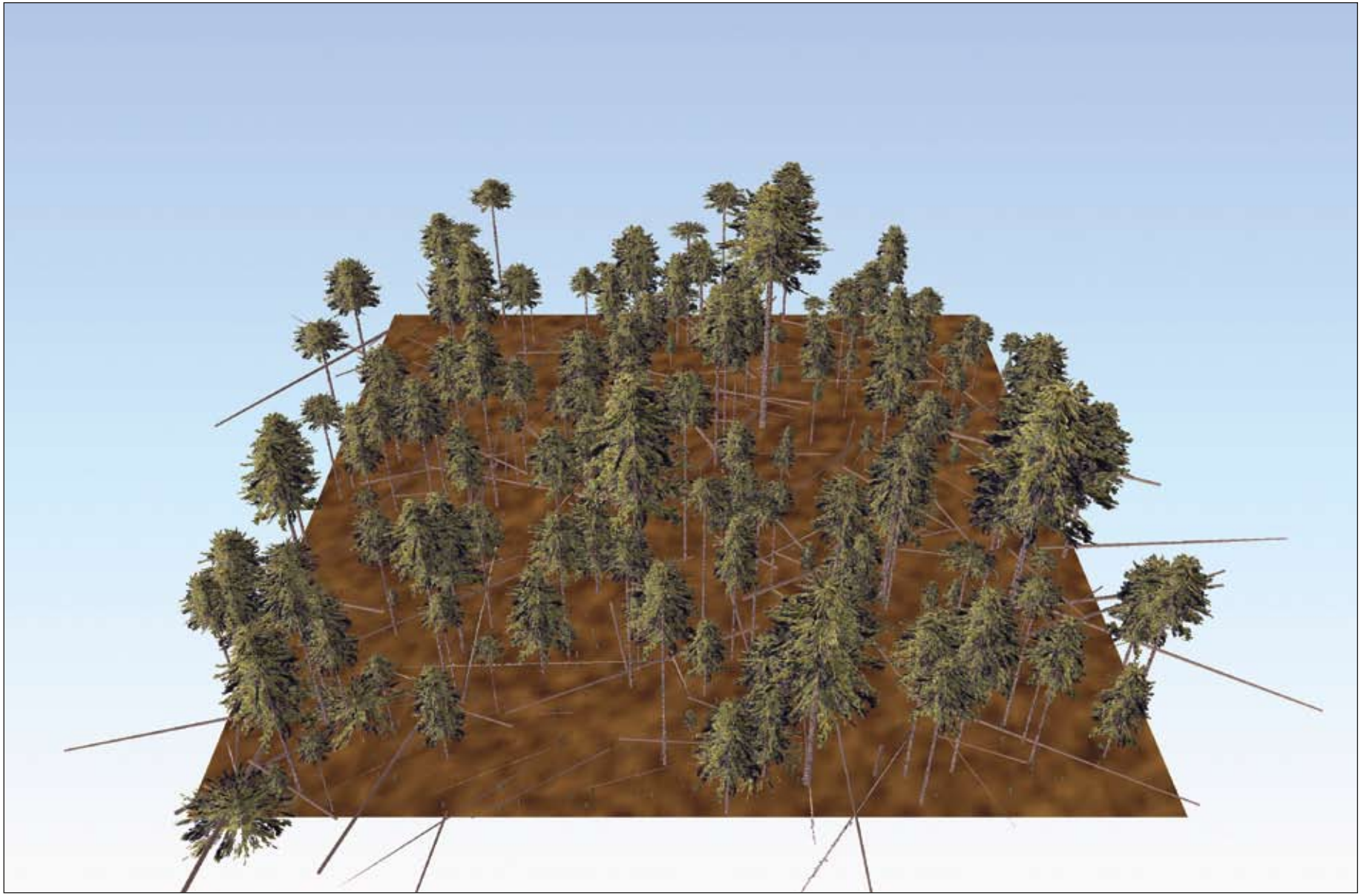


Initial stand conditions

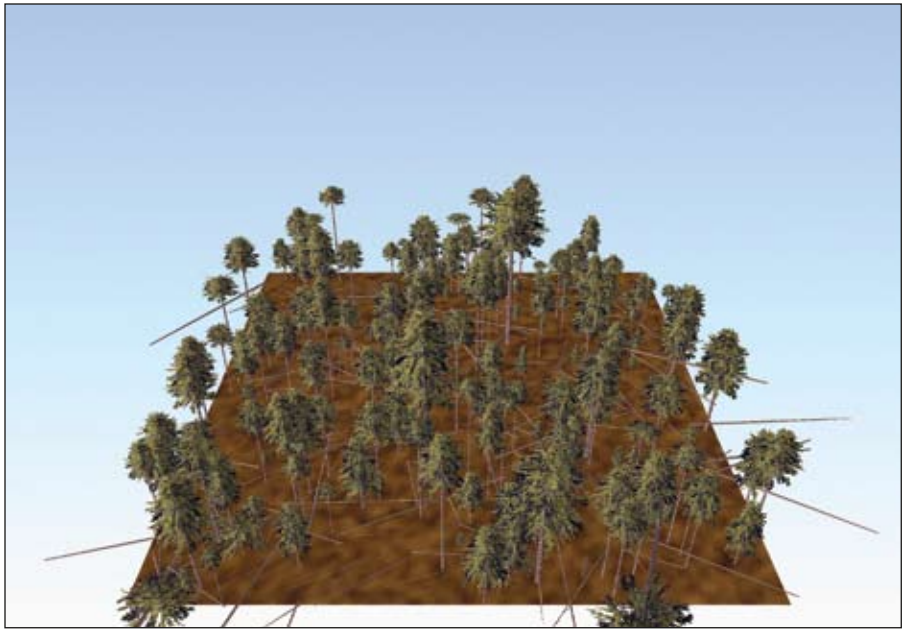
Site: Elevation = 5,400 ft, slope = 15 percent, aspect = 360°.

Species (based on trees per acre): Ponderosa pine (*Pinus ponderosa*) = 77 percent, gambel oak (*Quercus gambelii*) = 21 percent, Douglas-fir (*Pseudotsuga menziesii*) = 2 percent.

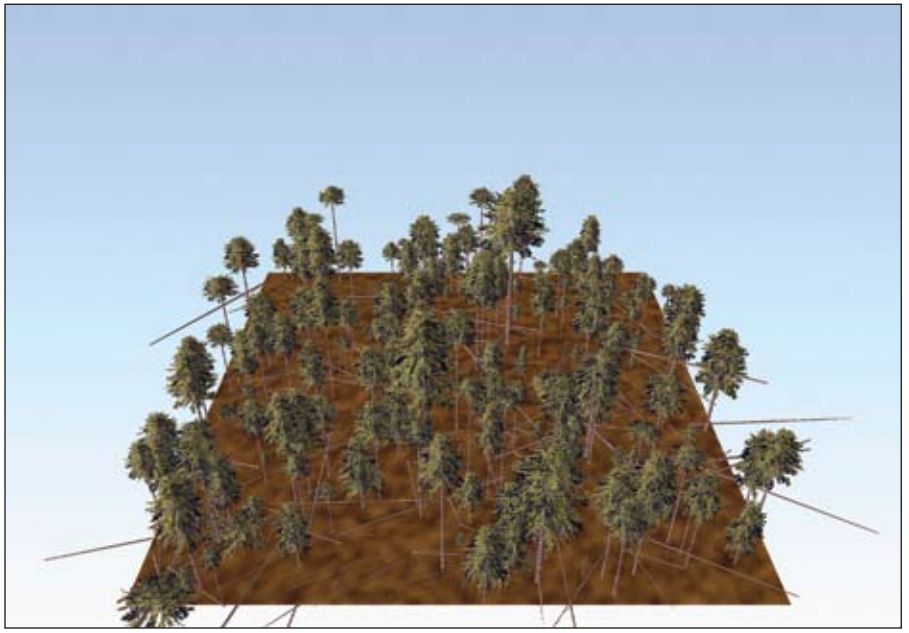
Stand attributes: Stem density = 571 tpa, basal area = 79 ft^2/ac, top height = 45 ft, stand density index = 190, quadratic mean diameter = 5.0 in, crown competition factor = 67, canopy cover = 49 percent.

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 initial tree density of 571 trees per acre (tpa) composed of Douglas-fir, gambel oak, and ponderosa pine in the understory and ponderosa pine in the overstory. Canopy bulk density is 0.04 kg/m^3 (0.0025 lb/ft^3), and canopy base height is 8 ft, so ladder fuels and canopy fuels are not sufficient to enable crown fire initiation or spread. Woody fuel loading is 6 tons/ac, and litter and duff loading is 6 tons/ac. Although the predicted fire type is surface fire, potential flame lengths are 5 ft and potential basal area mortality is 66 percent for severe fire weather because fire behavior is predicted by using fuel model 5 suggesting the importance of brush fuels. The FFE model does not track brush fuels directly, so these results should be interpreted with caution. Canopy base height decreases and canopy bulk density increases over time as smaller trees grow into the overstory, and in 10 years passive crown fire becomes likely for severe and moderate fire weather. In 30 years, canopy base height begins to increase again as the trees grow and crowns rise causing the predicted fire type to become surface fire again for severe and moderate fire weather. There is little surface fuel accumulation over time, and flame lengths decline as the fuel model shifts from 5 to 9.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment increases canopy base height and reduces canopy bulk density slightly and consumes much of the surface fuels. However, many snags are created that contribute to surface fuel loading in 10 years. Thinning to 50 tpa or less is required to increase canopy base height and decrease canopy bulk density; all other treatments have little effect on stand structure. Potential flame lengths and basal area mortality remain high for severe fire weather in all treatments because fire behavior is predicted by using fuel model 5. Potential flame lengths and basal area mortality are low for moderate fire weather in all treatments. The pile and burn and prescribed fire surface fuel treatments reduce woody surface fuels to below initial levels, but potential flame lengths and basal area mortality remain high for severe fire weather because the predominant fuel model is 5. The prescribed fire surface fuel treatment causes the highest potential flame lengths and basal area mortality.

Silvicultural and surface fuel treatments—long-term effects

Although the treatments have little effect on crown fire potential in the short term, they do reduce crown fire potential in the long term. In all treatments, canopy base height increases over time as the trees grow and the stand self-thins. Flame lengths remain high for severe fire weather, but the increase in canopy base height causes the predicted fire type to become surface fire in 10 years and remain surface fire for the duration of the 50-year projection. Potential flame lengths decrease in 20 years in the higher density treatments (200 tpa and 300 tpa) with a pile and burn or no surface fuel treatment as the fuel model shifts from 5 to 9. However, in the higher density treatments with prescribed fire, the additional tree mortality creates a more open stand with more brush fuels, and flame lengths remain above 5 ft for 40 years.

Table 12a—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	2	1	4	3	3	2
		3–6 in	2	0	2	2	2	2
		6–12 in	2	1	1	2	2	2
		>12 in	0	0	0	0	0	0
		Litter	2	0	2	2	2	2
		Duff	4	3	3	4	4	4
	Flame length (ft)	Moderate	1	1	1	1	1	1
		Severe	5	6	2	5	5	5
	Torching index	Severe	19	20	112	17	19	19
	Crowning index	Severe	52	66	90	59	52	52
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Surface	Surface
	Potential basal area mortality (%)	Moderate	33	25	14	31	33	33
		Severe	66	70	26	71	66	66
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			1	1	1	1
		3–6 in			1	1	1	1
		6–12 in			0	1	1	1
		>12 in			0	0	0	0
		Litter			2	1	1	1
		Duff			2	3	4	4
	Flame length (ft)	Moderate			1	1	1	1
		Severe			2	5	5	5
	Torching index	Severe			112	17	19	19
	Crowning index	Severe			90	59	52	52
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Passive	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	31	33	33
		Severe			11	71	66	66
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			0	0	0	0
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			0	0	0	0
		Duff			2	3	3	3
	Flame length (ft)	Moderate			1	1	1	1
		Severe			1	6	6	6
	Torching index	Severe			120	18	20	20
	Crowning index	Severe			96	73	66	66
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Passive	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	23	25	25
		Severe			8	73	70	70

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

Table 12b—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	2	2	3	3	4	5	1	4	3	3	3	3
		3–6 in	2	2	2	2	3	3	0	2	2	2	2	2
		6–12 in	2	2	2	2	2	2	1	3	3	3	3	3
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	2	3	4	4	5	5	0	1	1	2	2	2
		Duff	4	4	4	5	5	5	3	3	3	3	3	3
	Flame length (ft)	Moderate	1	1	2	2	2	2	1	1	1	1	1	1
		Severe	5	5	3	3	3	3	6	5	5	5	5	4
	Torching index	Severe	19	0	0	14	35	46	20	60	72	81	90	100
	Crowning index	Severe	52	43	38	35	32	30	66	71	63	57	54	52
	Type of fire	Moderate	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	5	8	10	9	24	26	124	10	6	4	4	4
		18–29.9 in	0	0	0	0	0	0	3	2	1	0	0	0
		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	4	3	2	2	2	3	3	3	3	3	3	4
		3–6 in	2	2	2	2	2	2	2	2	2	2	2	2
		6–12 in	1	1	1	1	1	1	2	2	2	2	2	2
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	2	1	1	1	1	1	2	1	1	2	2	2
		Duff	3	3	3	3	3	3	4	4	4	4	4	4
	Flame length (ft)	Moderate	1	1	1	1	1	1	1	1	1	1	2	2
		Severe	2	1	1	1	1	1	5	5	5	5	3	3
	Torching index	Severe	112	193	209	220	238	248	17	68	77	90	142	140
	Crowning index	Severe	90	89	80	75	73	71	59	64	59	54	52	51
	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	1	1	2	3	3	3	1	2	3	4	5	5
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 12b—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	1	1	1	2	2	2	1	1	2	2	3	4
		3–6 in	1	1	1	1	1	1	1	1	1	1	1	1
		6–12 in	0	0	0	1	1	1	1	1	1	1	1	1
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	2	1	1	1	1	2	1	1	1	2	2	2
		Duff	2	2	2	2	2	3	3	3	3	3	3	4
	Flame length (ft)	Moderate	1	1	1	1	1	1	1	1	1	1	2	2
		Severe	2	1	1	1	1	1	5	5	5	5	2	3
	Torching index	Severe	112	193	210	213	224	241	17	68	77	86	170	159
	Crowning index	Severe	90	84	76	72	68	67	59	64	59	53	51	50
	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	1	1	2	3	3	3	1	2	3	4	5	5
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		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	3	3	3	3	3
		3–6 in	0	1	1	1	1	1	1	1	1	1	1	2
		6–12 in	1	1	1	1	1	1	1	2	2	2	2	2
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	0	1	1	1	2	2	1	1	1	1	2	2
		Duff	2	2	2	2	2	2	3	3	3	3	3	3
	Flame length (ft)	Moderate	1	1	1	1	1	1	1	1	1	1	1	1
		Severe	2	1	1	1	1	1	5	6	5	5	5	5
	Torching index	Severe	112	162	166	185	201	206	17	61	68	76	84	87
	Crowning index	Severe	90	79	69	62	59	58	59	77	67	61	56	55
	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	5	4	4	3	3	3	17	10	6	4	4	4
		18–29.9 in	1	1	0	0	0	0	3	3	2	0	0	0
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 12b—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	3	2	3	3	4	4	2	2	3	3	3	4
		3–6 in	2	2	2	2	2	2	2	2	2	2	2	2
		6–12 in	2	2	2	2	2	2	2	2	2	2	2	2
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	2	2	2	3	3	3	2	2	3	3	4	4
		Duff	4	4	4	4	4	5	4	4	4	4	5	5
	Flame length (ft)	Moderate	1	1	2	2	2	2	1	1	2	2	2	2
		Severe	5	5	3	3	3	3	5	5	3	3	3	3
	Torching index	Severe	19	57	115	122	129	125	19	41	94	98	92	61
	Crowning index	Severe	52	49	45	41	40	39	52	43	38	35	33	32
	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	2	3	4	5	5	6	3	4	5	5	6	7
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		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	1	2	3	3	4	1	1	2	3	3	4
		3–6 in	1	1	1	1	1	1	1	1	1	1	1	1
		6–12 in	1	1	1	1	1	1	1	1	1	1	1	1
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	1	2	2	3	3	3	1	2	3	3	4	4
		Duff	4	4	4	4	4	4	4	4	4	4	4	4
	Flame length (ft)	Moderate	1	1	2	1	2	2	1	1	2	2	2	2
		Severe	5	5	2	2	2	3	5	5	2	2	3	3
	Torching index	Severe	19	57	129	152	147	138	19	41	114	120	60	77
	Crowning index	Severe	52	49	45	41	39	38	52	43	38	35	33	31
	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	2	3	4	5	5	6	3	4	5	5	6	8
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 12b—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	3	0	3	3	3	3	3
		3–6 in	0	2	2	2	2	2	0	2	2	2	2	2
		6–12 in	1	3	3	3	3	3	1	3	3	3	3	3
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	0	1	1	2	2	2	0	1	1	2	2	2
		Duff	3	3	3	3	3	3	3	3	3	3	3	3
	Flame length (ft)	Moderate	1	1	1	1	1	2	1	1	1	1	1	2
		Severe	6	5	5	5	5	3	6	5	5	5	5	3
	Torching index	Severe	20	60	72	81	90	135	20	60	69	81	90	135
	Crowning index	Severe	66	67	59	55	52	50	66	67	59	55	52	50
	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	33	10	7	4	4	4	50	10	7	4	4	4
		18–29.9 in	3	2	1	0	0	0	3	2	1	0	0	0
		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 12c—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	571	561	551	543	517	494	104	103	101	99	97	95
	Quadratic mean diameter (in)	5.0	5.7	6.3	6.8	7.4	7.9	5.0	11.0	12.3	13.5	14.5	15.4
	Total volume (ft^3)	1,188	1,655	2,144	2,618	3,038	3,435	1,067	1,265	1,671	2,071	2,461	2,832
	Merchantable volume (ft^3)	955	1,351	1,786	2,230	2,628	2,999	895	1,058	1,447	1,836	2,198	2,561
	Basal area (ft^2)	79	99	120	138	153	166	60	68	84	98	112	124
	Stand density index	190	227	263	295	316	335	108	120	142	160	177	191
	Canopy closure (percent)	49	56	63	67	71	73	39	43	49	53	57	60
	Crown competition factor	67	82	98	112	122	131	49	55	66	76	84	92
	Canopy base height (ft)	8	1	1	3	7	9	10	24	26	27	28	29
	Canopy bulk density (kg/m^3)	0.04	0.05	0.06	0.07	0.08	0.09	0.03	0.03	0.03	0.04	0.04	0.04

Table 12c—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	571	50	64	63	62	60	59	100	106	104	102	100	98
	Quadratic mean diameter (in)	5.0	12.8	12.7	14.1	15.2	16.3	17.2	11.1	12.0	13.2	14.2	15.1	15.9
	Total volume (ft^3)	1,188	890	1,037	1,340	1,651	1,960	2,256	1,262	1,460	1,866	2,272	2,663	3,031
	Merchantable volume (ft^3)	955	765	908	1,206	1,509	1,810	2,098	1,048	1,219	1,615	2,010	2,390	2,747
	Basal area (ft^2)	79	45	57	68	78	87	96	67	83	98	112	124	135
	Stand density index	190	75	95	108	121	132	142	118	142	162	179	194	206
	Canopy cover (percent)	49	30	35	39	43	46	49	42	49	54	57	60	63
	Crown competition factor	67	36	43	50	56	62	67	55	67	77	85	92	99
	Canopy base height (ft)	8	23	31	31	31	32	32	8	25	26	28	29	30
	Canopy bulk density (kg/m^3)	0.04	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Pile and burn	Trees per acre	571	50	72	70	69	68	66	100	110	108	106	104	102
	Quadratic mean diameter (in)	5.0	12.8	12.0	13.3	14.4	15.4	16.3	11.1	11.8	12.9	13.9	14.8	15.6
	Total volume (ft^3)	1,188	890	1,035	1,340	1,650	1,957	2,253	1,262	1,459	1,866	2,272	2,664	3,034
	Merchantable volume (ft^3)	955	765	906	1,205	1,507	1,805	2,092	1,048	1,219	1,615	2,010	2,391	2,749
	Basal area (ft^2)	79	45	57	68	78	87	96	67	83	98	112	124	135
	Stand density index	190	75	97	111	124	135	145	118	143	163	180	195	208
	Canopy cover (percent)	49	30	35	39	43	46	49	42	49	54	57	60	63
	Crown competition factor	67	36	43	50	56	62	67	55	67	77	85	92	99
	Canopy base height (ft)	8	23	31	31	30	30	31	8	25	26	27	29	30
	Canopy bulk density (kg/m^3)	0.04	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Prescribed fire	Trees per acre	571	50	89	87	85	84	82	100	95	93	91	89	88
	Quadratic mean diameter (in)	5.0	12.8	10.3	11.4	12.4	13.3	14.2	11.1	10.7	12.0	13.2	14.2	15.1
	Total volume (ft^3)	1,188	821	956	1,243	1,540	1,837	2,123	977	1,153	1,521	1,885	2,240	2,575
	Merchantable volume (ft^3)	955	708	841	1,121	1,409	1,695	1,968	821	979	1,338	1,691	2,035	2,360
	Basal area (ft^2)	79	45	51	61	71	81	90	67	60	73	86	98	109
	Stand density index	190	75	92	107	120	133	144	118	106	125	142	157	170
	Canopy cover (percent)	49	30	32	36	40	44	47	42	38	43	48	51	55
	Crown competition factor	67	36	39	45	52	58	63	55	48	57	65	72	79
	Canopy base height (ft)	8	23	28	26	27	28	29	10	26	27	28	29	30
	Canopy bulk density (kg/m^3)	0.04	0.02	0.02	0.03	0.03	0.03	0.04	0.03	0.02	0.03	0.03	0.04	0.04

Table 12c—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	571	200	200	197	193	189	186	300	299	294	289	284	277
	Quadratic mean diameter (in)	5.0	8.5	9.5	10.4	11.2	12	12.6	7.0	7.8	8.6	9.2	9.8	10.4
	Total volume (ft^3)	1,188	1,428	1,654	2,116	2,577	3,019	3,440	1,429	1,656	2,127	2,596	3,047	3,464
	Merchantable volume (ft^3)	955	1,179	1,355	1,789	2,233	2,660	3,064	1,180	1,357	1,799	2,248	2,681	3,083
	Basal area (ft^2)	79	79	99	117	133	148	161	79	99	117	135	150	163
	Stand density index	190	154	185	210	233	252	269	167	200	229	255	277	295
	Canopy cover (percent)	49	49	56	61	65	68	71	49	56	61	66	69	72
	Crown competition factor	67	67	81	94	105	114	123	67	81	95	107	117	126
	Canopy base height (ft)	8	8	19	21	23	25	25	8	14	18	19	18	14
	Canopy bulk density (kg/m^3)	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.04	0.06	0.06	0.07	0.08	0.09
Pile and burn	Trees per acre	571	200	202	198	195	191	187	300	301	296	291	286	279
	Quadratic mean diameter (in)	5.0	8.5	9.5	10.4	11.2	11.9	12.5	7.0	7.8	8.5	9.2	9.8	10.4
	Total volume (ft^3)	1,188	1,428	1,654	2,116	2,577	3,020	3,441	1,429	1,656	2,127	2,596	3,047	3,463
	Merchantable volume (ft^3)	955	1,179	1,355	1,789	2,233	2,660	3,065	1,180	1,357	1,799	2,248	2,681	3,082
	Basal area (ft^2)	79	79	99	117	133	148	161	79	99	117	135	150	163
	Stand density index	190	154	185	211	233	253	269	167	201	229	255	277	296
	Canopy cover (percent)	49	49	56	61	65	68	71	49	56	61	66	69	72
	Crown competition factor	67	67	81	94	105	114	123	67	81	95	107	117	126
	Canopy base height (ft)	8	8	19	21	23	25	25	8	14	18	19	10	14
	Canopy bulk density (kg/m^3)	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.04	0.06	0.06	0.07	0.08	0.09
Prescribed fire	Trees per acre	571	200	115	113	110	108	106	300	115	113	110	108	106
	Quadratic mean diameter (in)	5.0	8.5	10.4	11.7	12.8	13.8	14.6	7.0	10.4	11.7	12.8	13.8	14.6
	Total volume (ft^3)	1,188	1,067	1,264	1,669	2,072	2,465	2,837	1,067	1,264	1,671	2,074	2,467	2,843
	Merchantable volume (ft^3)	955	894	1,058	1,445	1,837	2,201	2,563	895	1,058	1,447	1,838	2,208	2,569
	Basal area (ft^2)	79	79	68	84	99	112	124	79	68	84	99	112	124
	Stand density index	190	154	123	145	164	181	196	167	123	145	164	181	196
	Canopy cover (percent)	49	49	43	49	53	57	60	49	43	49	53	57	60
	Crown competition factor	67	67	55	66	76	84	92	67	55	66	76	84	92
	Canopy base height (ft)	8	10	24	26	27	28	29	10	24	25	27	28	29
	Canopy bulk density (kg/m^3)	0.04	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.04

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

Table 12d—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	5	100							5	100						
	10	5	92	10	8					5	96	10	4				
	20	9	81	10	19					5	94	10	6				
	30	9	72	10	28					5	94	10	6				
	40	9	61	10	39					5	91	10	9				
	50	10	52	9	48					5	87	10	13				

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*				
None	1	8	91	10	9					5	99	10	1				
	10	8	100							5	100						
	20	8	100							5	100						
	30	8	100							5	97	10	3				
	40	8	100							9	90	10	10				
	50	8	100							9	83	10	17				
Pile and burn	1	8	91	10	9					5	100						
	10	8	100							5	100						
	20	8	100							5	100						
	30	8	100							5	100						
	40	8	100							9	100						
	50	8	100							9	92	10	8				
Prescribed fire	1	8	100							5	100						
	10	8	100							5	100						
	20	8	100							5	100						
	30	8	100							5	100						
	40	8	100							5	99	10	1				
	50	8	100							5	95	10	5				

Table 12d—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	5	100							5	100						
	10	5	99	10	1					5	96	10	4				
	20	9	95	10	5					9	90	10	10				
	30	9	88	10	12					9	82	10	18				
	40	9	79	10	21					9	73	10	27				
	50	9	70	10	30					9	62	10	38				
Pile and burn	1	5	100							5	100						
	10	5	100							5	100						
	20	9	100							9	100						
	30	9	100							9	96	10	4				
	40	9	91	10	9					9	85	10	15				
	50	9	80	10	20					9	71	10	29				
Prescribed fire	1	5	100							5	100						
	10	5	100	10						5	99	10	1				
	20	5	96	10	4					5	96	10	4				
	30	5	95	10	5					5	94	10	6				
	40	5	91	10	9					5	91	10	9				
	50	9	87	10	13					9	87	10	13				

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

Table 12e—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	19	87	3	5	12	16	50	100
Moderate—75th percentile	8	69	5	7	16	19	125	150

Table 12f—Prescribed fire weather conditions used in models

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

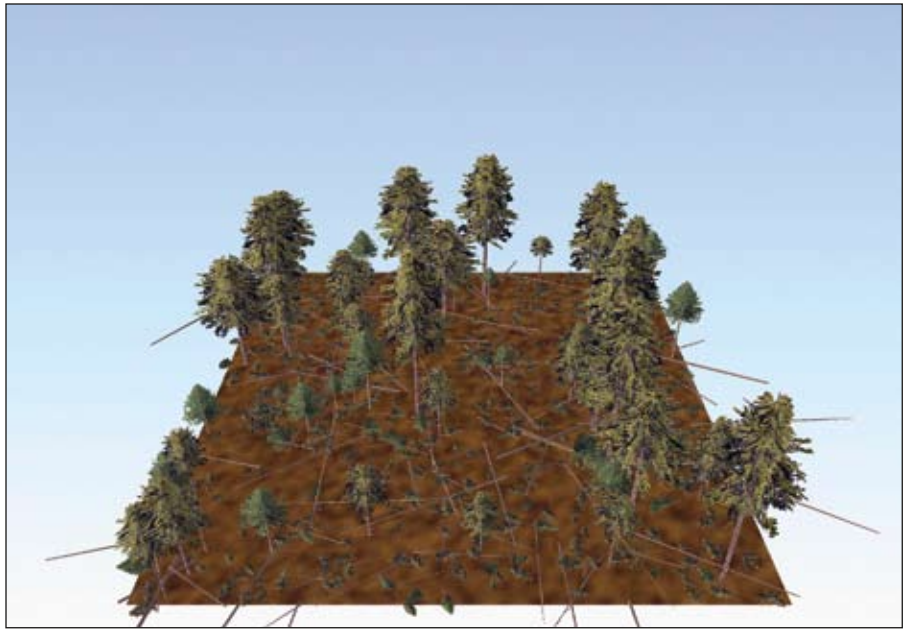
*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).

