	3	3	3	2	2
		Duff	8	8	9	9	9	9	8	8	9	9	9	9
	Flame length (ft)	Moderate	2	2	2	3	3	4	2	2	3	3	3	4
		Severe	3	3	3	4	5	5	3	3	4	4	5	6
	Torching index	Severe	11	26	33	40	49	77	11	29	25	26	31	27
	Crowning index	Severe	19	19	18	19	19	19	19	18	19	20	19	19
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	33	32	33	56	60	53	31	33	74	79	71	60
		18–29.9 in	5	6	6	7	7	6	5	6	6	7	7	6
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 23b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	1	4	3	3	3	4	1	4	4	3	4	4
		3–6 in	1	4	4	4	4	4	1	4	4	4	4	4
		6–12 in	2	7	7	7	7	7	2	7	7	7	7	7
		>12 in	1	3	4	6	7	8	1	3	4	6	7	9
		Litter	1	2	2	2	2	2	1	2	2	2	2	2
		Duff	0	0	1	1	1	1	0	0	1	1	1	1
	Flame length (ft)	Moderate	4	4	3	3	3	3	3	3	3	3	3	3
		Severe	5	5	5	5	5	5	5	5	5	5	5	5
	Torching index	Severe	39	51	70	79	6	12	19	24	27	32	6	12
	Crowning index	Severe	25	24	24	23	22	21	25	24	25	24	22	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	46	18	22	24	23	27	68	24	26	26	30	29
		18–29.9 in	6	6	6	6	6	5	6	6	7	6	6	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 23c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	544	450	386	328	270	221	151	150	142	134	127	119
	Quadratic mean diameter (in)	7.5	8.4	9.3	10.1	11.2	12.4	7.5	13.2	14.0	14.9	15.9	16.8
	Total volume (ft^3)	5,004	5,325	5,616	5,817	5,899	5,950	4,306	4,541	4,932	5,328	5,729	6,097
	Merchantable volume (ft^3)	4,531	4,777	5,173	5,305	5,409	5,612	3,978	4,202	4,637	4,966	5,413	5,820
	Basal area (ft^2)	167	174	180	184	185	185	134	141	152	163	174	184
	Stand density index	344	341	340	335	324	311	223	232	244	255	266	275
	Canopy closure (percent)	55	54	53	53	51	49	40	41	42	43	43	44
	Crown competition factor	153	150	149	145	138	134	104	107	112	115	119	122
	Canopy base height (ft)	3	4	5	6	5	7	7	8	11	12	14	17
	Canopy bulk density (kg/m^3)	0.14	0.14	0.14	0.14	0.14	0.14	0.10	0.10	0.11	0.11	0.12	0.14

Table 23c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	544	50	148	143	138	133	127	100	146	143	136	129	122
	Quadratic mean diameter (in)	7.5	18.8	11.2	11.6	12.2	12.8	13.6	15.3	13.1	13.8	14.6	15.5	16.5
	Total volume (ft^3)	5,004	3,463	3,527	3,688	3,866	4,074	4,310	4,434	4,612	5,031	5,393	5,754	6,117
	Merchantable volume (ft^3)	4,531	3,342	3,423	3,574	3,737	3,948	4,161	4,212	4,425	4,811	5,155	5,558	5,906
	Basal area (ft^2)	167	96	100	105	112	119	128	127	137	148	159	170	181
	Stand density index	344	137	176	182	190	198	207	198	226	239	250	261	272
	Canopy cover (percent)	55	25	25	26	28	30	31	36	37	38	39	40	41
	Crown competition factor	153	67	68	70	79	83	88	93	96	101	106	112	117
	Canopy base height (ft)	3	30	35	35	4	7	9	29	33	35	36	36	8
	Canopy bulk density (kg/m^3)	0.14	0.05	0.05	0.06	0.06	0.06	0.07	0.12	0.12	0.12	0.12	0.12	0.13
Pile and burn	Trees per acre	544	50	198	192	185	178	171	100	172	166	157	149	142
	Quadratic mean diameter (in)	7.5	18.8	9.6	10.0	10.6	11.2	11.9	15.3	12.1	12.8	13.6	14.4	15.3
	Total volume (ft^3)	5,004	3,463	3,527	3,691	3,874	4,094	4,353	4,434	4,612	5,000	5,356	5,726	6,107
	Merchantable volume (ft^3)	4,531	3,342	3,423	3,577	3,742	3,963	4,181	4,212	4,425	4,782	5,121	5,529	5,895
	Basal area (ft^2)	167	96	100	106	113	121	131	127	137	147	158	169	181
	Stand density index	344	137	187	193	202	212	224	198	233	245	256	268	281
	Canopy cover (percent)	55	25	25	26	29	32	34	36	37	38	39	40	41
	Crown competition factor	153	67	68	70	83	88	94	93	96	100	106	113	119
	Canopy base height (ft)	3	30	35	35	4	7	9	29	33	35	36	5	7
	Canopy bulk density (kg/m^3)	0.14	0.05	0.05	0.06	0.06	0.06	0.07	0.12	0.12	0.12	0.12	0.12	0.13
Prescribed fire	Trees per acre	544	50	340	331	319	308	296	100	222	217	206	196	176
	Quadratic mean diameter (in)	7.5	18.8	7.0	7.2	7.7	8.2	8.7	15.3	9.7	10.2	10.8	11.5	12.5
	Total volume (ft^3)	5,004	3,142	3,184	3,304	3,456	3,647	3,883	3,777	3,897	4,201	4,482	4,791	4,979
	Merchantable volume (ft^3)	4,531	3,039	3,095	3,206	3,332	3,501	3,681	3,606	3,755	4,034	4,298	4,622	4,789
	Basal area (ft^2)	167	96	90	94	102	112	123	127	114	122	131	142	149
	Stand density index	344	137	190	196	208	222	239	198	211	223	234	246	250
	Canopy cover (percent)	55	25	23	25	30	34	38	36	31	32	35	37	37
	Crown competition factor	153	67	61	63	88	95	104	93	79	83	93	102	104
	Canopy base height (ft)	3	31	36	36	4	7	9	29	34	35	4	6	8
	Canopy bulk density (kg/m^3)	0.14	0.04	0.05	0.05	0.05	0.09	0.13	0.08	0.09	0.09	0.09	0.10	0.10

Table 23c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	544	200	207	190	161	137	118	300	304	251	208	174	147
	Quadratic mean diameter (in)	7.5	12.1	12.3	13.3	14.5	15.7	16.9	10.1	10.5	11.6	12.7	14.0	15.2
	Total volume (ft^3)	5,004	5,147	5,405	5,851	5,989	6,062	6,124	5,295	5,577	5,758	5,889	5,969	6,049
	Merchantable volume (ft^3)	4,531	4,665	4,919	5,478	5,588	5,735	5,865	4,730	4,995	5,292	5,368	5,478	5,666
	Basal area (ft^2)	167	161	172	183	184	184	185	166	182	183	184	184	185
	Stand density index	344	273	290	300	292	283	276	303	327	317	307	296	288
	Canopy cover (percent)	55	48	49	49	47	45	43	52	54	52	50	47	45
	Crown competition factor	153	128	131	134	129	124	121	143	149	142	136	130	125
	Canopy base height (ft)	3	3	6	10	14	17	33	3	6	8	10	13	15
	Canopy bulk density (kg/m^3)	0.14	0.14	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.14	0.13	0.14	0.14
Pile and burn	Trees per acre	544	200	220	202	170	144	123	300	317	261	215	179	150
	Quadratic mean diameter (in)	7.5	12.1	12.0	12.9	14.1	15.3	16.6	10.1	10.3	11.4	12.5	13.8	15.0
	Total volume (ft^3)	5,004	5,147	5,405	5,859	5,987	6,077	6,118	5,295	5,577	5,769	5,895	5,979	6,045
	Merchantable volume (ft^3)	4,531	4,665	4,919	5,486	5,590	5,729	5,849	4,730	4,995	5,303	5,376	5,488	5,665
	Basal area (ft^2)	167	161	172	183	184	185	185	166	182	184	184	185	185
	Stand density index	344	273	293	304	295	286	277	303	330	320	309	298	289
	Canopy cover (percent)	55	48	49	49	47	45	43	52	54	52	50	47	45
	Crown competition factor	153	128	131	134	129	125	121	143	149	143	136	130	125
	Canopy base height (ft)	3	3	6	10	14	18	33	3	6	8	10	13	15
	Canopy bulk density (kg/m^3)	0.14	0.14	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.15	0.13	0.14	0.14
Prescribed fire	Trees per acre	544	200	197	185	175	165	151	300	213	199	188	172	157
	Quadratic mean diameter (in)	7.5	12.1	11.4	12.1	13.0	13.8	14.9	10.1	10.9	11.7	12.5	13.5	14.5
	Total volume (ft^3)	5,004	4,280	4,492	4,863	5,280	5,694	6,009	4,296	4,456	4,822	5,241	5,589	5,919
	Merchantable volume (ft^3)	4,531	3,973	4,192	4,629	4,988	5,436	5,791	3,969	4,138	4,545	4,897	5,273	5,661
	Basal area (ft^2)	167	161	139	148	160	172	181	166	138	148	160	170	179
	Stand density index	344	273	241	252	265	278	284	303	245	255	269	276	284
	Canopy cover (percent)	55	48	39	40	41	43	43	52	40	41	42	43	43
	Crown competition factor	153	128	102	106	111	119	122	143	104	107	113	119	121
	Canopy base height (ft)	3	18	24	32	34	5	7	8	12	13	14	5	7
	Canopy bulk density (kg/m^3)	0.14	0.10	0.10	0.11	0.11	0.12	0.12	0.10	0.10	0.10	0.11	0.12	0.12

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 23d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*		*Percent*		
None	1	9	80	10	20					2	63	9	37				
	10	9	61	10	39					10	52	9	29	6	19		
	20	10	64	9	36					10	49	9	36	6	15		
	30	10	88	9	12					10	55	9	35	6	10		
	40	10	90	12	10					10	65	9	29	6	5		
	50	10	73	12	27					10	76	9	21	6	3		

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	11	91	14	9					11	77	2	21	9	2		
	10	6	70	10	30					6	57	10	30	9	13		
	20	6	85	10	15					6	54	9	24	10	22		
	30	6	86	10	14					6	45	9	31	10	24		
	40	6	83	10	17					9	34	6	33	10	33		
	`50	6	78	10	22					10	44	9	34	6	23		
Pile and burn	1	2	90	10	10					2	90	9	10				
	10	6	100							6	81	9	19				
	20	6	100							6	70	9	29				
	30	6	100							6	53	9	37	10	9		
	40	6	96	10	4					9	42	6	37	10	21		
	50	6	90	10	10					9	44	10	32	6	24		
Prescribed fire	1	2	100							2	100						
	10	6	100							6	80	10	20				
	20	6	94	10	6					6	74	10	26				
	30	6	87	10	13					6	69	10	31				
	40	6	81	10	19					6	53	10	37	9	10		
	50	6	54	10	25	9	21			10	48	6	41	9	12		

Table 23d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	9	65	11	35					9	76	10	24				
	10	9	64	10	36					9	68	10	32				
	20	9	51	10	49					10	54	9	46				
	30	10	70	9	30					10	87	9	13				
	40	10	98	12	2					10	88	12	12				
	50	10	81	12	19					10	72	12	28				
Pile and burn	1	9	100							9	100						
	10	9	93	10	7					9	95	10	5				
	20	9	72	10	28					9	65	10	35				
	30	10	52	9	48					10	71	9	29				
	40	10	87	9	13					10	97	12	3				
	50	10	88	12	12					10	79	12	21				
Prescribed fire	1	2	76	9	24					2	65	9	35				
	10	10	48	6	30	9	22			10	52	9	24	6	24		
	20	10	52	9	25	6	23			10	58	9	25	6	17		
	30	10	60	9	26	6	14			10	65	9	25	6	10		
	40	10	67	9	25	6	8			10	78	9	17	6	5		
	50	10	83	9	14	6	4			10	93	9	6	6	1		

tpa = trees per acre, d.b.h. = diameter at breast height.

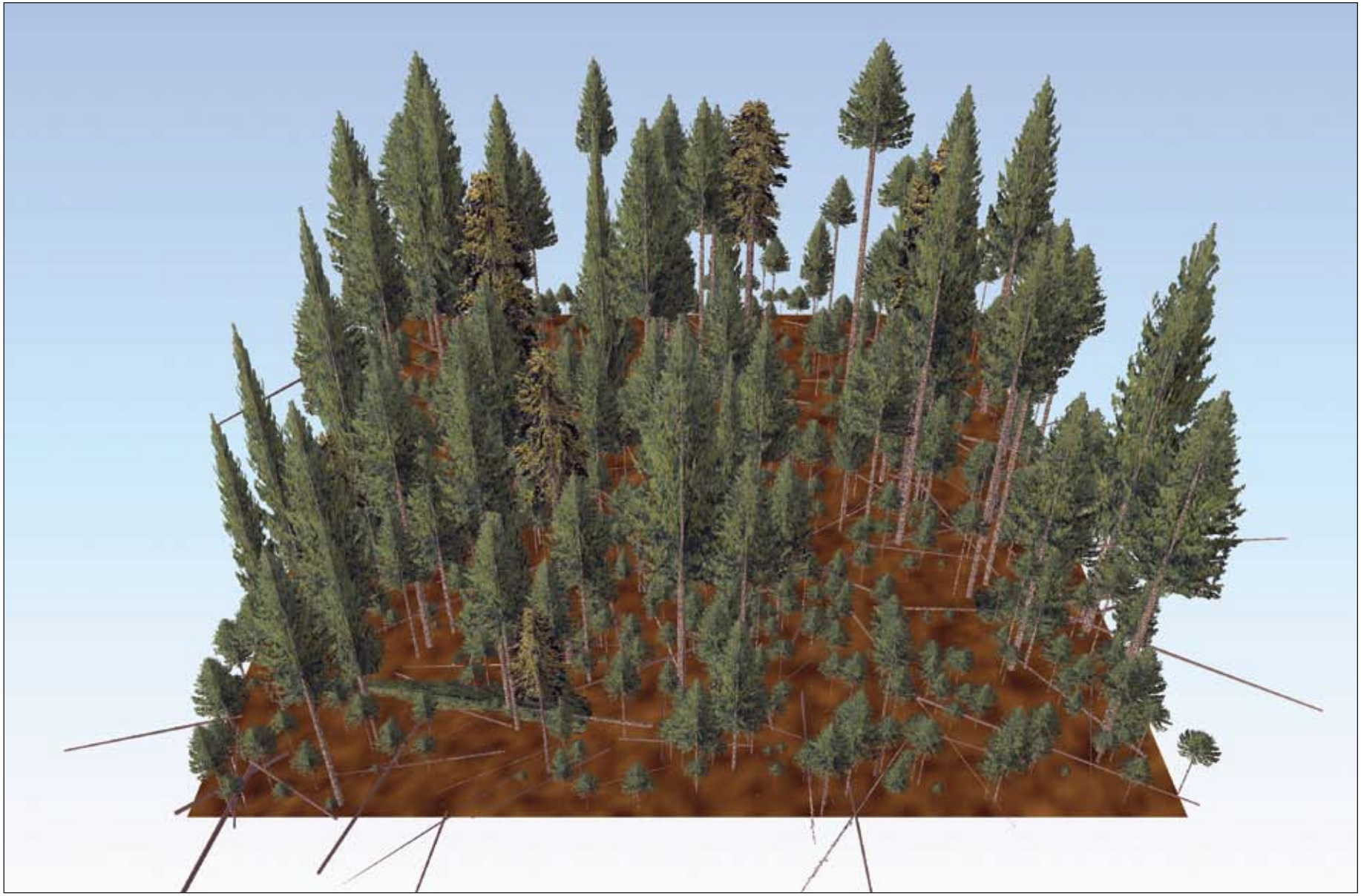
Table 23e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	*°F*	*Percent*					
Severe—98th percentile	14	90	3	5	8	15	50	100
	9	71	5	8	11	24	125	150

Table 23f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

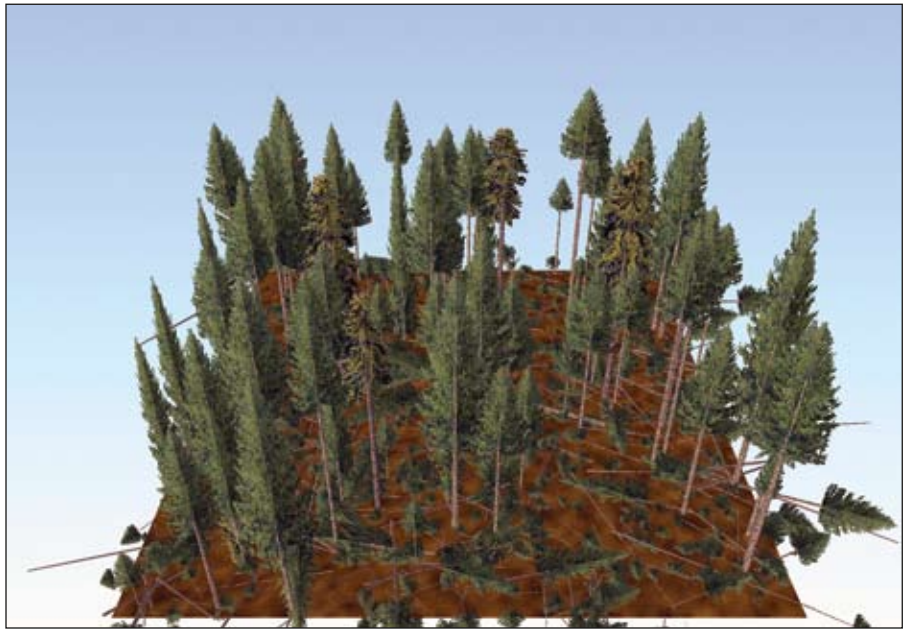


Initial stand conditions

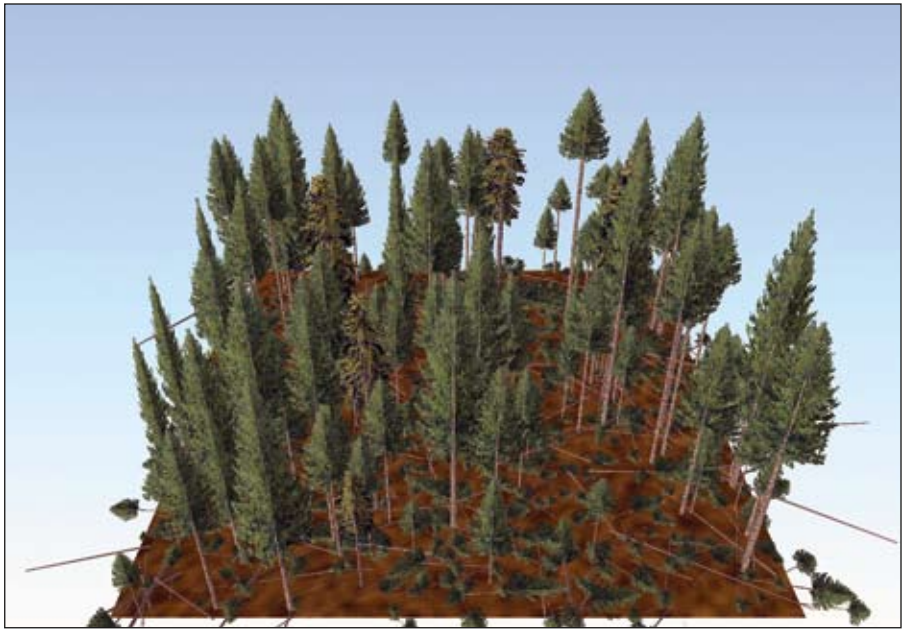
Site: Elevation = 4,600 ft, slope = 29 percent, aspect = 140°.