Initial stand conditions

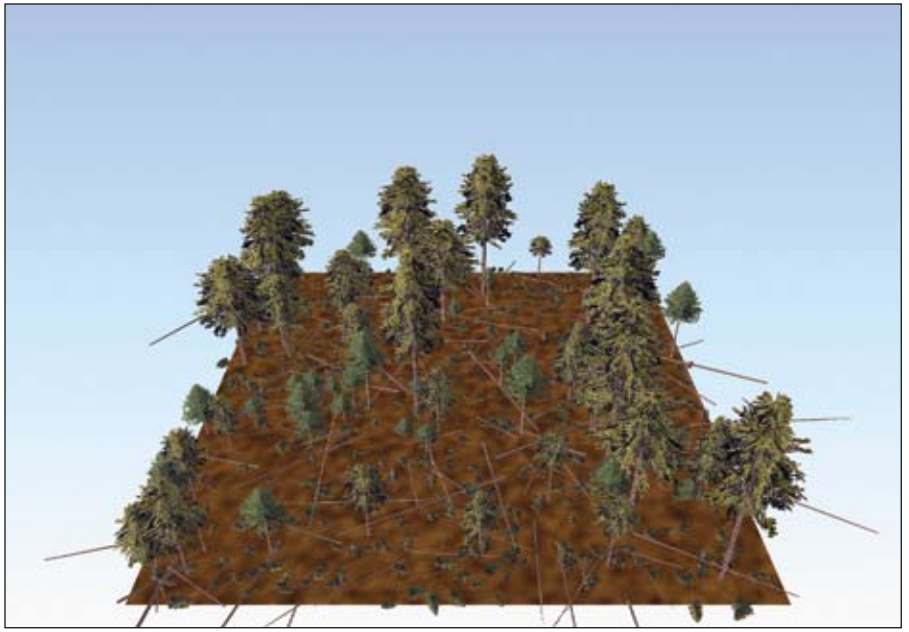
Site: Elevation = 5,400 ft, slope = 15 percent, aspect = 360°.

Species (based on trees per acre): Ponderosa pine (*Pinus ponderosa*) = 68 percent, gambel oak (*Quercus gambelii*) = 19 percent, mountain juniper (*Juniperus scopulorum*) = 12 percent.

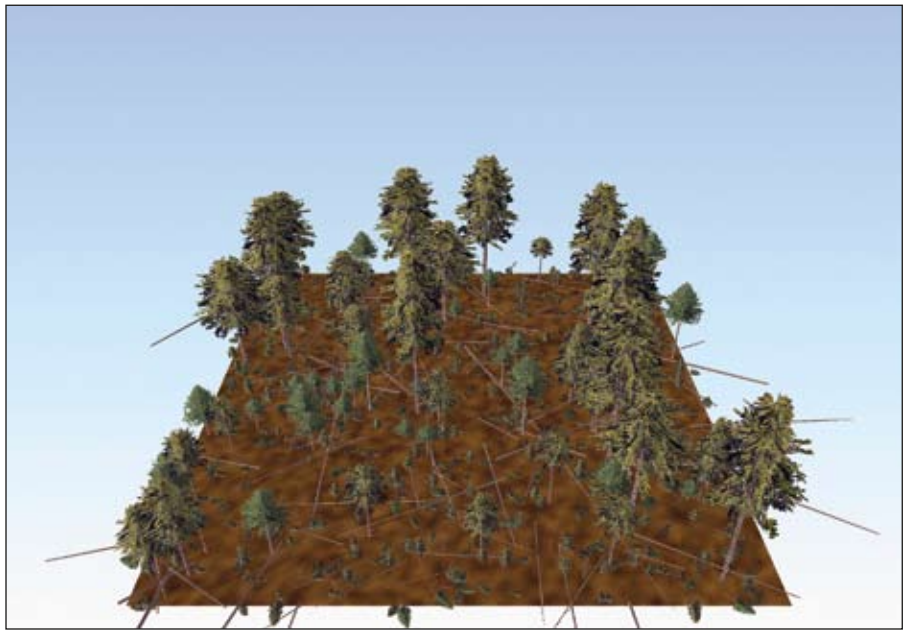
Stand attributes: Stem density = 838 tpa, basal area = 87 ft^2/ac, top height = 46 ft, stand density index = 221, quadratic mean diameter = 4.4 in, crown competition factor = 72, canopy cover = 51 percent.



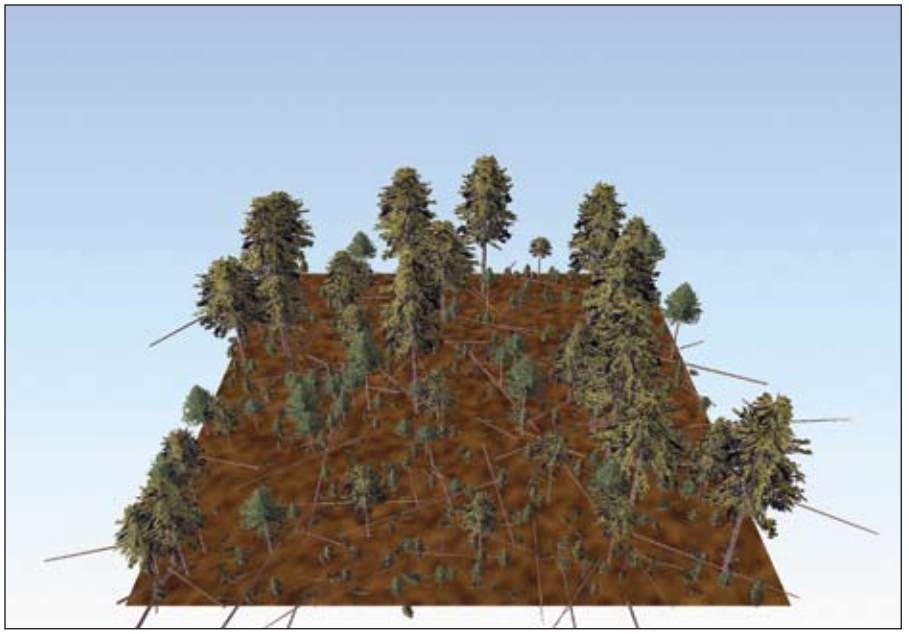
Thin from below to 50 tpa, 18-in d.b.h. limit



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 initial tree density of 838 trees per acre (tpa) composed of gambel oak, juniper, and ponderosa pine in the understory and a ponderosa pine overstory. Canopy base height is only 3 ft, and canopy bulk density is 0.07 kg/m^3 (0.0044 lb/ft^3), so initial conditions have high potential for passive crown fire but low potential for active crown fire spread under severe fire weather. Potential tree mortality is 61 percent for severe fire but only 10 percent for moderate fire weather. Woody fuel loading is 6 tons/ac, and litter and duff loading is 7 tons/ac. With no action, canopy base height will increase as the trees grow and the stand self-thins, making passive crown fire unlikely in 20 yrs, but flame lengths increase as surface fuels accumulate.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment initially reduces surface fuels but has little effect on canopy base height and canopy bulk density. Passive crown fire remains likely after treatment, but potential flame lengths and basal area mortality are lower than initial conditions. Thinning to 100 tpa or less is needed to increase canopy base height and decrease canopy bulk density. The low-density treatments decrease crown fire potential (predicted fire type changes to surface fire) and basal area mortality, but activity fuels generated from the thinning prevent potential flame lengths from decreasing with treatment. The pile and burn surface fuel treatment and, to a greater extent, the prescribed fire treatment reduce surface fuels to below initial conditions. These surface fuel treatments further decrease crown fire potential, flame lengths, and basal area mortality for severe and moderate fire weather in the low-density treatments. Surface fuel treatments also decrease potential flame lengths and basal area mortality in the higher density treatments, but canopy base height is still low enough that passive crown fire remains likely for severe fire weather.

Silvicultural and surface fuel treatments—long-term effects

The prescribed fire only treatment increases canopy base height over time as the trees grow and the stand self-thins. In 10 years, the predicted fire type changes to surface fire for severe and moderate fire weather and remains surface fire for the 50-year projection. Surface fuels accumulate slowly, and potential flame lengths increase slightly over time. Regeneration in the low-density treatments causes a decrease in canopy base height in 20 years, and passive crown fire becomes likely. In reality, the decrease in canopy base height may not be as extreme or sudden as the model predicts, but generally regeneration in the more open stands can be expected to increase crown fire potential and another treatment may be necessary. Canopy base height continues to increase in the high-density treatments, and the predicted fire type changes from passive to surface fire in 10 years. In the high-density treatments with pile and burn or no surface fuel treatment, surface fuels accumulate and flame lengths increase, and passive crown fire is predicted again in 20 to 30 years. At this time, a second treatment would be necessary to reduce surface fuels. The high-density treatments with prescribed fire have a long-term effect on crown fire potential, because both surface fuels and regeneration are low.

Table 13a—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	2	1	4	4	3	3
		3–6 in	2	0	3	3	2	2
		6–12 in	2	1	3	2	2	2
		>12 in	0	0	0	0	0	0
		Litter	3	1	3	3	3	3
		Duff	4	3	4	4	4	4
	Flame length (ft)	Moderate	1	1	2	1	1	1
		Severe	2	1	2	2	2	2
	Torching index	Severe	17	18	47	52	10	11
	Crowning index	Severe	35	44	59	58	58	50
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate	10	6	8	9	10	11
		Severe	61	11	12	14	17	20
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			1	1	1	1
		3–6 in			1	1	1	1
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			3	3	3	3
		Duff			3	3	3	3
	Flame length (ft)	Moderate			2	1	1	1
		Severe			2	2	2	2
	Torching index	Severe			47	52	10	11
	Crowning index	Severe			59	58	58	50
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate			3	4	5	6
		Severe			6	7	9	10
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			0	0	0	0
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			3	3	3	3
	Flame length (ft)	Moderate			1	1	1	1
		Severe			1	1	1	1
	Torching index	Severe			88	86	17	17
	Crowning index	Severe			63	62	61	61
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate			3	4	5	5
		Severe			5	7	9	9

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

Table 13b—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	2	3	4	5	6	7	1	2	3	4	5	6
		3–6 in	2	2	3	3	3	4	0	1	1	1	2	2
		6–12 in	2	2	2	2	2	2	1	2	1	1	2	2
		>12 in	0	0	0	0	0	1	0	0	0	0	1	1
		Litter	3	4	4	5	5	5	1	3	4	5	5	5
		Duff	4	4	4	4	5	5	3	3	3	3	3	4
	Flame length (ft)	Moderate	1	2	2	2	2	2	1	1	2	2	2	2
		Severe	2	3	3	3	3	3	1	1	3	3	3	3
	Torching index	Severe	17	12	21	38	52	62	18	30	19	29	41	54
	Crowning index	Severe	35	29	30	31	34	35	44	37	33	35	35	36
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	14	16	38	47	39	31	61	7	12	31	37	31
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		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	4	3	3	4	4	4	4	3	3	4	4	5
		3–6 in	3	3	3	3	4	4	3	3	3	3	3	4
		6–12 in	3	3	3	3	3	2	2	3	2	2	2	2
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	3	2	3	4	4	4	3	3	4	4	4	5
		Duff	4	4	4	4	4	5	4	4	4	4	4	5
	Flame length (ft)	Moderate	2	2	2	2	2	2	1	2	2	2	2	2
		Severe	2	3	3	3	3	3	2	3	3	3	3	3
	Torching index	Severe	47	82	0	18	15	32	52	18	0	8	20	32
	Crowning index	Severe	59	53	51	49	43	36	58	53	51	45	36	34
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Passive	Passive	Surface	Surface	Passive	Passive	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	6	4	2	3	3	3	7	5	3	4	4	4
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 13b—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	1	2	2	3	4	4	1	2	2	3	4	5
		3–6 in	1	1	1	2	2	2	1	1	1	2	2	2
		6–12 in	1	1	1	1	1	1	1	1	1	1	1	1
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	3	2	3	4	4	4	3	3	4	4	4	5
		Duff	3	4	4	4	4	4	3	4	4	4	4	4
	Flame length (ft)	Moderate	2	1	1	1	2	2	1	1	1	2	2	2
		Severe	2	1	1	2	3	3	2	1	1	3	3	3
	Torching index	Severe	47	111	0	25	15	31	52	26	0	8	20	31
	Crowning index	Severe	59	53	51	49	43	36	58	53	51	45	36	34
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Passive	Surface	Surface	Surface	Passive	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	6	4	2	3	3	3	7	5	3	4	4	4
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		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	1	2	3	4	4
		3–6 in	0	1	1	1	2	2	1	1	1	1	2	2
		6–12 in	1	2	2	2	2	2	1	2	2	2	2	2
		>12 in	0	0	0	1	1	1	0	0	0	0	1	1
		Litter	1	2	3	3	4	4	3	2	3	4	4	4
		Duff	3	3	3	3	3	3	3	3	3	3	3	3
	Flame length (ft)	Moderate	1	1	1	1	2	2	1	1	1	1	2	2
		Severe	2	1	1	2	3	3	2	1	1	2	3	3
	Torching index	Severe	50	115	0	25	18	22	56	106	0	24	19	24
	Crowning index	Severe	59	55	52	51	44	40	58	55	53	47	38	37
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Passive	Surface	Surface	Surface	Passive	Surface	Passive	Surface
	Hard snags (stems/ac)	0–17.9 in	6	2	3	3	3	2	10	2	3	3	3	3
		18–29.9 in	1	1	0	0	0	0	0	0	0	0	0	0
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 13b—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	3	3	3	4	5	5	3	3	3	4	5	6
		3–6 in	2	3	3	3	3	4	2	3	3	3	3	4
		6–12 in	2	3	2	2	2	2	2	3	2	2	2	2
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	3	3	4	4	4	5	3	3	4	4	5	5
		Duff	4	4	4	4	4	5	4	4	4	4	4	5
	Flame length (ft)	Moderate	1	1	2	2	2	2	1	1	2	2	2	2
		Severe	2	2	3	3	3	3	2	2	3	3	3	3
	Torching index	Severe	10	19	33	15	21	30	11	21	14	16	23	34
	Crowning index	Severe	58	54	51	49	41	39	50	54	49	43	37	37
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Passive	Surface	Surface	Passive	Surface	Passive	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	8	6	5	5	5	5	9	8	8	8	13	22
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		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	2	2	3	4	5	1	2	3	4	5	5
		3–6 in	1	1	1	2	2	2	1	1	1	2	2	2
		6–12 in	1	1	1	1	1	1	1	1	1	1	1	1
		>12 in	0	0	0	0	0	0	0	0	0	0	0	0
		Litter	3	3	4	4	4	5	3	3	4	4	5	5
		Duff	3	4	4	4	4	4	3	4	4	4	4	4
	Flame length (ft)	Moderate	1	1	1	2	2	2	1	1	2	2	2	2
		Severe	2	1	2	3	3	3	2	1	3	3	3	3
	Torching index	Severe	10	28	44	15	20	34	11	30	16	16	22	37
	Crowning index	Severe	58	54	51	49	41	39	50	54	49	43	37	37
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Passive	Surface	Surface	Passive	Surface	Passive	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	8	6	5	5	5	5	9	8	8	8	13	22
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 13b—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	2	2	3	4	4	0	2	2	3	4	5
		3–6 in	0	1	1	1	2	2	0	1	1	1	2	2
		6–12 in	1	2	2	2	2	2	1	2	2	2	2	2
		>12 in	0	0	0	0	1	1	0	0	0	0	1	1
		Litter	1	3	3	4	4	4	1	3	3	4	4	5
		Duff	3	3	3	3	3	3	3	3	3	3	3	3
	Flame length (ft)	Moderate	1	1	1	1	2	2	1	1	1	2	2	2
		Severe	1	1	2	2	3	3	1	1	2	3	3	3
	Torching index	Severe	17	26	35	31	18	31	17	28	44	15	20	34
	Crowning index	Severe	61	55	53	52	46	44	61	55	53	48	41	38
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Passive	Surface	Passive	Surface	Surface	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	17	3	4	4	4	4	24	4	6	6	6	5
		18–29.9 in	0	0	0	0	0	0	0	0	0	0	0	0
		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 13c—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	838	822	782	738	703	676	613	607	595	563	530	504
	Quadratic mean diameter (in)	4.4	5.0	5.7	6.3	6.9	7.4	4.4	5.5	6.2	6.9	7.6	8.2
	Total volume (ft^3)	1,493	1,928	2,378	2,858	3,377	3,924	1,601	1,815	2,257	2,709	3,189	3,670
	Merchantable volume (ft^3)	1,315	1,662	2,007	2,474	2,930	3,589	1,427	1,601	1,957	2,392	2,903	3,447
	Basal area (ft^2)	87	114	139	162	183	203	90	102	126	147	166	184
	Stand density index	221	274	318	355	389	419	213	235	278	312	340	365
	Canopy closure (percent)	51	62	69	74	78	81	52	57	65	70	74	77
	Crown competition factor	72	96	118	136	153	169	73	83	104	121	135	149
	Canopy base height (ft)	3	5	7	10	12	13	3	4	7	9	11	13
	Canopy bulk density (kg/m^3)	0.07	0.09	0.09	0.08	0.08	0.07	0.05	0.07	0.08	0.07	0.07	0.07

Table 13c—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	838	50	274	272	271	269	267	100	323	320	318	315	312
	Quadratic mean diameter (in)	4.4	15.6	7.1	7.8	8.4	9.0	9.7	11.5	6.9	7.5	8.1	8.8	9.4
	Total volume (ft^3)	1,493	1,547	1,714	2,148	2,521	2,930	3,376	1,594	1,773	2,221	2,617	3,049	3,520
	Merchantable volume (ft^3)	1,315	1,459	1,636	2,001	2,354	2,695	3,027	1,489	1,676	2,054	2,433	2,802	3,159
	Basal area (ft^2)	87	66	76	90	103	119	136	72	84	99	115	132	151
	Stand density index	221	102	160	181	204	227	253	125	179	203	229	256	283
	Canopy cover (percent)	51	38	42	50	57	63	69	42	46	54	61	67	73
	Crown competition factor	72	48	54	69	84	99	117	54	62	78	94	111	129
	Canopy base height (ft)	3	13	16	1	4	6	10	13	4	1	4	7	9
	Canopy bulk density (kg/m^3)	0.07	0.03	0.04	0.04	0.05	0.05	0.07	0.04	0.04	0.04	0.05	0.07	0.08
Pile and burn	Trees per acre	838	50	274	272	271	269	267	100	323	320	318	315	312
	Quadratic mean diameter (in)	4.4	15.6	7.1	7.8	8.4	9.0	9.7	11.5	6.9	7.5	8.1	8.8	9.4
	Total volume (ft^3)	1,493	1,547	1,714	2,148	2,521	2,930	3,376	1,594	1,773	2,221	2,617	3,049	3,520
	Merchantable volume (ft^3)	1,315	1,459	1,636	2,001	2,354	2,695	3,027	1,489	1,676	2,054	2,433	2,802	3,159
	Basal area (ft^2)	87	66	76	90	103	119	136	72	84	99	115	132	151
	Stand density index	221	102	160	181	204	227	253	125	179	203	229	256	283
	Canopy cover (percent)	51	38	42	50	57	63	69	42	46	54	61	67	73
	Crown competition factor	72	48	54	69	84	99	117	54	62	78	94	111	129
	Canopy base height (ft)	3	13	16	1	4	6	10	13	4	1	4	7	9
	Canopy bulk density (kg/m^3)	0.07	0.03	0.04	0.04	0.05	0.05	0.07	0.04	0.04	0.04	0.05	0.07	0.08
Prescribed fire	Trees per acre	838	50	269	267	266	264	262	100	303	301	299	296	294
	Quadratic mean diameter (in)	4.4	15.6	7.0	7.6	8.2	8.9	9.6	11.5	6.9	7.5	8.1	8.8	9.4
	Total volume (ft^3)	1,493	1,466	1,634	2,054	2,415	2,819	3,263	1,509	1,680	2,108	2,490	2,906	3,367
	Merchantable volume (ft^3)	1,315	1,384	1,562	1,915	2,255	2,589	2,932	1,415	1,594	1,955	2,317	2,666	3,013
	Basal area (ft^2)	87	66	71	84	98	114	131	72	78	92	107	124	142
	Stand density index	221	102	151	172	194	218	244	125	166	189	214	239	267
	Canopy cover (percent)	51	38	40	48	55	61	68	42	43	52	58	65	71
	Crown competition factor	72	48	51	65	79	95	113	54	57	72	88	104	123
	Canopy base height (ft)	3	14	17	1	4	7	9	13	15	1	4	7	9
	Canopy bulk density (kg/m^3)	0.07	0.03	0.04	0.04	0.04	0.05	0.07	0.03	0.04	0.04	0.05	0.06	0.07

Table 13c—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	838	200	271	267	263	259	255	300	369	362	356	345	326
	Quadratic mean diameter (in)	4.4	8.4	7.9	8.6	9.4	10.0	10.7	7.0	7.0	7.7	8.4	9.0	9.7
	Total volume (ft^3)	1,493	1,623	1,812	2,239	2,662	3,102	3,558	1,635	1,840	2,287	2,730	3,178	3,596
	Merchantable volume (ft^3)	1,315	1,487	1,669	2,060	2,521	2,945	3,369	1,486	1,664	2,046	2,540	2,978	3,402
	Basal area (ft^2)	87	76	92	109	126	143	160	80	98	117	136	154	168
	Stand density index	221	150	185	211	237	261	285	169	207	238	268	293	311
	Canopy cover (percent)	51	44	50	57	63	67	71	47	54	61	67	71	74
	Crown competition factor	72	58	70	84	98	112	125	63	77	94	110	124	135
	Canopy base height (ft)	3	3	4	6	6	7	10	3	4	6	6	7	10
	Canopy bulk density (kg/m^3)	0.07	0.04	0.04	0.04	0.05	0.06	0.06	0.04	0.04	0.05	0.05	0.07	0.07
Pile and burn	Trees per acre	838	200	271	267	263	259	255	300	369	362	356	345	326
	Quadratic mean diameter (in)	4.4	8.4	7.9	8.6	9.4	10.0	10.7	7.0	7.0	7.7	8.4	9.0	9.7
	Total volume (ft^3)	1,493	1,623	1,812	2,239	2,662	3,102	3,558	1,635	1,840	2,287	2,730	3,178	3,596
	Merchantable volume (ft^3)	1,315	1,487	1,669	2,060	2,521	2,945	3,369	1,486	1,664	2,046	2,540	2,978	3,402
	Basal area (ft^2)	87	76	92	109	126	143	160	80	98	117	136	154	168
	Stand density index	221	150	185	211	237	261	285	169	207	238	268	293	311
	Canopy cover (percent)	51	44	50	57	63	67	71	47	54	61	67	71	74
	Crown competition factor	72	58	70	84	98	112	125	63	77	94	110	124	135
	Canopy base height (ft)	3	3	4	6	6	7	10	3	4	6	6	7	10
	Canopy bulk density (kg/m^3)	0.07	0.04	0.04	0.04	0.05	0.06	0.06	0.04	0.04	0.05	0.05	0.07	0.07
Prescribed fire	Trees per acre	838	200	225	221	218	215	212	300	296	291	286	281	278
	Quadratic mean diameter (in)	4.4	8.4	8.3	9.1	9.8	10.5	11.2	7.0	7.4	8.2	8.9	9.6	10.2
	Total volume (ft^3)	1,493	1,536	1,715	2,118	2,519	2,935	3,366	1,551	1,740	2,161	2,578	3,016	3,477
	Merchantable volume (ft^3)	1,315	1,420	1,595	1,989	2,400	2,799	3,196	1,423	1,596	1,968	2,421	2,858	3,293
	Basal area (ft^2)	87	76	84	99	115	130	146	80	89	106	123	141	158
	Stand density index	221	150	166	189	212	234	255	169	183	210	237	263	288
	Canopy cover (percent)	51	44	47	53	59	64	68	47	50	57	62	67	72
	Crown competition factor	72	58	63	76	88	101	113	63	68	83	98	112	126
	Canopy base height (ft)	3	3	4	5	5	7	10	3	4	6	6	7	10
	Canopy bulk density (kg/m^3)	0.07	0.03	0.04	0.04	0.04	0.05	0.05	0.03	0.04	0.04	0.05	0.06	0.06

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

Table 13d—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	94	10	6					8	100						
	10	9	77	10	23					8	99	10	1				
	20	9	60	10	40					9	81	10	19				
	30	10	60	9	40					9	63	10	37				
	40	10	75	9	25					10	54	9	46				
	50	10	88	9	12					10	69	9	31				

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*				
None	1	8	63	11	37					8	73	11	27				
	10	8	78	10	22					8	78	10	22				
	20	8	74	10	26					8	72	10	28				
	30	8	65	10	35					9	62	10	38				
	40	9	56	10	44					9	50	10	50				
	50	10	53	9	47					10	60	9	40				
Pile and burn	1	8	63	11	37					8	73	11	27				
	10	8	100							8	100						
	20	8	100							8	96	10	4				
	30	8	87	10	13					9	81	10	19				
	40	9	74	10	26					9	67	10	33				
	50	9	63	10	37					9	55	10	45				
Prescribed fire	1	8	100							8	100						
	10	8	100							8	100						
	20	8	100							8	98	10	2				
	30	8	89	10	11					8	84	10	16				
	40	9	76	10	24					9	69	10	31				
	50	9	65	10	35					9	58	10	42				

Table 13d—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	8	79	11	21					8	82	11	18				
	10	8	78	10	22					8	78	10	22				
	20	8	70	10	30					9	69	10	31				
	30	9	59	10	41					9	56	10	44				
	40	10	52	9	48					10	55	9	45				
	50	10	62	9	38					10	69	9	31				
Pile and burn	1	8	79	11	21					8	82	11	18				
	10	8	100							8	100						
	20	8	93	10	7					9	91	10	9				
	30	9	77	10	23					9	74	10	26				
	40	9	64	10	36					9	60	10	40				
	50	9	52	10	48					10	55	9	45				
Prescribed fire	1	8	100							8	100						
	10	8	100							8	100						
	20	8	94	10	6					8	94	10	6				
	30	8	80	10	20					9	78	10	22				
	40	9	68	10	32					9	64	10	36				
	50	9	56	10	44					9	53	10	47				

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

Table 13e—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	19	87	3	5	12	16	50	100
Moderate—75th percentile	8	69	5	7	16	19	125	150

Table 13f—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 = 23 percent, aspect = 225°.

Species (based on trees per acre): Ponderosa pine (*Pinus ponderosa*) = 2 percent, Engelmann spruce (*Picea engelmannii*) = 38 percent, grand fir (*Abies grandis*) = 56 percent, Douglas-fir (*Pseudotsuga menziesii*) = 4 percent, western larch (*Larix occidentalis*) = <1 percent.

Stand attributes: Stem density = 2,079 tpa, basal area = 240 ft^2/ac, top height = 103 ft, stand density index = 598, quadratic mean diameter = 4.6 in, crown competition factor = 74, canopy cover = 52 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 is composed of Ponderosa pine, Engelmann spruce, grand fir, Douglas-fir, and western larch with 2,079 trees per acre (tpa). Canopy bulk density is 0.27 kg/m^3 (0.0169 lb/ft^3), and canopy base height is 2 ft, so ladder fuels are not sufficient to enable crown fire initiation, but canopy fuels are sufficient to enable active crown fire spread for severe fire weather. Woody fuel loading is 18 tons/ac, and litter and duff loading is 27 tons/ac. Predicted flame lengths are 3 ft, and potential basal area mortality is 100 percent for severe fire weather and 25 percent for moderate fire weather. With no action, canopy base height increases slightly and canopy bulk density decreases as trees grow and the stand self-thins. However surface fuels accumulate causing higher flame lengths, so crown fire potential increases over time. In 20 years, passive crown fire is likely for moderate fire weather, and active crown fire remains likely for severe fire weather for the 50-year projection.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment increases canopy base height and decreases canopy bulk density and surface fuel loading, which reduces crown fire potential and flame lengths, but many snags are created that contribute to high surface fuel loading and increase crown fire potential in 10 years. All thinning treatments reduce canopy bulk density and increase canopy base height, but the higher density treatments (200 and 300 tpa) increase canopy base height by only 1 ft. Activity fuels from thinning increase potential flame lengths in all treatments; the greater the thinning, the greater is the increase in surface fuel loading. In the 200 tpa treatment the increase in canopy base height is not enough to compensate for greater potential flame lengths, so passive crown fire remains likely for severe fire weather, and potential basal area mortality is 82 percent. The pile and burn surface fuel treatment and, to a greater extent, the prescribed fire treatment reduce surface fuel loading, so potential flame lengths and basal area mortality are lower. The reduction in potential flame lengths is sufficient to change the predicted fire type to surface fire in the 200 tpa treatment.

Silvicultural and surface fuel treatments—long-term effects

In the prescribed fire only treatment, fallen snags contribute to higher surface fuel loading in 10 years and potential flame lengths increase, but canopy base height continues to increase, so crown fire potential remains low for the 50-year trajectory. Regeneration in the 50 tpa treatment causes canopy base height to decrease in 20 years, but potential flame lengths are low, so crown fire remains unlikely for the 50-year projection regardless of surface fuel treatment. In the 100 tpa, 200 tpa, and 300 tpa treatments, regeneration causes canopy base height to decrease in 30 years, and potential flame lengths are high enough that passive crown fire is predicted for severe fire weather. At this time, another treatment would be necessary to decrease crown fire potential. However canopy base height increases over time as regeneration grows, and in 50 years the predicted fire type becomes surface fire again, but potential flame lengths are at least 4 ft for severe fire weather.

Table 14a—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	13	9	7	6
		3–6 in	7	1	4	4	4	3
		6–12 in	7	3	3	3	3	3
		>12 in	0	0	0	0	0	0
		Litter	2	1	5	4	4	4
		Duff	25	17	5	5	5	5
	Flame length (ft)	Moderate	2	1	4	3	2	2
		Severe	3	2	6	4	4	3
	Torching index	Severe	2	109	80	99	16	23
	Crowning index	Severe	12	34	41	32	30	26
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Active	Surface	Surface	Surface	Passive	Surface
	Potential basal area mortality (%)	Moderate	25	14	8	11	16	19
		Severe	100	14	15	13	82	21
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			3	2	2	2
		3–6 in			1	1	1	1
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			5	4	4	3
		Duff			5	5	5	5
	Flame length (ft)	Moderate			2	1	1	1
		Severe			3	2	2	2
	Torching index	Severe			245	291	75	77
	Crowning index	Severe			41	32	30	26
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			8	11	15	17
		Severe			8	11	15	18
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			1	1	1	1
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			4	4	4	4
	Flame length (ft)	Moderate			1	1	1	1
		Severe			2	2	2	2
	Torching index	Severe			368	365	176	125
	Crowning index	Severe			44	35	34	34
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			7	11	12	13
		Severe			7	11	12	13

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

Table 14b—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	7	10	10	10	10	1	6	6	6	6	6
		3–6 in	7	7	8	8	9	9	1	3	4	4	5	5
		6–12 in	7	7	8	9	10	11	3	7	8	8	8	9
		>12 in	0	1	3	6	10	14	0	2	4	6	9	11
		Litter	2	4	4	4	4	4	1	2	3	3	3	3
		Duff	25	25	25	25	26	26	17	17	18	18	18	18
	Flame length (ft)	Moderate	2	3	4	4	4	5	1	2	2	3	3	4
		Severe	3	4	5	6	6	7	2	4	4	4	5	5
	Torching index	Severe	2	0	0	0	0	0	109	60	90	109	120	125
	Crowning index	Severe	12	13	16	17	19	20	34	30	28	28	28	29
	Type of fire	Moderate	Surface	Surface	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Active	Active	Active	Active	Active	Active	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	339	448	394	317	238	177	548	41	35	31	31	29
		18–29.9 in	4	6	11	14	16	17	6	7	9	11	12	13
		30–36 in	1	1	2	2	2	3	1	1	1	2	2	2

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	13	6	4	3	4	4	9	6	5	5	6	6
		3–6 in	4	4	4	4	4	5	4	4	5	5	5	6
		6–12 in	3	3	4	4	4	3	3	3	4	5	5	6
		>12 in	0	1	1	2	3	5	0	1	2	4	7	9
		Litter	5	2	2	2	2	2	4	2	2	3	3	2
		Duff	5	5	6	6	6	6	5	5	6	6	6	7
	Flame length (ft)	Moderate	4	2	2	2	2	2	3	2	2	2	2	3
		Severe	6	3	3	3	3	3	4	3	3	4	4	5
	Torching index	Severe	80	272	22	36	42	44	99	227	238	16	17	21
	Crowning index	Severe	41	40	40	41	41	42	32	29	28	29	29	31
	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	Passive	Surface
	Hard snags (stems/ac)	0–17.9 in	22	28	17	75	74	52	26	32	26	63	64	48
		18–29.9 in	3	3	4	6	7	7	3	4	7	10	12	13
		30–36 in	1	1	1	1	1	1	1	1	1	1	2	2

Table 14b—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	4	2	3	5	5	6	6
		3–6 in	1	2	2	2	3	3	1	2	2	3	4	4
		6–12 in	1	2	3	3	3	3	1	2	3	4	4	5
		>12 in	0	1	1	2	3	5	0	1	2	4	7	9
		Litter	5	2	2	2	2	2	4	2	2	3	3	3
		Duff	5	5	5	5	5	5	5	5	5	5	6	6
	Flame length (ft)	Moderate	2	1	1	1	2	2	1	1	2	2	2	3
		Severe	3	2	2	2	2	3	2	2	3	3	4	4
	Torching index	Severe	245	554	45	53	55	55	291	427	309	23	22	25
	Crowning index	Severe	41	40	40	41	41	42	32	29	28	29	29	31
	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	22	28	18	82	81	57	26	33	27	68	67	51
		18–29.9 in	3	3	4	5	7	7	3	4	7	10	12	13
		30–36 in	1	1	1	1	1	1	1	1	1	1	2	2
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	2	2	3	3	4	0	3	4	4	5	5
		3–6 in	1	2	2	2	3	3	1	2	3	3	4	4
		6–12 in	2	3	4	4	3	3	2	4	6	6	6	6
		>12 in	0	1	3	4	5	6	0	2	4	6	8	10
		Litter	1	1	2	2	2	2	4	2	2	2	2	2
		Duff	4	4	4	4	4	4	5	4	4	4	5	5
	Flame length (ft)	Moderate	1	1	1	2	2	2	1	1	2	2	2	3
		Severe	2	2	2	2	3	3	2	2	3	3	4	4
	Torching index	Severe	368	510	37	42	47	49	365	376	17	18	19	14
	Crowning index	Severe	44	43	43	43	44	44	35	33	32	32	32	32
	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	Passive	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	25	33	22	91	87	61	41	43	30	79	76	55
		18–29.9 in	5	5	6	6	6	6	5	6	7	9	10	11
		30–36 in	1	1	1	1	1	1	1	1	1	1	2	2

Table 14b—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	7	6	7	7	7	7	6	6	7	8	8	8
		3–6 in	4	4	5	5	6	6	3	3	4	5	6	7
		6–12 in	3	3	5	6	7	8	3	3	5	6	7	8
		>12 in	0	1	3	5	8	12	0	1	3	5	9	13
		Litter	4	3	3	3	3	3	4	3	3	3	3	3
		Duff	5	5	6	6	7	7	5	5	6	6	7	7
	Flame length (ft)	Moderate	2	2	2	3	3	4	2	2	2	3	4	4
		Severe	4	3	4	4	5	6	3	3	4	5	5	6
	Torching index	Severe	16	71	90	7	9	13	23	72	83	11	71	69
	Crowning index	Severe	30	27	25	25	26	26	26	25	25	25	25	24
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	33	42	39	74	76	59	40	54	53	81	80	65
		18–29.9 in	3	5	9	12	14	15	4	6	9	13	16	16
		30–36 in	1	1	1	2	2	2	1	1	1	2	2	3
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	4	6	7	7	7	2	4	7	8	8	8
		3–6 in	1	2	3	3	4	5	1	2	3	4	5	6
		6–12 in	1	2	3	5	6	7	1	2	4	5	6	7
		>12 in	0	1	2	5	8	12	0	1	3	5	9	13
		Litter	4	3	3	3	3	3	3	3	3	3	3	3
		Duff	5	5	5	6	6	6	5	5	5	6	6	7
	Flame length (ft)	Moderate	1	1	2	2	3	4	1	1	2	3	3	4
		Severe	2	2	3	4	5	5	2	2	3	4	5	6
	Torching index	Severe	75	129	114	12	11	87	77	122	101	7	8	75
	Crowning index	Severe	30	27	25	25	26	27	26	25	25	25	25	24
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Passive	Passive	Surface
	Hard snags (stems/ac)	0–17.9 in	33	43	40	78	80	61	40	55	53	83	84	67
		18–29.9 in	3	5	8	12	14	15	4	6	9	13	15	16
		30–36 in	1	1	1	2	2	2	1	1	1	2	2	2

Table 14b—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	5	5	5	6	0	4	5	5	6	6
		3–6 in	1	3	3	4	4	5	1	3	4	4	5	5
		6–12 in	2	5	7	7	7	7	2	5	7	7	7	7
		>12 in	0	2	4	6	8	11	0	2	4	6	8	11
		Litter	1	2	3	3	3	3	1	2	3	3	3	3
		Duff	4	4	4	4	5	5	4	4	4	4	5	5
	Flame length (ft)	Moderate	1	2	2	2	3	3	1	2	2	2	3	3
		Severe	2	3	3	4	4	5	2	3	3	4	4	5
	Torching index	Severe	176	193	208	12	13	18	125	94	102	10	12	12
	Crowning index	Severe	34	30	29	28	29	30	34	31	29	29	29	30
	Type of fire	Moderate	Surface	Surface	Surface	Surface	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	60	44	33	84	80	59	81	46	35	87	84	62
		18–29.9 in	5	6	8	10	11	12	5	6	8	10	12	13
		30–36 in	1	1	1	1	2	2	1	1	1	1	2	2

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

Table 14c—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	2,079	1,544	1,176	888	680	533	171	163	148	135	123	112
	Quadratic mean diameter (in)	4.6	5.6	6.6	7.7	8.9	10.1	4.6	15.3	16.7	17.9	19.2	20.4
	Total volume (ft^3)	7,514	8,635	9,521	10,280	10,953	11,568	7,088	7,652	8,655	9,517	10,281	10,959
	Merchantable volume (ft^3)	6,777	7,716	8,375	8,924	9,392	10,321	6,620	7,184	8,124	8,924	9,640	10,404
	Basal area (ft^2)	240	265	279	288	293	297	197	208	224	236	246	253
	Stand density index	598	611	604	585	563	543	312	322	336	344	348	350
	Canopy closure (percent)	91	93	93	94	94	93	81	83	84	85	86	87
	Crown competition factor	236	260	271	274	274	272	167	174	186	193	198	201
	Canopy base height (ft)	2	3	3	4	5	5	6	10	17	24	30	34
	Canopy bulk density (kg/m^3)	0.27	0.25	0.19	0.17	0.15	0.14	0.07	0.08	0.09	0.09	0.09	0.09

Table 14c—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	2,079	50	332	321	240	176	134	100	264	251	197	151	121
	Quadratic mean diameter (in)	4.6	22.5	9.2	9.9	11.8	14.3	16.8	18.6	12.1	12.8	14.9	17.4	19.7
	Total volume (ft^3)	7,514	5,664	6,133	7,015	7,846	8,613	9,315	7,431	8,003	9,023	9,934	10,746	11,459
	Merchantable volume (ft^3)	6,777	5,419	5,886	6,733	7,532	8,267	8,922	7,062	7,634	8,632	9,527	10,291	10,996
	Basal area (ft^2)	240	138	154	170	184	196	206	189	209	226	239	249	257
	Stand density index	598	183	292	313	315	312	307	271	357	375	374	367	361
	Canopy cover (percent)	91	65	69	72	75	76	78	79	81	83	84	85	86
	Crown competition factor	236	106	117	128	138	145	150	154	167	178	185	191	195
	Canopy base height (ft)	2	29	38	3	4	5	6	20	28	33	4	5	7
	Canopy bulk density (kg/m^3)	0.27	0.05	0.06	0.05	0.05	0.05	0.05	0.08	0.09	0.09	0.09	0.08	0.08
Pile and burn	Trees per acre	2,079	50	361	349	260	189	141	100	282	268	207	158	126
	Quadratic mean diameter (in)	4.6	22.5	8.8	9.4	11.4	13.8	16.3	18.6	11.7	12.4	14.5	17.0	19.4
	Total volume (ft^3)	7,514	5,664	6,134	7,020	7,854	8,623	9,328	7,431	8,005	9,030	9,950	10,767	11,491
	Merchantable volume (ft^3)	6,777	5,419	5,887	6,741	7,540	8,284	8,959	7,062	7,635	8,634	9,530	10,336	11,033
	Basal area (ft^2)	240	138	154	170	183	195	205	189	210	226	239	250	258
	Stand density index	598	183	296	318	320	315	309	271	361	380	378	371	364
	Canopy cover (percent)	91	65	69	72	75	76	78	79	81	83	84	85	86
	Crown competition factor	236	106	117	128	137	144	150	154	167	178	185	191	195
	Canopy base height (ft)	2	29	38	3	4	5	6	20	28	33	4	5	7
	Canopy bulk density (kg/m^3)	0.27	0.05	0.06	0.06	0.05	0.05	0.05	0.08	0.09	0.09	0.09	0.09	0.08
Prescribed fire	Trees per acre	2,079	50	391	377	277	202	151	100	325	310	233	173	134
	Quadratic mean diameter (in)	4.6	22.5	8.2	8.8	10.8	13.1	15.5	18.6	10.4	11.1	13.2	15.8	18.3
	Total volume (ft^3)	7,514	5,311	5,769	6,630	7,448	8,211	8,917	6,782	7,345	8,376	9,303	10,134	10,869
	Merchantable volume (ft^3)	6,777	5,083	5,537	6,358	7,144	7,854	8,494	6,448	7,015	8,025	8,913	9,715	10,414
	Basal area (ft^2)	240	138	145	161	175	188	198	189	191	209	223	234	243
	Stand density index	598	183	287	310	312	310	306	271	345	367	366	359	352
	Canopy cover (percent)	91	65	66	70	73	75	77	79	78	80	82	83	84
	Crown competition factor	236	106	109	122	131	139	145	154	150	162	171	177	182
	Canopy base height (ft)	2	29	38	3	4	5	6	23	31	3	4	5	7
	Canopy bulk density (kg/m^3)	0.27	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0.07	0.08	0.08	0.08	0.07

Table 14c—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	2,079	200	333	312	253	202	168	300	392	359	296	243	206
	Quadratic mean diameter (in)	4.6	13.9	11.3	12.2	13.8	15.8	17.6	11.6	10.7	11.6	13.0	14.6	16.1
	Total volume (ft^3)	7,514	7,904	8,503	9,555	10,480	11,301	12,036	7,988	8,577	9,609	10,496	11,293	12,010
	Merchantable volume (ft^3)	6,777	7,388	7,969	8,935	9,766	10,643	11,457	7,346	7,878	8,750	9,465	10,296	11,301
	Basal area (ft^2)	240	210	234	251	265	275	283	219	244	262	274	283	291
	Stand density index	598	339	408	426	427	421	415	379	436	453	453	447	442
	Canopy cover (percent)	91	84	86	88	89	89	90	86	88	90	91	91	91
	Crown competition factor	236	182	197	209	217	222	226	197	216	229	237	241	244
	Canopy base height (ft)	2	4	9	15	4	5	25	4	9	15	5	21	24
	Canopy bulk density (kg/m^3)	0.27	0.08	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.11	0.11	0.11
Pile and burn	Trees per acre	2,079	200	348	326	263	207	171	300	404	371	306	249	210
	Quadratic mean diameter (in)	4.6	13.9	11.1	11.9	13.6	15.6	17.4	11.6	10.5	11.4	12.8	14.4	15.9
	Total volume (ft^3)	7,514	7,904	8,504	9,547	10,469	11,292	12,030	7,988	8,578	9,606	10,503	11,302	12,018
	Merchantable volume (ft^3)	6,777	7,388	7,970	8,940	9,755	10,655	11,485	7,346	7,879	8,745	9,480	10,276	11,272
	Basal area (ft^2)	240	210	234	251	264	275	283	219	244	262	274	284	291
	Stand density index	598	339	411	430	429	423	417	379	438	456	456	450	444
	Canopy cover (percent)	91	84	86	88	89	89	90	86	88	90	91	91	91
	Crown competition factor	236	182	197	209	217	222	226	197	216	229	237	242	245
	Canopy base height (ft)	2	4	9	15	4	5	25	4	9	15	4	5	24
	Canopy bulk density (kg/m^3)	0.27	0.08	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.11	0.11	0.11
Prescribed fire	Trees per acre	2,079	200	346	329	250	188	147	300	368	349	268	204	161
	Quadratic mean diameter (in)	4.6	13.9	10.4	11.1	13.2	15.5	17.9	11.6	10.1	10.9	12.8	15.0	17.2
	Total volume (ft^3)	7,514	7,056	7,647	8,713	9,676	10,531	11,299	7,078	7,669	8,736	9,697	10,562	11,333
	Merchantable volume (ft^3)	6,777	6,671	7,263	8,301	9,208	10,062	10,821	6,657	7,247	8,256	9,151	10,019	10,819
	Basal area (ft^2)	240	210	203	221	236	247	257	219	206	224	239	251	261
	Stand density index	598	339	366	389	388	381	374	379	375	398	398	392	386
	Canopy cover (percent)	91	84	81	83	84	85	86	86	82	84	85	86	87
	Crown competition factor	236	182	164	177	186	192	197	197	169	183	192	199	204
	Canopy base height (ft)	2	10	20	30	4	5	7	7	11	16	4	5	6
	Canopy bulk density (kg/m^3)	0.27	0.07	0.08	0.09	0.09	0.09	0.08	0.07	0.08	0.09	0.09	0.09	0.08

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

Table 14d—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*		*Percent*		
None	1	10	53	8	32	9	15			8	61	9	39				
	10	10	100							10	71	8	17	9	11		
	20	10	67	12	33					10	95	8	3	9	2		
	30	12	54	10	46					10	92	12	8				
	40	12	70	10	30					10	81	12	19				
	50	12	86	10	14					10	69	12	31				

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	12	35					10	98	12	2				
	10	10	45	8	34	9	22			10	45	8	32	9	23		
	20	8	42	10	30	9	28			10	57	8	25	9	18		
	30	8	43	10	29	9	28			10	72	8	16	9	12		
	40	8	39	10	36	9	26			10	95	8	3	9	2		
	`50	10	46	8	32	9	22			10	88	12	12				
Pile and burn	1	8	46	9	28	10	26			8	56	9	37	10	7		
	10	8	61	9	39					8	57	9	40	10	3		
	20	8	59	9	38	10	3			8	40	10	32	9	28		
	30	8	54	9	35	10	11			10	52	8	27	9	20		
	40	8	48	9	31	10	21			10	78	8	13	9	9		
	50	8	41	10	33	9	27			10	96	12	4				
Prescribed fire	1	8	61	9	39					8	58	9	42				
	10	8	60	9	40					8	49	9	38	10	13		
	20	8	55	9	38	10	7			10	44	8	31	9	25		
	30	8	48	9	34	10	18			10	65	8	20	9	16		
	40	8	42	9	30	10	28			10	85	8	8	9	7		
	50	10	39	8	35	9	26			10	96	12	4				

Table 14d—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	74	8	16	9	9			10	55	8	29	9	16		
	10	10	47	8	33	9	19			10	47	8	35	9	18		
	20	10	78	8	14	9	8			10	88	8	8	9	4		
	30	10	97	12	3					10	88	12	12				
	40	10	80	12	20					10	69	12	31				
	50	10	62	12	38					12	52	10	48				
Pile and burn	1	8	64	9	36					8	65	9	35				
	10	8	56	9	32	10	11			8	55	9	29	10	16		
	20	10	53	8	30	9	17			10	66	8	22	9	12		
	30	10	85	8	10	9	5			10	97	12	3				
	40	10	89	12	11					10	77	12	23				
	50	10	70	12	30					10	55	12	45				
Prescribed fire	1	8	60	9	40					8	61	9	39				
	10	8	41	10	31	9	28			10	40	8	36	9	24		
	20	10	63	8	22	9	15			10	69	8	18	9	12		
	30	10	86	8	8	9	6			10	93	8	4	9	3		
	40	10	95	12	5					10	91	12	9				
	50	10	81	12	19					10	77	12	23				

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

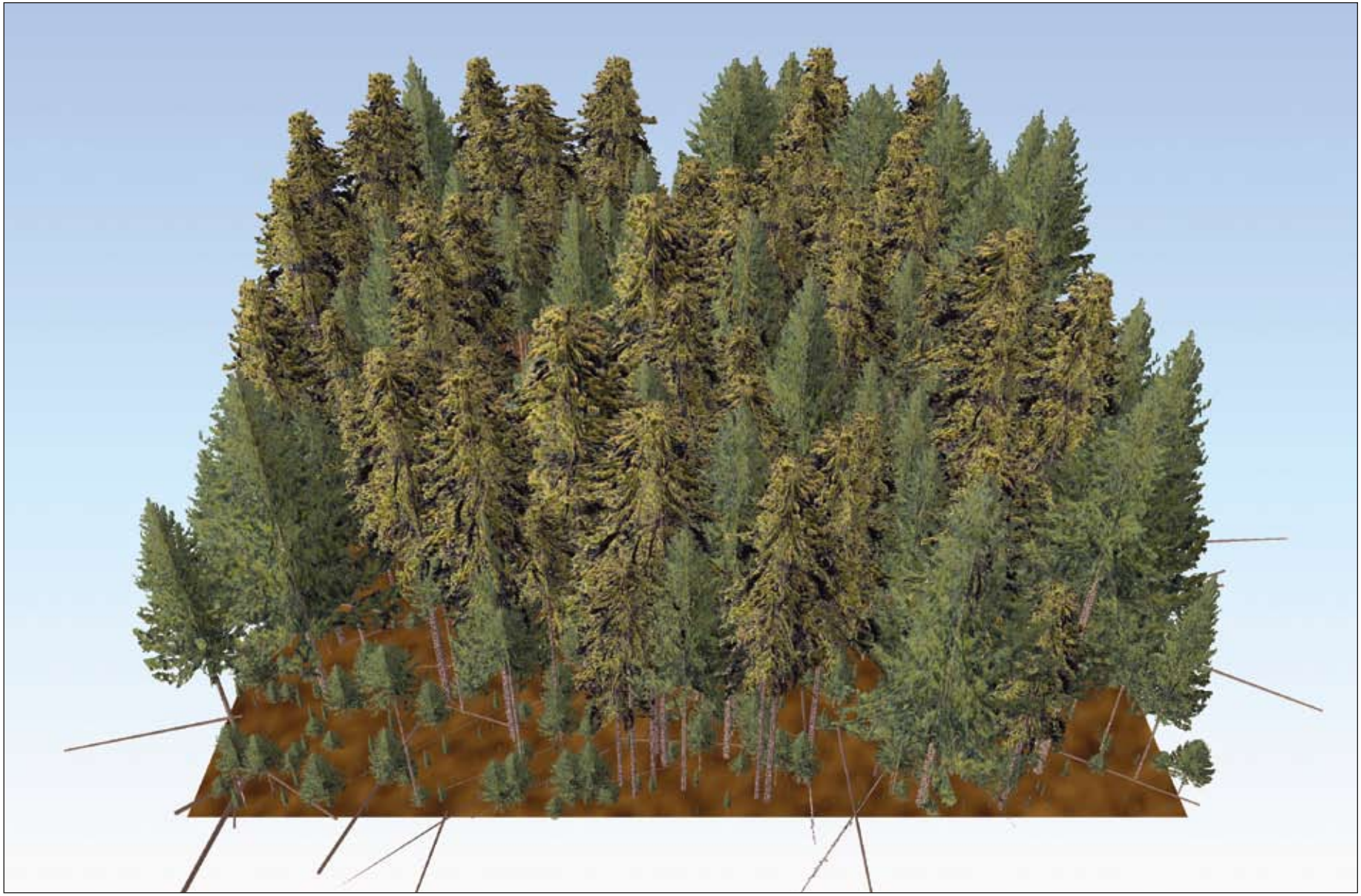
Table 14e—FVS fuel model selection

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	20	85	3	5	8	15	50	100
Moderate—75th percentile	11	69	6	7	10	18	125	150

Table 14f—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 = 20 percent, aspect = 315°

Species (based on trees per acre): Grand fir (*Abies grandis*) = 85 percent, ponderosa pine (*Pinus ponderosa*) = 6 percent, Douglas-fir (*Pseudotsuga menziesii*) = 8 percent.