Species (based on trees per acre): Grand fir (*Abies grandis*) = 82 percent, Douglas-fir (*Pseudotsuga menziesii*) = 14 percent, ponderosa pine (*Pinus ponderosa*) = 3 percent, western larch (*Larix occidentalis*) = 2 percent.

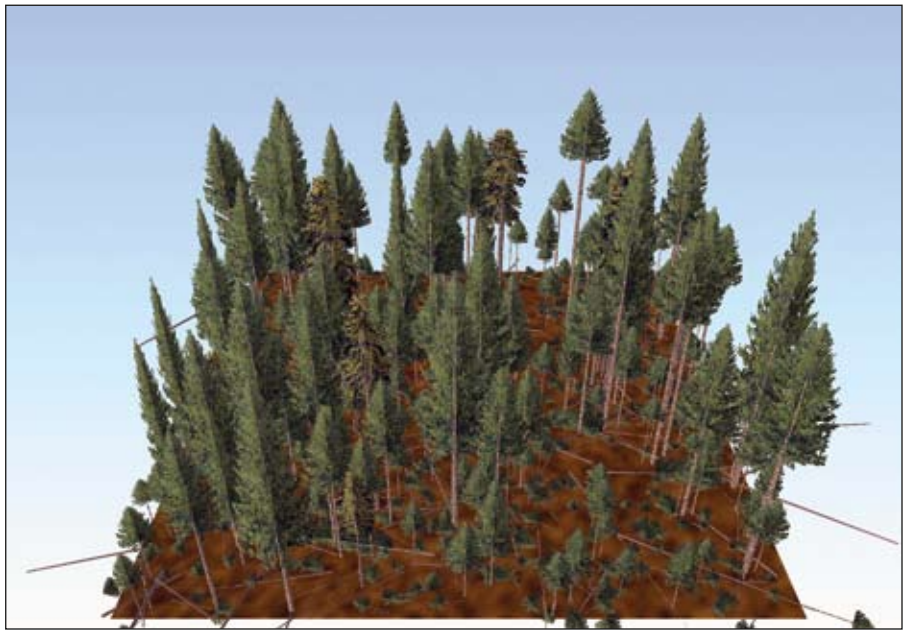
Stand attributes: Stem density = 1,216 tpa, basal area = 174 ft^2/ac, top height = 93 ft, stand density index = 415, quadratic mean diameter = 5.1 in, crown competition factor = 199, canopy cover = 69 percent.



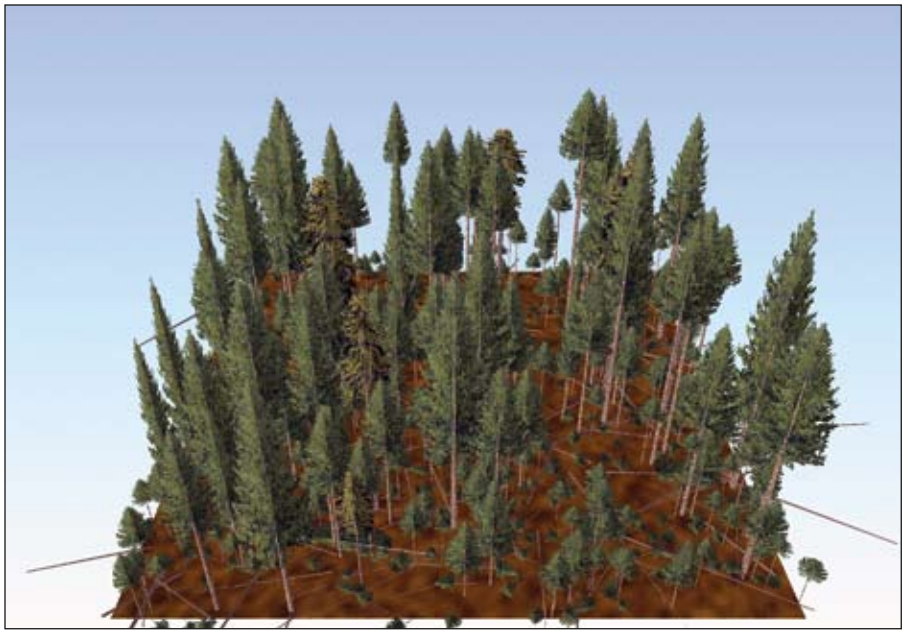
Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit



Thin from below to 200 tpa, 18-in d.b.h. limit



Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This stand has 1,216 trees per acre (tpa) composed of primarily grand fir understory with Douglas-fir and ponderosa pine overstory. Canopy base height is 3 ft, and canopy bulk density is 0.21 kg/m^3 (0.0131 lb/ft^3), so initial conditions are conducive to active crown fire spread for severe fire weather but not for moderate fire weather. Similarly, potential tree mortality is high for severe fire weather but low for moderate fire weather. Woody fuel loading is 19 tons/ac, and litter and duff loading is 27 tons/ac. With no action, canopy base height will increase and canopy bulk density will decrease as trees grow and the stand self-thins, but passive crown fire remains likely for severe fire weather for 50 years.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment reduces crown fire potential, surface fuel loading, potential flame lengths, and potential mortality but creates many snags that will contribute to surface fuels in the future. All thinning treatments are effective at reducing canopy bulk density and increasing canopy base height enough to reduce the potential for active and passive crown fire. The greater the thinning, the greater the reduction in crown fire potential, but the differences between the 300 tpa treatment and the 200 tpa treatment are minor. All thinning treatments increase surface fuel loadings; the greater the thinning, the greater the activity fuels. These activity fuels increase potential flame lengths, but potential tree mortality remains lower than initial conditions because canopy base height is higher. The pile and burn and prescribed fire treatments reduce surface fuels to below initial conditions and decrease potential flame lengths and mortality more than thinning without surface fuel treatments. The prescribed fire treatment also partially reduces the duff layer, but it still remains at 17 tons/ac after the treatment. The flame lengths of the 50 tpa treatment with a pile and burn or prescribed fire are higher than other thinnings with the same surface fuel treatments, because the 50 tpa treatment is the most open stand, and conditions are characterized by predominantly fuel model 5 rather than fuel model 8. The importance of brush as a driver of fire behavior is not predicted well in FFE and is site specific, so this result should be interpreted with caution.

Silvicultural and surface fuel treatments—long-term effects

Crown fire remains unlikely for thinning treatments with a pile and burn or no surface fuel treatment for the 50-year projection, because flame lengths remain low, preventing passive crown fire even when regeneration causes canopy case height to decrease. Passive crown fire is predicted in 30 to 40 years for all treatments with prescribed fire, because these treatments have the greatest regeneration and therefore the biggest decrease in canopy base height when regeneration moves into the canopy. All treatments reduce canopy bulk density enough that active crown fire remains unlikely for the 50-year projection.

Table 24a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	4	1	10	8	6	6
		3–6 in	7	1	8	8	7	7
		6–12 in	7	3	7	7	7	7
		>12 in	1	0	1	1	1	1
		Litter	2	1	3	3	3	3
		Duff	25	17	25	25	25	25
	Flame length (ft)	Moderate	2	1	4	3	3	2
		Severe	3	1	6	5	4	3
	Torching index	Severe	10	155	109	90	63	46
	Crowning index	Severe	14	35	36	30	25	22
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Active	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	25	16	9	14	18	21
		Severe	100	16	15	20	22	24
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			2	2	2	2
		3–6 in			2	2	2	2
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			3	3	2	2
		Duff			23	23	23	23
	Flame length (ft)	Moderate			2	1	1	1
		Severe			4	1	1	1
	Torching index	Severe			151	424	300	217
	Crowning index	Severe			36	30	25	22
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			9	14	18	21
		Severe			9	14	18	21
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			2	2	2	2
		6–12 in			4	4	4	4
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			17	17	17	17
	Flame length (ft)	Moderate			2	1	1	1
		Severe			6	1	1	1
	Torching index	Severe			106	472	273	259
	Crowning index	Severe			40	35	35	35
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			9	12	15	15
		Severe			13	12	15	15

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 24b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	4	4	5	5	6	6	1	5	3	3	3	3
		3–6 in	7	7	7	6	6	5	1	4	4	4	3	3
		6–12 in	7	8	9	9	8	8	3	7	8	8	8	3
		>12 in	1	2	4	5	6	7	0	3	5	7	8	3
		Litter	2	2	3	3	3	3	1	2	2	2	2	2
		Duff	25	25	25	25	25	25	17	17	17	17	17	17
	Flame length (ft)	Moderate	2	2	3	3	3	3	1	2	2	2	2	2
		Severe	3	3	4	4	4	4	1	4	4	4	4	4
	Torching index	Severe	10	14	2	7	7	12	155	39	46	59	82	113
	Crowning index	Severe	14	15	17	18	17	15	35	33	30	28	25	24
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Active	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	65	62	54	55	50	44	308	34	23	13	11	10
		18–29.9 in	5	4	4	4	4	4	7	6	5	4	4	4
		30–36 in	0	0	0	0	1	1	0	0	0	0	1	1

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	10	5	3	2	2	2	8	4	3	2	3	3
		3–6 in	8	8	8	7	6	5	8	8	8	7	6	6
		6–12 in	7	8	9	9	8	7	7	8	9	9	8	7
		>12 in	1	2	4	5	5	6	1	2	4	5	6	6
		Litter	3	1	1	1	1	1	3	1	2	2	2	2
		Duff	25	25	25	24	24	24	25	25	25	25	24	24
	Flame length (ft)	Moderate	4	3	3	3	2	2	3	3	3	3	3	2
		Severe	6	5	5	4	4	4	5	4	4	4	4	4
	Torching index	Severe	109	90	121	9	24	36	90	91	102	123	157	17
	Crowning index	Severe	36	36	37	38	38	37	30	29	28	28	28	26
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	51	38	14	8	6	6	51	39	16	9	7	7
		18–29.9 in	5	5	4	3	3	3	5	4	4	3	3	3
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	1

Table 24b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	2	2	2	2	2	2	2	2	2	2	3
		3–6 in	2	3	3	3	3	3	2	3	3	3	3	3
		6–12 in	2	4	5	6	5	5	2	4	5	6	5	5
		>12 in	0	2	3	5	5	5	0	2	3	5	5	6
		Litter	3	1	1	1	1	1	3	1	2	2	2	2
		Duff	23	22	22	22	22	22	23	22	22	22	22	22
	Flame length (ft)	Moderate	2	1	1	2	2	2	1	1	2	2	2	2
		Severe	4	4	3	2	2	2	1	2	2	3	3	3
	Torching index	Severe	151	271	388	38	62	67	424	483	311	288	31	39
	Crowning index	Severe	36	36	37	38	37	37	30	29	28	28	27	26
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	51	38	14	8	7	7	51	39	16	9	8	8
		18–29.9 in	5	5	4	3	2	3	5	4	4	3	3	3
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	2	2	2	2	2	0	2	2	2	2	2
		3–6 in	2	3	3	3	3	3	2	4	4	4	3	3
		6–12 in	4	7	8	8	7	6	4	8	9	9	8	7
		>12 in	0	3	5	7	7	7	0	3	5	7	7	7
		Litter	1	1	1	1	1	1	3	1	1	1	2	2
		Duff	17	17	17	17	17	17	23	17	17	17	17	17
	Flame length (ft)	Moderate	2	2	2	2	2	2	1	2	2	2	2	2
		Severe	6	5	3	3	3	3	1	3	4	4	4	3
	Torching index	Severe	106	126	13	22	33	45	472	220	168	8	22	25
	Crowning index	Severe	40	40	41	34	27	23	35	34	33	32	32	31
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	42	28	18	11	9	9	52	33	20	10	8	7
		18–29.9 in	7	6	5	3	3	2	7	6	5	4	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 24b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	6	4	3	3	3	4	6	4	3	3	4	4
		3–6 in	7	7	7	7	6	5	7	7	7	6	6	5
		6–12 in	7	8	9	9	8	8	7	8	9	9	8	8
		>12 in	1	2	4	5	6	6	1	2	4	5	6	6
		Litter	3	2	2	2	2	2	3	2	2	2	3	3
		Duff	25	25	25	25	25	25	25	25	25	25	25	25
	Flame length (ft)	Moderate	3	3	3	3	3	3	2	3	3	3	3	3
		Severe	4	4	4	4	4	4	3	4	4	4	4	4
	Torching index	Severe	63	64	81	91	125	141	46	42	47	80	90	110
	Crowning index	Severe	25	23	22	21	20	19	22	23	22	20	18	17
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	53	41	19	12	11	11	54	43	21	15	13	12
		18–29.9 in	5	4	4	4	3	4	5	4	4	4	3	3
		30–36 in	0	0	0	0	0	1	0	0	0	0	0	1
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	3	3	3	3	4	2	3	3	3	4	4
		3–6 in	2	3	3	3	3	3	2	3	3	3	3	3
		6–12 in	2	4	5	6	6	5	2	4	5	6	5	5
		>12 in	0	2	3	5	6	6	0	2	3	5	6	6
		Litter	2	2	2	2	2	2	2	2	2	2	3	3
		Duff	23	22	22	22	22	22	23	22	22	22	22	22
	Flame length (ft)	Moderate	1	1	2	2	2	2	1	1	2	2	2	2
		Severe	1	2	3	3	3	3	1	2	3	3	3	3
	Torching index	Severe	300	293	220	194	226	246	217	190	130	154	162	202
	Crowning index	Severe	25	23	22	21	20	18	22	23	22	20	18	16
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	53	41	19	12	11	11	54	43	21	14	13	14
		18–29.9 in	5	4	4	4	3	4	5	4	4	3	3	4
		30–36 in	0	0	0	0	0	1	0	0	0	0	0	1

Table 24b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	3	2	2	2	3	0	4	3	2	2	3
		3–6 in	2	5	4	4	4	3	2	5	5	4	4	3
		6–12 in	4	8	9	9	8	7	4	8	9	9	8	7
		>12 in	0	3	5	7	7	7	0	3	5	7	7	7
		Litter	1	1	1	2	2	2	1	1	2	2	2	2
		Duff	17	17	17	17	17	17	17	17	17	17	17	17
	Flame length (ft)	Moderate	1	2	2	2	2	2	1	2	2	2	2	2
		Severe	1	3	4	4	4	4	1	4	4	4	4	4
	Torching index	Severe	273	107	106	120	19	21	259	87	88	90	13	21
	Crowning index	Severe	35	34	31	29	28	26	35	33	31	29	27	25
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface
	Hard snags (stems/ac)	0–17.9 in	69	33	20	10	8	8	88	33	21	11	8	8
		18–29.9 in	7	6	5	4	3	3	7	6	5	4	3	3
		30–36 in	0	0	0	0	0	1	0	0	0	0	0	1

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 24c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	1,216	1,186	1,149	1,105	1,067	1,033	209	206	201	197	192	187
	Quadratic mean diameter (in)	5.1	5.5	5.9	6.3	6.7	7.1	5.1	11.5	12.3	13.1	13.9	14.7
	Total volume (ft^3)	4,813	5,830	6,890	7,943	9,013	10,110	4,446	4,847	5,680	6,540	7,416	8,275
	Merchantable volume (ft^3)	4,041	4,945	5,927	6,864	7,762	8,651	3,965	4,343	5,141	5,927	6,674	7,446
	Basal area (ft^2)	174	198	220	241	262	283	139	148	166	184	202	220
	Stand density index	415	459	497	530	562	594	246	257	281	303	326	347
	Canopy closure (percent)	69	71	74	75	77	78	47	48	51	53	55	57
	Crown competition factor	199	215	228	239	250	261	115	120	131	141	151	161
	Canopy base height (ft)	3	4	4	5	5	6	7	8	10	13	17	22
	Canopy bulk density (kg/m^3)	0.21	0.18	0.16	0.14	0.15	0.18	0.06	0.07	0.08	0.08	0.09	0.10

Table 24c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	1,216	50	149	146	144	141	139	100	148	145	143	140	137
	Quadratic mean diameter (in)	5.1	20.4	12.3	13.0	13.7	14.5	15.2	16.0	13.9	14.9	15.8	16.7	17.6
	Total volume (ft^3)	4,813	4,186	4,484	5,108	5,693	6,245	6,740	4,880	5,315	6,242	7,199	8,157	9,053
	Merchantable volume (ft^3)	4,041	3,894	4,176	4,760	5,317	5,820	6,254	4,470	4,867	5,756	6,671	7,558	8,401
	Basal area (ft^2)	174	113	124	136	148	161	174	140	157	175	194	213	232
	Stand density index	415	157	209	224	240	255	271	213	252	274	297	319	340
	Canopy cover (percent)	69	31	32	34	37	39	42	42	44	47	49	51	53
	Crown competition factor	199	75	80	87	101	109	117	103	113	123	134	145	158
	Canopy base height (ft)	3	34	37	38	4	6	7	21	27	27	30	34	5
	Canopy bulk density (kg/m^3)	0.21	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.08	0.08	0.08	0.09
Pile and burn	Trees per acre	1,216	50	199	196	192	189	186	100	174	171	168	165	162
	Quadratic mean diameter (in)	5.1	20.4	10.7	11.3	11.9	12.6	13.2	16.0	12.9	13.7	14.6	15.4	16.3
	Total volume (ft^3)	4,813	4,186	4,484	5,108	5,701	6,284	6,769	4,880	5,315	6,252	7,217	8,179	9,081
	Merchantable volume (ft^3)	4,041	3,894	4,176	4,760	5,320	5,850	6,275	4,470	4,867	5,764	6,688	7,579	8,426
	Basal area (ft^2)	174	113	124	136	149	163	176	140	157	175	195	214	233
	Stand density index	415	157	221	237	255	273	289	213	261	284	307	331	352
	Canopy cover (percent)	69	31	32	35	38	41	44	42	44	47	49	51	53
	Crown competition factor	199	75	80	87	106	115	123	103	113	123	134	146	160
	Canopy base height (ft)	3	34	37	38	4	6	6	21	27	27	30	4	5
	Canopy bulk density (kg/m^3)	0.21	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.08	0.08	0.09	0.09
Prescribed fire	Trees per acre	1,216	50	343	338	332	327	321	100	225	221	217	213	209
	Quadratic mean diameter (in)	5.1	20.4	7.8	8.2	8.7	9.2	9.7	16.0	10.5	11.2	11.9	12.6	13.3
	Total volume (ft^3)	4,813	3,833	4,101	4,659	5,224	5,731	6,211	4,306	4,669	5,445	6,234	7,053	7,799
	Merchantable volume (ft^3)	4,041	3,572	3,821	4,339	4,860	5,308	5,725	3,965	4,302	5,051	5,784	6,548	7,256
	Basal area (ft^2)	174	113	113	124	138	151	166	140	135	151	167	185	202
	Stand density index	415	157	228	246	267	287	307	213	243	264	286	310	331
	Canopy cover (percent)	69	31	29	34	41	45	48	42	38	41	44	47	49
	Crown competition factor	199	75	73	81	113	123	133	103	95	104	118	135	145
	Canopy base height (ft)	3	35	38	3	4	5	6	24	29	29	3	5	6
	Canopy bulk density (kg/m^3)	0.21	0.05	0.05	0.05	0.06	0.09	0.11	0.06	0.07	0.07	0.07	0.07	0.07

Table 24c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	1,216	200	220	215	210	206	201	300	318	311	304	297	292
	Quadratic mean diameter (in)	5.1	12.0	12.1	13.0	13.9	14.9	15.8	10.0	10.3	11.1	11.9	12.7	13.5
	Total volume (ft^3)	4,813	5,138	5,635	6,734	7,933	9,213	10,493	5,209	5,723	6,846	8,085	9,426	10,818
	Merchantable volume (ft^3)	4,041	4,491	4,970	6,038	7,213	8,310	9,497	4,485	4,950	6,043	7,206	8,269	9,474
	Basal area (ft^2)	174	156	176	199	222	247	272	162	184	208	234	261	289
	Stand density index	415	266	299	328	358	388	417	298	334	366	400	435	470
	Canopy cover (percent)	69	52	54	57	59	62	64	57	60	63	66	68	70
	Crown competition factor	199	127	138	151	164	178	191	144	157	171	186	202	218
	Canopy base height (ft)	3	12	16	19	21	27	32	8	10	11	17	19	25
	Canopy bulk density (kg/m^3)	0.21	0.10	0.11	0.11	0.12	0.13	0.14	0.11	0.11	0.12	0.13	0.15	0.16
Pile and burn	Trees per acre	1,216	200	233	228	223	218	213	300	331	324	317	309	303
	Quadratic mean diameter (in)	5.1	12.0	11.8	12.6	13.5	14.4	15.3	10.0	10.1	10.9	11.6	12.4	13.2
	Total volume (ft^3)	4,813	5,138	5,635	6,742	7,941	9,215	10,492	5,209	5,723	6,854	8,105	9,440	10,773
	Merchantable volume (ft^3)	4,041	4,491	4,970	6,045	7,219	8,308	9,493	4,485	4,950	6,049	7,220	8,289	9,439
	Basal area (ft^2)	174	156	176	199	223	248	272	162	184	208	234	261	287
	Stand density index	415	266	303	332	362	393	422	298	337	369	404	439	472
	Canopy cover (percent)	69	52	54	57	60	62	64	57	60	63	66	68	70
	Crown competition factor	199	127	138	151	164	178	191	144	157	171	187	202	217
	Canopy base height (ft)	3	12	16	19	21	27	32	8	10	11	16	19	26
	Canopy bulk density (kg/m^3)	0.21	0.10	0.11	0.11	0.12	0.13	0.14	0.11	0.11	0.12	0.13	0.15	0.16
Prescribed fire	Trees per acre	1,216	200	187	183	180	176	173	300	205	201	198	194	190
	Quadratic mean diameter (in)	5.1	12.0	11.8	12.7	13.5	14.4	15.3	10.0	11.4	12.2	13.0	13.9	14.8
	Total volume (ft^3)	4,813	4,410	4,798	5,654	6,565	7,528	8,454	4,428	4,826	5,699	6,622	7,602	8,572
	Merchantable volume (ft^3)	4,041	3,976	4,337	5,188	6,051	6,941	7,830	3,971	4,349	5,193	6,065	6,899	7,897
	Basal area (ft^2)	174	156	143	160	179	200	219	162	145	164	183	204	225
	Stand density index	415	266	245	268	292	317	340	298	253	277	303	329	354
	Canopy cover (percent)	69	52	43	45	48	51	53	57	45	48	50	53	55
	Crown competition factor	199	127	105	115	126	142	153	144	110	121	133	147	161
	Canopy base height (ft)	3	13	18	21	25	5	5	12	16	18	19	4	5
	Canopy bulk density (kg/m^3)	0.21	0.06	0.06	0.07	0.08	0.08	0.09	0.06	0.07	0.07	0.08	0.09	0.10

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 24d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*				
None	1	10	56	8	44					8	100						
	10	10	69	8	31					10	53	8	47				
	20	10	95	8	5					10	60	8	40				
	30	10	96	12	4					10	66	8	34				
	40	10	94	12	6					10	66	8	34				
	50	10	92	12	8					10	66	8	34				

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*				
None	1	11	65	14	35					11	82	14	18				
	10	10	84	8	11	5	5			10	82	8	18				
	20	10	71	8	26	5	3			10	76	8	24				
	30	10	63	8	37					10	73	8	27				
	40	10	53	8	47					10	68	8	32				
	`50	8	55	10	45					10	64	8	36				
Pile and burn	1	8	50	5	39	10	11			8	98	10	2				
	10	8	67	5	32					8	95	10	5				
	20	8	83	10	12	5	4			8	81	10	19				
	30	8	82	10	18					8	73	10	27				
	40	8	83	10	17					8	70	10	30				
	50	8	84	10	16					8	68	10	32				
Prescribed fire	1	5	73	8	27					8	100						
	10	5	51	8	35	10	13			8	70	10	30				
	20	8	66	10	28	5	7			8	56	10	44				
	30	8	64	10	36					10	52	8	48				
	40	8	66	10	34					8	50	10	50				
	50	8	70	10	30					8	55	10	45				

Table 24d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*				
None	1	11	98	14	2					11	88	8	12				
	10	10	77	8	23					10	74	8	26				
	20	10	77	8	23					10	78	8	22				
	30	10	80	8	20					10	81	8	19				
	40	10	80	8	20					10	86	8	14				
	50	10	82	8	18					10	89	8	11				
Pile and burn	1	8	100							8	100						
	10	8	92	10	8					8	90	10	10				
	20	8	76	10	24					8	73	10	27				
	30	8	64	10	36					8	61	10	39				
	40	8	57	10	43					8	52	10	48				
	50	10	50	8	50					10	57	8	43				
Prescribed fire	1	8	100							8	100						
	10	8	57	10	43					8	51	10	49				
	20	10	54	8	46					10	58	8	42				
	30	10	61	8	39					10	63	8	37				
	40	10	59	8	41					10	60	8	40				
	50	10	57	8	43					10	58	8	42				

tpa = trees per acre, d.b.h. = diameter at breast height.

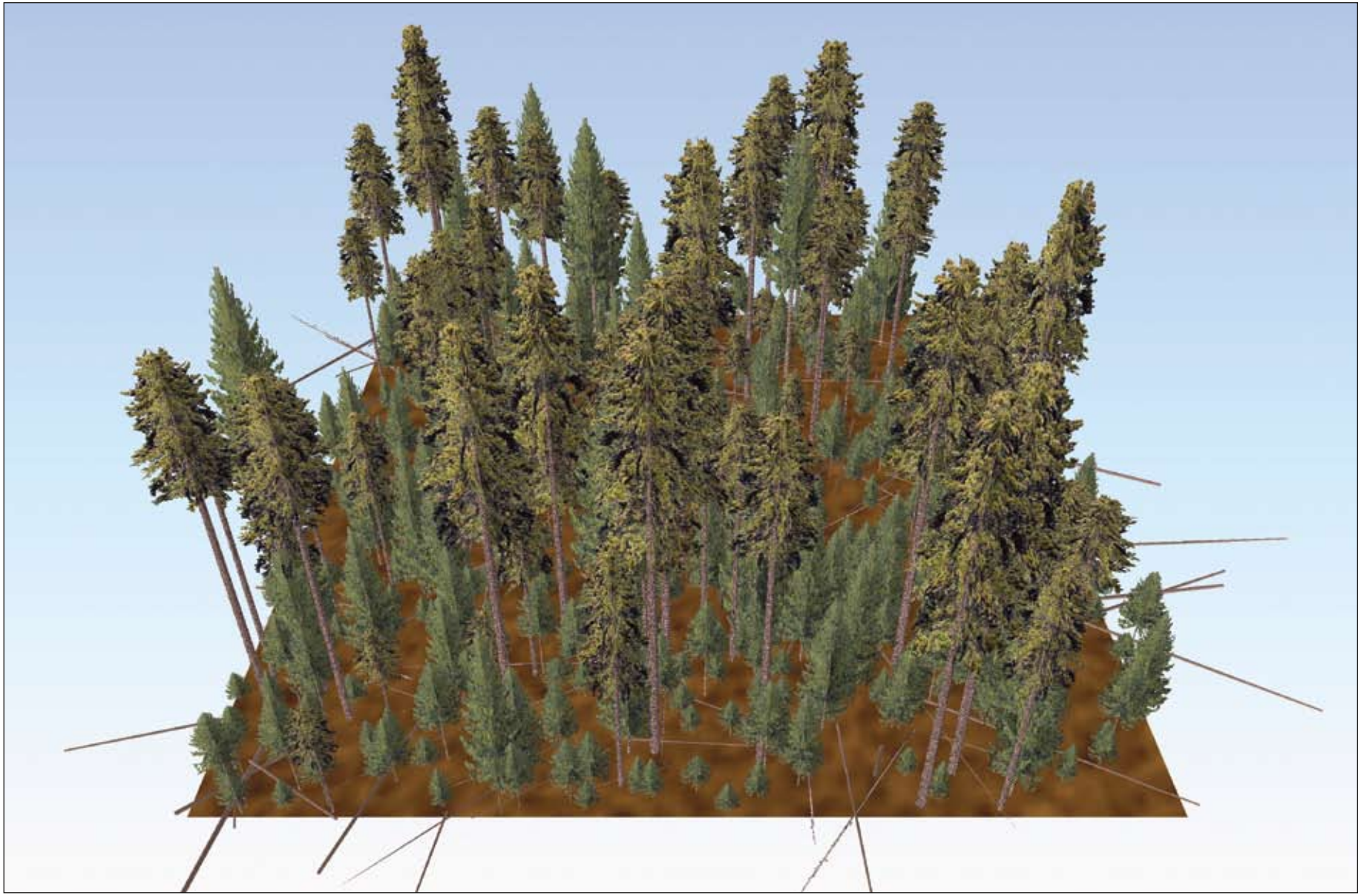
Table 24e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	*°F*	*Percent*					
Severe—98th percentile	14	90	2	5	8	15	50	100
Moderate—75th percentile	9	71	5	7	10	23	125	150

Table 24f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

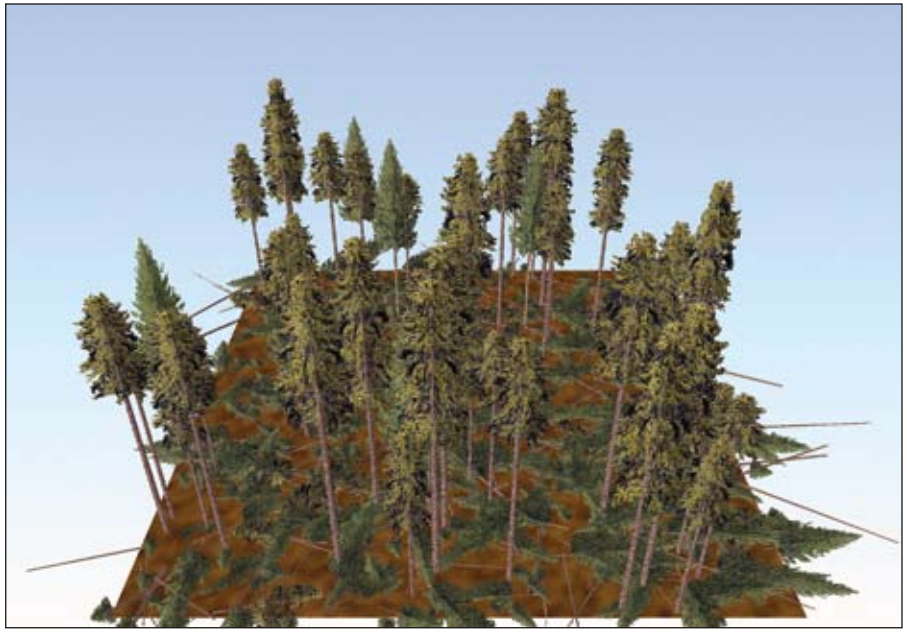


Initial stand conditions

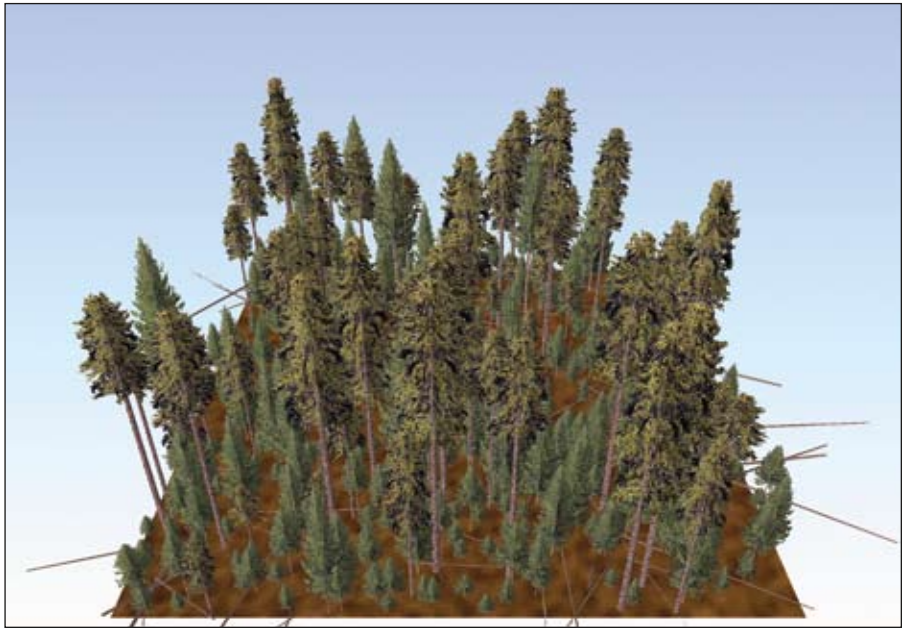
Site: Elevation = 4,400 ft, slope = 34 percent, aspect = 220°.

Species (based on trees per ac): Douglas-fir (*Pseudotsuga menziesii*) = 90 percent, ponderosa pine (*Pinus ponderosa*) = 9 percent.

Stand attributes: Stem density = 764 tpa, basal area = 174 ft^2/ac, top height = 90 ft, stand density index = 379, quadratic mean diameter = 6.5 in, crown competition factor = 204, canopy cover = 65 percent.



Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit

Thin from below to 200 tpa, 18-in d.b.h. limit

Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This stand has 764 trees per acre (tpa) composed of primarily understory Douglas-fir with overstory ponderosa pine. Canopy base height is only 2 ft and canopy bulk density is 0.08 kg/m^3 (0.005 lb/ft^3), so initial conditions have high potential for passive crown fire and low potential for active crown fire spread under severe fire weather. Potential basal area mortality is 70 percent for severe fire weather, but only 18 percent for moderate fire weather. Woody fuel loading is 9 tons/ac, and litter and duff loading is 7 tons/ac. With no action, canopy base height increases as the trees grow and the stand self-thins, making passive crown fire unlikely in 10 years, but crown fire potential declines only slightly because flame lengths increase as surface fuels accumulate.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment has little effect on canopy base height and crown fire potential and creates more snags. Surface fuel loading is reduced, but potential flame lengths increase because the more open stand is characterized by predominantly fuel model 6, brush fuels. Brush fuels are not tracked in FFE and the presence of brush following prescribed fire is site specific, so these results should be interpreted with caution. All thinning treatments increase canopy base height and reduce canopy bulk density. The 100 tpa thinning without a surface fuel treatment is the only treatment that remains susceptible to passive crown fire. Thinning to 50 tpa increases canopy base height much more than the other prescriptions because some larger overstory trees are removed as well as ladder fuels. All thinning treatments increase surface fuels, the greater the thinning, the greater is the increase in surface fuel loading. The 100 tpa treatment demonstrates that thinning must increase canopy base height enough to compensate for higher flame lengths associated with activity fuels if no surface fuel treatment is applied. The pile and burn treatment and, to a greater extent, the prescribed fire treatment reduce surface fuels, but flame lengths remain high because the low-density stands with scarce surface fuels are predominantly characterized by fuel model 6.

Silvicultural and surface fuel treatments—long-term effects

Canopy bulk density remains low enough in all treatments that active crown fire is unlikely for the 50-year projection. In the prescribed fire only treatment, crown fire potential decreases over time, and passive crown fire becomes unlikely in 10 years and remains unlikely for the 50-year projection. In all thinned stands, canopy base height continues to increase as trees grow and the stand self-thins, and passive crown fire remains unlikely for 50 years in the 100, 200, and 300 tpa treatments. Abundant regeneration causes a drop in canopy base height in 30 years in the 50 tpa treatments with a pile and burn and with no surface fuel treatment, and in 10 years in the 50 tpa treatment with prescribed fire. At this time, passive crown fire is predicted again, but the increase in crown fire potential is fleeting and soon decreases as the regeneration grows and crowns rise. Surface fuels accumulate over time in all thinned stands with pile and burn or prescribed fire treatments, but potential flame lengths decrease as the stand becomes less open and the assigned fuel model shifts from model 6 to model 9.

Table 25a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	3	1	7	6	4	4
		3–6 in	3	0	3	3	3	3
		6–12 in	3	1	1	2	2	2
		>12 in	0	0	0	0	0	0
		Litter	2	1	3	3	2	2
		Duff	5	4	3	3	5	5
	Flame length (ft)	Moderate	2	3	4	4	3	2
		Severe	3	5	6	6	4	3
	Torching index	Severe	0	10	81	26	12	17
	Crowning index	Severe	29	48	50	45	33	31
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Surface	Surface	Passive	Surface
	Potential basal area mortality (%)	Moderate	18	16	6	11	16	17
		Severe	70	36	7	20	30	21
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			2	1	1	1
		3–6 in			1	1	1	1
		6–12 in			0	1	1	1
		>12 in			0	0	0	0
		Litter			3	3	2	2
		Duff			2	3	4	4
	Flame length (ft)	Moderate			4	4	3	2
		Severe			7	6	4	3
	Torching index	Severe			61	20	13	20
	Crowning index	Severe			50	45	33	31
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			6	12	15	17
		Severe			15	25	26	20
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			1	1	1	1
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			0	1	1	1
		Duff			2	2	3	3
	Flame length (ft)	Moderate			4	4	4	4
		Severe			7	6	6	5
	Torching index	Severe			49	29	18	12
	Crowning index	Severe			53	48	48	47
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Passive
	Potential basal area mortality (%)	Moderate			6	10	14	16
		Severe			15	24	25	33

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 25b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	3	5	7	7	7	7	1	4	4	5	5	5
		3–6 in	3	3	4	5	5	6	0	3	3	3	4	5
		6–12 in	3	2	3	4	5	6	1	3	3	4	5	6
		>12 in	0	0	1	2	3	4	0	1	2	3	4	5
		Litter	2	3	3	3	3	3	1	2	2	2	2	2
		Duff	5	5	6	6	7	7	4	4	4	4	5	5
	Flame length (ft)	Moderate	2	2	3	3	3	3	3	3	3	3	3	3
		Severe	3	3	4	4	4	5	5	5	5	5	5	5
	Torching index	Severe	0	11	16	19	21	21	10	29	42	60	39	97
	Crowning index	Severe	29	30	29	30	33	35	48	45	44	41	40	41
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	42	106	115	92	86	76	164	12	23	33	35	34
		18–29.9 in	0	1	1	1	1	1	1	1	1	1	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	7	5	3	3	3	3	6	4	4	4	4	5
		3–6 in	3	3	3	3	3	3	3	3	3	4	4	4
		6–12 in	1	1	1	1	2	2	2	2	2	2	3	3
		>12 in	0	0	0	1	1	2	0	0	0	1	1	2
		Litter	3	1	2	2	2	2	3	2	2	2	2	2
		Duff	3	3	3	3	3	4	3	4	4	4	5	5
	Flame length (ft)	Moderate	4	4	4	4	2	2	4	4	4	4	4	3
		Severe	6	7	7	6	3	3	6	6	6	5	5	5
	Torching index	Severe	81	94	93	0	25	32	26	52	57	75	89	98
	Crowning index	Severe	50	48	48	47	47	47	45	43	42	42	42	41
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	1	2	6	8	9	10	1	3	9	13	21	24
		18–29.9 in	0	0	0	0	0	1	0	0	0	0	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 25b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	2	2	2	2	3	1	2	3	4	4	5
		3–6 in	1	1	1	2	2	2	1	1	1	2	2	3
		6–12 in	0	0	1	1	1	1	1	1	1	1	2	3
		>12 in	0	0	0	1	1	2	0	0	0	1	2	3
		Litter	3	1	2	2	2	2	3	2	2	2	2	2
		Duff	2	2	3	3	3	3	3	3	4	4	4	4
	Flame length (ft)	Moderate	4	4	4	2	2	2	4	4	4	4	4	4
		Severe	7	7	7	3	3	3	6	6	6	6	6	5
	Torching index	Severe	61	75	78	15	27	39	20	47	53	74	89	8
	Crowning index	Severe	50	48	48	47	47	47	45	43	42	41	41	41
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive
	Hard snags (stems/ac)	0–17.9 in	1	2	6	9	12	14	1	3	10	19	26	27
		18–29.9 in	0	0	0	0	0	1	0	0	0	1	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	1	2	2	3	4	0	2	3	3	3	4
		3–6 in	1	1	1	2	2	2	1	2	2	2	3	3
		6–12 in	1	1	1	2	2	2	1	2	3	3	3	4
		>12 in	0	1	1	2	3	4	0	1	2	3	3	4
		Litter	0	1	2	2	2	2	3	2	2	2	2	2
		Duff	2	2	2	2	3	3	3	3	3	3	3	4
	Flame length (ft)	Moderate	4	2	2	2	2	2	4	4	4	4	2	2
		Severe	7	3	3	3	3	4	6	6	6	6	4	4
	Torching index	Severe	49	0	16	27	30	29	29	37	63	4	13	14
	Crowning index	Severe	53	50	37	30	27	27	48	45	44	43	44	44
	Type of fire	Moderate	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	7	7	13	17	34	44	15	10	14	12	21	31
		18–29.9 in	1	1	1	1	1	2	1	1	1	0	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 25b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	4	5	5	6	6	7	4	4	6	6	7	7
		3–6 in	3	3	3	4	5	6	3	3	3	4	5	6
		6–12 in	2	2	3	4	5	7	2	2	3	3	5	6
		>12 in	0	0	1	2	3	5	0	0	1	1	2	4
		Litter	2	3	3	3	3	2	2	3	3	3	3	3
		Duff	5	5	5	5	6	6	5	5	6	6	6	7
	Flame length (ft)	Moderate	3	3	3	3	3	3	2	2	2	3	3	3
		Severe	4	4	4	5	5	5	3	3	4	4	4	5
	Torching index	Severe	12	36	52	74	90	84	17	31	43	36	40	39
	Crowning index	Severe	33	39	39	39	38	39	31	33	32	35	35	36
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	14	20	34	42	45	43	15	25	38	48	55	55
		18–29.9 in	0	0	1	1	2	2	0	0	1	1	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	1	3	5	6	6	6	1	3	5	6	7	7
		3–6 in	1	1	2	3	4	5	1	1	2	3	4	5
		6–12 in	1	1	1	3	4	6	1	1	1	2	3	5
		>12 in	0	0	1	2	3	5	0	0	1	1	2	3
		Litter	2	3	3	3	3	2	2	3	3	3	3	3
		Duff	4	4	5	5	5	6	4	5	5	5	6	6
	Flame length (ft)	Moderate	3	3	3	3	3	3	2	2	2	2	3	3
		Severe	4	4	4	5	5	5	3	3	3	4	4	4
	Torching index	Severe	13	35	50	70	83	102	20	48	49	38	41	51
	Crowning index	Severe	33	38	38	39	38	39	31	33	31	34	35	35
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	14	20	34	43	46	45	15	25	38	47	52	53
		18–29.9 in	0	0	1	1	2	3	0	0	1	1	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 25b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	3	4	4	5	5	0	4	4	5	5	5
		3–6 in	1	3	3	4	4	5	1	3	3	4	4	5
		6–12 in	1	3	3	4	5	6	1	3	3	4	5	6
		>12 in	0	1	2	3	3	5	0	1	2	3	4	5
		Litter	1	2	2	2	2	2	1	2	3	3	2	2
		Duff	3	3	4	4	4	5	3	4	4	4	5	5
	Flame length (ft)	Moderate	3	3	3	3	3	3	2	3	3	3	3	3
		Severe	4	5	5	5	5	5	3	5	5	5	5	5
	Torching index	Severe	12	32	55	67	77	11	17	25	44	61	76	92
	Crowning index	Severe	33	45	44	41	40	40	31	45	44	41	40	40
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	28	11	20	28	35	34	47	12	28	39	42	38
		18–29.9 in	1	1	1	1	1	2	1	1	1	1	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 25c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	764	651	571	506	446	394	186	182	168	149	133	117
	Quadratic mean diameter (in)	6.5	7.2	7.8	8.4	9.0	9.7	6.5	12.6	13.5	14.4	15.4	16.5
	Total volume (ft^3)	5,287	5,717	5,994	6,350	6,635	6,954	4,981	5,273	5,621	5,854	6,093	6,301
	Merchantable volume (ft^3)	4,494	4,912	5,110	5,576	5,857	6,190	4,360	4,663	4,922	5,231	5,430	5,654
	Basal area (ft^2)	174	184	189	196	199	203	150	158	166	169	171	172
	Stand density index	379	384	383	384	379	377	255	265	271	268	264	260
	Canopy closure (percent)	65	66	64	64	63	62	49	50	50	49	48	46
	Crown competition factor	204	207	208	208	206	204	144	151	156	155	153	150
	Canopy base height (ft)	2	4	6	7	8	9	6	13	18	24	16	34
	Canopy bulk density (kg/m^3)	0.08	0.08	0.08	0.08	0.07	0.07	0.04	0.05	0.05	0.05	0.05	0.05

Table 25c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	764	50	149	146	141	135	128	100	148	143	137	126	116
	Quadratic mean diameter (in)	6.5	20.3	12.1	12.5	13.2	14.0	14.8	16.1	13.8	14.5	15.2	16.0	16.8
	Total volume (ft^3)	5,287	4,344	4,502	4,758	5,128	5,505	5,835	5,138	5,378	5,765	6,191	6,458	6,635
	Merchantable volume (ft^3)	4,494	3,956	4,155	4,343	4,712	5,030	5,346	4,549	4,813	5,099	5,474	5,720	5,883
	Basal area (ft^2)	174	112	119	124	134	144	152	142	154	163	172	176	178
	Stand density index	379	155	202	209	221	231	239	215	249	259	267	268	266
	Canopy cover (percent)	65	29	30	31	35	37	38	41	42	43	44	43	43
	Crown competition factor	204	88	93	96	109	116	122	121	130	136	141	143	144
	Canopy base height (ft)	2	41	45	45	4	7	9	13	23	25	32	37	40
	Canopy bulk density (kg/m^3)	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
Pile and burn	Trees per acre	764	50	199	195	189	179	168	100	174	168	158	143	130
	Quadratic mean diameter (in)	6.5	20.3	10.5	10.8	11.5	12.2	13.0	16.1	12.8	13.3	14.0	14.9	15.7
	Total volume (ft^3)	5,287	4,344	4,502	4,759	5,131	5,515	5,863	5,138	5,378	5,766	6,084	6,357	6,494
	Merchantable volume (ft^3)	4,494	3,956	4,155	4,345	4,713	5,036	5,361	4,549	4,813	5,100	5,392	5,638	5,764
	Basal area (ft^2)	174	112	119	124	135	146	155	142	154	163	169	173	174
	Stand density index	379	155	214	221	235	247	257	215	257	267	271	271	268
	Canopy cover (percent)	65	29	30	31	36	39	40	41	42	43	43	43	43
	Crown competition factor	204	88	93	96	112	121	128	121	130	136	138	141	142
	Canopy base height (ft)	2	41	45	46	4	6	9	13	23	25	32	37	6
	Canopy bulk density (kg/m^3)	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
Prescribed fire	Trees per acre	764	50	345	336	323	293	259	100	227	218	212	199	178
	Quadratic mean diameter (in)	6.5	20.3	7.8	8.3	9.0	9.8	10.7	16.1	10.5	10.9	11.5	12.1	13.0
	Total volume (ft^3)	5,287	4,088	4,236	4,525	4,919	5,118	5,459	4,668	4,873	5,173	5,566	5,813	6,025
	Merchantable volume (ft^3)	4,494	3,722	3,910	4,094	4,439	4,554	4,776	4,168	4,400	4,620	4,976	5,160	5,366
	Basal area (ft^2)	174	112	114	127	144	153	161	142	136	143	152	159	163
	Stand density index	379	155	231	251	274	283	288	215	245	252	265	270	270
	Canopy cover (percent)	65	29	34	41	46	48	48	41	37	38	40	42	42
	Crown competition factor	204	88	97	120	135	141	145	121	112	116	126	134	136
	Canopy base height (ft)	2	42	2	4	6	8	11	19	22	28	5	5	7
	Canopy bulk density (kg/m^3)	0.08	0.04	0.04	0.06	0.08	0.09	0.10	0.04	0.05	0.05	0.05	0.05	0.05

Table 25c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	764	200	206	182	160	138	119	300	300	273	241	209	180
	Quadratic mean diameter (in)	6.5	12.2	12.5	13.5	14.4	15.4	16.4	10.2	10.6	11.5	12.4	13.3	14.2
	Total volume (ft^3)	5,287	5,475	5,692	6,005	6,217	6,363	6,418	5,558	5,833	6,289	6,649	6,873	7,018
	Merchantable volume (ft^3)	4,494	4,723	4,982	5,214	5,543	5,666	5,765	4,736	5,018	5,351	5,818	6,081	6,270
	Basal area (ft^2)	174	163	174	180	180	179	176	169	185	196	201	201	199
	Stand density index	379	276	293	294	286	277	265	308	331	341	339	329	318
	Canopy cover (percent)	65	53	54	53	51	49	47	59	61	61	60	58	55
	Crown competition factor	204	160	168	169	166	160	154	178	191	198	198	192	185
	Canopy base height (ft)	2	6	14	20	27	30	33	5	8	12	11	13	26
	Canopy bulk density (kg/m^3)	0.08	0.07	0.06	0.06	0.06	0.06	0.06	0.08	0.07	0.07	0.07	0.06	0.06
Pile and burn	Trees per acre	764	200	219	194	169	147	126	300	313	285	254	223	193
	Quadratic mean diameter (in)	6.5	12.2	12.1	13.1	14.0	15.0	16.0	10.2	10.4	11.2	12.1	13.0	13.9
	Total volume (ft^3)	5,287	5,475	5,692	6,005	6,204	6,363	6,421	5,558	5,833	6,290	6,680	6,984	7,124
	Merchantable volume (ft^3)	4,494	4,723	4,982	5,213	5,536	5,668	5,771	4,736	5,018	5,352	5,856	6,175	6,349
	Basal area (ft^2)	174	163	175	180	180	179	176	169	185	196	202	204	203
	Stand density index	379	276	297	297	289	280	268	308	334	344	343	338	327
	Canopy cover (percent)	65	53	54	53	51	49	47	59	61	61	60	58	56
	Crown competition factor	204	160	168	169	165	160	154	178	191	199	199	196	189
	Canopy base height (ft)	2	6	14	20	27	30	33	5	8	12	11	13	16
	Canopy bulk density (kg/m^3)	0.08	0.07	0.06	0.06	0.06	0.06	0.06	0.08	0.07	0.07	0.07	0.06	0.07
Prescribed fire	Trees per acre	764	200	203	189	172	154	137	300	229	207	181	160	141
	Quadratic mean diameter (in)	6.5	12.2	11.8	12.5	13.3	14.1	15.1	10.2	11.2	12.1	13.0	13.9	14.9
	Total volume (ft^3)	5,287	4,938	5,199	5,571	5,920	6,082	6,316	4,978	5,272	5,592	5,865	6,046	6,276
	Merchantable volume (ft^3)	4,494	4,347	4,633	4,924	5,320	5,439	5,670	4,360	4,669	4,914	5,244	5,389	5,637
	Basal area (ft^2)	174	163	153	161	167	167	171	169	158	164	167	168	171
	Stand density index	379	276	263	270	273	268	266	308	276	279	276	270	267
	Canopy cover (percent)	65	53	46	46	46	45	44	59	49	48	47	46	45
	Crown competition factor	204	160	138	143	145	144	145	178	147	150	150	148	147
	Canopy base height (ft)	2	10	15	24	28	31	7	7	12	19	25	29	32
	Canopy bulk density (kg/m^3)	0.08	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 25d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*		*Percent*		
None	1	9	96	10	4					6	65	9	35				
	10	9	66	10	34					9	36	6	35	10	29		
	20	10	68	9	32					10	36	9	33	6	31		
	30	10	86	9	14					10	54	6	25	9	21		
	40	10	99	12	1					10	71	6	18	9	11		
	50	10	92	12	8					10	88	6	8	9	4		

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	10	65	6	34	2	1			6	51	10	48	9	2		
	10	6	83	10	17					6	71	10	21	9	8		
	20	6	90	10	10					6	67	10	22	9	11		
	30	6	93	10	7					6	61	10	25	9	13		
	40	9	93	10	7					6	52	10	37	9	11		
	`50	9	89	10	11					10	50	6	42	9	8		
Pile and burn	1	6	97	2	3					6	97	9	3				
	10	6	100							6	90	9	10				
	20	6	100							6	86	9	14				
	30	9	100							6	75	9	13	10	12		
	40	9	100							6	61	10	27	9	12		
	50	9	97	10	3					6	49	10	43	9	8		
Prescribed fire	1	6	88	2	12					6	100						
	10	9	100							6	100						
	20	9	100							6	88	10	12				
	30	9	97	10	3					6	78	10	21	9	1		
	40	9	85	10	15					9	71	10	29				
	50	9	70	10	30					9	58	10	42				

Table 25d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	9	53	6	26	10	21			9	82	10	13	6	5		
	10	9	50	10	29	6	21			9	71	10	29				
	20	10	45	9	36	6	19			9	52	10	48				
	30	10	67	9	19	6	14			10	68	9	32				
	40	10	91	6	5	9	4			10	90	9	8	6	1		
	50	10	91	12	9					10	93	12	7				
Pile and burn	1	9	67	6	33					9	94	6	6				
	10	9	70	6	29	10	1			9	97	10	3				
	20	9	49	10	26	6	25			9	71	10	29				
	30	10	51	9	28	6	21			10	52	9	48				
	40	10	76	6	13	9	11			10	72	9	25	6	2		
	50	10	99	6	1					10	93	9	5	6	1		
Prescribed fire	1	6	83	9	17					6	71	9	29				
	10	6	57	9	24	10	19			6	43	9	33	10	24		
	20	6	49	10	29	9	22			6	37	10	36	9	27		
	30	10	47	6	37	9	15			10	56	6	27	9	16		
	40	10	62	6	29	9	9			10	75	6	17	9	8		
	50	10	80	6	16	9	4			10	94	6	5	9	2		

tpa = trees per acre, d.b.h. = diameter at breast height.