Stand attributes: Stem density = 3,158 tpa, basal area = 289 ft^2/ac, top height = 96 ft, stand density index = 754, quadratic mean diameter = 4.2 in, crown competition factor = 277, canopy cover = 94 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 3,158 trees per acre (tpa) composed of Douglas-fir and grand fir understory with a low-density ponderosa pine overstory. Canopy bulk density is 0.17 kg/m^3 (0.0106 lb/ft^3), and canopy base height is 3 ft, so ladder fuels are not sufficient to enable crown fire initiation, but canopy fuels are sufficient to enable active crown fire spread for severe fire weather. Woody fuel loading is 9 tons/ac, and litter and duff loading is 8 tons/ac. Predicted flame lengths and potential basal area mortality are low for severe and moderate fire weather. With no action, canopy base height increases slightly and canopy bulk density decreases as trees grow and the stand self-thins, but surface fuels accumulate rapidly causing higher flame lengths and crown fire potential. In 10 years, the predicted fire type is active crown fire for severe fire weather and passive crown fire for moderate fire weather. In 40 years, canopy base height increases enough that the predicted fire type becomes passive crown fire for both moderate and severe 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 fuel loading, which decreases crown fire potential. Thinning to 200 tpa or less is required to increase canopy base height and reduce canopy bulk density sufficiently to affect crown fire potential. Activity fuels from thinning treatments increase surface fuel loading, which causes higher potential flame lengths and basal area mortality; the greater the thinning, the greater are activity fuels. The pile and burn, and to a greater extent, the prescribed fire treatments reduce surface fuels, which decreases potential flame lengths and basal area mortality. The prescribed fire treatment also causes tree mortality, which increases canopy base height. This additional increase in canopy base height is sufficient to change the predicted fire type to surface fire in the 300 tpa treatment.

Silvicultural and surface fuel treatments—long-term effects

In the prescribed fire only treatment, surface fuel loading increases from fallen snags in 10 years, and potential flame lengths increase. Passive crown fire is likely again because the treatment does not increase canopy base height sufficiently to compensate for higher flame lengths associated with surface fuel accumulation. In 20 years, canopy base height increases and the predicted fire type is surface fire, but surface fuels continue to accumulate and potential flame lengths increase. In 50 years, potential flame lengths are 5 ft and 8 ft for moderate and severe fire weather respectively, so an additional treatment may be necessary to reduce surface fuels. In the 50 tpa treatment, regeneration causes canopy base height to decrease in 20 years and passive crown fire is likely again, but the effect is short lived and the predicted fire type changes to surface fire again in 30 years. In all other treatments, regeneration causes a decrease in canopy base height in 20 or 30 years, and passive crown fire remains likely for the duration of the 50-year projection. A second treatment would be necessary to decrease crown fire potential. Surface fuels accumulate over time, and flame lengths exceed 5 ft in 50 years for severe fire weather, so an additional surface fuel treatment may also be necessary to reduce tree mortality.

Table 15a—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	17	12	8	6
		3–6 in	3	0	4	4	4	4
		6–12 in	3	1	3	3	3	3
		>12 in	0	0	0	0	0	0
		Litter	3	2	7	7	6	5
		Duff	5	4	5	5	5	5
	Flame length (ft)	Moderate	1	1	5	4	2	2
		Severe	2	2	7	5	4	3
	Torching index	Severe	38	55	69	111	125	53
	Crowning index	Severe	18	21	43	29	21	18
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Conditional	Surface	Surface	Surface	Surface	Conditional
	Potential basal area mortality (%)	Moderate	18	14	6	8	12	14
		Severe	19	14	45	11	12	15
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			4	3	2	2
		3–6 in			1	1	1	1
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			7	6	5	5
		Duff			5	5	5	5
	Flame length (ft)	Moderate			2	2	1	1
		Severe			4	3	2	2
	Torching index	Severe			140	233	249	127
	Crowning index	Severe			43	29	21	18
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Conditional
	Potential basal area mortality (%)	Moderate			6	8	12	14
		Severe			6	8	12	14
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			1	1	1	1
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			1	1	1	2
		Duff			4	4	4	4
	Flame length (ft)	Moderate			2	1	1	1
		Severe			3	2	2	2
	Torching index	Severe			201	350	282	283
	Crowning index	Severe			45	31	24	21
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			6	8	11	13
		Severe			6	8	11	13

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

Table 15b—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	9	15	16	16	15	1	8	11	11	12	12
		3–6 in	3	4	6	8	10	12	0	4	6	7	9	10
		6–12 in	3	4	7	11	14	17	1	6	9	12	14	16
		>12 in	0	1	4	8	13	18	0	2	5	8	12	16
		Litter	3	8	7	7	7	6	2	5	5	5	5	4
		Duff	5	6	7	8	9	10	4	4	5	6	6	7
	Flame length (ft)	Moderate	1	3	4	5	6	6	1	3	4	5	5	5
		Severe	2	4	6	7	8	9	2	4	6	7	7	8
	Torching index	Severe	38	0	0	0	0	0	55	12	36	52	54	59
	Crowning index	Severe	18	13	14	20	22	23	21	23	23	24	26	27
	Type of fire	Moderate	Surface	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Conditional	Active	Active	Active	Passive	Passive	Surface	Passive	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	601	773	733	524	366	250	812	77	80	67	59	53
		18–29.9 in	3	7	11	14	14	14	4	6	9	11	12	12
		30–36 in	0	0	1	1	1	2	0	0	0	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	17	9	6	6	6	7	12	8	7	8	8	9
		3–6 in	4	5	5	5	6	7	4	4	5	6	7	8
		6–12 in	3	3	4	4	4	4	3	4	5	5	6	7
		>12 in	0	1	2	2	3	5	0	1	2	4	6	9
		Litter	7	3	3	3	4	4	7	4	4	5	5	5
		Duff	5	6	6	7	7	7	5	6	6	7	7	8
	Flame length (ft)	Moderate	5	3	2	2	2	3	4	2	3	3	4	4
		Severe	7	4	4	4	4	4	5	4	4	5	5	6
	Torching index	Severe	69	138	5	19	24	22	111	188	0	5	7	7
	Crowning index	Severe	43	43	35	32	41	46	29	30	30	31	32	33
	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	Passive	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	24	30	16	129	121	89	28	39	28	147	147	103
		18–29.9 in	1	1	3	4	5	7	1	3	5	8	9	11
		30–36 in	0	0	0	0	1	1	0	0	0	1	1	1

Table 15b—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	4	3	4	4	6	7	3	4	5	7	8	9
		3–6 in	1	2	2	3	4	5	1	2	3	4	5	6
		6–12 in	1	2	3	3	3	3	1	2	3	4	5	6
		>12 in	0	1	1	2	3	5	0	1	2	4	6	9
		Litter	7	3	3	3	4	4	6	4	4	5	5	5
		Duff	5	5	5	6	6	7	5	5	6	6	7	7
	Flame length (ft)	Moderate	2	2	2	2	2	2	2	2	2	2	3	4
		Severe	4	3	3	3	3	4	3	3	3	4	5	6
	Torching index	Severe	140	225	17	28	29	29	233	263	10	10	10	5
	Crowning index	Severe	43	43	33	30	39	46	29	30	30	31	32	33
	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	Passive	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	24	31	16	137	129	95	28	40	28	157	160	111
		18–29.9 in	1	1	3	4	5	7	1	3	5	8	9	11
		30–36 in	0	0	0	0	1	1	0	0	0	1	1	1
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	2	3	4	5	7	0	3	4	6	7	8
		3–6 in	1	2	2	3	4	5	1	2	3	4	5	6
		6–12 in	2	3	4	4	4	4	2	3	5	6	6	7
		>12 in	0	1	3	4	4	6	0	2	4	6	8	10
		Litter	1	2	3	3	4	4	6	4	4	4	5	4
		Duff	4	4	4	4	5	5	5	4	4	5	5	6
	Flame length (ft)	Moderate	2	1	2	2	2	3	1	2	2	3	3	4
		Severe	3	2	3	3	4	4	2	3	3	4	5	6
	Torching index	Severe	201	266	17	26	27	27	350	271	9	8	4	5
	Crowning index	Severe	45	44	32	29	38	43	31	31	32	32	33	34
	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	Passive	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	28	35	18	143	134	99	40	49	30	165	163	114
		18–29.9 in	3	3	4	4	5	7	3	4	6	7	9	10
		30–36 in	0	0	0	0	1	1	0	0	0	1	1	1

Table 15b—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	8	10	11	11	11	6	8	11	12	12	13
		3–6 in	4	5	6	7	8	10	4	4	6	8	10	11
		6–12 in	3	4	6	8	11	12	3	4	7	10	13	15
		>12 in	0	1	3	6	10	15	0	1	3	7	11	16
		Litter	6	5	5	5	5	5	5	6	6	6	5	5
		Duff	5	6	6	7	8	9	5	6	6	7	8	9
	Flame length (ft)	Moderate	2	3	3	4	5	5	2	3	4	4	5	5
		Severe	4	4	5	6	7	7	3	4	6	7	7	8
	Torching index	Severe	125	161	125	0	0	0	53	47	108	0	0	0
	Crowning index	Severe	21	21	22	23	24	25	18	19	20	21	23	23
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Passive	Passive	Surface	Surface	Surface	Passive	Passive	Passive
		Severe	Surface	Surface	Surface	Passive	Passive	Passive	Cond.	Cond.	Surface	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	39	53	53	131	135	99	50	68	73	120	117	90
		18–29.9 in	2	4	8	11	12	13	3	5	9	12	13	13
		30–36 in	0	0	0	1	1	2	0	0	0	1	1	2
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	2	5	8	10	11	11	2	6	10	11	12	12
		3–6 in	1	2	4	5	7	8	1	2	4	6	8	10
		6–12 in	1	2	5	7	9	11	1	2	5	8	11	14
		>12 in	0	1	3	6	10	15	0	1	3	7	11	16
		Litter	5	5	5	5	5	5	5	6	6	6	5	5
		Duff	5	5	6	6	7	8	5	5	6	7	7	8
	Flame length (ft)	Moderate	1	2	3	4	4	5	1	2	3	4	5	5
		Severe	2	3	4	6	6	7	2	3	5	6	7	8
	Torching index	Severe	249	204	154	0	0	0	127	67	122	0	0	0
	Crowning index	Severe	21	21	22	23	24	26	18	19	20	21	23	24
	Type of fire	Moderate	Surface	Surface	Surface	Passive	Passive	Passive	Surface	Surface	Surface	Passive	Passive	Passive
		Severe	Surface	Surface	Surface	Passive	Passive	Passive	Cond.	Cond.	Cond.	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	39	54	54	138	144	105	50	68	73	125	123	93
		18–29.9 in	2	4	8	11	12	13	3	5	9	12	13	13
		30–36 in	0	0	0	1	1	2	0	0	0	1	1	1

Table 15b—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	5	7	9	10	11	0	6	8	10	11	11
		3–6 in	1	3	4	6	7	8	1	4	6	7	9	10
		6–12 in	2	5	8	10	12	13	2	6	9	12	13	15
		>12 in	0	2	4	8	11	14	0	2	5	8	11	15
		Litter	1	5	5	5	5	5	2	5	5	6	5	5
		Duff	4	4	5	5	6	7	4	4	5	5	6	7
	Flame length (ft)	Moderate	1	2	3	4	5	5	1	2	4	4	5	5
		Severe	2	3	5	6	7	7	2	4	5	6	7	8
	Torching index	Severe	282	183	0	0	0	0	283	167	0	0	0	0
	Crowning index	Severe	24	23	23	24	25	27	21	21	22	22	24	25
	Type of fire	Moderate	Surface	Surface	Passive	Passive	Passive	Passive	Surface	Surface	Passive	Passive	Passive	Passive
		Severe	Surface	Surface	Passive	Passive	Passive	Passive	Surface	Surface	Passive	Passive	Passive	Passive
	Hard snags (stems/ac)	0–17.9 in	60	66	51	163	167	116	73	70	60	161	163	116
		18–29.9 in	3	5	8	10	11	12	3	5	8	11	12	12
		30–36 in	0	0	0	1	1	1	0	0	0	1	1	1

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

Table 15c—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	3,158	2,221	1,512	1,053	742	537	321	292	248	213	185	163
	Quadratic mean diameter (in)	4.1	5.0	6.1	7.3	8.8	10.3	4.1	12.7	14.0	15.3	16.5	17.7
	Total volume (ft^3)	8,386	9,128	9,715	10,264	10,791	11,282	7,963	8,400	9,169	9,835	10,441	10,970
	Merchantable volume (ft^3)	7,266	8,131	8,628	9,152	9,636	10,349	7,169	7,726	8,470	9,126	9,739	10,336
	Basal area (ft^2)	289	303	308	309	310	310	252	258	267	272	276	278
	Stand density index	754	731	685	641	599	562	430	430	428	422	415	407
	Canopy closure (percent)	94	95	95	95	94	94	89	89	89	89	89	89
	Crown competition factor	277	296	296	292	289	282	219	221	224	224	225	222
	Canopy base height (ft)	3	3	4	4	5	5	4	5	14	21	24	28
	Canopy bulk density (kg/m^3)	0.17	0.25	0.22	0.14	0.12	0.12	0.13	0.12	0.12	0.11	0.10	0.10

Table 15c—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	3,158	50	623	613	464	361	288	100	621	606	451	330	250
	Quadratic mean diameter (in)	4.1	21.1	6.3	6.8	8.3	9.9	11.5	18.3	7.7	8.1	9.7	11.6	13.5
	Total volume (ft^3)	8,386	4,602	5,026	5,863	6,680	7,473	8,249	6,595	7,103	8,033	8,898	9,688	10,403
	Merchantable volume (ft^3)	7,266	4,405	4,812	5,567	6,338	7,017	7,587	6,290	6,757	7,637	8,473	9,214	9,885
	Basal area (ft^2)	289	122	137	156	174	191	207	183	199	217	230	241	250
	Stand density index	754	166	300	333	343	353	360	264	406	433	428	417	406
	Canopy cover (percent)	94	59	63	69	73	76	78	76	78	81	82	83	84
	Crown competition factor	277	90	100	117	130	143	153	143	152	166	173	178	182
	Canopy base height (ft)	3	33	34	3	5	6	7	32	34	3	4	5	6
	Canopy bulk density (kg/m^3)	3.00	0.05	0.05	0.07	0.08	0.05	0.05	0.09	0.08	0.08	0.08	0.08	0.07
Pile and burn	Trees per acre	3,158	50	659	648	490	380	302	100	668	652	486	353	266
	Quadratic mean diameter (in)	4.1	21.1	6.2	6.7	8.1	9.6	11.3	18.3	7.4	7.8	9.3	11.2	13.2
	Total volume (ft^3)	8,386	4,602	5,027	5,864	6,681	7,489	8,277	6,595	7,105	8,061	8,935	9,735	10,463
	Merchantable volume (ft^3)	7,266	4,405	4,813	5,570	6,318	6,989	7,553	6,290	6,759	7,693	8,516	9,269	9,985
	Basal area (ft^2)	289	122	137	157	174	192	209	183	199	218	231	242	251
	Stand density index	754	166	303	337	348	358	365	264	411	440	435	424	413
	Canopy cover (percent)	94	59	63	69	73	76	79	76	78	81	82	83	84
	Crown competition factor	277	90	100	118	131	144	154	143	152	166	174	179	183
	Canopy base height (ft)	3	33	34	3	5	6	7	32	34	3	4	5	5
	Canopy bulk density (kg/m^3)	3.00	0.05	0.05	0.07	0.08	0.06	0.05	0.09	0.08	0.08	0.08	0.08	0.07
Prescribed fire	Trees per acre	3,158	50	695	684	519	403	319	100	704	689	510	373	282
	Quadratic mean diameter (in)	4.1	21.1	5.9	6.4	7.7	9.3	10.9	18.3	7.0	7.4	8.9	10.7	12.6
	Total volume (ft^3)	8,386	4,374	4,788	5,611	6,431	7,227	8,022	6,134	6,719	7,680	8,568	9,376	10,115
	Merchantable volume (ft^3)	7,266	4,374	4,591	5,327	6,080	6,715	7,286	5,812	6,405	7,325	8,164	8,904	9,602
	Basal area (ft^2)	289	122	130	151	169	188	206	183	188	208	222	234	244
	Stand density index	754	166	295	330	344	356	365	264	397	428	425	417	408
	Canopy cover (percent)	94	59	61	68	72	76	78	76	76	80	81	82	83
	Crown competition factor	277	90	95	114	128	142	153	143	143	159	167	173	178
	Canopy base height (ft)	3	34	34	3	5	6	7	32	33	3	4	4	5
	Canopy bulk density (kg/m^3)	0.17	0.05	0.05	0.08	0.09	0.06	0.04	0.08	0.08	0.08	0.07	0.07	0.07

Table 15c—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	3,158	200	514	489	375	274	210	300	477	441	349	271	219
	Quadratic mean diameter (in)	4.1	15.1	9.7	10.1	11.8	13.9	16.0	12.9	10.4	11.0	12.5	14.2	15.9
	Total volume (ft^3)	8,386	8,237	8,716	9,558	10,347	11,077	11,732	8,709	9,153	9,938	10,676	11,338	11,915
	Merchantable volume (ft^3)	7,266	7,717	8,192	9,015	9,774	10,524	11,157	7,711	8,392	9,199	9,975	10,618	11,209
	Basal area (ft^2)	289	250	262	274	282	288	293	270	281	289	296	300	302
	Stand density index	754	389	488	500	485	464	446	449	507	511	497	478	461
	Canopy cover (percent)	94	88	88	89	89	89	89	91	91	91	91	91	91
	Crown competition factor	277	210	214	220	223	223	222	239	241	243	243	245	241
	Canopy base height (ft)	3	23	31	34	4	5	5	9	11	32	4	5	7
	Canopy bulk density (kg/m^3)	3.00	0.14	0.13	0.13	0.12	0.11	0.10	0.17	0.15	0.14	0.13	0.12	0.11
Pile and burn	Trees per acre	3,158	200	547	522	399	290	220	300	498	461	364	280	225
	Quadratic mean diameter (in)	4.1	15.1	9.4	9.8	11.4	13.5	15.6	12.9	10.2	10.7	12.2	14.0	15.7
	Total volume (ft^3)	8,386	8,237	8,718	9,565	10,358	11,096	11,761	8,709	9,155	9,941	10,680	11,328	11,912
	Merchantable volume (ft^3)	7,266	7,717	8,194	9,059	9,827	10,570	11,227	7,711	8,393	9,195	9,957	10,623	11,232
	Basal area (ft^2)	289	250	263	274	283	289	294	270	281	289	296	299	302
	Stand density index	754	389	494	507	492	470	451	449	512	516	501	481	463
	Canopy cover (percent)	94	88	88	89	89	89	89	91	91	91	91	91	91
	Crown competition factor	277	210	215	220	223	224	223	239	241	243	243	244	241
	Canopy base height (ft)	3	23	31	34	4	5	5	9	11	32	4	5	6
	Canopy bulk density (kg/m^3)	3.00	0.14	0.13	0.13	0.12	0.11	0.10	0.17	0.15	0.14	0.13	0.12	0.11
Prescribed fire	Trees per acre	3,158	200	642	619	462	328	244	300	640	611	461	334	252
	Quadratic mean diameter (in)	4.1	15.1	8.3	8.7	10.3	12.4	14.6	12.9	8.5	9.0	10.5	12.5	14.5
	Total volume (ft^3)	8,386	7,632	8,137	9,041	9,890	10,663	11,351	7,945	8,439	9,327	10,159	10,895	11,551
	Merchantable volume (ft^3)	7,266	7,632	7,655	8,564	9,378	10,157	10,847	7,945	7,840	8,726	9,536	10,287	10,948
	Basal area (ft^2)	289	250	243	258	268	276	282	270	255	268	278	284	289
	Stand density index	754	389	478	498	486	464	446	449	497	513	499	477	458
	Canopy cover (percent)	94	88	86	87	88	88	88	91	88	89	89	90	90
	Crown competition factor	277	210	196	206	211	212	213	239	212	220	225	227	226
	Canopy base height (ft)	3	23	30	3	4	5	5	22	30	3	4	5	5
	Canopy bulk density (kg/m^3)	3.00	0.11	0.12	0.11	0.11	0.11	0.10	0.13	0.13	0.13	0.12	0.11	0.10

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

Table 15d—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	48	8	47	10	5			9	56	8	44				
	10	10	87	12	13					10	90	12	10				
	20	12	76	10	24					12	51	10	49				
	30	12	85	13	15					12	80	10	20				
	40	12	58	13	42					12	96	13	4				
	50	13	65	12	35					12	75	13	25				

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	12	80	10	20					10	61	12	39				
	10	10	99	12	1					10	97	9	2	8	1		
	20	10	81	9	13	8	6			10	96	12	4				
	30	10	81	9	13	8	6			10	83	12	17				
	40	10	96	9	3	8	1			10	66	12	34				
	`50	10	88	12	12					12	54	10	46				
Pile and burn	1	10	58	9	27	8	13	2	1	9	42	10	35	8	24		
	10	9	59	8	28	10	13			9	46	10	27	8	26		
	20	9	50	10	27	8	23			10	62	9	25	8	14		
	30	10	46	9	38	8	17			10	98	9	1	8	1		
	40	10	70	9	21	8	9			10	79	12	21				
	50	10	100							10	56	12	44				
Prescribed fire	1	9	57	8	28	2	16			9	64	8	36				
	10	9	68	8	32					9	50	8	28	10	22		
	20	9	52	10	24	8	24			10	68	9	21	8	11		
	30	10	49	9	35	8	15			10	93	12	7				
	40	10	77	9	16	8	6			10	74	12	26				
	50	10	95	12	5					10	53	12	47				

Table 15d—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	94	9	4	8	2			10	65	9	19	8	16		
	10	10	98	12	2					10	96	12	4				
	20	10	68	12	32					10	56	12	44				
	30	12	61	10	39					12	78	10	22				
	40	12	87	10	13					12	90	13	10				
	50	12	88	13	12					12	65	13	35				
Pile and burn	1	9	54	8	38	10	8			9	54	8	46				
	10	10	54	9	27	8	19			10	65	9	19	8	16		
	20	10	89	12	11					10	75	12	25				
	30	10	54	12	46					12	64	10	36				
	40	12	76	10	24					12	100						
	50	12	96	13	4					12	73	13	27				
Prescribed fire	1	9	60	8	40					9	57	8	43				
	10	10	66	9	20	8	14			10	94	9	4	8	2		
	20	10	80	12	20					10	62	12	38				
	30	12	54	10	46					12	71	10	29				
	40	12	79	10	21					12	100						
	50	12	95	13	5					12	78	13	22				

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

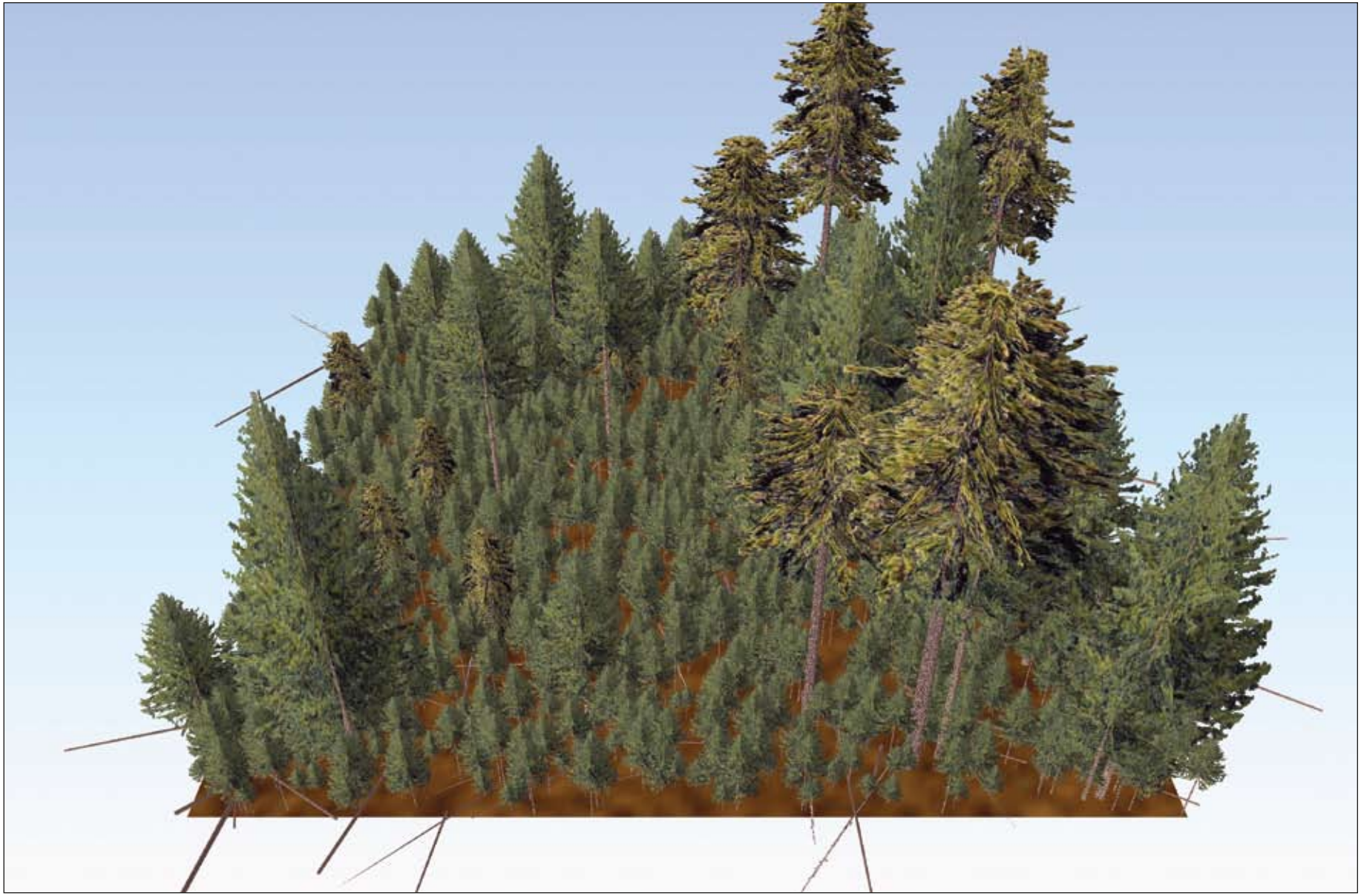
Table 15e—FVS fuel model selection

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	20	85	3	5	8	15	50	100
Moderate—75th percentile	11	69	6	8	11	18	125	150

Table 15f—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).