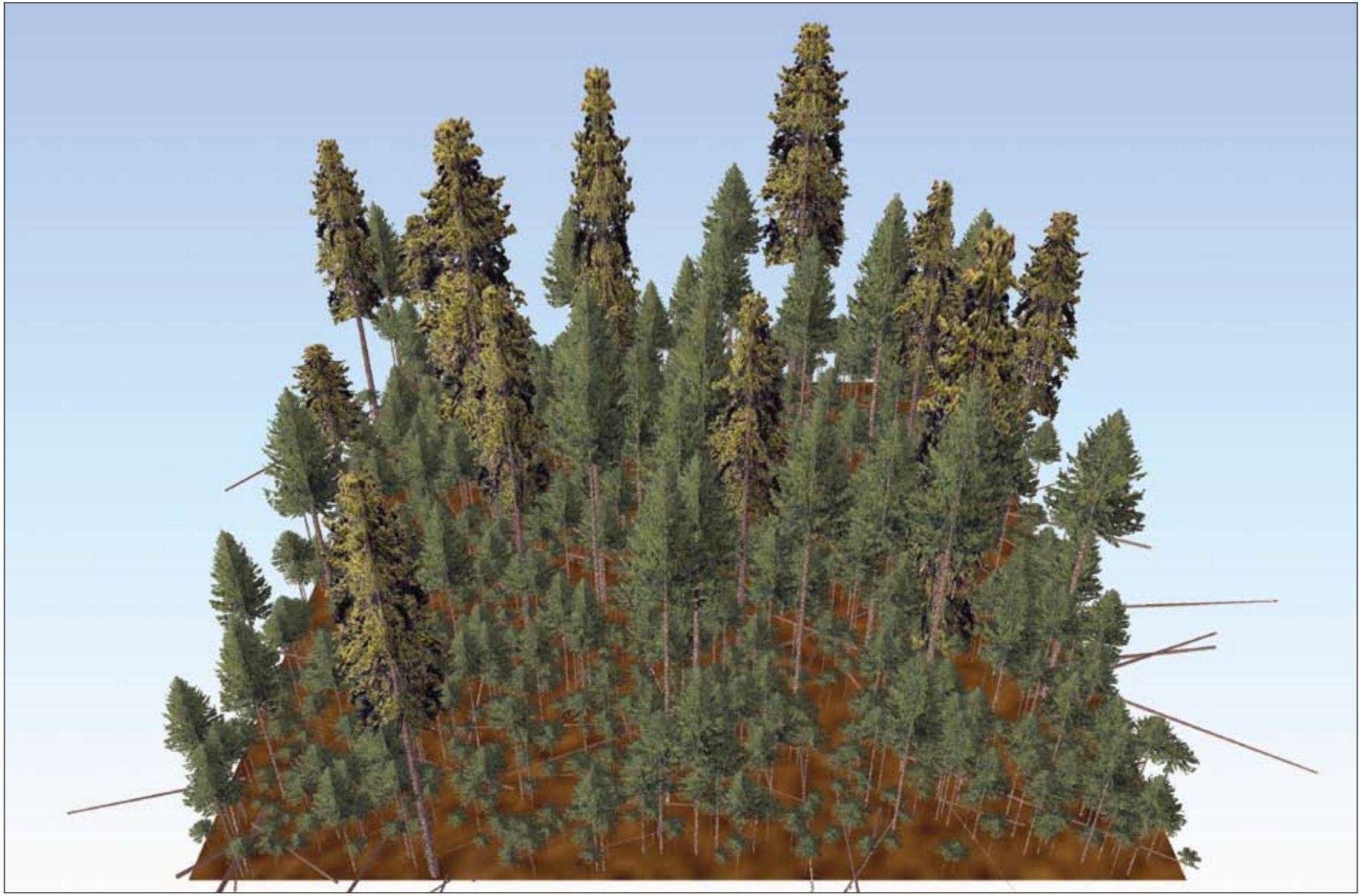
Table 25e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	*°F*	*Percent*					
Severe—98th percentile	14	81	3	5	8	15	50	100
Moderate—75th percentile	8	64	6	8	11	18	125	150

Table 25f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).



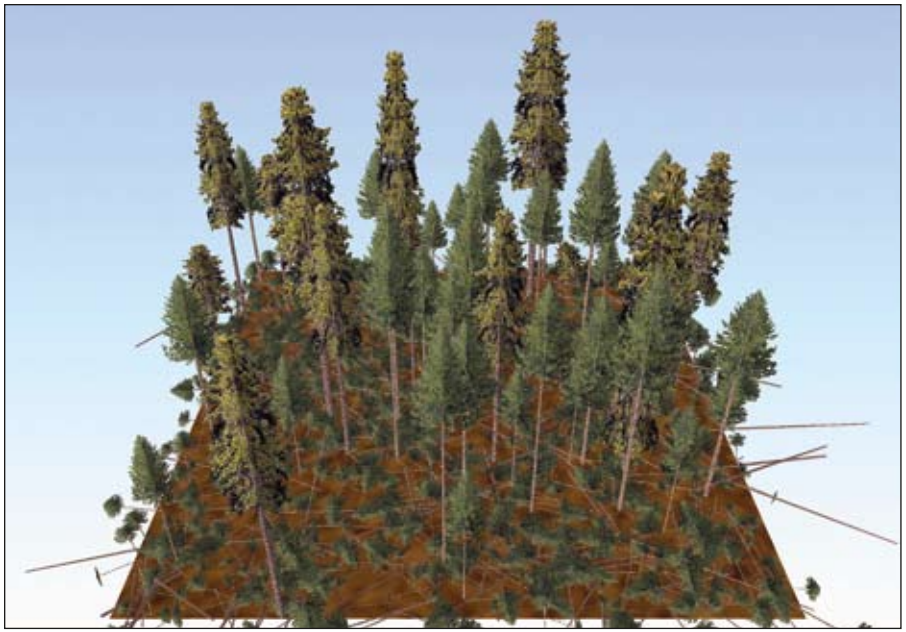
Initial stand conditions

Site: Elevation = 4,800 ft, slope = 25 percent, aspect = 145°.

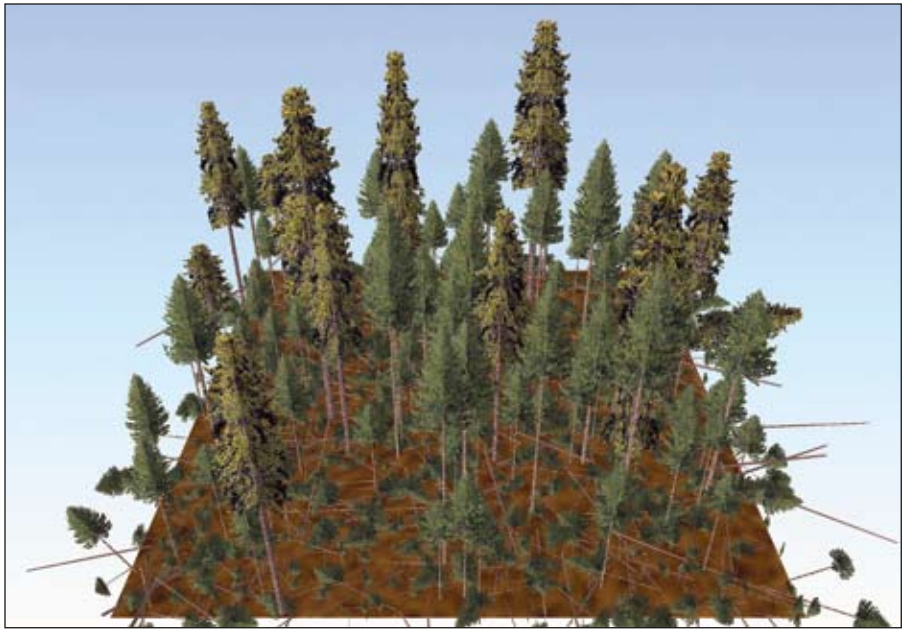
Species (based on trees per acre): Douglas-fir (*Pseudotsuga menziesii*) = 99 percent, ponderosa pine (*Pinus ponderosa*) = 1 percent.

Stand attributes: Stem density = 2,514 tpa, basal area = 188 ft^2/ac, top height = 86 ft, stand density index = 510, quadratic mean diameter = 3.7 in, crown competition factor = 369, canopy cover = 88 percent.

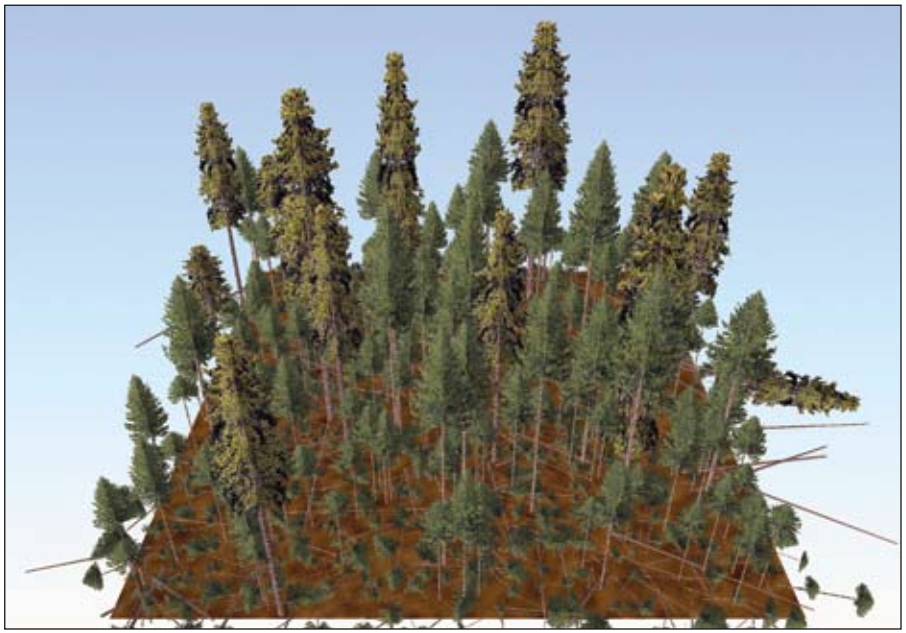
300



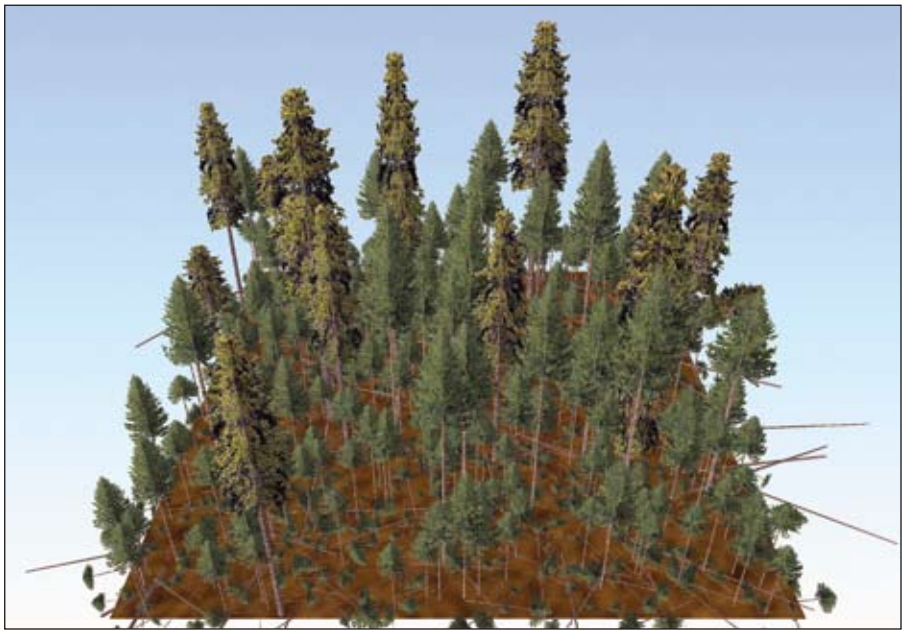
Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit



Thin from below to 200 tpa, 18-in d.b.h. limit



Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This is a dense stand with 2,514 trees per acre (tpa) composed of primarily understory Douglas-fir with overstory ponderosa pine. Canopy base height is 7 ft and canopy bulk density is 0.52 kg/m^3 (0.0325 lb/ft^3), so initial conditions have low potential for passive crown fire but high potential for active crown fire spread (conditional crown fire) under severe fire weather. Potential tree mortality is 34 percent, and flame lengths are only 2 ft. Woody fuel loading is 11 tons/ac, and litter and duff loading is 12 tons/ac. With no action, canopy base height remains constant, canopy bulk density decreases, and flame lengths increase, so the potential for crown fire spread decreases, but the potential for passive crown fire increases. In 40 years, passive crown fire is predicted for severe fire weather, but surface fire is predicted for moderate fire weather. Surface fuels accumulate over time, and flame lengths are 6 ft in 50 years for severe fire weather.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment does not affect canopy base height, but fire-caused mortality of small trees reduces canopy bulk density and increases snag density. Surface fuel loading is greatly reduced and potential flame lengths decrease initially. All thinning treatments increase canopy base height and reduce canopy bulk density; the greater the thinning, the greater the change in forest structure. Immediately after the thinning the predicted fire type changes to surface fire for all treatments, but extensive activity fuels cause higher potential flame lengths. Both the pile and burn and the prescribed fire surface fuel treatments reduce woody fuels, and the prescribed fire treatment also reduces litter and duff, but potential flame lengths decrease only slightly because fuel model 5 is assigned to the open stands with low woody fuel loading. Flame lengths remain above 4 ft for severe fire weather, but are 2 ft or less for moderate fire weather. Brush fuels are not tracked in FFE and may or may not be present following treatment.

Silvicultural and surface fuel treatments—long-term effects

All treatments reduce canopy bulk density sufficiently that active crown fire spread remains unlikely for the 50-year projection. In the prescribed fire only treatment, forest structure changes little over time, but surface fuels accumulate, and higher flame lengths cause a gradual increase in crown fire potential. In the 50 and 100 tpa treatments, regeneration causes an abrupt decline in canopy base height in 10 to 30 years depending on surface fuel treatment, but because flame lengths are low, the decline in canopy base height only temporarily increases crown fire potential. In the 200 and 300 tpa treatments, regeneration is minimal, so canopy base height continues to increase over time as the trees grow and the stand self-thins. In high-density treatments with prescribed fire, regeneration is greater and canopy base height decreases in 40 years, at which time surface fuels have accumulated and flame lengths are higher, so passive crown fire is predicted again for severe fire weather. Another treatment would be necessary to reduce surface fuels or increase canopy base height. Crown fire potential remains low in all treatments for moderate fire weather for the entire 50-year projection.