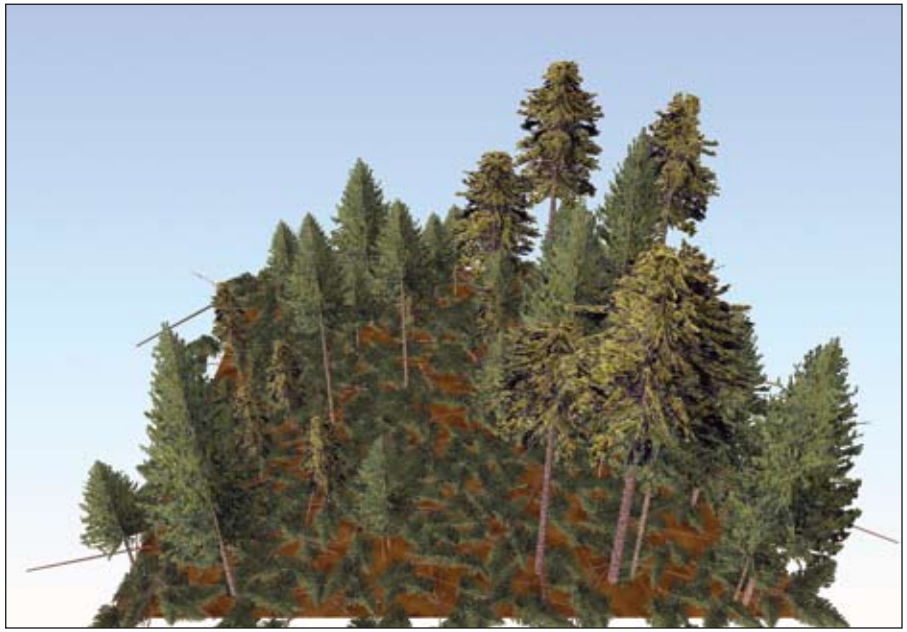


Initial stand conditions

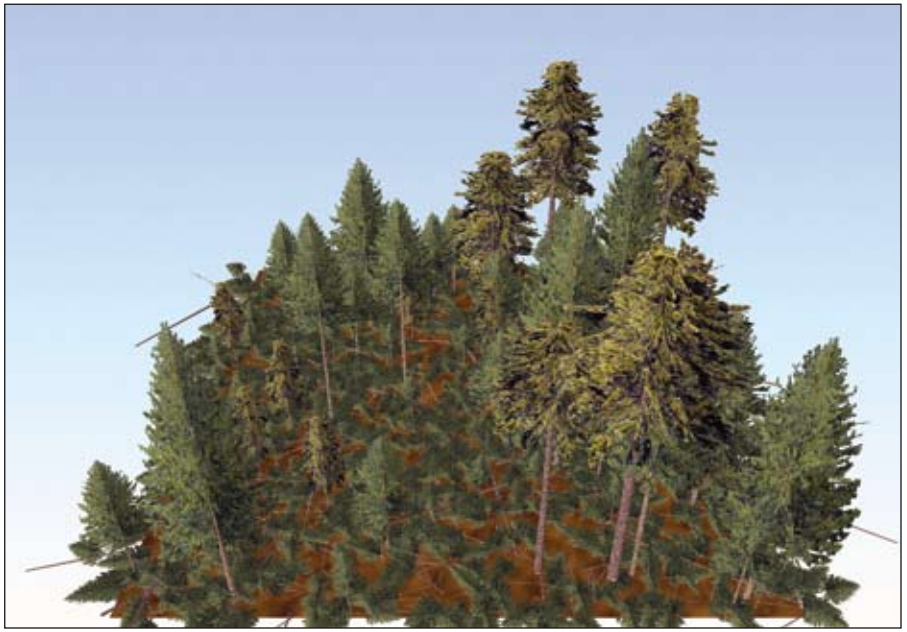
Site: Elevation = 5,800 ft, slope = 25 percent, aspect = 135°.

Species (based on trees per acre): Douglas-fir (*Pseudotsuga menziesii*) = 62 percent, grand fir (*Abies grandis*) =33 percent, ponderosa pine (*Pinus ponderosa*) = 5 percent.

Stand attributes: Stem density = 2,144 tpa, basal area = 181 ft^2/ac, top height = 67 ft, stand density index = 479, quadratic mean diameter = 3.9 in, crown competition factor = 242, canopy cover = 91 percent.

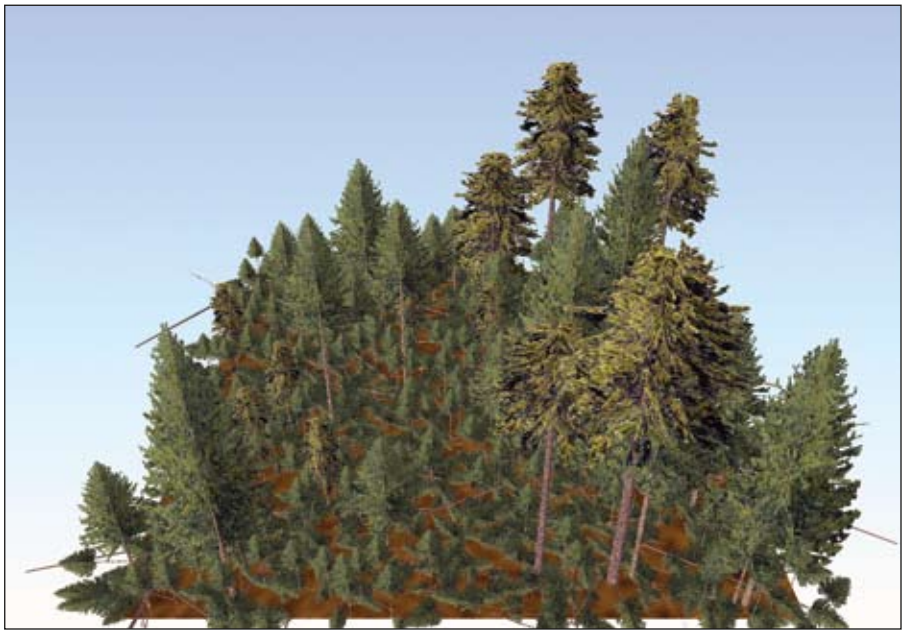


Thin from below to 50 tpa, 18-in d.b.h. limit



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 2,144 trees per acre (tpa) composed of Douglas-fir and grand fir understory with a low-density ponderosa pine overstory. Canopy bulk density is 0.42 kg/m^3 (0.0262 lb/ft^3), and canopy base height is 3 ft, so ladder fuels are not sufficient to enable crown fire initiation. Canopy fuels are sufficient to enable crown fire spread for severe fire weather. Woody fuel loading is 11 tons/ac, and litter and duff loading is 12 tons/ac. Predicted flame lengths are low, and potential basal area mortality is about 40 percent for severe and moderate fire weather. With no action, canopy base height increases and canopy bulk density decreases slightly as trees grow and the stand self-thins, but surface fuels accumulate rapidly causing higher flame lengths, so crown fire potential increases. In 10 years, predicted fire type is active crown fire for severe fire weather and remains so for the duration of the 50-year projection.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment creates many snags and has little effect on crown fire potential because canopy base height does not increase and canopy bulk density is not reduced enough to prevent conditional crown fire for severe fire weather. All thinning treatments increase canopy base height to a similar height, but the greater the thinning, the greater is the reduction in canopy bulk density. The 300 tpa treatment does not reduce canopy bulk density sufficiently enough to prevent conditional crown fire for severe fire weather. In all treatments, extensive activity fuels increase potential flame lengths to at least 5 ft for moderate and severe fire weather, so passive crown fire remains likely and potential basal area mortality is higher than initial conditions. Surface fuel treatments are necessary to further decrease crown fire potential and flame lengths. The pile and burn, and to a greater extent, the prescribed fire treatments, reduce surface fuels, which decreases potential flame lengths and basal area mortality. However, even after surface fuel treatments are applied, flame lengths and potential basal area mortality remain greater than initial conditions, because fire behavior is predicted by using primarily fuel model 2, suggesting grass fuels greatly influence fire behavior following surface fuel treatments. These results should be interpreted cautiously because grass fuels are not tracked in FFE.

Silvicultural and surface fuel treatments—long-term effects

In the prescribed fire only treatment, surface fuel loading increases from fallen snags in 10 years and then declines again as fuels decompose, but flame lengths remain higher than initial conditions for the 50-year projection. Canopy base height increases as trees grow and the stand self-thins, but canopy bulk density remains high enough that conditional crown fire is predicted for the entire 50-year projection. In the thinned stands without surface fuel treatment, surface fuels decompose rapidly and passive crown fire becomes unlikely in 10 years. Regeneration causes a decrease in canopy base height in all thinned stands in 20 years; this increases the potential for passive crown fire in stands without surface fuel treatment or with prescribed fire, but crown fire potential declines again in 30 years. The thinned stands with a pile and burn surface fuel treatment can sustain only a surface fire and have the lowest flame lengths for the 50-year projection.

Table 16a—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	17	16	15	13
		3–6 in	4	0	10	10	9	8
		6–12 in	4	2	3	3	3	4
		>12 in	0	0	0	0	0	0
		Litter	2	1	6	6	6	5
		Duff	10	7	9	9	10	10
	Flame length (ft)	Moderate	1	1	6	5	5	5
		Severe	2	2	8	8	7	7
	Torching index	Severe	51	49	14	14	18	23
	Crowning index	Severe	8	18	51	42	25	18
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Conditional	Conditional	Passive	Passive	Passive	Conditional
	Potential basal area mortality (%)	Moderate	39	24	24	27	30	33
		Severe	43	25	90	92	85	49
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			4	4	4	3
		3–6 in			3	3	3	2
		6–12 in			1	1	1	1
		>12 in			0	0	0	0
		Litter			6	5	5	5
		Duff			8	8	9	9
	Flame length (ft)	Moderate			3	3	2	2
		Severe			5	4	4	3
	Torching index	Severe			40	46	73	96
	Crowning index	Severe			51	42	25	18
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Conditional
	Potential basal area mortality (%)	Moderate			9	11	16	19
		Severe			23	24	23	24
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			3	3	2	2
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			0	0	0	0
		Duff			6	7	7	7
	Flame length (ft)	Moderate			4	3	3	3
		Severe			6	6	6	6
	Torching index	Severe			48	48	49	52
	Crowning index	Severe			72	69	63	58
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			5	6	6	7
		Severe			18	18	19	21

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

Table 16b—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	7	12	14	14	14	1	9	8	8	8	8
		3–6 in	4	4	5	7	9	12	0	5	5	6	6	7
		6–12 in	4	3	3	3	4	5	2	2	2	2	3	3
		>12 in	0	0	1	1	3	4	0	0	1	1	2	3
		Litter	2	6	7	7	7	7	1	3	3	4	4	4
		Duff	10	11	11	12	13	14	7	7	8	8	9	9
	Flame length (ft)	Moderate	1	2	3	4	5	5	1	2	2	2	3	3
		Severe	2	4	5	6	7	7	2	4	4	4	4	4
	Torching index	Severe	51	2	6	6	13	12	49	19	48	71	81	87
	Crowning index	Severe	8	8	8	8	9	10	18	18	16	16	16	17
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Cond.	Active	Active	Active	Active	Active	Cond.	Active	Cond.	Cond.	Cond.	Cond.
	Hard snags (stems/ac)	0–17.9 in	246	369	460	358	263	199	447	51	78	68	59	51
		18–29.9 in	1	2	4	5	6	6	1	2	2	3	3	4
		30–36 in	0	0	1	1	2	2	0	0	1	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	17	9	6	4	4	5	16	9	6	5	5	5
		3–6 in	10	9	9	8	8	8	10	9	8	8	8	8
		6–12 in	3	3	3	2	2	2	3	3	3	3	3	3
		>12 in	0	0	0	0	1	2	0	0	0	0	1	2
		Litter	6	2	2	2	3	3	6	2	2	3	3	3
		Duff	9	10	10	10	10	11	9	10	10	10	11	11
	Flame length (ft)	Moderate	6	3	2	2	2	2	5	3	2	2	2	2
		Severe	8	5	4	4	4	4	8	5	4	4	4	4
	Torching index	Severe	14	55	4	22	37	42	14	45	5	23	38	42
	Crowning index	Severe	51	47	46	45	45	40	42	41	39	37	36	35
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Passive	Surface	Surface	Surface	Passive	Surface	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	2	6	5	54	51	39	5	10	10	59	58	46
		18–29.9 in	0	1	1	1	2	3	0	1	1	2	2	4
		30–36 in	0	0	0	0	1	1	0	0	0	1	1	1

Table 16b—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	4	3	3	3	4	5	4	3	3	3	4	5
		3–6 in	3	3	3	3	3	4	3	3	3	3	3	4
		6–12 in	1	1	1	1	1	1	1	1	1	1	1	1
		>12 in	0	0	0	0	1	2	0	0	0	0	1	2
		Litter	6	2	2	2	3	3	5	2	2	3	3	3
		Duff	8	8	9	9	9	9	8	9	9	9	9	10
	Flame length (ft)	Moderate	3	2	1	1	2	2	3	2	1	2	2	2
		Severe	5	4	2	2	3	3	4	3	2	2	3	3
	Torching index	Severe	40	108	30	51	61	59	46	131	33	52	62	59
	Crowning index	Severe	51	47	46	45	45	39	42	41	39	37	36	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	2	6	6	59	56	43	5	10	10	64	63	49
		18–29.9 in	0	1	1	1	2	3	0	1	1	2	2	4
		30–36 in	0	0	0	0	1	1	0	0	0	1	1	1
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	2	2	2	3	3	0	2	2	2	3	3
		3–6 in	3	3	3	3	3	3	3	3	3	3	3	4
		6–12 in	2	3	3	3	3	3	2	3	3	3	3	3
		>12 in	0	0	1	1	1	1	0	0	1	1	1	1
		Litter	0	1	1	2	2	2	5	1	1	2	2	2
		Duff	6	6	7	7	7	7	8	7	7	7	7	7
	Flame length (ft)	Moderate	4	3	3	2	2	2	3	3	3	2	2	2
		Severe	6	6	5	3	3	3	6	5	4	3	3	3
	Torching index	Severe	48	71	11	34	59	58	48	72	12	35	58	57
	Crowning index	Severe	72	65	49	48	50	44	69	63	48	48	48	44
	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	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	19	16	7	55	53	41	31	14	6	56	53	41
		18–29.9 in	1	1	1	1	1	2	1	1	1	1	2	2
		30–36 in	0	0	0	0	1	1	0	0	0	0	1	1

Table 16b—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	15	9	6	5	6	6	13	8	6	6	6	7
		3–6 in	9	8	8	8	8	8	8	8	8	8	8	9
		6–12 in	3	3	3	3	3	3	4	3	3	3	3	4
		>12 in	0	0	0	1	1	2	0	0	0	1	1	2
		Litter	6	2	3	3	3	3	5	3	3	4	4	4
		Duff	10	11	11	11	11	12	10	11	11	11	12	12
	Flame length (ft)	Moderate	5	3	2	2	2	3	5	3	2	2	3	3
		Severe	7	5	4	4	4	4	7	4	4	4	4	4
	Torching index	Severe	18	49	4	16	28	29	23	66	4	21	23	23
	Crowning index	Severe	25	27	28	27	27	27	18	22	23	22	22	22
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Passive	Passive	Surface	Surface	Conditional	Surface	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	11	20	21	70	69	56	19	32	34	81	79	65
		18–29.9 in	0	1	1	2	3	4	0	1	2	2	3	4
		30–36 in	0	0	0	1	1	1	0	0	0	1	1	2
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	4	3	3	4	5	6	3	3	4	5	6	7
		3–6 in	3	3	3	3	4	5	2	2	3	3	4	5
		6–12 in	1	1	1	1	1	2	1	1	1	1	1	2
		>12 in	0	0	0	1	1	2	0	0	0	1	1	2
		Litter	5	2	3	3	3	4	5	3	3	4	4	4
		Duff	9	9	10	10	10	10	9	9	10	10	10	11
	Flame length (ft)	Moderate	2	1	1	2	2	2	2	1	2	2	2	2
		Severe	4	2	2	3	3	3	3	2	2	3	3	4
	Torching index	Severe	73	167	34	40	47	50	96	202	33	45	39	42
	Crowning index	Severe	25	27	28	27	27	27	18	22	23	22	23	23
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface	Conditional	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	11	20	21	74	74	59	19	32	35	86	83	69
		18–29.9 in	0	1	1	2	3	4	0	1	2	2	3	4
		30–36 in	0	0	0	1	1	1	0	0	0	1	1	2

Table 16b—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	3	4	0	4	3	3	3	4
		3–6 in	2	4	4	4	4	4	2	4	4	4	4	5
		6–12 in	2	3	3	3	3	2	2	3	3	3	2	2
		>12 in	0	0	1	1	1	2	0	0	1	1	1	2
		Litter	0	1	2	2	2	3	0	1	2	2	2	3
		Duff	7	7	7	7	8	8	7	7	7	8	8	8
	Flame length (ft)	Moderate	3	3	2	2	2	2	3	3	2	2	2	2
		Severe	6	5	4	3	3	3	6	5	4	3	3	3
	Torching index	Severe	49	68	13	38	56	56	52	66	14	40	52	53
	Crowning index	Severe	63	59	49	48	47	41	58	57	49	49	44	39
	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	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	49	9	6	57	55	42	76	11	7	59	57	44
		18–29.9 in	1	1	1	1	2	3	1	1	1	1	2	3
		30–36 in	0	0	0	0	1	1	0	0	0	0	1	1

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

Table 16c—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	2,144	1,705	1,299	1,010	802	650	506	461	397	345	302	267
	Quadratic mean diameter (in)	3.9	4.7	5.6	6.5	7.5	8.4	3.9	7.2	8.3	9.3	10.3	11.3
	Total volume (ft^3)	3,633	4,316	4,910	5,489	6,056	6,601	3,120	3,415	4,014	4,584	5,142	5,691
	Merchantable volume (ft^3)	2,559	2,751	2,886	2,978	3,659	4,090	2,564	2,712	2,987	3,249	3,840	4,718
	Basal area (ft^2)	181	209	223	234	244	250	122	132	150	164	176	187
	Stand density index	479	515	514	509	501	492	262	274	295	309	319	326
	Canopy closure (percent)	91	93	94	94	94	94	73	75	79	81	83	84
	Crown competition factor	242	272	280	285	287	286	130	139	156	168	177	185
	Canopy base height (ft)	3	3	5	6	9	10	3	5	9	13	16	20
	Canopy bulk density (kg/m^3)	0.42	0.42	0.40	0.39	0.35	0.32	0.16	0.16	0.18	0.19	0.18	0.18

Table 16c—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	2,144	50	310	305	244	201	169	100	353	346	281	234	199
	Quadratic mean diameter (in)	3.9	17.9	7.7	8.3	9.9	11.6	13.3	13.0	7.4	8.1	9.6	11.1	12.6
	Total volume (ft^3)	3,633	2,923	3,179	3,706	4,287	4,919	5,577	2,990	3,260	3,838	4,460	5,115	5,780
	Merchantable volume (ft^3)	2,559	2,769	3,011	3,509	4,023	4,560	5,052	2,768	3,004	3,475	3,966	4,696	5,225
	Basal area (ft^2)	181	87	100	115	131	148	163	92	106	123	140	157	173
	Stand density index	479	127	203	227	241	255	267	151	219	246	262	277	289
	Canopy cover (percent)	91	49	54	59	64	68	71	53	58	64	68	72	75
	Crown competition factor	242	68	77	90	102	114	125	76	87	102	115	128	139
	Canopy base height (ft)	3	14	19	3	5	7	8	13	15	3	5	7	8
	Canopy bulk density (kg/m^3)	0.42	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07
Pile and burn	Trees per acre	2,144	50	336	331	264	217	183	100	379	372	302	250	211
	Quadratic mean diameter (in)	3.9	17.9	7.4	8.0	9.6	11.2	12.9	13.0	7.2	7.8	9.3	10.8	12.3
	Total volume (ft^3)	3,633	2,923	3,180	3,715	4,295	4,920	5,586	2,990	3,261	3,844	4,474	5,138	5,826
	Merchantable volume (ft^3)	2,559	2,769	3,012	3,512	4,034	4,534	5,027	2,768	3,004	3,488	3,991	4,703	5,267
	Basal area (ft^2)	181	87	100	116	132	149	165	92	106	124	141	159	175
	Stand density index	479	127	207	232	246	261	274	151	222	250	267	283	296
	Canopy cover (percent)	91	49	54	60	64	69	72	53	58	64	69	73	76
	Crown competition factor	242	68	77	91	103	116	127	76	87	103	117	130	142
	Canopy base height (ft)	3	14	19	3	5	7	8	13	15	3	5	7	8
	Canopy bulk density (kg/m^3)	0.42	0.04	0.04	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.06	0.06	0.07
Prescribed fire	Trees per acre	2,144	50	335	331	267	222	188	100	338	334	268	223	188
	Quadratic mean diameter (in)	3.9	17.9	6.6	7.1	8.5	10.1	11.7	13.0	6.7	7.2	8.6	10.2	11.8
	Total volume (ft^3)	3,633	2,574	2,753	3,120	3,548	4,075	4,697	2,601	2,786	3,166	3,602	4,146	4,774
	Merchantable volume (ft^3)	2,559	2,463	2,643	2,984	3,331	3,656	4,278	2,486	2,671	3,023	3,378	3,730	4,337
	Basal area (ft^2)	181	87	81	92	106	124	141	92	82	94	109	126	143
	Stand density index	479	127	174	193	208	226	243	151	177	197	211	229	246
	Canopy cover (percent)	91	49	45	50	56	61	66	53	46	51	57	62	66
	Crown competition factor	242	68	59	70	81	95	107	76	61	72	83	97	109
	Canopy base height (ft)	3	27	29	3	5	7	9	25	27	3	5	7	9
	Canopy bulk density (kg/m^3)	0.42	0.02	0.03	0.04	0.04	0.04	0.05	0.03	0.03	0.04	0.04	0.04	0.05

Table 16c—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	2,144	200	433	418	345	289	246	300	504	479	397	334	285
	Quadratic mean diameter (in)	3.9	9.6	7.0	7.7	9.1	10.5	11.9	8.2	6.8	7.5	8.8	10.1	11.3
	Total volume (ft^3)	3,633	3,112	3,405	4,053	4,732	5,456	6,152	3,227	3,535	4,203	4,933	5,643	6,344
	Merchantable volume (ft^3)	2,559	2,760	2,984	3,429	3,826	4,786	5,528	2,753	2,960	3,353	3,732	4,494	5,655
	Basal area (ft^2)	181	100	117	137	155	174	189	109	127	148	168	185	200
	Stand density index	479	187	246	278	296	313	323	217	272	304	324	339	349
	Canopy cover (percent)	91	60	65	71	75	78	80	65	70	76	79	82	84
	Crown competition factor	242	91	104	123	138	152	163	106	121	141	158	171	181
	Canopy base height (ft)	3	13	14	3	4	6	8	13	15	3	5	6	8
	Canopy bulk density (kg/m^3)	0.42	0.10	0.09	0.09	0.09	0.09	0.09	0.15	0.12	0.12	0.12	0.12	0.12
Pile and burn	Trees per acre	2,144	200	459	443	365	304	258	300	528	502	415	348	294
	Quadratic mean diameter (in)	3.9	9.6	6.8	7.5	8.9	10.2	11.6	8.2	6.7	7.4	8.6	9.9	11.2
	Total volume (ft^3)	3,633	3,112	3,406	4,040	4,731	5,446	6,153	3,227	3,536	4,211	4,935	5,655	6,340
	Merchantable volume (ft^3)	2,559	2,760	2,984	3,415	3,836	4,786	5,585	2,753	2,960	3,359	3,716	4,716	5,636
	Basal area (ft^2)	181	100	117	137	156	174	190	109	127	149	169	186	200
	Stand density index	479	187	249	281	300	316	328	217	275	308	328	343	352
	Canopy cover (percent)	91	60	65	71	75	78	80	65	70	76	80	82	84
	Crown competition factor	242	91	105	123	139	152	163	106	122	142	159	172	181
	Canopy base height (ft)	3	13	14	3	4	6	8	13	15	3	5	6	8
	Canopy bulk density (kg/m^3)	0.42	0.10	0.09	0.09	0.09	0.09	0.09	0.15	0.12	0.12	0.12	0.12	0.12
Prescribed fire	Trees per acre	2,144	200	343	339	273	225	190	300	355	350	282	234	197
	Quadratic mean diameter (in)	3.9	9.6	6.8	7.3	8.7	10.3	11.9	8.2	6.8	7.3	8.8	10.3	12.0
	Total volume (ft^3)	3,633	2,650	2,847	3,255	3,724	4,296	4,934	2,702	2,913	3,353	3,858	4,435	5,094
	Merchantable volume (ft^3)	2,559	2,527	2,719	3,099	3,491	3,873	4,426	2,562	2,761	3,172	3,589	3,984	4,581
	Basal area (ft^2)	181	100	85	98	113	131	148	109	89	103	118	136	154
	Stand density index	479	187	183	203	218	237	253	217	190	213	229	247	263
	Canopy cover (percent)	91	60	47	53	58	63	68	65	49	55	60	65	69
	Crown competition factor	242	91	64	75	87	101	113	106	68	80	93	106	119
	Canopy base height (ft)	3	22	24	3	5	7	8	20	21	3	5	7	8
	Canopy bulk density (kg/m^3)	0.42	0.03	0.03	0.04	0.04	0.04	0.05	0.03	0.03	0.04	0.04	0.05	0.06

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

Table 16d—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*		*Percent*		
None	1	8	70	9	20	10	10			8	66	9	34				
	10	10	84	8	12	9	4			10	85	8	10	9	5		
	20	10	73	12	27					10	83	8	12	9	5		
	30	12	52	10	48					10	88	8	9	9	3		
	40	12	70	10	30					10	99	8	1				
	50	12	87	10	13					10	91	12	9				

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*		*Percent*
None	1	12	89	10	11					12	84	10	16				
	10	10	94	12	6					10	94	12	6				
	20	10	69	8	16	9	14	2	1	10	72	8	16	9	12		
	30	10	54	8	24	9	22			10	60	8	23	9	17		
	40	10	55	8	23	9	22			10	64	8	20	9	16		
	`50	10	65	9	18	8	17			10	76	8	13	9	11		
Pile and burn	1	10	55	2	24	8	12	9	10	10	51	8	18	2	17	9	14
	10	8	37	9	31	2	30	10	2	8	49	9	38	2	9	10	4
	20	8	52	9	46	2	2	10	1	8	54	9	41	10	5		
	30	8	48	9	45	10	7			8	49	9	38	10	13		
	40	9	40	8	40	10	19			8	40	9	32	10	28		
	50	10	35	9	34	8	31			10	46	8	30	9	25		
Prescribed fire	1	2	96	8	2	9	2			2	92	8	5	9	4		
	10	2	77	8	13	9	11			2	72	8	15	9	13		
	20	2	49	8	27	9	24			2	44	8	30	9	25	10	1
	30	8	39	9	37	2	21	10	3	8	41	9	38	2	17	10	4
	40	9	46	8	43	10	12			9	44	8	42	10	13		
	50	9	42	8	35	10	24			9	40	8	34	10	26		

Table 16d—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		Percent
None	1	12	72	10	28					12	58	10	42				
	10	10	96	12	4					10	99	12	1				
	20	10	77	8	14	9	9			10	78	8	14	9	7		
	30	10	71	8	18	9	11			10	79	8	14	9	7		
	40	10	80	8	12	9	7			10	93	8	5	9	2		
	50	10	97	8	2	9	1			10	92	12	8				
Pile and burn	1	10	44	8	33	9	22	2	1	8	40	10	36	9	23		
	10	8	57	9	36	10	7			8	59	9	32	10	9		
	20	8	54	9	33	10	12			8	53	9	28	10	19		
	30	8	47	9	28	10	25			8	43	10	35	9	21		
	40	10	43	8	36	9	21			10	57	8	29	9	14		
	50	10	64	8	23	9	13			10	81	8	13	9	6		
Prescribed fire	1	2	84	8	8	9	7			2	76	8	13	9	11		
	10	2	57	8	18	9	15	10	10	2	42	10	21	8	20	9	17
	20	2	34	8	32	9	27	10	7	8	35	9	30	2	21	10	14
	30	8	43	9	39	10	9	2	8	8	44	9	40	10	15		
	40	9	42	8	41	10	18			9	38	8	38	10	24		
	50	9	37	8	32	10	31			10	39	9	33	8	29		

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

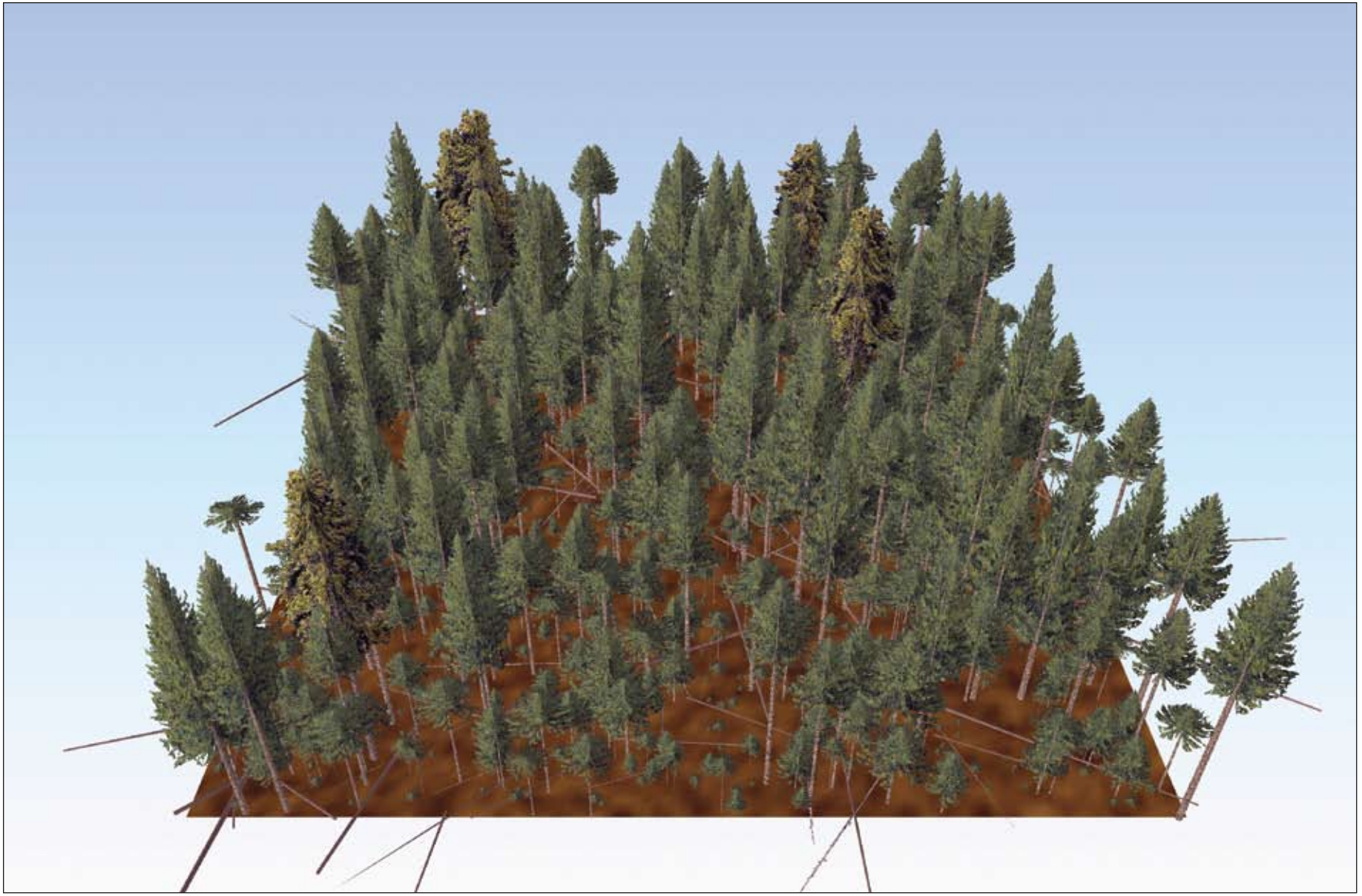
Table 16e—FVS fuel model selection

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	20	85	3	5	10	15	50	100
Moderate—75th percentile	11	69	6	8	15	18	125	150

Table 16f—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).

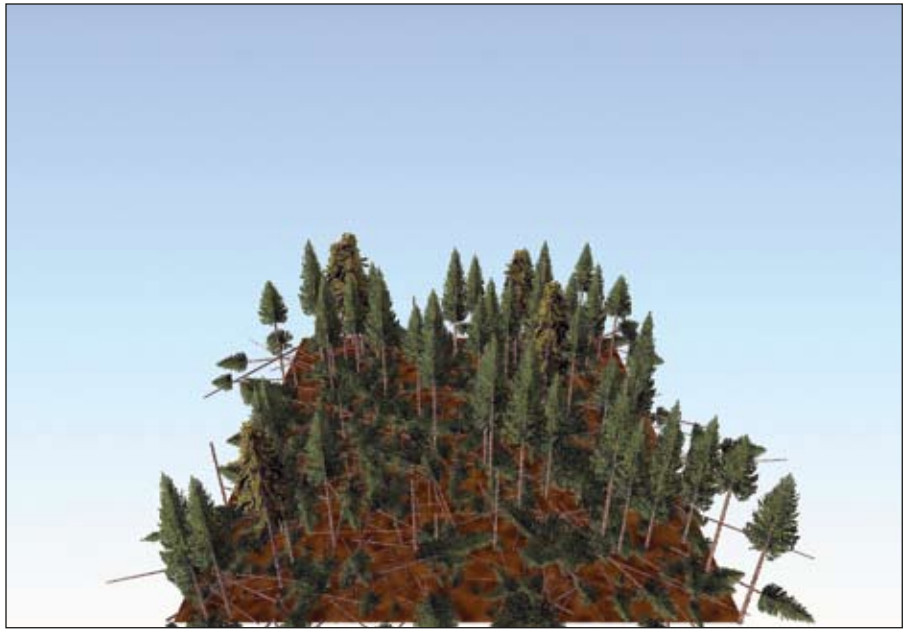


Initial stand conditions

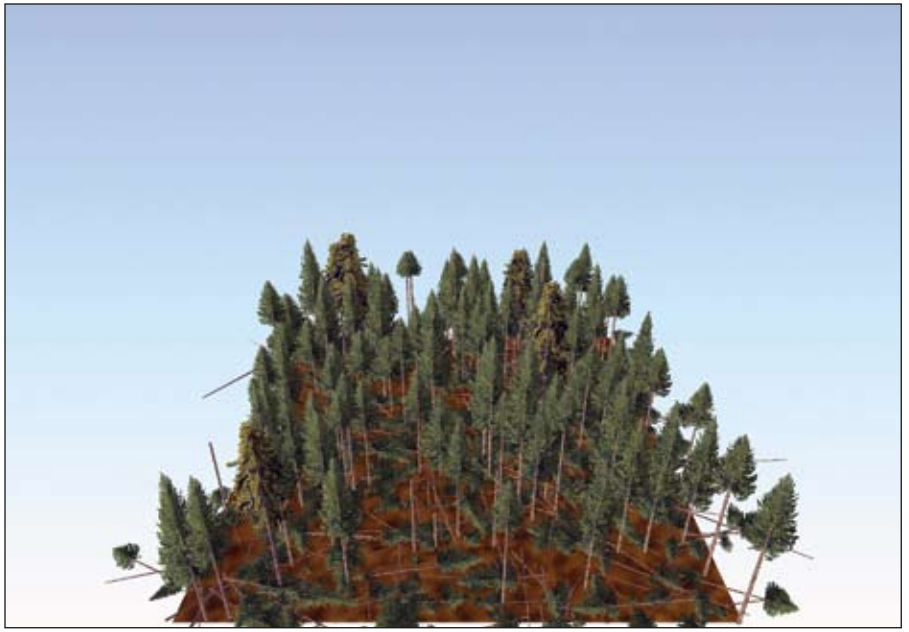
Site: Elevation = 5,100 ft, slope = 10 percent, aspect = 180°.

Species (based on trees per acre): Hardwoods = 56 percent, white fir (*Abies concolor*) = 43 percent, ponderosa pine (*Pinus ponderosa*) = 1 percent.

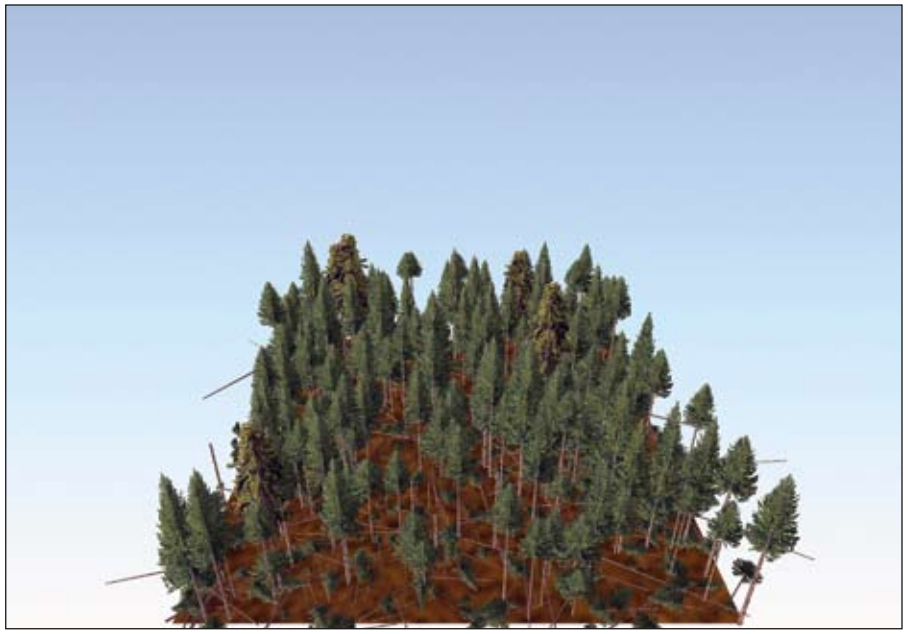
Stand attributes: Stem density = 1,427 tpa, basal area = 272 ft^2/ac, top height = 85 ft, stand density index = 614, quadratic mean diameter = 5.9 in, crown competition factor = 169, canopy cover = 82 percent.



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 1,427 trees per acre (tpa) composed primarily of white fir and hardwoods with a low-density ponderosa pine overstory. Canopy bulk density is 0.23 kg/m^3 (0.0144 lb/ft^3), and canopy base height is 6 ft, so ladder fuels and canopy fuels are not sufficient to enable crown fire initiation or spread. Woody fuel loading is 14 tons/ac and litter and duff loading is 20 tons/ac. Potential flame lengths are less than 2 ft and potential basal area mortality is about 35 percent for moderate and severe fire weather. For the 50-year projection, canopy base height increases as the trees grow, and canopy bulk density declines as the stand self-thins, but surface fuels accumulate rapidly contributing to higher flame lengths. In 20 years, predicted flame lengths are 7 ft and fire type is passive crown fire for severe fire weather. Surface fire is predicted again at 40 years owing to higher canopy base height, but predicted flame lengths are 6 and 8 ft for moderate and severe fire weather, respectively.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment increases canopy base height and decreases canopy bulk density and surface fuel loading, which reduces crown fire potential and flame lengths, but many snags are created, contributing to high surface fuel loading and increased crown fire potential in 10 years. The low density (50 and 100 tpa) thinning treatments create similar stand structures; both raise canopy base height and reduce canopy bulk density. The high-density treatments (200 and 300 tpa) also raise canopy base height but have little effect on canopy bulk density. All thinning treatments increase surface fuel loading; the greater the thinning the greater the surface fuel loading, so thinning without surface fuel treatment increases potential flame lengths and basal area mortality despite the changes in canopy base height. Surface fuel treatments are critical to reducing flame lengths and crown fire potential in this stand. The pile and burn treatment reduces surface fuels, but the lower density treatments still have higher surface fuel loadings and potential flame lengths than the initial conditions. In the higher density treatments, the pile and burn treatment decreases surface fuels and potential flame lengths to below that of the initial conditions. Prescribed fire reduces all size classes of surface fuels more than the pile and burn, but fuel model selection is not sensitive to this difference in surface fuel loading, so flame lengths and potential mortality are similar for the surface fuel treatment options.

Silvicultural and surface fuel treatments—long-term effects

Regeneration in the more open stands (50 and 100 tpa) causes canopy base height to decrease and crown fire potential to increase in 30 or 40 years, but passive crown fire is predicted only in the 50 tpa treatment with no surface fuel treatment because of higher flame lengths from residual activity fuels. Surface fire is the predicted fire type for the 50-year trajectory in all other treatments, but without further treatment, surface fuels accumulate and potential flame lengths increase over time.

Table 17a—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	23	18	12	9
		3–6 in	5	1	8	9	9	8
		6–12 in	5	2	5	6	6	5
		>12 in	0	0	0	0	0	0
		Litter	4	2	1	1	2	3
		Duff	16	11	15	19	19	18
	Flame length (ft)	Moderate	1	1	6	5	3	2
		Severe	2	1	8	6	5	3
	Torching index	Severe	125	456	24	36	51	89
	Crowning index	Severe	14	18	30	18	15	14
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	34	26	19	19	27	30
		Severe	35	26	96	93	49	37
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			6	4	3	2
		3–6 in			2	3	3	2
		6–12 in			1	2	2	2
		>12 in			0	0	0	0
		Litter			1	1	2	3
		Duff			13	17	17	16
	Flame length (ft)	Moderate			2	1	1	1
		Severe			2	2	1	1
	Torching index	Severe			218	410	687	827
	Crowning index	Severe			30	18	15	14
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			13	18	26	30
		Severe			13	18	26	30
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			2	2	2	2
		6–12 in			3	4	3	3
		>12 in			0	0	0	0
		Litter			1	1	2	2
		Duff			10	13	13	12
	Flame length (ft)	Moderate			1	1	2	1
		Severe			1	1	2	1
	Torching index	Severe			494	521	358	651
	Crowning index	Severe			32	21	18	18
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			12	16	22	24
		Severe			12	16	22	24

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

Table 17b—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	15	31	42	46	45	1	16	19	21	24	27
		3–6 in	5	5	7	10	12	14	1	8	7	7	8	8
		6–12 in	5	5	8	12	17	21	2	11	12	12	13	14
		>12 in	0	1	2	4	6	9	0	2	4	6	6	8
		Litter	4	4	4	4	3	3	2	2	3	3	3	3
		Duff	16	16	16	17	17	17	11	11	11	11	12	12
	Flame length (ft)	Moderate	1	3	5	6	6	6	1	4	5	5	5	6
		Severe	2	4	7	8	8	8	1	6	6	7	7	8
	Torching index	Severe	125	13	5	5	13	27	456	5	10	19	28	29
	Crowning index	Severe	14	14	14	14	15	16	18	18	20	20	19	20
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	196	301	265	183	182	120	367	52	45	39	34	56
		18–29.9 in	1	1	3	4	8	13	3	3	3	3	5	10
		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	23	18	14	12	11	11	18	16	15	15	16	18
		3–6 in	8	7	6	5	4	4	9	8	7	6	5	5
		6–12 in	5	4	4	4	3	3	6	5	5	5	5	5
		>12 in	0	1	1	2	2	2	0	1	1	2	3	4
		Litter	1	1	1	1	1	1	1	1	2	2	2	2
		Duff	15	15	14	14	14	14	19	19	19	18	18	18
	Flame length (ft)	Moderate	6	5	4	3	3	3	5	4	4	4	4	4
		Severe	8	7	5	5	4	4	6	6	5	5	5	6
	Torching index	Severe	24	37	53	7	25	66	36	52	70	85	96	100
	Crowning index	Severe	30	34	35	35	35	34	18	21	23	23	22	22
	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	37	29	12	6	5	6	39	32	15	9	14	23
		18–29.9 in	1	2	2	2	2	3	1	1	1	2	6	11
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 17b—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	6	6	6	6	7	8	4	6	8	10	13	17
		3–6 in	2	2	2	2	2	2	3	2	2	2	2	3
		6–12 in	1	2	2	2	2	2	2	2	2	3	3	4
		>12 in	0	1	1	2	2	2	0	1	1	2	3	4
		Litter	1	1	1	1	1	1	1	1	2	2	2	2
		Duff	13	13	13	13	12	12	17	17	17	16	16	16
	Flame length (ft)	Moderate	2	1	2	2	2	2	1	1	2	2	3	4
		Severe	2	2	2	2	3	3	2	2	3	3	4	5
	Torching index	Severe	218	269	286	38	69	128	410	285	219	172	36	112
	Crowning index	Severe	30	34	35	35	34	34	18	21	22	22	22	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	37	29	13	7	6	6	39	32	16	10	17	24
		18–29.9 in	1	2	2	3	2	3	1	1	1	2	6	10
		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	3	4	4	5	7	0	5	7	8	10	12
		3–6 in	2	2	2	2	2	2	3	3	3	3	3	2
		6–12 in	3	3	4	3	3	3	4	5	6	6	6	5
		>12 in	0	1	2	3	3	3	0	2	4	5	5	5
		Litter	1	1	1	1	1	1	1	1	1	1	2	2
		Duff	10	10	10	10	10	10	17	13	13	13	13	13
	Flame length (ft)	Moderate	6	1	1	2	2	2	5	2	2	2	3	3
		Severe	8	1	2	2	2	3	6	2	3	4	4	4
	Torching index	Severe	24	599	377	43	78	90	36	237	135	20	34	41
	Crowning index	Severe	30	37	39	38	38	37	18	25	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	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	38	27	19	9	7	7	61	44	26	10	8	14
		18–29.9 in	3	3	3	2	2	2	3	3	2	3	2	6
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 17b—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	14	19	24	30	34	9	15	23	30	35	38
		3–6 in	9	8	7	7	8	10	8	7	7	8	11	14
		6–12 in	6	5	6	9	13	20	5	5	7	10	16	25
		>12 in	0	1	1	3	6	11	0	1	1	3	6	10
		Litter	2	3	3	3	3	2	3	3	3	3	3	2
		Duff	19	19	19	19	19	19	18	18	18	18	18	18
	Flame length (ft)	Moderate	3	3	4	5	6	6	2	3	4	5	6	6
		Severe	5	5	5	6	8	9	3	4	6	7	8	9
	Torching index	Severe	51	91	108	116	87	69	89	124	137	109	89	81
	Crowning index	Severe	15	17	17	17	19	19	14	15	15	15	17	18
	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	40	33	33	43	59	73	46	52	45	57	78	83
		18–29.9 in	1	1	2	4	14	15	1	1	2	2	11	13
		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	8	15	22	27	31	2	10	20	28	34	37
		3–6 in	3	2	3	4	5	7	2	2	3	5	8	11
		6–12 in	2	2	3	6	11	18	2	2	4	8	15	23
		>12 in	0	1	1	3	6	11	0	1	1	3	6	10
		Litter	2	3	3	3	3	2	3	3	3	3	3	2
		Duff	17	17	17	17	17	17	16	16	16	16	16	16
	Flame length (ft)	Moderate	1	2	3	4	5	6	1	2	4	5	6	6
		Severe	1	2	4	6	7	9	1	2	5	7	8	9
	Torching index	Severe	687	319	157	133	100	66	827	315	154	131	89	79
	Crowning index	Severe	15	17	17	17	19	21	14	15	15	15	18	19
	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	40	33	33	41	62	72	46	52	45	59	77	83
		18–29.9 in	1	1	2	4	15	16	1	1	2	2	11	13
		30–36 in	0	0	0	0	0	0	0	0	0	0	0	0

Table 17b—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	9	12	14	17	21	0	12	15	17	20	24
		3–6 in	2	5	5	5	5	5	2	7	6	6	6	7
		6–12 in	3	11	11	11	11	12	3	12	12	12	13	14
		>12 in	0	2	4	5	6	8	0	2	4	5	6	8
		Litter	2	2	2	2	2	2	2	2	2	2	2	2
		Duff	13	13	13	13	13	13	12	12	12	12	12	12
	Flame length (ft)	Moderate	2	3	4	4	4	5	1	4	4	4	5	5
		Severe	2	4	5	5	6	7	1	5	6	6	7	7
	Torching index	Severe	358	83	76	90	18	99	651	72	80	90	101	96
	Crowning index	Severe	18	20	22	21	21	21	18	19	20	20	20	20
	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	79	50	27	18	27	40	97	50	24	27	28	29
		18–29.9 in	3	3	2	3	5	12	3	3	2	3	5	7
		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 17c—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	1,427	1,095	840	676	507	427	286	281	261	235	214	176
	Quadratic mean diameter (in)	5.9	7.1	8.3	9.5	11.0	12.0	5.9	12.0	13.5	15.2	16.7	18.7
	Total volume (ft^3)	6,334	8,840	10,724	12,336	13,387	14,296	5,555	6,836	9,303	11,577	13,819	14,896
	Merchantable volume (ft^3)	4,801	7,090	8,891	10,446	11,641	12,562	4,647	5,822	8,077	10,206	12,348	13,517
	Basal area (ft^2)	272	301	318	332	334	334	198	220	260	294	327	334
	Stand density index	614	631	626	621	590	571	347	376	423	458	489	479
	Canopy closure (percent)	82	81	80	78	75	73	59	61	64	65	66	63
	Crown competition factor	169	168	160	151	139	129	89	94	102	105	108	99
	Canopy base height (ft)	6	5	9	11	15	23	15	6	10	15	21	25
	Canopy bulk density (kg/m^3)	0.23	0.22	0.23	0.24	0.22	0.19	0.17	0.17	0.15	0.15	0.15	0.15

Table 17c—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	1,427	50	98	96	94	92	89	100	122	118	114	108	98
	Quadratic mean diameter (in)	5.9	19	15.3	17.3	19.2	21.1	22.7	16.8	17.1	19.2	21.1	23.0	25.0
	Total volume (ft^3)	6,334	3,478	4,246	5,820	7,538	9,409	11,130	5,214	6,381	8,771	11,173	13,284	14,968
	Merchantable volume (ft^3)	4,801	3,151	3,869	5,352	6,961	8,698	10,271	4,637	5,731	8,006	10,280	12,260	13,871
	Basal area (ft^2)	272	98	126	156	188	222	251	155	194	237	279	311	333
	Stand density index	614	140	196	231	267	303	333	231	288	336	380	410	426
	Canopy cover (percent)	82	25	28	33	37	41	45	41	45	49	52	55	55
	Crown competition factor	169	28	33	40	46	53	60	53	60	67	74	79	80
	Canopy base height (ft)	6	26	29	32	5	10	22	25	29	34	38	42	46
	Canopy bulk density (kg/m^3)	0.23	0.09	0.07	0.07	0.07	0.07	0.07	0.17	0.13	0.12	0.12	0.13	0.12
Pile and burn	Trees per acre	1,427	50	124	121	117	114	110	100	135	131	127	118	107
	Quadratic mean diameter (in)	5.9	19.0	13.6	15.4	17.2	18.9	20.4	16.8	16.2	18.2	20.1	22.0	23.9
	Total volume (ft^3)	6,334	3,478	4,246	5,818	7,539	9,395	11,109	5,214	6,381	8,776	11,169	13,245	14,944
	Merchantable volume (ft^3)	4,801	3,151	3,869	5,332	6,962	8,684	10,270	4,637	5,731	8,010	10,279	12,238	13,816
	Basal area (ft^2)	272	98	126	156	188	222	250	155	194	237	279	310	333
	Stand density index	614	140	205	242	279	316	346	231	294	343	388	417	433
	Canopy cover (percent)	82	25	28	33	37	41	44	41	45	49	52	55	55
	Crown competition factor	169	28	33	39	46	53	58	53	60	67	74	79	80
	Canopy base height (ft)	6	26	29	32	5	10	22	25	29	35	38	13	47
	Canopy bulk density (kg/m^3)	0.23	0.09	0.07	0.07	0.07	0.07	0.07	0.17	0.13	0.12	0.12	0.13	0.13
Prescribed fire	Trees per acre	1,427	50	192	186	181	176	170	100	144	139	135	131	122
	Quadratic mean diameter (in)	5.9	19.0	10.3	11.6	13.1	14.4	15.7	16.8	14.4	16.2	18.0	19.8	21.5
	Total volume (ft^3)	6,334	3,035	3,697	5,064	6,702	8,245	9,970	4,320	5,328	7,373	9,514	11,860	13,711
	Merchantable volume (ft^3)	4,801	2,750	3,371	4,645	6,206	7,582	9,121	3,863	4,825	6,724	8,754	10,955	12,678
	Basal area (ft^2)	272	98	110	136	168	198	228	155	162	200	238	279	307
	Stand density index	614	140	200	236	277	314	350	231	257	302	346	391	416
	Canopy cover (percent)	82	25	25	30	35	40	44	41	38	42	46	50	52
	Crown competition factor	169	28	29	36	44	51	58	53	47	54	62	70	74
	Canopy base height (ft)	6	30	34	34	5	10	21	25	29	33	7	12	24
	Canopy bulk density (kg/m^3)	0.23	0.08	0.06	0.06	0.06	0.06	0.06	0.14	0.11	0.10	0.10	0.11	0.11