Table 26a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	3	1	14	14	12	10
		3–6 in	4	0	8	9	8	6
		6–12 in	4	2	2	3	3	4
		>12 in	0	0	0	0	0	0
		Litter	2	1	5	5	4	4
		Duff	10	7	7	8	9	10
	Flame length (ft)	Moderate	1	1	5	5	4	3
		Severe	2	1	8	7	6	5
	Torching index	Severe	197	232	38	43	45	53
	Crowning index	Severe	6	22	48	40	23	17
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Conditional	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	34	23	8	12	18	22
		Severe	34	23	29	28	36	35
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			3	3	3	2
		3–6 in			2	3	2	2
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			5	4	4	4
		Duff			6	7	8	9
	Flame length (ft)	Moderate			2	2	2	1
		Severe			6	5	4	2
	Torching index	Severe			50	62	138	447
	Crowning index	Severe			48	40	23	17
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			8	12	18	22
		Severe			10	18	18	22
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			2	2	2	2
		6–12 in			1	2	2	2
		>12 in			0	0	0	0
		Litter			0	1	1	1
		Duff			5	6	6	7
	Flame length (ft)	Moderate			2	1	1	1
		Severe			6	6	5	4
	Torching index	Severe			43	53	50	81
	Crowning index	Severe			51	51	36	29
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			7	10	14	17
		Severe			9	18	24	22

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 26b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	3	6	8	10	10	10	1	7	5	5	6	6
		3–6 in	4	4	5	6	7	8	0	6	6	6	6	7
		6–12 in	4	3	4	4	6	7	2	3	3	4	5	6
		>12 in	0	1	2	3	5	6	0	1	2	4	6	7
		Litter	2	6	6	6	6	5	1	3	3	3	4	4
		Duff	10	10	11	12	12	13	7	7	8	8	9	9
	Flame length (ft)	Moderate	1	2	3	3	4	4	1	2	2	2	3	3
		Severe	2	3	4	5	5	6	1	4	3	4	4	5
	Torching index	Severe	197	45	22	15	11	8	232	28	35	29	19	17
	Crowning index	Severe	6	10	13	16	18	19	22	23	23	24	25	25
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Cond.	Cond.	Cond.	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	159	295	474	353	314	229	536	18	39	59	70	74
		18–29.9 in	4	4	5	5	5	5	5	5	5	6	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	14	8	5	4	3	3	14	8	5	4	4	4
		3–6 in	8	8	7	7	7	7	9	8	8	8	7	7
		6–12 in	2	2	3	3	4	4	3	3	3	3	4	5
		>12 in	0	1	2	3	5	7	0	1	2	3	5	6
		Litter	5	1	2	2	2	2	5	2	2	2	2	2
		Duff	7	7	8	8	8	8	8	8	9	9	9	9
	Flame length (ft)	Moderate	5	3	3	3	3	3	5	3	2	2	3	3
		Severe	8	5	6	4	4	4	7	5	5	5	5	5
	Torching index	Severe	38	73	79	9	17	22	43	87	78	83	10	17
	Crowning index	Severe	48	47	45	45	47	49	40	41	40	37	34	35
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface
	Hard snags (stems/ac)	0–17.9 in	6	7	12	17	21	21	6	8	13	17	21	25
		18–29.9 in	4	4	5	5	6	5	4	4	5	5	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 26b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	3	3	3	3	3	3	3	3	3	3	3	4
		3–6 in	2	2	2	3	3	3	3	2	3	3	3	4
		6–12 in	1	1	1	2	2	3	1	1	1	2	3	4
		>12 in	0	1	2	3	5	6	0	1	2	3	5	6
		Litter	5	1	2	2	2	2	4	2	2	2	2	2
		Duff	6	6	7	7	7	7	7	7	8	8	8	8
	Flame length (ft)	Moderate	2	2	4	2	2	2	2	1	2	2	2	2
		Severe	6	6	6	3	3	4	5	5	5	5	5	4
	Torching index	Severe	50	51	65	16	23	26	62	70	72	86	11	38
	Crowning index	Severe	48	47	45	45	46	40	40	39	39	36	33	34
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface
	Hard snags (stems/ac)	0–17.9 in	6	7	12	19	24	24	6	8	13	18	22	26
		18–29.9 in	4	4	5	5	6	5	4	4	5	5	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	1	2	3	3	4	0	2	2	2	3	3
		3–6 in	2	3	3	3	3	3	3	3	4	4	4	4
		6–12 in	1	2	2	3	3	4	2	3	3	4	4	5
		>12 in	0	1	3	4	6	7	0	1	3	4	6	7
		Litter	0	1	2	2	2	2	4	2	2	2	2	2
		Duff	5	5	5	5	5	6	7	6	6	6	6	6
	Flame length (ft)	Moderate	2	2	2	2	2	2	1	1	2	2	2	2
		Severe	6	3	3	3	3	4	6	6	5	3	4	4
	Torching index	Severe	43	4	17	24	31	35	53	61	67	31	18	19
	Crowning index	Severe	51	50	33	24	22	20	51	49	47	42	40	40
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	10	10	15	24	32	34	16	10	14	18	23	27
		18–29.9 in	5	5	5	5	5	5	5	5	5	5	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 26b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	12	7	5	5	5	5	10	6	5	6	6	7
		3–6 in	8	7	7	7	7	8	6	6	6	6	7	7
		6–12 in	3	3	3	4	5	6	4	3	3	4	5	7
		>12 in	0	1	2	3	5	6	0	1	2	3	5	6
		Litter	4	3	3	3	3	3	4	3	3	4	4	4
		Duff	9	10	10	10	11	11	10	11	11	11	12	12
	Flame length (ft)	Moderate	4	3	2	2	3	3	3	2	2	2	3	3
		Severe	6	4	4	4	4	5	5	4	3	4	4	5
	Torching index	Severe	45	95	120	124	111	96	53	120	147	128	102	87
	Crowning index	Severe	23	25	26	26	26	26	17	20	19	20	21	21
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	4	7	14	22	29	33	7	13	25	37	48	54
		18–29.9 in	4	4	5	5	5	5	4	4	5	5	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	3	3	3	4	5	5	2	3	4	5	6	7
		3–6 in	2	2	3	3	3	4	2	2	2	3	4	5
		6–12 in	1	1	1	2	3	5	1	1	1	2	4	6
		>12 in	0	1	2	3	5	6	0	1	2	3	5	6
		Litter	4	3	3	3	3	3	4	3	3	4	4	4
		Duff	8	9	9	9	9	10	9	9	10	10	10	11
	Flame length (ft)	Moderate	2	1	1	2	2	3	1	1	1	2	2	3
		Severe	4	3	3	3	4	4	2	2	2	3	4	5
	Torching index	Severe	138	270	264	208	156	133	447	545	360	218	145	105
	Crowning index	Severe	23	25	26	26	26	25	17	19	19	20	20	22
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	7	10	18	27	33	36	7	13	25	36	48	55
		18–29.9 in	4	4	5	5	5	5	4	4	5	5	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 26b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	3	3	3	3	4	0	4	3	4	4	5
		3–6 in	2	5	5	5	5	5	2	5	5	5	6	6
		6–12 in	2	3	4	4	5	6	2	4	4	4	5	6
		>12 in	0	1	3	4	6	7	0	1	3	4	6	7
		Litter	1	2	2	2	2	2	1	2	2	3	3	3
		Duff	6	7	7	7	7	8	7	7	7	8	8	8
	Flame length (ft)	Moderate	1	2	2	2	2	3	1	2	2	2	3	3
		Severe	5	5	5	5	4	4	4	4	4	4	4	5
	Torching index	Severe	50	69	76	86	13	23	81	88	90	92	14	11
	Crowning index	Severe	36	37	38	38	35	33	29	31	30	32	32	31
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	29	11	16	21	25	29	43	12	20	26	33	36
		18–29.9 in	5	5	5	5	5	5	5	5	5	6	5	5
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

tpa = trees per acre; d.b.h. = diameter at breast height; cond. = conditional.

Table 26c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	2,514	2,182	1,773	1,532	1,277	1,126	544	534	505	461	411	361
	Quadratic mean diameter (in)	3.7	4.1	4.6	5.1	5.7	6.1	3.7	6.9	7.5	8.1	8.8	9.5
	Total volume (ft^3)	4,651	5,145	5,504	5,977	6,340	6,818	4,049	4,273	4,691	5,049	5,435	5,805
	Merchantable volume (ft^3)	3,579	3,884	4,497	5,166	5,691	6,264	3,400	3,550	4,115	4,550	5,025	5,417
	Basal area (ft^2)	188	202	208	219	224	231	132	140	154	164	172	177
	Stand density index	510	525	517	522	513	514	284	297	317	327	332	331
	Canopy closure (percent)	88	88	86	85	83	82	63	65	67	67	66	65
	Crown competition factor	369	365	349	345	334	331	189	197	211	217	219	218
	Canopy base height (ft)	7	7	7	7	7	7	7	7	7	7	7	8
	Canopy bulk density (kg/m^3)	0.52	0.31	0.25	0.18	0.16	0.15	0.12	0.12	0.12	0.11	0.11	0.10

Table 26c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	2,514	50	148	144	136	127	118	100	147	142	135	127	118
	Quadratic mean diameter (in)	3.7	18.0	10.7	11.1	11.7	12.3	13.1	13.8	11.8	12.3	12.9	13.7	14.4
	Total volume (ft^3)	4,651	3,562	3,653	3,792	3,944	4,055	4,216	3,894	4,034	4,281	4,573	4,887	5,130
	Merchantable volume (ft^3)	3,579	3,387	3,437	3,572	3,725	3,796	3,881	3,701	3,803	4,028	4,334	4,654	4,848
	Basal area (ft^2)	188	89	93	96	101	105	110	103	111	117	123	129	133
	Stand density index	510	129	166	169	175	178	182	167	191	198	204	210	211
	Canopy cover (percent)	88	28	28	30	32	33	34	38	39	40	41	42	42
	Crown competition factor	369	86	89	92	100	103	106	110	117	121	127	133	135
	Canopy base height (ft)	7	31	35	40	5	8	10	28	32	32	33	6	8
	Canopy bulk density (kg/m^3)	0.52	0.04	0.04	0.05	0.05	0.04	0.04	0.06	0.05	0.05	0.06	0.07	0.07
Pile and burn	Trees per acre	2,514	50	148	144	136	127	118	100	173	168	160	151	140
	Quadratic mean diameter (in)	3.7	18.0	10.7	11.1	11.7	12.3	13.1	13.8	10.8	11.3	11.9	12.6	13.3
	Total volume (ft^3)	4,651	3,562	3,653	3,792	3,944	4,055	4,216	3,894	4,034	4,279	4,576	4,900	5,146
	Merchantable volume (ft^3)	3,579	3,387	3,437	3,572	3,725	3,796	3,881	3,701	3,803	4,026	4,337	4,663	4,858
	Basal area (ft^2)	188	89	93	96	101	105	110	103	111	117	123	130	135
	Stand density index	510	129	166	169	175	178	182	167	197	204	211	219	221
	Canopy cover (percent)	88	28	28	30	34	36	37	38	39	40	41	43	43
	Crown competition factor	369	86	89	92	100	103	106	110	117	121	128	135	138
	Canopy base height (ft)	7	31	35	40	5	8	10	28	32	32	33	6	8
	Canopy bulk density (kg/m^3)	0.52	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07
Prescribed fire	Trees per acre	2,514	50	341	334	319	299	278	100	220	215	206	195	181
	Quadratic mean diameter (in)	3.7	18.0	7.0	7.6	8.3	9.1	9.9	13.8	9.0	9.3	9.9	10.5	11.2
	Total volume (ft^3)	4,651	3,361	3,438	3,624	3,836	4,203	4,524	3,560	3,665	3,838	4,074	4,300	4,517
	Merchantable volume (ft^3)	3,579	3,187	3,230	3,338	3,470	3,619	4,075	3,375	3,452	3,600	3,835	4,041	4,192
	Basal area (ft^2)	188	89	90	105	120	134	147	103	97	101	110	117	124
	Stand density index	510	129	190	214	237	255	271	167	186	191	202	211	217
	Canopy cover (percent)	88	28	33	41	47	50	52	38	33	34	38	40	42
	Crown competition factor	369	86	94	119	134	144	153	110	98	101	117	123	128
	Canopy base height (ft)	7	42	2	4	7	10	13	29	32	33	4	7	9
	Canopy bulk density (kg/m^3)	0.52	0.04	0.04	0.07	0.11	0.12	0.14	0.04	0.04	0.04	0.05	0.06	0.05

Table 26c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	2,514	200	220	211	197	181	166	300	317	301	278	250	221
	Quadratic mean diameter (in)	3.7	10.6	10.7	11.4	12.1	13.0	13.7	9.2	9.5	10.2	11.0	11.8	12.6
	Total volume (ft^3)	4,651	4,302	4,515	4,913	5,346	5,814	6,157	4,583	4,837	5,320	5,814	6,247	6,630
	Merchantable volume (ft^3)	3,579	3,770	4,008	4,618	5,099	5,577	5,914	3,763	4,000	4,808	5,527	5,973	6,338
	Basal area (ft^2)	188	124	137	149	158	166	171	139	157	172	183	189	192
	Stand density index	510	221	245	259	269	274	276	263	293	313	324	325	321
	Canopy cover (percent)	88	51	54	55	56	56	55	60	64	65	65	64	63
	Crown competition factor	369	148	161	172	179	183	186	179	198	212	220	221	219
	Canopy base height (ft)	7	23	26	27	29	31	35	19	22	24	26	29	32
	Canopy bulk density (kg/m^3)	0.52	0.12	0.10	0.10	0.10	0.10	0.10	0.17	0.14	0.15	0.14	0.13	0.13
Pile and burn	Trees per acre	2,514	200	233	224	209	193	176	300	330	314	291	262	230
	Quadratic mean diameter (in)	3.7	10.6	10.4	11.0	11.8	12.6	13.4	9.2	9.3	10.0	10.7	11.5	12.4
	Total volume (ft^3)	4,651	4,302	4,515	4,913	5,345	5,813	6,163	4,583	4,837	5,320	5,809	6,254	6,600
	Merchantable volume (ft^3)	3,579	3,770	4,008	4,617	5,098	5,576	5,915	3,763	4,000	4,808	5,521	5,975	6,321
	Basal area (ft^2)	188	124	137	149	158	166	171	139	157	172	183	189	191
	Stand density index	510	221	248	262	272	278	280	263	296	315	327	328	323
	Canopy cover (percent)	88	51	54	55	56	56	55	60	64	65	65	65	63
	Crown competition factor	369	148	161	172	179	183	186	179	198	212	220	222	218
	Canopy base height (ft)	7	23	26	27	29	31	35	19	22	24	26	29	32
	Canopy bulk density (kg/m^3)	0.52	0.12	0.10	0.10	0.10	0.10	0.10	0.17	0.15	0.15	0.14	0.13	0.13
Prescribed fire	Trees per acre	2,514	200	197	190	180	168	154	300	242	231	217	199	181
	Quadratic mean diameter (in)	3.7	10.6	10.2	10.7	11.3	12.0	12.8	9.2	9.5	10.1	10.7	11.4	12.2
	Total volume (ft^3)	4,651	3,777	3,925	4,184	4,480	4,808	5,091	3,908	4,072	4,370	4,687	5,014	5,298
	Merchantable volume (ft^3)	3,579	3,419	3,582	3,930	4,254	4,585	4,843	3,414	3,571	4,032	4,448	4,777	5,027
	Basal area (ft^2)	188	124	111	118	125	132	138	139	120	129	136	142	146
	Stand density index	510	221	202	211	219	225	229	263	225	235	243	247	248
	Canopy cover (percent)	88	51	42	43	44	45	45	60	48	49	50	50	49
	Crown competition factor	369	148	121	127	135	142	145	179	139	146	152	156	158
	Canopy base height (ft)	7	24	26	27	29	6	8	19	23	23	25	6	6
	Canopy bulk density (kg/m^3)	0.52	0.06	0.06	0.06	0.06	0.07	0.07	0.09	0.08	0.08	0.08	0.07	0.08

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 26d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*				
None	1	8	89	10	11					8	100						
	10	10	71	8	29					10	85	8	15				
	20	10	92	12	8					10	74	8	26				
	30	10	72	12	28					10	86	8	14				
	40	10	56	12	44					10	95	12	5				
	50	12	57	10	43					10	81	12	19				

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	12	62	10	38					12	57	10	43				
	10	10	89	5	10	1	1			10	95	5	5				
	20	10	60	6	40					10	68	5	32				
	30	10	53	9	47					10	65	5	34	8	2		
	40	10	60	9	40					10	74	5	24	8	2		
	`50	10	72	9	28					10	90	5	10	8	1		
Pile and burn	1	5	56	10	38	1	6			5	67	10	33				
	10	5	92	1	8					5	98	10	2				
	20	6	98	2	2	10	1			5	92	10	8				
	30	9	89	10	11					5	74	10	20	8	6		
	40	9	73	10	27					5	55	10	37	8	8		
	50	9	57	10	43					10	57	8	43				
Prescribed fire	1	5	77	1	23					5	100						
	10	9	100							5	99	10	1				
	20	9	98	10	2					5	87	10	13				
	30	9	78	10	22					8	72	10	28				
	40	9	56	10	44					9	56	10	44				
	50	10	66	9	34					10	63	9	37				

Table 26d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		Percent		Percent				Percent		Percent		Percent		
None	1	10	61	12	39					10	85	12	15				
	10	10	90	8	7	5	3			10	76	8	24				
	20	10	72	8	21	5	7			10	71	8	29				
	30	10	79	8	17	5	4			10	88	8	12				
	40	10	100	8		5				10	90	12	10				
	50	10	87	12	13					10	73	12	27				
Pile and burn	1	8	45	5	35	10	21			8	92	10	8				
	10	8	65	5	29	10	6			8	92	10	8				
	20	8	64	5	20	10	16			8	75	10	25				
	30	8	51	10	36	5	13			10	52	8	48				
	40	10	62	8	30	5	8			10	86	8	14				
	50	10	92	8	6	5	2			10	88	12	12				
Prescribed fire	1	5	100							5	74	8	26				
	10	5	71	10	22	8	7			10	39	5	37	8	24		
	20	5	59	10	31	8	10			10	45	5	30	8	25		
	30	10	46	5	43	8	12			10	62	5	20	8	18		
	40	10	64	5	26	8	9			10	84	5	8	8	8		
	50	10	86	8	14					10	95	12	5				

tpa = trees per acre, d.b.h. = diameter at breast height.