Table 17c—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	1,427	200	207	190	168	139	106	300	289	258	216	168	121
	Quadratic mean diameter (in)	5.9	14.1	15.3	17.1	19.1	21.0	24.0	12.2	13.5	15.1	17.0	19.1	22.5
	Total volume (ft^3)	6,334	6,964	8,531	11,267	13,418	14,416	15,019	7,501	8,952	11,627	13,623	14,244	14,912
	Merchantable volume (ft^3)	4,801	5,986	7,465	10,034	12,139	13,130	13,845	6,193	7,580	10,162	12,195	12,939	13,738
	Basal area (ft^2)	272	217	266	305	332	333	334	245	286	321	342	333	333
	Stand density index	614	348	412	452	472	456	433	414	466	500	509	474	444
	Canopy cover (percent)	82	63	66	68	67	65	58	71	73	73	70	66	59
	Crown competition factor	169	98	109	113	110	106	87	124	129	131	122	109	89
	Canopy base height (ft)	6	20	32	40	49	51	51	20	36	46	53	56	57
	Canopy bulk density (kg/m^3)	0.23	0.21	0.18	0.18	0.18	0.16	0.15	0.23	0.21	0.20	0.21	0.17	0.16
Pile and burn	Trees per acre	1,427	200	214	196	173	141	109	300	296	265	221	172	125
	Quadratic mean diameter (in)	5.9	14.1	15.1	16.9	18.8	20.8	23.6	12.2	13.3	14.9	16.8	18.8	22.1
	Total volume (ft^3)	6,334	6,964	8,531	11,262	13,421	14,367	14,974	7,501	8,952	11,617	13,564	14,242	14,920
	Merchantable volume (ft^3)	4,801	5,986	7,465	10,031	12,134	13,089	13,794	6,193	7,580	10,151	12,189	12,932	13,712
	Basal area (ft^2)	272	217	266	305	333	332	332	245	286	320	341	333	334
	Stand density index	614	348	415	455	476	456	434	414	468	502	509	476	447
	Canopy cover (percent)	82	63	66	68	67	65	58	71	73	73	70	67	60
	Crown competition factor	169	98	109	113	111	106	88	124	129	131	121	110	90
	Canopy base height (ft)	6	20	32	41	49	51	51	20	36	47	54	56	57
	Canopy bulk density (kg/m^3)	0.23	0.21	0.18	0.18	0.18	0.15	0.14	0.23	0.21	0.21	0.21	0.17	0.15
Prescribed fire	Trees per acre	1,427	200	169	164	154	139	119	300	199	196	175	159	143
	Quadratic mean diameter (in)	5.9	14.1	14.8	16.6	18.5	20.5	22.6	12.2	14.0	15.6	17.6	19.4	21.2
	Total volume (ft^3)	6,334	5,287	6,550	9,142	11,651	13,740	15,029	5,495	6,798	9,516	11,798	13,966	15,857
	Merchantable volume (ft^3)	4,801	4,621	5,800	8,224	10,603	12,603	13,864	4,720	5,943	8,482	10,698	12,762	14,585
	Basal area (ft^2)	272	217	202	247	289	320	333	245	213	259	294	325	351
	Stand density index	614	348	318	370	415	442	442	414	342	399	431	459	478
	Canopy cover (percent)	82	63	51	56	58	59	58	71	56	60	61	62	63
	Crown competition factor	169	98	72	81	88	90	87	124	82	93	95	98	98
	Canopy base height (ft)	6	23	31	34	39	13	50	23	32	36	40	47	52
	Canopy bulk density (kg/m^3)	0.23	0.16	0.14	0.13	0.13	0.14	0.13	0.17	0.16	0.14	0.14	0.15	0.15

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

Table 17d—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	80	10	20					8	100						
	10	10	83	12	17					12	71	10	29				
	20	12	51	13	49					12	99	10	1				
	30	13	100							12	85	13	15				
	40	13	100							12	63	13	37				
	50	13	100							13	67	12	33				

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*				
None	1	12	97	10	3					12	71	10	29				
	10	12	54	10	46					10	53	12	47				
	20	10	73	12	27					10	62	12	38				
	30	10	90	12	10					10	63	12	37				
	40	10	99	12	1					10	57	12	43				
	`50	10	99	8	1					12	65	10	35				
Pile and burn	1	8	81	10	19					8	91	10	9				
	10	8	82	10	18					8	73	10	27				
	20	8	77	10	23					10	53	8	47				
	30	8	70	10	30					10	78	8	22				
	40	8	61	10	39					10	93	12	7				
	50	10	51	8	49					10	59	12	41				
Prescribed fire	1	8	100							8	100						
	10	8	100							8	69	10	31				
	20	8	86	10	14					10	73	8	27				
	30	8	76	10	24					10	93	8	7				
	40	8	67	10	33					10	98	12	2				
	50	8	51	10	49					10	83	12	17				

Table 17d—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	10	70	12	30					10	97	12	3				
	10	10	64	12	36					10	69	12	31				
	20	12	63	10	37					12	93	10	7				
	30	12	87	13	13					13	57	12	43				
	40	13	69	12	31					13	100						
	50	13	100							13	100						
Pile and burn	1	8	100							8	100						
	10	8	56	10	44					10	60	8	40				
	20	10	89	12	11					12	53	10	47				
	30	12	77	10	23					12	74	13	26				
	40	12	60	13	40					13	100	12					
	50	13	100							13	100						
Prescribed fire	1	8	81	6	19					8	100						
	10	10	87	12	13					10	58	12	42				
	20	10	57	12	43					12	70	10	30				
	30	12	53	10	47					12	83	10	17				
	40	12	80	10	20					12	89	13	11				
	50	12	86	13	14					12	58	13	42				

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

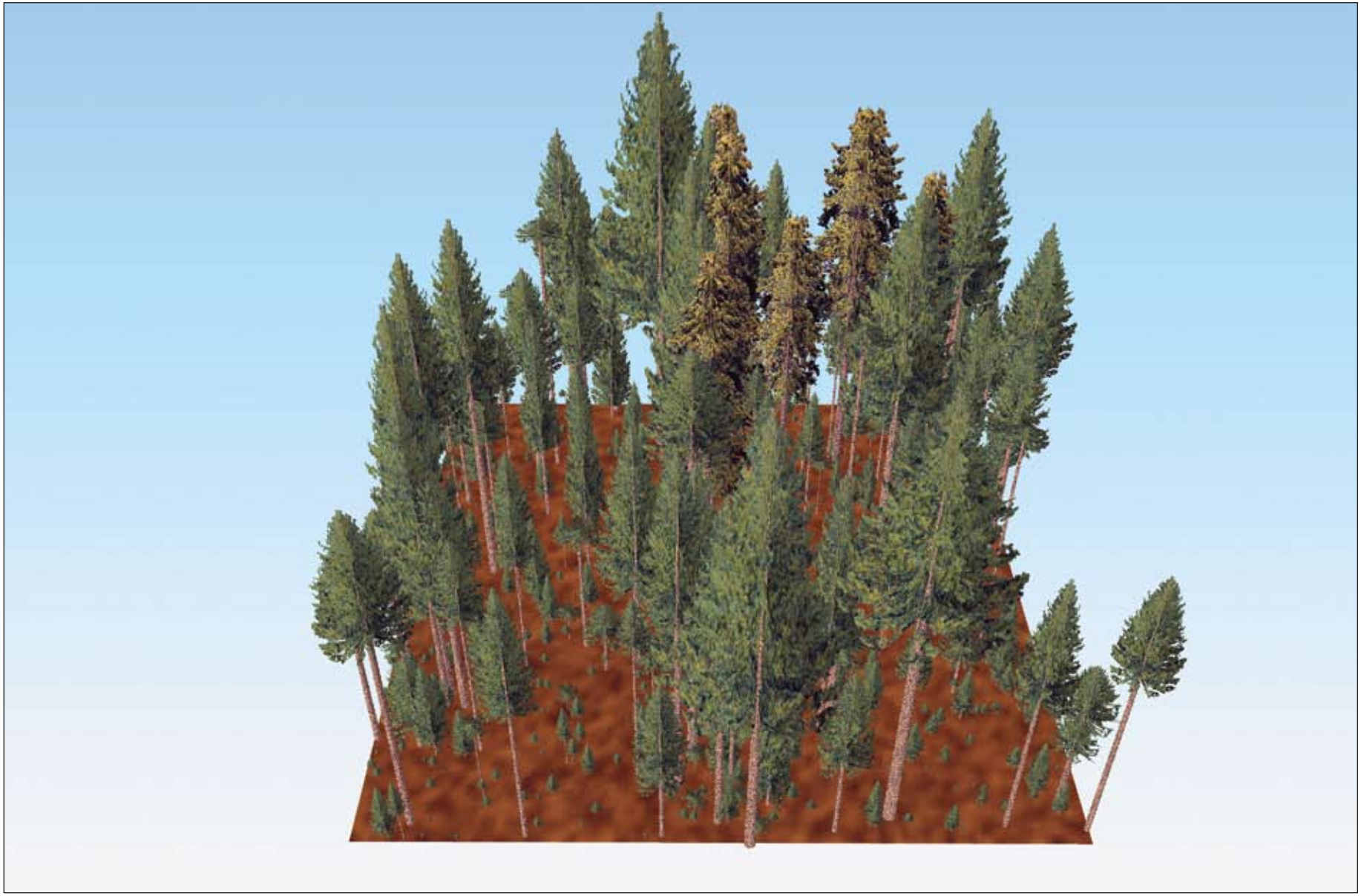
Table 17e—FVS fuel model selection

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	12	97	3	4	7	15	125	100
Moderate—75th percentile	8	72	5	7	10	23	125	150

Table 17f—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).

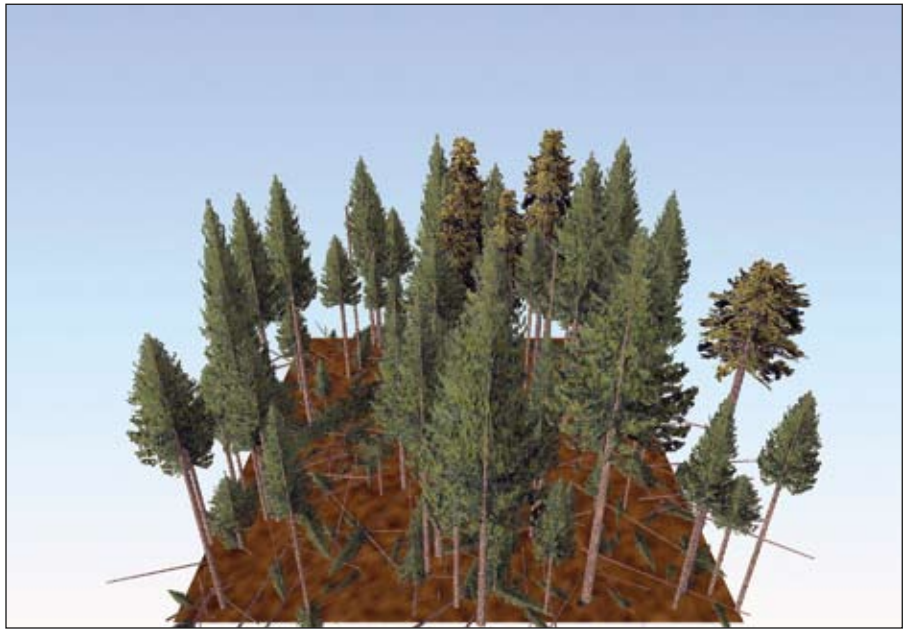


Initial stand conditions

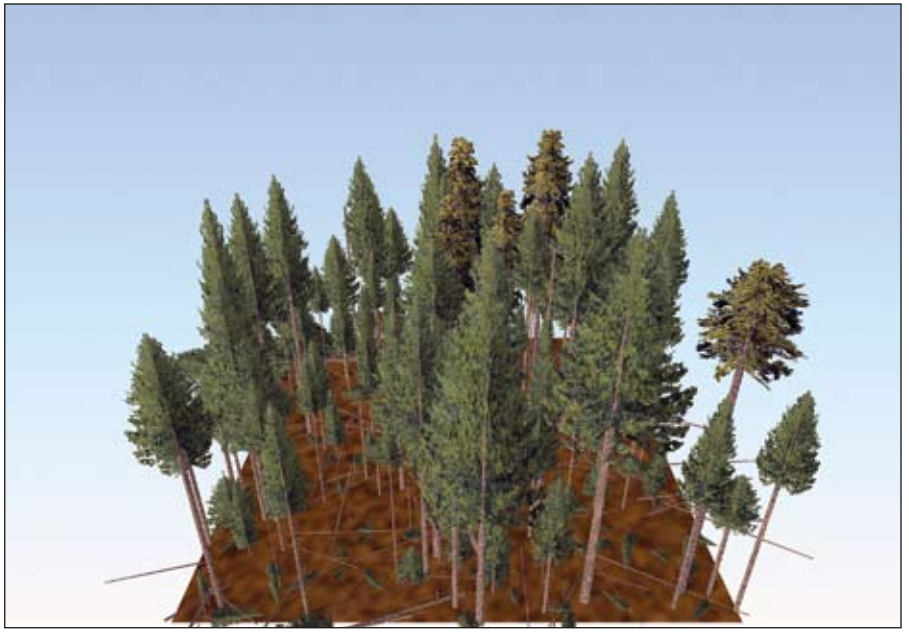
Site: Elevation = 5,000 ft, slope = 30 percent, aspect = 225°.

Species (based on trees per acre): White fir (*Abies concolor*) = 77 percent, hardwoods = 13 percent, sugar pine (*Pinus lambertiana*) = 8 percent, ponderosa pine (*Pinus ponderosa*) = 1 percent.

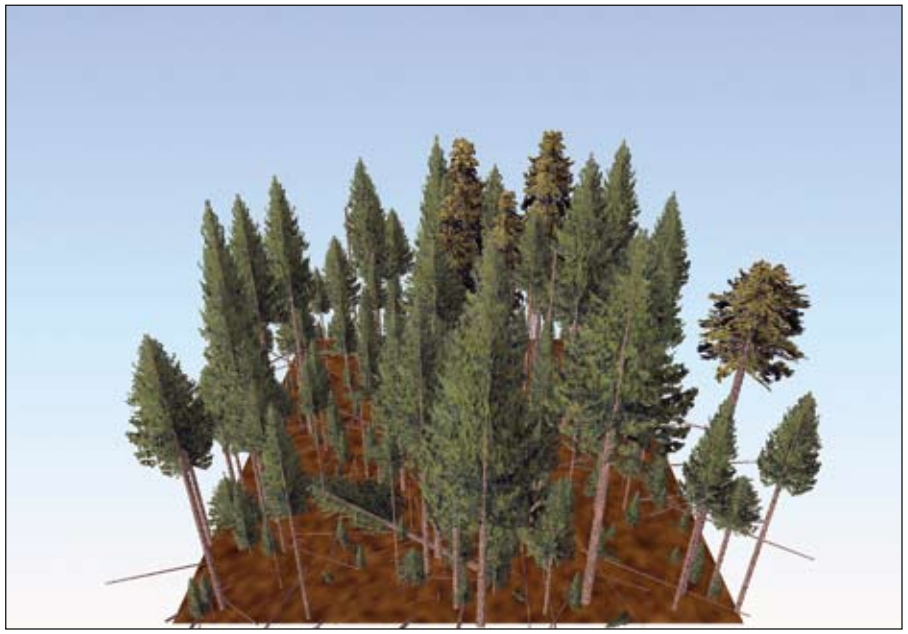
Stand attributes: Stem density = 776 tpa, basal area = 291 ft^2/ac, top height = 119 ft, stand density index = 575, quadratic mean diameter = 8.3 in, crown competition factor = 85, canopy cover = 60 percent.



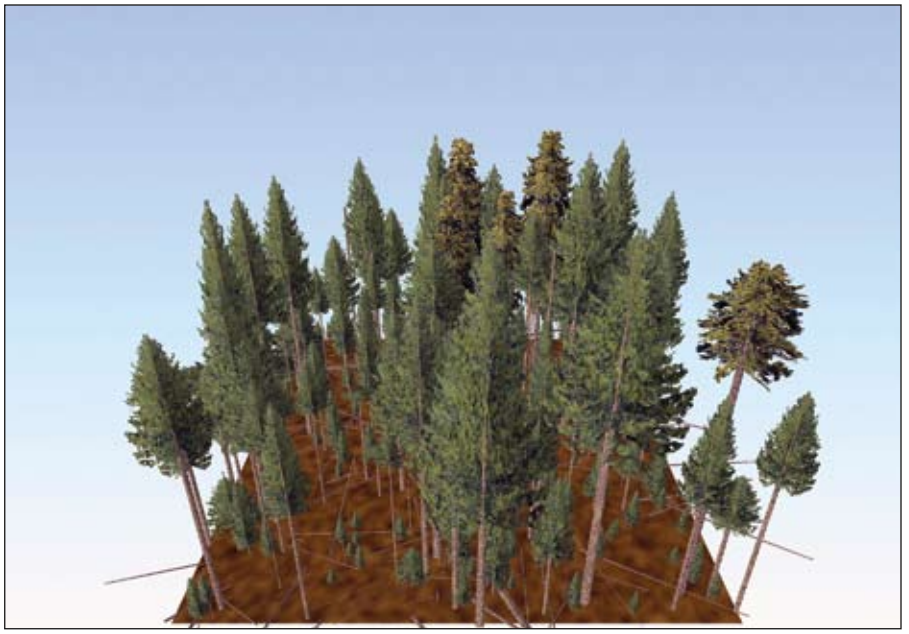
Thin from below to 50 tpa, 18-in d.b.h. limit



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 776 trees per acre (tpa) composed primarily of white fir and hardwood understory with ponderosa pine and sugar pine overstory. Canopy bulk density is 0.07 kg/m^3 (0.0044 lb/ft^3), and canopy base height is 2 ft, so ladder fuels are sufficient to enable passive crown fire, but crown fire spread is unlikely. Woody fuel loading is 18 tons/ac, and litter and duff loading is 16 tons/ac. Potential flame lengths are 5 ft, and potential basal area mortality is 95 percent for severe fire. With no action, canopy base height increases and canopy bulk density decreases rapidly as trees grow. In 30 years, passive crown fire is unlikely for moderate and severe fire weather. Surface fuels also accumulate rapidly, and in 50 years, flame lengths are 8 ft and 12 ft for moderate and severe fire weather respectively.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment raises canopy base height and reduces crown fire potential and flame lengths, but creates many snags that contribute to higher surface fuel loading in 10 years. In the short term, the lower density thinning treatments (50 and 100 tpa) effectively raise canopy base height, reducing crown fire potential, but potential flame lengths are higher than initial conditions because of activity fuels from the treatment. The 200 tpa treatment does not reduce canopy bulk density and only slightly increases canopy base height; the predicted fire type remains passive crown fire, and potential basal area mortality is 95 percent for severe fire weather. The 300 tpa treatment is not sufficient to affect canopy base height or canopy bulk density, so crown fire potential remains similar to initial conditions. The low-density treatments increase surface fuels slightly, but flame lengths remain similar to initial conditions, and the higher density treatments have little effect on surface fuels. The pile and burn treatment and, to a greater extent the prescribed fire treatment, reduce surface fuels and flame lengths to below initial conditions. The prescribed fire treatment reduces crown fire potential more than thinning alone because fire-caused mortality of small trees further increase canopy base height.

Silvicultural and surface fuel treatments—long-term effects

In the prescribed fire only treatment, crown fire potential increases slightly over time as surface fuels accumulate, but the predicted fire type is surface fire for 50 years, and potential flame lengths remain lower than the no-action trajectory. Surface fuels accumulate rapidly in the low-density treatments without surface fuel treatment, and flame lengths exceed 10 ft in 20 years, but canopy base height also increases as the trees grow and the stand continues to self-thin. Canopy base height remains high in relation to flame lengths in the 50 tpa treatment with a pile and burn, and in the 100 tpa treatment with no surface fuel treatment and pile and burn. The predicted fire type is surface fire for the 50-year projection. In the 50 tpa treatment without surface fuel treatment, the combination of regeneration and high activity fuels creates conditions conducive to passive crown fire in 20 years. Regeneration causes a decrease in canopy base height in the 50 tpa and 100 tpa treatments with prescribed fire in 20 years, and passive crown fire is the predicted fire type for severe and moderate fire weather. In the higher density treatments, canopy base height increases in 10 years and the predicted fire type becomes surface fire and remains surface fire for the 50-year projection.

Table 18a—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	6	4	3	3
		3–6 in	7	1	6	7	7	7
		6–12 in	8	4	7	7	8	8
		>12 in	0	0	0	0	0	0
		Litter	1	1	1	1	1	1
		Duff	15	10	13	14	14	15
	Flame length (ft)	Moderate	3	1	3	2	3	3
		Severe	5	2	4	4	5	5
	Torching index	Severe	0	557	137	203	0	0
	Crowning index	Severe	30	38	36	30	30	30
	Type of fire	Moderate	Passive	Surface	Surface	Surface	Surface	Passive
		Severe	Passive	Surface	Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate	31	9	8	11	13	31
		Severe	95	9	8	12	94	95
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			2	1	1	1
		3–6 in			2	2	2	2
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			12	13	13	13
	Flame length (ft)	Moderate			1	1	3	3
		Severe			1	1	5	5
	Torching index	Severe			736	761	0	0
	Crowning index	Severe			36	30	30	30
	Type of fire	Moderate			Surface	Surface	Surface	Passive
		Severe			Surface	Surface	Passive	Passive
	Potential basal area mortality (%)	Moderate			8	11	13	31
		Severe			8	11	94	95
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			9	10	10	10
	Flame length (ft)	Moderate			1	1	1	1
		Severe			2	1	1	2
	Torching index	Severe			686	752	753	563
	Crowning index	Severe			39	34	34	38
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			7	9	9	9
		Severe			7	9	9	9

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

Table 18b—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	9	19	25	27	28	1	8	10	11	14	15
		3–6 in	7	7	8	8	7	8	1	3	3	3	3	3
		6–12 in	8	9	11	12	13	13	4	7	9	8	8	9
		>12 in	0	4	10	18	25	33	0	6	14	17	21	28
		Litter	1	2	2	2	1	1	1	1	1	1	1	1
		Duff	15	15	15	15	15	15	10	10	10	10	10	10
	Flame length (ft)	Moderate	3	4	6	8	8	8	1	3	5	5	6	7
		Severe	5	5	9	11	11	12	2	5	7	8	9	10
	Torching index	Severe	0	0	0	13	24	37	557	134	109	124	142	129
	Crowning index	Severe	30	19	19	23	29	46	38	41	40	43	48	53
	Type of fire	Moderate	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	185	221	230	209	172	140	245	58	32	30	40	38
		18–29.9 in	21	25	32	32	34	33	30	27	22	24	31	31
		30–36 in	7	8	10	13	15	15	11	10	9	10	12	14

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	6	8	10	13	17	18	4	8	13	16	19	20
		3–6 in	6	6	6	5	6	6	7	7	7	7	7	7
		6–12 in	7	7	7	7	8	8	7	8	9	11	12	12
		>12 in	0	3	6	10	15	23	0	3	9	16	24	32
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	13	13	13	13	12	12	14	14	14	14	13	13
	Flame length (ft)	Moderate	3	3	4	5	6	7	2	3	5	7	8	8
		Severe	4	5	6	7	9	10	4	5	8	9	11	11
	Torching index	Severe	137	146	0	122	129	134	203	130	97	92	80	85
	Crowning index	Severe	36	37	40	45	49	59	30	34	39	45	47	51
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	61	44	33	40	45	39	68	67	60	57	54	46
		18–29.9 in	14	14	19	27	26	33	16	21	29	33	34	35
		30–36 in	6	6	8	10	12	17	6	7	10	12	15	16

Table 18b—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	5	9	13	16	19	1	6	12	17	18	19
		3–6 in	2	2	3	3	4	4	2	3	4	5	5	5
		6–12 in	2	3	4	4	5	6	2	3	6	8	9	10
		>12 in	0	2	6	10	14	22	0	3	9	16	24	32
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	12	12	11	11	11	11	13	12	12	12	12	12
	Flame length (ft)	Moderate	1	2	3	5	6	7	1	2	4	6	7	8
		Severe	1	3	5	7	8	10	1	3	6	9	10	11
	Torching index	Severe	736	508	205	132	161	145	761	375	109	105	93	93
	Crowning index	Severe	36	35	38	40	50	53	30	34	38	41	43	47
	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	61	44	35	38	45	40	68	67	58	56	46	54
		18–29.9 in	14	14	19	22	35	31	16	21	28	32	34	34
		30–36 in	6	6	7	10	14	15	6	7	10	13	15	17
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	5	8	12	15	17	0	6	10	15	17	19
		3–6 in	2	3	3	3	3	3	2	3	3	5	5	5
		6–12 in	4	5	6	6	5	6	4	7	8	9	9	10
		>12 in	0	4	9	12	15	19	0	4	10	15	22	28
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	9	9	9	9	9	9	13	10	10	10	10	10
	Flame length (ft)	Moderate	1	2	4	5	6	6	1	3	4	6	7	7
		Severe	2	3	5	7	8	9	1	4	6	8	10	10
	Torching index	Severe	686	332	0	31	50	151	752	210	0	6	21	26
	Crowning index	Severe	39	38	40	40	44	44	34	33	37	40	45	48
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Passive	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	57	40	36	36	46	57	69	47	57	61	51	53
		18–29.9 in	22	20	20	17	23	29	22	20	25	24	33	30
		30–36 in	8	7	8	8	11	15	8	7	9	12	14	14