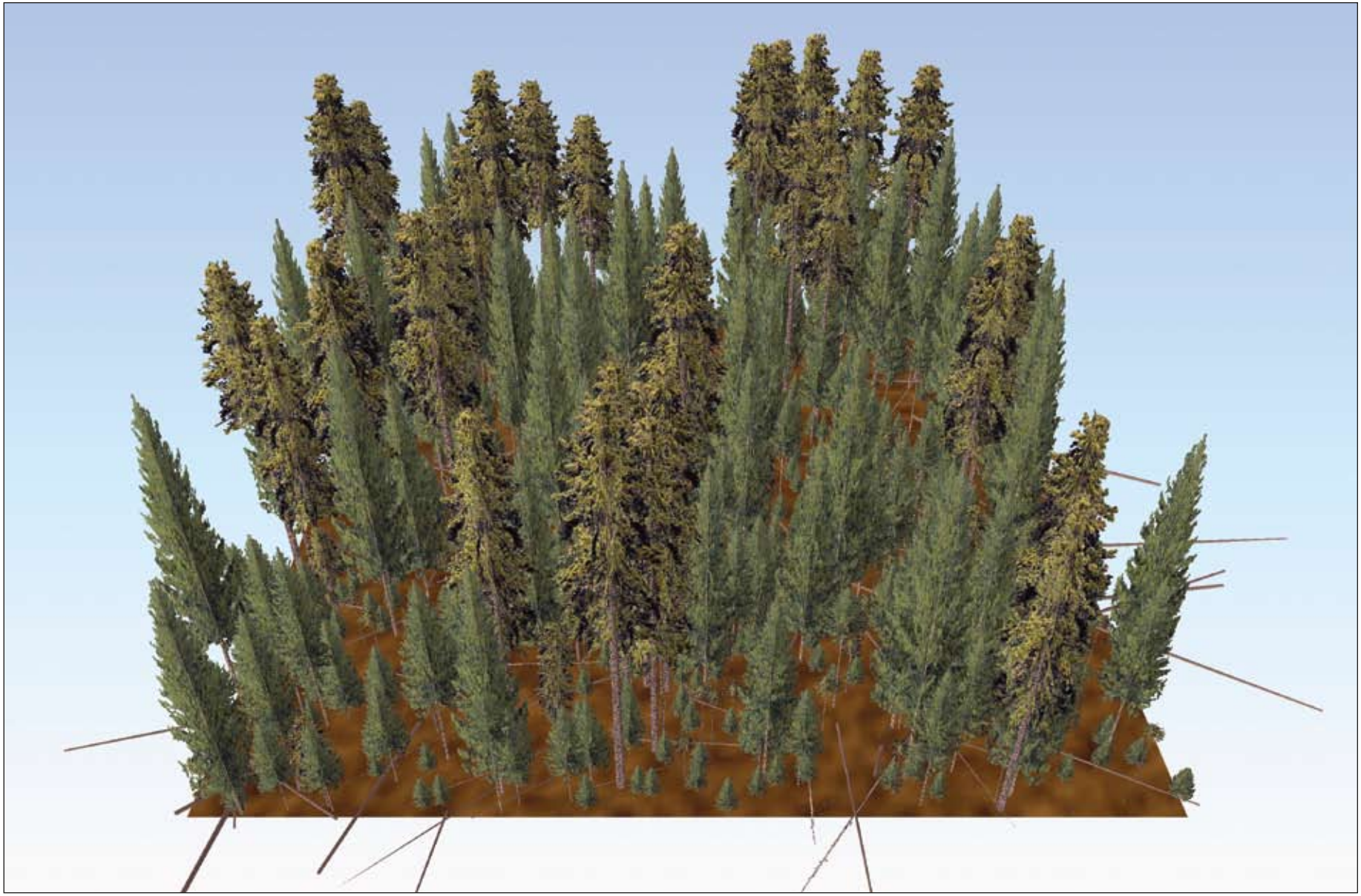
Table 26e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	°F	Percent					
Severe—98th percentile	14	81	3	5	10	15	50	100
Moderate—75th percentile	8	64	6	8	15	18	125	150

Table 26f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

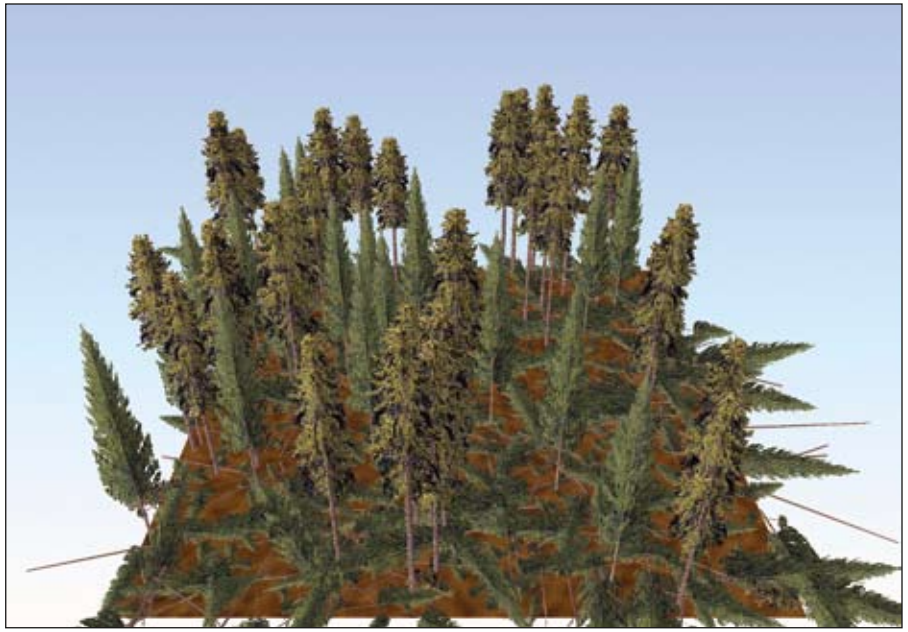


Initial stand conditions

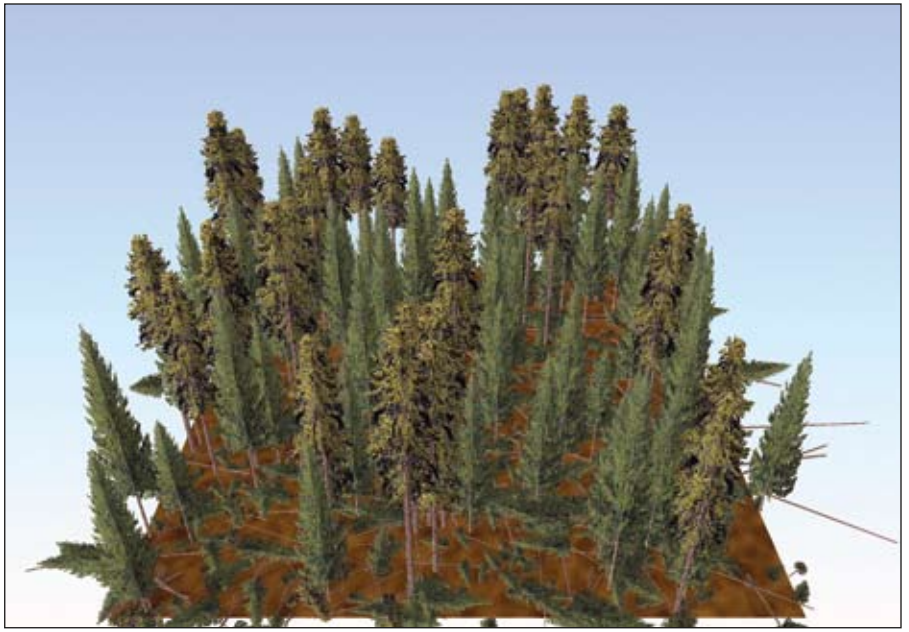
Site: Elevation = 3,400 ft, slope = 36 percent, aspect = 266°.

Species (based on trees per acre): Grand fir (*Abies grandis*) = 53 percent, Douglas-fir (*Pseudotsuga menziesii*) = 38 percent, lodgepole pine (*Pinus contorta*) = 1 percent, ponderosa pine (*Pinus ponderosa*) = 8 percent.

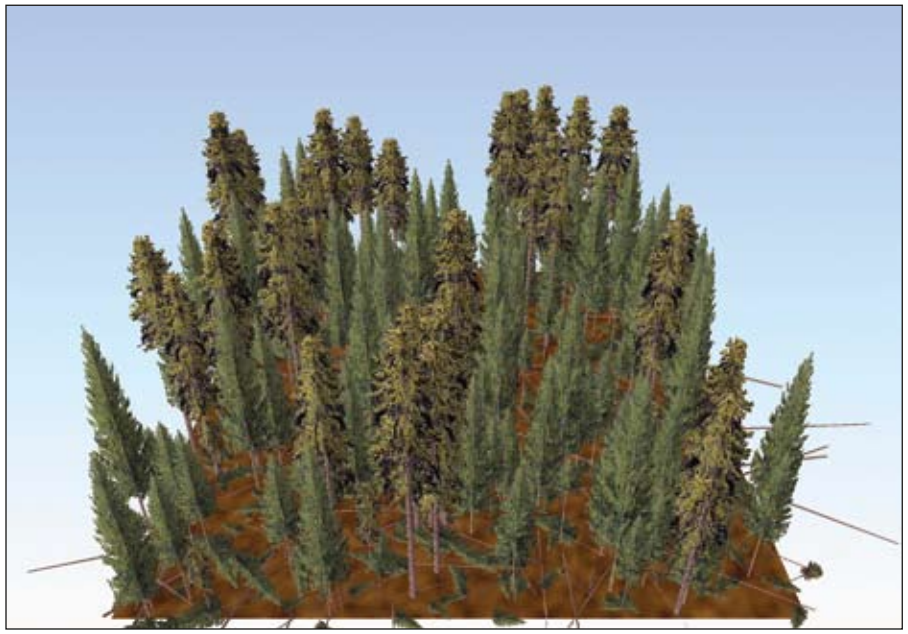
Stand attributes: Stem density = 2,092 tpa, basal area = 166 ft^2/ac, top height = 92 ft, stand density index = 445, quadratic mean diameter = 3.8 in, crown competition factor = 217, canopy cover = 66 percent.



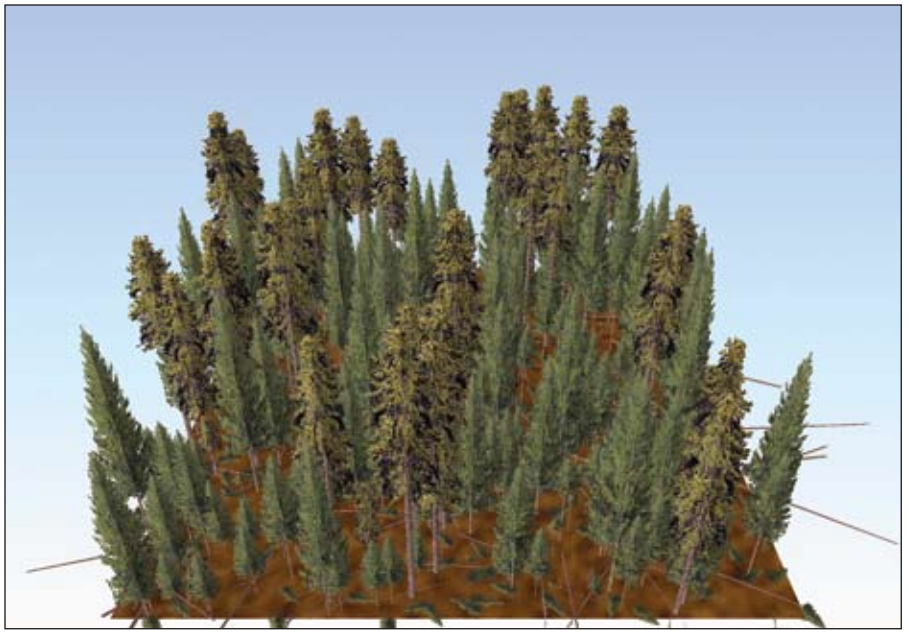
Thin from below to 50 tpa, 18-in d.b.h. limit



Thin from below to 100 tpa, 18-in d.b.h. limit



Thin from below to 200 tpa, 18-in d.b.h. limit



Thin from below to 300 tpa, 18-in d.b.h. limit

Initial conditions/no-action trajectory

This is a dense stand with 2,092 trees per acre (tpa) composed of grand fir, Douglas-fir, lodgepole pine, and ponderosa pine. Canopy base height is 2 ft, and canopy bulk density is 0.08 kg/m^3 (0.005 lb/ft^3) so initial conditions have high potential for passive crown fire and tree mortality, but low potential for active crown fire spread under severe fire weather. Initial woody fuel loading is 9 tons/ac, and litter and duff loading is 7 tons/ac. With no action, canopy base height will increase and canopy bulk density will decrease over time as trees grow and the stand self-thins, but surface fuels accumulate and potential flame lengths increase, so crown fire potential remains similar. Passive crown fire is predicted for the entire 50-year trajectory for severe fire weather, but surface fire is predicted for moderate fire weather.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment increases canopy base height and reduces canopy bulk density and surface fuels enough to change the predicted fire type to surface fire for severe and moderate fire weather; however, many snags are created and surface fuels accumulate rapidly. Potential flame lengths increase immediately after treatment despite the reduction in woody surface fuels, because the more open stand is characterized by fuel model 6 suggesting that brush fuels are an important contributor to fire behavior following prescribed fire; this may or may not be a factor, depending on the site. All thinning treatments effectively reduce canopy bulk density and increase canopy base height enough to reduce crown fire potential and tree mortality, but the 100 to 300 tpa treatments similarly affect stand structure. The thinning treatments also increase surface fuels and potential flame lengths; the greater the thinning, the greater the change in surface fuels and flame lengths. These activity fuels are reduced by the pile and burn treatment and to a greater extent by prescribed fire, but this change in surface fuels does not reduce flame lengths, because the more open stands with low surface fuels are characterized by fuel model 6. The 300 tpa treatment with a prescribed burn surface fuel treatment is still predicted to be passive crown fire immediately after treatment because canopy base height is relatively low and fuel model 6 is the primary model used. Brush fuels are not tracked in FFE, so these results should be interpreted with caution.

Silvicultural and surface fuel treatments—long-term effects

Crown fire potential decreases over time in the prescribed fire only treatment as canopy base height continues to increase, but surface fuels accumulate and flame lengths are predicted to be 5 ft in 50 years. Regeneration in the 50 tpa treatment causes an abrupt decline in canopy base height, and passive crown fire becomes likely again in 30 years. At this time, a second treatment would be necessary to prevent passive crown fire. Regeneration plays an important role in crown fire potential over time, but the decrease in canopy base height may not be as extreme or abrupt in reality. Canopy base height continues to increase in all other thinning treatments, so crown fire potential remains low for both moderate and severe fire weather for the entire 50-year projection.

Table 27a—Projected treatment effects on fuels and fire first cycle after treatments implemented

Surface fuel treatment	Fuel/fire attribute		Initial condition	Prescribed fire only	Thin from below to 50 tpa, 18-in d.b.h. limit	Thin from below to 100 tpa, 18-in d.b.h. limit	Thin from below to 200 tpa, 18-in d.b.h. limit	Thin from below to 300 tpa, 18-in d.b.h. limit
None	Surface fuel loadings (tons/ac)	0–3 in	3	1	7	6	5	4
		3–6 in	3	0	4	5	3	3
		6–12 in	3	1	1	2	2	2
		>12 in	0	0	0	0	0	0
		Litter	2	1	4	3	3	3
		Duff	5	4	2	4	4	5
	Flame length (ft)	Moderate	2	4	4	4	3	2
		Severe	3	5	6	5	4	3
	Torching index	Severe	0	19	63	22	26	34
	Crowning index	Severe	31	43	53	40	34	31
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	21	16	7	11	16	19
		Severe	75	30	11	25	26	23
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			2	2	1	1
		3–6 in			1	1	1	1
		6–12 in			0	1	1	1
		>12 in			0	0	0	0
		Litter			3	3	3	3
		Duff			2	3	4	4
	Flame length (ft)	Moderate			4	4	3	2
		Severe			7	6	4	3
	Torching index	Severe			41	18	26	37
	Crowning index	Severe			53	40	34	31
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			7	12	16	19
		Severe			24	31	25	21
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			1	1	1	1
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			2	3	3	3
	Flame length (ft)	Moderate			4	4	4	3
		Severe			7	6	6	8
	Torching index	Severe			31	22	22	7
	Crowning index	Severe			56	43	42	42
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Passive
	Potential basal area mortality (%)	Moderate			7	11	15	16
		Severe			23	31	32	56

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 27b—Treatment effect on fuels and fire behavior, 50-year projection

Surface fuel treatment	Fuel/fire attribute		No action						Prescribed fire only					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	3	6	9	10	9	8	1	5	6	6	7	7
		3–6 in	3	3	5	6	7	8	0	4	4	4	5	5
		6–12 in	3	3	4	6	8	9	1	4	4	4	5	5
		>12 in	0	0	1	2	4	6	0	1	1	2	3	4
		Litter	2	4	4	3	3	3	1	3	3	3	3	3
		Duff	5	5	6	6	7	7	4	4	4	5	5	5
	Flame length (ft)	Moderate	2	2	3	4	4	4	4	3	3	3	3	3
		Severe	3	4	4	5	6	6	5	5	4	4	4	5
	Torching index	Severe	0	8	5	5	7	9	19	41	49	102	132	155
	Crowning index	Severe	31	33	36	36	36	37	43	40	36	35	35	34
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	189	407	395	229	166	127	520	9	11	21	21	20
		18–29.9 in	1	2	3	4	4	4	1	1	1	1	1	1
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	7	5	4	3	4	4	6	5	5	5	6	6
		3–6 in	4	4	4	4	4	5	5	4	5	5	5	6
		6–12 in	1	1	1	1	1	1	2	2	2	2	2	3
		>12 in	0	0	0	0	0	1	0	0	0	0	1	2
		Litter	4	2	2	2	3	3	3	3	3	3	3	3
		Duff	2	3	3	3	4	4	4	4	4	5	5	5
	Flame length (ft)	Moderate	4	4	4	4	4	2	4	3	3	3	3	3
		Severe	6	6	6	6	6	4	5	5	5	5	5	5
	Torching index	Severe	63	82	103	0	7	22	22	60	99	124	145	177
	Crowning index	Severe	53	51	50	50	49	48	40	37	35	34	35	35
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	1	1	3	3	3	4	1	2	4	10	17	18
		18–29.9 in	0	0	0	0	1	1	0	0	0	1	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 27b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	2	3	3	4	4	2	3	4	5	6	6
		3–6 in	1	1	2	2	3	3	1	2	2	3	3	4
		6–12 in	0	0	1	1	1	1	1	1	1	1	1	2
		>12 in	0	0	0	0	0	1	0	0	0	0	1	2
		Litter	3	2	2	2	3	3	3	3	3	3	3	3
		Duff	2	2	3	3	3	4	3	4	4	4	5	5
	Flame length (ft)	Moderate	4	4	4	4	2	2	4	4	3	3	3	3
		Severe	7	7	7	6	3	4	6	5	5	5	5	5
	Torching index	Severe	41	62	78	0	21	21	18	55	88	117	138	162
	Crowning index	Severe	53	51	50	50	49	49	40	37	34	34	35	35
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	1	1	4	4	4	9	1	2	3	15	18	19
		18–29.9 in	0	0	0	0	1	1	0	0	0	1	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	2	2	3	3	4	0	3	3	4	5	5
		3–6 in	1	2	2	2	3	4	1	2	3	3	4	4
		6–12 in	1	1	2	2	2	2	1	3	4	4	4	4
		>12 in	0	1	1	1	2	2	0	1	1	2	2	3
		Litter	1	2	2	2	3	3	3	2	3	3	3	3
		Duff	2	2	2	2	3	3	3	3	3	3	4	4
	Flame length (ft)	Moderate	4	4	4	2	2	2	4	4	4	3	3	3
		Severe	7	7	7	3	3	4	6	6	6	5	5	5
	Torching index	Severe	31	51	77	12	18	19	22	52	92	116	132	5
	Crowning index	Severe	56	54	54	44	35	33	43	40	38	37	38	38
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive
	Hard snags (stems/ac)	0–17.9 in	9	8	8	7	12	18	16	9	7	10	17	20
		18–29.9 in	1	1	1	0	1	1	1	1	1	1	1	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 27b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Surface fuel loadings (tons/ac)	0–3 in	5	5	7	7	7	8	4	5	8	9	9	9
		3–6 in	3	3	4	5	5	6	3	3	4	5	6	7
		6–12 in	2	2	2	3	4	5	2	2	3	4	5	7
		>12 in	0	0	0	1	2	3	0	0	0	1	2	4
		Litter	3	3	3	3	3	3	3	4	3	4	4	4
		Duff	4	5	5	6	6	7	5	5	6	6	7	7
	Flame length (ft)	Moderate	3	3	3	3	3	3	2	2	3	3	3	4
		Severe	4	4	4	4	4	5	3	3	4	4	5	5
	Torching index	Severe	26	72	102	123	150	150	34	56	66	121	118	103
	Crowning index	Severe	34	35	33	32	32	32	31	35	33	32	34	34
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	1	10	21	23	23	35	11	26	37	30	46	59
		18–29.9 in	0	0	1	1	1	3	0	0	1	1	1	4
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	1	3	6	7	7	8	1	4	7	8	8	9
		3–6 in	1	1	2	3	4	5	1	1	2	4	4	6
		6–12 in	1	1	1	2	3	4	1	1	1	2	3	6
		>12 in	0	0	0	1	2	3	0	0	0	1	2	4
		Litter	3	3	3	3	3	3	3	4	3	4	4	4
		Duff	4	4	5	5	6	6	4	5	5	6	6	7
	Flame length (ft)	Moderate	3	2	3	3	3	3	2	2	3	3	3	4
		Severe	4	4	4	4	4	4	3	3	4	4	4	5
	Torching index	Severe	26	70	100	119	142	174	37	71	67	114	139	107
	Crowning index	Severe	34	35	33	32	32	30	31	35	33	32	33	34
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	1	10	22	23	22	36	11	26	36	29	49	68
		18–29.9 in	0	0	1	1	1	3	0	0	1	1	2	2
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 27b—Treatment effect on fuels and fire behavior, 50-year projection (continued)

Surface fuel treatment	Fuel/fire attribute		Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	4	4	5	6	6	0	4	5	6	6	7
		3–6 in	1	3	4	4	5	6	1	4	4	5	5	6
		6–12 in	1	4	4	4	5	5	1	4	4	5	5	6
		>12 in	0	1	1	2	2	3	0	1	1	2	3	4
		Litter	1	3	3	3	3	3	1	3	3	3	3	3
		Duff	3	3	4	4	5	5	3	4	4	4	5	5
	Flame length (ft)	Moderate	4	3	3	3	3	3	3	3	3	3	4	4
		Severe	6	5	5	5	4	5	8	4	4	4	5	6
	Torching index	Severe	22	46	80	101	132	170	7	26	52	96	93	101
	Crowning index	Severe	42	39	36	35	35	35	42	38	36	36	36	36
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	30	9	10	20	22	20	48	9	17	25	23	21
		18–29.9 in	1	1	1	1	2	2	1	1	1	1	1	1
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 27c—Treatment effect on forest stand attributes, 50-year trajectory

Surface fuel treatment	Stand attribute	No action						Prescribed fire only					
		1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	2,092	1,630	1,318	1,139	984	876	194	193	187	172	162	153
	Quadratic mean diameter (in)	3.8	4.5	5.1	5.7	6.2	6.7	3.8	12.2	13.3	14.4	15.4	16.5
	Total volume (ft^3)	4,896	5,758	6,373	7,074	7,695	8,232	4,759	5,312	6,395	7,266	8,168	9,043
	Merchantable volume (ft^3)	4,328	5,236	5,887	6,689	7,290	7,841	4,379	4,967	6,012	6,922	7,752	8,607
	Basal area (ft^2)	166	181	188	199	206	212	144	157	180	196	211	226
	Stand density index	445	454	449	456	456	457	248	265	295	310	326	341
	Canopy closure (percent)	66	66	65	62	62	61	49	51	54	56	57	58
	Crown competition factor	217	217	214	218	219	220	145	158	179	191	203	215
	Canopy base height (ft)	2	4	5	6	7	8	10	16	17	31	36	41
	Canopy bulk density (kg/m^3)	0.08	0.07	0.07	0.07	0.07	0.06	0.05	0.06	0.07	0.07	0.07	0.07

Table 27c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 50 tpa, 18-in d.b.h. limit						Thin from below to 100 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	2,092	50	149	147	145	142	140	100	149	147	141	133	125
	Quadratic mean diameter (in)	3.8	19.3	11.9	12.7	13.6	14.3	15.1	15.5	13.8	14.8	15.8	16.8	17.9
	Total volume (ft^3)	4,896	4,120	4,516	5,294	6,169	6,944	7,786	4,980	5,554	6,658	7,629	8,463	9,317
	Merchantable volume (ft^3)	4,328	3,955	4,355	5,076	5,961	6,679	7,506	4,741	5,362	6,378	7,378	8,161	9,014
	Basal area (ft^2)	166	102	116	130	146	159	173	131	155	177	193	205	219
	Stand density index	445	144	198	216	237	253	270	202	250	277	295	306	319
	Canopy cover (percent)	66	29	31	33	37	39	40	42	46	49	50	51	51
	Crown competition factor	217	84	95	105	120	133	144	124	146	164	177	186	196
	Canopy base height (ft)	2	31	38	44	4	6	8	11	25	39	47	51	56
	Canopy bulk density (kg/m^3)	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.07	0.07	0.07	0.07
Pile and burn	Trees per acre	2,092	50	199	196	193	190	183	100	175	173	162	153	144
	Quadratic mean diameter (in)	3.8	19.3	10.3	11.0	11.8	12.4	13.1	15.5	12.7	13.7	14.7	15.6	16.6
	Total volume (ft^3)	4,896	4,120	4,516	5,293	6,166	6,935	7,697	4,980	5,554	6,657	7,534	8,418	9,238
	Merchantable volume (ft^3)	4,328	3,955	4,355	5,076	5,960	6,665	7,417	4,741	5,362	6,378	7,287	8,118	8,926
	Basal area (ft^2)	166	102	116	130	146	159	172	131	155	177	191	204	217
	Stand density index	445	144	210	229	251	268	283	202	259	286	300	313	326
	Canopy cover (percent)	66	29	31	34	37	40	41	42	46	49	50	50	51
	Crown competition factor	217	84	95	105	121	137	146	124	146	164	175	185	195
	Canopy base height (ft)	2	31	38	44	4	6	7	11	25	38	47	52	56
	Canopy bulk density (kg/m^3)	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.07	0.07	0.07	0.07
Prescribed fire	Trees per acre	2,092	50	344	339	334	324	310	100	230	227	221	208	195
	Quadratic mean diameter (in)	3.8	19.3	7.6	8.1	8.7	9.2	9.7	15.5	10.4	11.2	11.9	12.8	13.6
	Total volume (ft^3)	4,896	3,834	4,199	4,920	5,733	6,429	7,057	4,467	4,968	5,942	6,851	7,701	8,470
	Merchantable volume (ft^3)	4,328	3,678	4,047	4,715	5,533	6,166	6,770	4,258	4,794	5,697	6,620	7,406	8,196
	Basal area (ft^2)	166	102	108	120	136	149	159	131	136	155	171	184	197
	Stand density index	445	144	220	240	265	282	295	202	246	272	292	307	319
	Canopy cover (percent)	66	29	29	33	39	42	43	42	40	43	45	47	48
	Crown competition factor	217	84	87	98	122	138	146	124	124	140	153	164	174
	Canopy base height (ft)	2	31	39	44	4	6	8	15	23	37	46	50	4
	Canopy bulk density (kg/m^3)	0.08	0.04	0.04	0.04	0.05	0.07	0.08	0.05	0.06	0.06	0.06	0.06	0.06

Table 27c—Treatment effect on forest stand attributes, 50-year trajectory (continued)

Surface fuel treatment	Stand attribute	Initial condition	Thin from below to 200 tpa, 18-in d.b.h. limit						Thin from below to 300 tpa, 18-in d.b.h. limit					
			1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs	1 yr	10 yrs	20 yrs	30 yrs	40 yrs	50 yrs
None	Trees per acre	2,092	200	217	202	190	179	161	300	300	273	255	226	185
	Quadratic mean diameter (in)	3.8	11.8	12.4	13.5	14.6	15.6	16.7	9.9	10.8	11.9	13.0	14.1	15.5
	Total volume (ft^3)	4,896	5,462	6,036	7,097	8,148	9,149	9,704	5,508	6,093	7,188	8,307	9,083	9,373
	Merchantable volume (ft^3)	4,328	4,968	5,637	6,702	7,768	8,703	9,266	4,902	5,536	6,609	7,874	8,605	8,931
	Basal area (ft^2)	166	151	181	202	221	238	243	159	189	212	235	245	244
	Stand density index	445	260	305	328	348	366	364	293	337	363	388	391	376
	Canopy cover (percent)	66	53	57	58	60	61	60	58	62	64	66	65	64
	Crown competition factor	217	157	184	201	216	230	234	176	203	222	242	245	244
	Canopy base height (ft)	2	11	24	30	33	37	42	10	14	17	27	31	37
	Canopy bulk density (kg/m^3)	0.08	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.07	0.07	0.08	0.07	0.07
Pile and burn	Trees per acre	2,092	200	230	213	200	189	169	300	313	286	267	234	198
	Quadratic mean diameter (in)	3.8	11.8	12.0	13.2	14.2	15.2	16.2	9.9	10.5	11.7	12.7	13.8	15.0
	Total volume (ft^3)	4,896	5,462	6,036	7,093	8,142	9,147	9,722	5,508	6,093	7,205	8,322	9,067	9,531
	Merchantable volume (ft^3)	4,328	4,968	5,637	6,700	7,762	8,699	9,286	4,902	5,536	6,623	7,890	8,593	9,085
	Basal area (ft^2)	166	151	181	202	220	237	243	159	189	213	236	245	244
	Stand density index	445	260	308	332	352	369	368	293	340	367	393	395	381
	Canopy cover (percent)	66	53	57	58	60	61	60	58	62	64	66	65	62
	Crown competition factor	217	157	184	201	215	230	234	176	203	223	243	248	237
	Canopy base height (ft)	2	11	24	30	33	37	42	10	14	17	27	31	35
	Canopy bulk density (kg/m^3)	0.08	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.07	0.07	0.08	0.07	0.07
Prescribed fire	Trees per acre	2,092	200	203	198	183	172	163	300	236	224	206	195	183
	Quadratic mean diameter (in)	3.8	11.8	11.7	12.7	13.7	14.7	15.6	9.9	11.0	12.0	13.1	14.0	15.0
	Total volume (ft^3)	4,896	4,708	5,269	6,365	7,253	8,143	9,004	4,754	5,322	6,326	7,238	8,190	9,129
	Merchantable volume (ft^3)	4,328	4,380	5,005	6,051	6,940	7,759	8,641	4,380	4,986	5,928	6,895	7,786	8,756
	Basal area (ft^2)	166	151	151	174	189	204	217	159	156	177	193	209	226
	Stand density index	445	260	261	291	305	320	334	293	275	301	318	336	353
	Canopy cover (percent)	66	53	47	50	51	52	53	58	50	53	54	55	57
	Crown competition factor	217	157	146	165	176	188	198	176	155	173	186	199	212
	Canopy base height (ft)	2	12	20	31	35	40	46	10	17	22	27	31	36
	Canopy bulk density (kg/m^3)	0.08	0.05	0.06	0.07	0.07	0.07	0.07	0.05	0.06	0.07	0.07	0.07	0.07

tpa = trees per acre; d.b.h. = diameter at breast height.

Table 27d—Forest Vegetation Simulator fuel model selection

Surface fuel treatment	Years	No action								Prescribed fire only							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*						*Percent*		*Percent*		*Percent*		
None	1	9	96	10	4					6	68	9	32				
	10	10	52	9	48					10	51	9	28	6	21		
	20	10	97	12	3					10	57	9	31	6	12		
	30	10	75	12	25					10	74	9	20	6	6		
	40	10	65	12	35					10	90	9	9	6	2		
	50	10	60	12	40					10	98	12	2				

Surface fuel treatment	Years	Thin from below to 50 tpa, 18-in. d.b.h. limit								Thin from below to 100 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	10	77	6	21	2	1			10	61	6	35	9	5		
	10	6	70	10	30					6	44	10	38	9	18		
	20	6	78	10	22					10	42	6	33	9	25		
	30	6	82	10	18					10	48	9	26	6	26		
	40	6	76	10	24					10	61	9	21	6	18		
	`50	9	65	10	35					10	78	9	13	6	9		
Pile and burn	1	6	95	2	5					6	88	9	12				
	10	6	100							6	70	9	30				
	20	6	100							6	48	9	37	10	15		
	30	6	99	10	1					6	34	10	33	9	33		
	40	9	89	10	11					10	47	9	28	6	25		
	50	9	74	10	26					10	63	9	21	6	16		
Prescribed fire	1	6	83	2	17					6	100						
	10	6	93	2	7					6	89	10	9	9	2		
	20	6	100							6	61	10	27	9	12		
	30	9	92	10	8					6	45	10	38	9	17		
	40	9	80	10	20					10	54	6	30	9	14		
	50	9	65	10	35					10	69	6	19	9	12		

Table 27d—Forest Vegetation Simulator fuel model selection (continued)

Surface fuel treatment	Years	Thin from below to 200 tpa, 18-in. d.b.h. limit								Thin from below to 300 tpa, 18-in. d.b.h. limit							
		Fuel models								Fuel models							
		Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight	Model	Weight
			Percent		*Percent*		*Percent*				*Percent*		*Percent*		*Percent*		
None	1	9	44	10	31	6	26			9	73	10	19	6	7		
	10	9	55	10	34	6	11			9	60	10	40				
	20	10	58	9	39	6	3			10	75	9	25				
	30	10	78	9	22					10	99	9	1				
	40	10	93	9	7					10	92	12	8				
	50	10	93	12	7					10	75	12	25				
Pile and burn	1	9	63	6	37					9	91	6	9				
	10	9	80	6	16	10	3			9	88	10	12				
	20	9	57	10	38	6	5			10	54	9	46				
	30	10	62	9	37	6	1			10	81	9	19				
	40	10	77	9	23					10	98	9	2				
	50	10	98	9	2					10	78	12	22				
Prescribed fire	1	6	85	9	15					6	60	9	40				
	10	6	45	10	30	9	25			9	41	10	32	6	27		
	20	10	45	9	28	6	27			10	66	9	23	6	11		
	30	10	66	9	19	6	15			10	99	9	1				
	40	10	85	9	9	6	6			10	84	12	16				
	50	10	100	12						10	67	12	33				

tpa = trees per acre, d.b.h. = diameter at breast height.

Table 27e—FVS fuel model selection

Fire weather conditions	Windspeed	Temperature	Fuel moisture					
			1-hr (0–0.25 in)	10-hr (0.25–1 in)	100-hr (1–3 in)	1,000-hr (3+ in)	Duff	Live
	Miles/hour	*°F*	*Percent*					
Severe—98th percentile	14	81	3	5	8	15	50	100
Moderate—75th percentile	8	61	6	8	11	18	125	150

Table 27f—Prescribed fire weather conditions used in models

Windspeed (mph)	10
Moisture category*	3 = Moist
Temperature (°F)	70

*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

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