Table 18b—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	3	8	15	19	23	23	3	8	15	21	22	25
		3–6 in	7	7	7	7	8	8	7	7	7	7	7	8
		6–12 in	8	8	10	11	12	13	8	8	10	12	13	13
		>12 in	0	3	9	16	24	34	0	3	10	17	24	32
		Litter	1	2	1	1	1	1	1	2	1	1	1	1
		Duff	14	14	14	14	14	14	15	14	14	14	14	14
	Flame length (ft)	Moderate	3	3	6	7	8	8	3	3	6	7	8	8
		Severe	5	5	8	10	11	12	5	5	8	10	11	12
	Torching index	Severe	0	20	22	73	68	69	0	12	18	21	58	58
	Crowning index	Severe	30	32	36	45	49	51	30	32	37	39	46	48
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	80	94	95	89	64	49	87	136	115	84	90	63
		18–29.9 in	18	23	28	33	36	37	18	23	31	32	34	35
		30–36 in	7	7	10	13	16	17	7	7	9	11	14	17
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	1	6	14	18	21	23	1	6	14	20	22	24
		3–6 in	2	3	4	4	5	5	2	3	4	4	5	6
		6–12 in	2	4	6	9	10	11	2	4	6	9	10	11
		>12 in	0	3	9	16	24	33	0	3	9	17	24	32
		Litter	1	2	1	1	1	1	1	2	1	1	1	1
		Duff	13	13	13	13	13	13	13	13	13	13	13	13
	Flame length (ft)	Moderate	3	2	5	7	8	8	3	2	5	7	8	8
		Severe	5	3	7	9	11	12	5	3	7	10	11	12
	Torching index	Severe	0	68	29	78	78	76	0	50	25	25	60	46
	Crowning index	Severe	30	32	36	43	52	56	30	32	37	40	46	51
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Passive	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	80	94	81	90	76	52	87	136	117	82	90	64
		18–29.9 in	18	23	29	32	38	37	18	23	31	32	34	35
		30–36 in	7	7	10	12	14	15	7	7	9	11	14	17

Table 18b—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	6	10	15	17	18	0	7	9	11	15	16
		3–6 in	2	3	4	5	5	5	2	4	4	4	5	5
		6–12 in	4	7	8	9	10	10	4	8	9	9	9	9
		>12 in	0	4	10	15	23	30	0	6	14	18	22	28
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	10	10	10	10	10	10	10	10	10	10	10	10
	Flame length (ft)	Moderate	1	3	4	6	7	7	1	3	5	6	6	7
		Severe	1	4	7	9	10	11	2	5	7	8	9	10
	Torching index	Severe	753	181	108	106	98	93	563	119	99	113	118	113
	Crowning index	Severe	34	35	39	43	46	50	38	39	41	44	46	49
	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	95	49	52	50	44	53	128	58	41	40	50	39
		18–29.9 in	22	21	25	30	33	33	30	27	24	26	28	31
		30–36 in	8	8	9	13	15	18	11	10	10	11	14	16

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

Table 18c—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	776	565	406	270	183	97	62	61	60	53	43	37
	Quadratic mean diameter (in)	8.3	10.0	11.8	14.5	17.6	24.1	8.3	27.9	30.2	32.8	36.3	39.0
	Total volume (ft^3)	11,693	13,764	15,053	16,298	17,045	17,531	10,817	12,422	15,718	17,678	18,358	18,765
	Merchantable volume (ft^3)	10,745	12,648	13,828	15,001	15,682	16,317	10,055	11,577	14,711	16,582	17,293	17,668
	Basal area (ft^2)	291	310	309	310	308	306	241	261	300	314	308	308
	Stand density index	575	568	530	491	453	397	300	319	355	360	339	330
	Canopy closure (percent)	60	66	65	63	61	58	47	49	54	56	55	55
	Crown competition factor	85	116	102	89	79	68	55	58	64	65	61	60
	Canopy base height (ft)	2	3	10	21	31	40	31	45	52	59	69	74
	Canopy bulk density (kg/m^3)	0.07	0.13	0.13	0.11	0.08	0.04	0.06	0.05	0.05	0.05	0.04	0.03

Table 18c—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	776	53	102	88	72	53	43	100	109	87	70	54	45
	Quadratic mean diameter (in)	8.3	29.4	22.7	25.3	27.9	33.2	36.0	22.9	22.7	25.4	28.4	32.3	35.2
	Total volume (ft^3)	11,693	12,340	13,972	16,223	17,199	18,698	18,764	13,266	14,299	15,947	16,843	17,662	18,539
	Merchantable volume (ft^3)	10,745	11,500	13,044	15,203	16,141	17,582	17,660	12,289	13,300	14,919	15,803	16,588	17,445
	Basal area (ft^2)	291	250	288	305	306	318	307	286	306	306	306	306	308
	Stand density index	575	299	381	388	373	363	339	378	406	389	372	353	343
	Canopy cover (percent)	60	48	52	55	55	56	55	54	55	55	55	54	54
	Crown competition factor	85	54	60	65	63	63	59	70	70	68	65	62	60
	Canopy base height (ft)	2	31	46	4	58	65	77	29	41	49	54	60	69
	Canopy bulk density (kg/m^3)	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.07	0.06	0.05	0.04	0.04	0.04
Pile and burn	Trees per acre	776	53	128	108	92	74	63	100	122	98	77	68	46
	Quadratic mean diameter (in)	8.3	29.4	20.3	22.8	25.2	27.5	30.4	22.9	21.5	23.9	27.1	29.1	35.1
	Total volume (ft^3)	11,693	12,340	13,972	16,235	17,732	18,057	19,310	13,266	14,299	15,858	17,141	18,127	18,425
	Merchantable volume (ft^3)	10,745	11,500	13,044	15,209	16,630	16,949	18,140	12,289	13,300	14,835	16,068	17,027	17,321
	Basal area (ft^2)	291	250	288	306	317	303	316	286	306	306	309	311	308
	Stand density index	575	299	399	405	403	373	374	378	415	398	382	375	344
	Canopy cover (percent)	60	48	52	56	57	57	57	54	55	55	55	55	54
	Crown competition factor	85	54	60	68	68	64	64	70	70	69	66	64	60
	Canopy base height (ft)	2	31	44	52	57	73	77	29	41	48	56	62	69
	Canopy bulk density (kg/m^3)	0.07	0.06	0.06	0.06	0.05	0.04	0.03	0.07	0.06	0.06	0.05	0.05	0.04
Prescribed fire	Trees per acre	776	53	197	173	153	128	101	100	140	120	85	74	56
	Quadratic mean diameter (in)	8.3	29.4	15.8	17.6	19.7	21.4	23.6	22.9	19.3	21.7	25.5	27.4	32.3
	Total volume (ft^3)	11,693	11,540	13,078	15,451	18,082	18,719	18,263	12,307	13,572	15,968	16,917	17,686	18,992
	Merchantable volume (ft^3)	10,745	10,762	12,222	14,458	16,906	17,509	17,093	11,427	12,645	14,929	15,864	16,603	17,863
	Basal area (ft^2)	291	250	266	292	323	318	305	286	285	306	303	304	318
	Stand density index	575	299	408	429	453	433	398	378	403	414	383	375	367
	Canopy cover (percent)	60	48	50	57	60	59	57	54	54	56	57	56	57
	Crown competition factor	85	54	56	73	77	72	66	70	66	71	66	64	64
	Canopy base height (ft)	2	32	45	4	17	29	69	31	42	4	11	23	73
	Canopy bulk density (kg/m^3)	0.07	0.05	0.05	0.05	0.05	0.05	0.04	0.06	0.07	0.06	0.05	0.04	0.04

Table 18c—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	776	200	169	120	75	60	51	300	222	168	129	80	65
	Quadratic mean diameter (in)	8.3	16.3	18.3	21.7	27.4	30.4	33.0	13.3	15.9	18.2	20.9	26.5	29.2
	Total volume (ft^3)	11,693	13,148	14,097	15,666	16,492	17,063	17,911	13,177	13,976	15,481	16,818	17,244	17,670
	Merchantable volume (ft^3)	10,745	12,121	13,030	14,578	15,431	15,995	16,813	12,131	12,912	14,353	15,626	16,130	16,544
	Basal area (ft^2)	291	291	306	306	306	302	303	291	307	305	307	304	302
	Stand density index	575	439	443	414	377	356	347	476	469	440	421	380	363
	Canopy cover (percent)	60	57	57	56	55	55	55	57	59	58	57	56	55
	Crown competition factor	85	80	78	72	66	63	61	85	83	77	72	66	63
	Canopy base height (ft)	2	4	9	18	50	58	64	2	7	16	25	51	57
	Canopy bulk density (kg/m^3)	0.07	0.07	0.07	0.06	0.04	0.04	0.03	0.07	0.07	0.06	0.05	0.04	0.04
Pile and burn	Trees per acre	776	200	173	137	85	61	53	300	229	172	136	84	68
	Quadratic mean diameter (in)	8.3	16.3	18.0	20.2	25.7	30.1	32.2	13.3	15.7	18.1	20.3	25.8	28.5
	Total volume (ft^3)	11,693	13,148	14,097	15,709	16,668	17,082	17,855	13,177	13,976	15,501	16,798	17,260	17,693
	Merchantable volume (ft^3)	10,745	12,121	13,030	14,596	15,599	16,019	16,781	12,131	12,912	14,372	15,597	16,138	16,547
	Basal area (ft^2)	291	291	306	307	306	299	300	291	307	305	307	305	302
	Stand density index	575	439	445	426	387	354	347	476	471	443	425	384	367
	Canopy cover (percent)	60	57	57	57	56	55	55	57	59	58	57	56	55
	Crown competition factor	85	80	78	74	67	62	61	85	83	78	73	66	63
	Canopy base height (ft)	2	4	9	18	48	59	65	2	7	16	25	50	47
	Canopy bulk density (kg/m^3)	0.07	0.07	0.07	0.06	0.05	0.04	0.03	0.07	0.07	0.06	0.05	0.04	0.04
Prescribed fire	Trees per acre	776	200	120	99	79	68	46	300	102	95	81	57	51
	Quadratic mean diameter (in)	8.3	16.3	21.1	23.8	26.7	28.9	35.0	13.3	21.7	23.8	26.3	31.4	33.4
	Total volume (ft^3)	11,693	12,247	13,896	15,967	17,243	18,144	18,357	10,829	12,460	15,264	17,155	18,167	18,931
	Merchantable volume (ft^3)	10,745	11,362	12,921	14,937	16,183	17,034	17,262	10,066	11,612	14,283	16,083	17,065	17,812
	Basal area (ft^2)	291	291	294	306	309	311	308	291	261	291	306	309	311
	Stand density index	575	439	401	398	384	375	344	476	353	379	383	360	354
	Canopy cover (percent)	60	57	54	55	55	55	54	57	50	54	55	55	55
	Crown competition factor	85	80	67	69	67	64	61	85	58	65	66	63	62
	Canopy base height (ft)	2	31	40	48	55	61	66	31	42	49	56	63	71
	Canopy bulk density (kg/m^3)	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.06	0.05	0.05	0.05	0.04	0.04

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

Table 18d—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	100							8	93	5	7				
	10	10	83	12	17					10	99	12	1				
	20	12	91	13	9					10	55	12	45				
	30	13	71	12	29					12	61	10	39				
	40	13	100							12	94	10	6				
	50	13	100							12	74	13	26				

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*				
None	1	10	67	8	33					8	55	10	45				
	10	10	100							10	98	12	2				
	20	10	77	12	23					12	62	10	38				
	30	12	55	10	45					12	89	13	11				
	40	12	98	13	2					13	56	12	44				
	`50	12	71	13	29					13	86	12	14				
Pile and burn	1	8	100							8	100						
	10	8	78	10	22					8	66	10	34				
	20	10	88	8	12					10	69	12	31				
	30	10	61	12	39					12	97	10	3				
	40	12	75	10	25					12	62	13	38				
	50	12	76	13	24					13	64	12	36				
Prescribed fire	1	8	98	5	2					8	100						
	10	8	60	10	40					10	67	8	33				
	20	10	91	12	9					10	70	12	30				
	30	10	59	12	41					12	87	10	13				
	40	12	73	10	27					12	74	13	26				
	50	12	97	13	3					13	56	12	44				

Table 18d—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	10	100							10	100						
	10	10	95	12	5					10	94	12	6				
	20	12	78	10	22					12	80	10	20				
	30	12	70	13	30					12	55	13	45				
	40	13	79	12	21					13	78	12	22				
	50	13	100							13	100						
Pile and burn	1	10	100							10	100						
	10	8	60	10	40					8	58	10	42				
	20	10	53	12	47					10	51	12	49				
	30	12	89	13	11					12	76	13	24				
	40	13	56	12	44					13	63	12	37				
	50	13	96	12	4					13	100						
Prescribed fire	1	8	100							8	94	5	6				
	10	10	73	8	27					10	97	12	3				
	20	10	67	12	33					10	51	12	49				
	30	12	88	10	12					12	69	10	31				
	40	12	72	13	28					12	94	13	6				
	50	13	54	12	46					12	61	13	39				

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

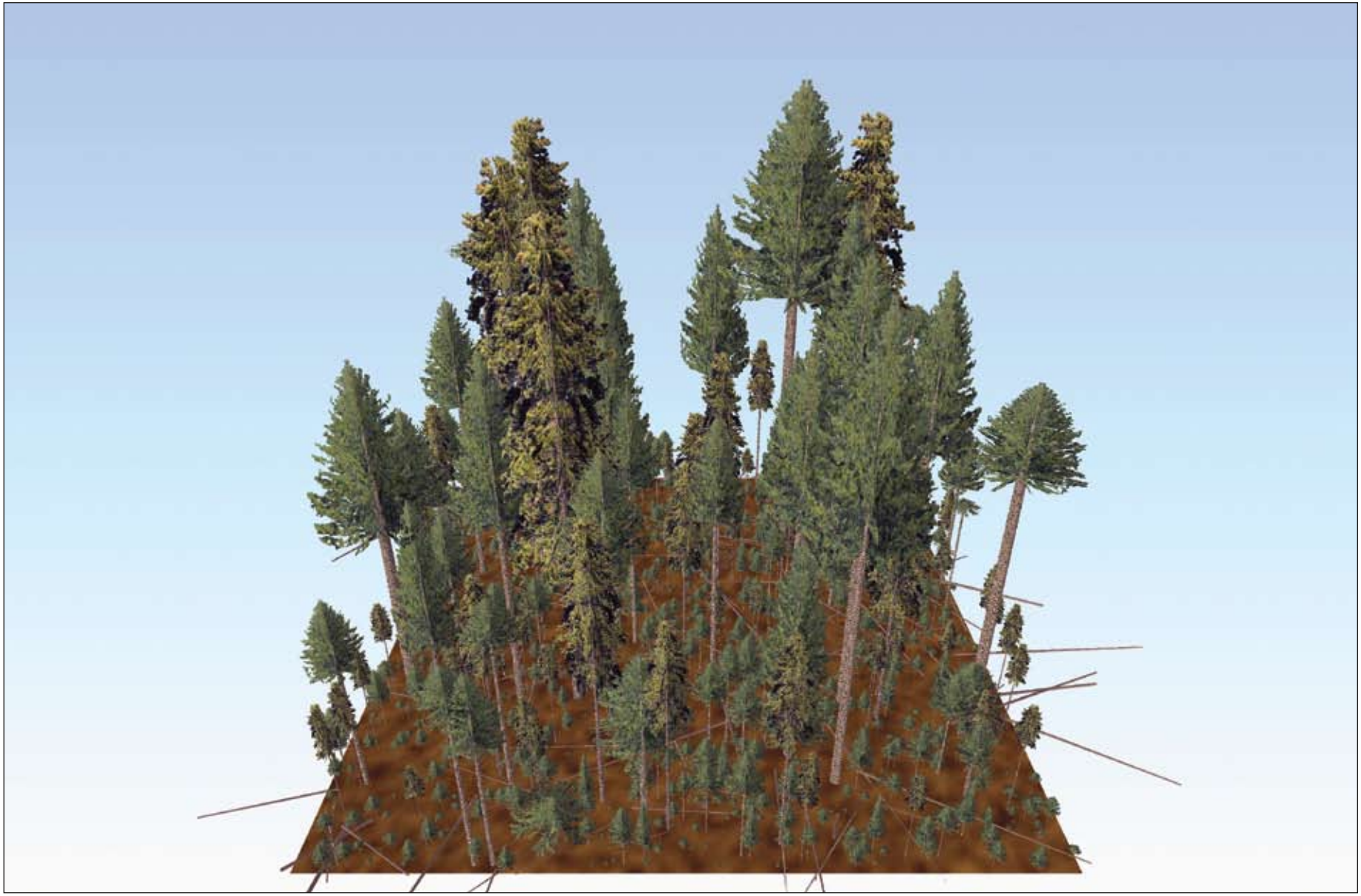
Table 18e—FVS fuel model selection

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	17	83	2	5	10	15	50	100
Moderate—75th percentile	11	72	5	7	15	17	125	150

Table 18f—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).

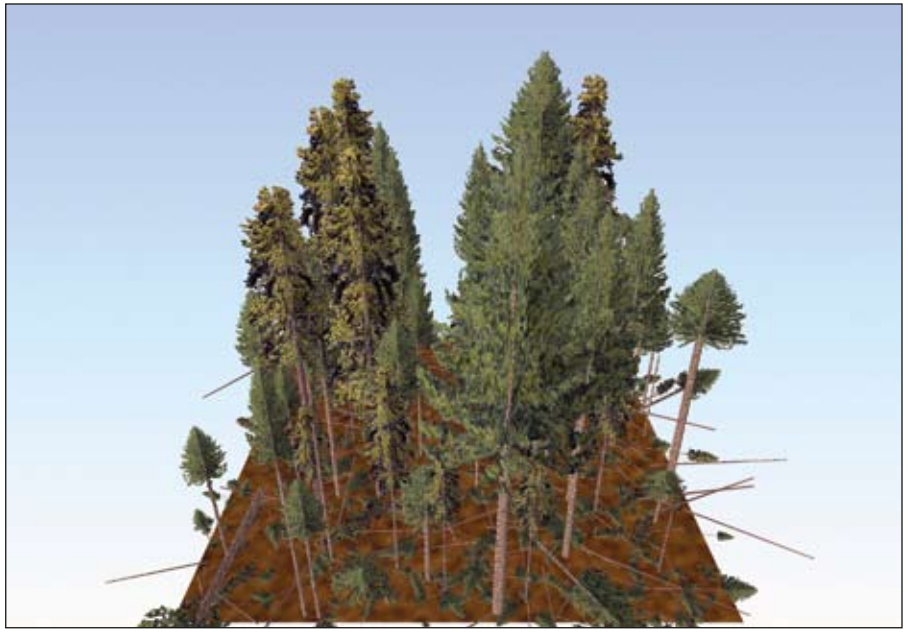


Initial stand conditions

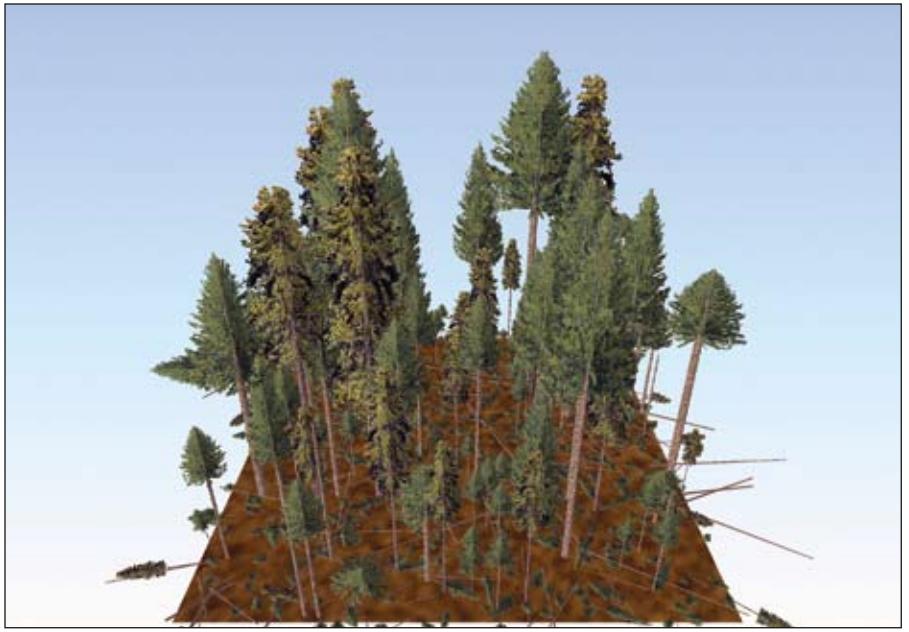
Site: Elevation = 4,500 ft, slope = 40 percent, aspect = 360°.

Species (based on trees per acre): Hardwoods = 77 percent, sugar pine (*Pinus lambertiana*) = 13 percent, white fir (*Abies concolor*) = 4 percent, ponderosa pine (*Pinus ponderosa*) = 4 percent.

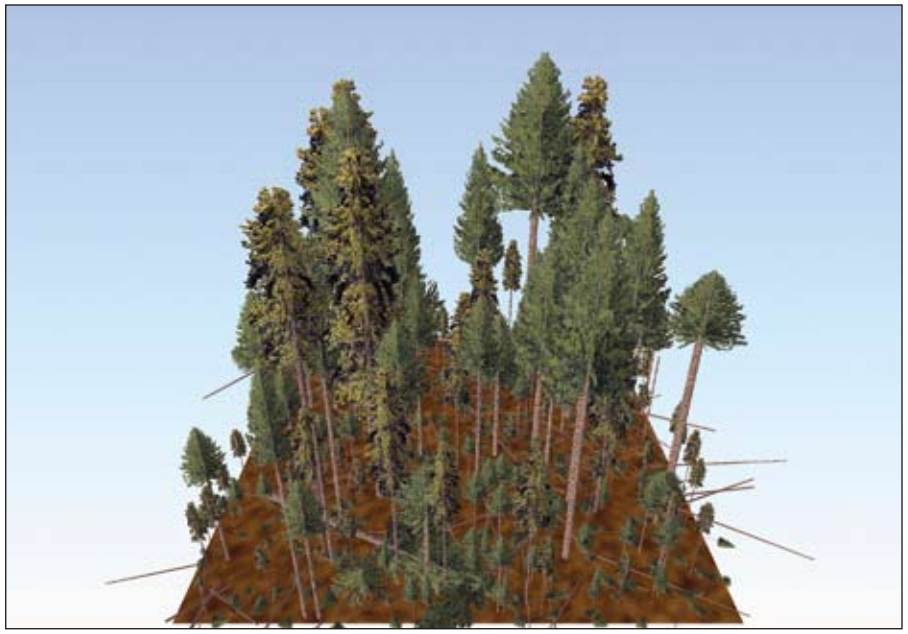
Stand attributes: Stem density = 1,817 tpa, basal area = 289 ft^2/ac, top height = 112 ft, stand density index = 676, quadratic mean diameter = 5.4 in, crown competition factor = 136, canopy cover = 69 percent.



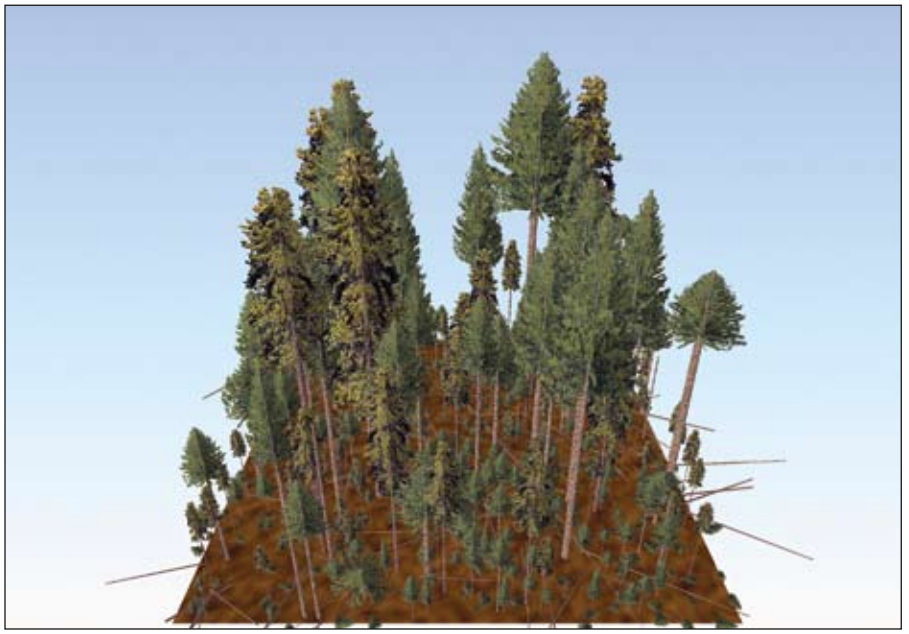
Thin from below to 50 tpa, 18-in d.b.h. limit



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 1,817 trees per acre (tpa) composed primarily of white fir and hardwood understory with ponderosa pine and sugar pine overstory. Canopy bulk density is 0.05 kg/m^3 (0.0031 lb/ft^3), and canopy base height is 6 ft, so ladder fuels and canopy fuels are not sufficient to enable crown fire under moderate or severe fire weather. Woody fuel loading is 18 tons/ac, and litter and duff loading is 16 tons/ac. Potential flame lengths are 3 ft, and potential basal area mortality is 15 percent for severe fire. With no action, canopy base height decreases and canopy bulk density increases in 10 years as smaller trees grow into the overstory, and passive crown fire is predicted for moderate and severe fire weather. In 20 years, canopy base height increases again, but surface fuels also increase potential flame lengths, so passive crown fire remains likely for severe fire weather, and surface fire is predicted for moderate fire weather. Surface fuels continue to accumulate contributing to higher potential flame lengths; in 50 years flame lengths are 9 ft and 12 ft for moderate and severe fire weather, respectively.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment reduces crown fire potential, flame lengths, and basal area mortality, but creates many snags that contribute to higher surface fuel loadings and potential flame lengths in 10 years. In the short term, all thinning treatments increase canopy base height and reduce crown fire potential and basal area mortality; the greater the thinning, the greater is the reduction in crown fire potential and basal area mortality. However, if no surface fuel treatment is applied, activity fuels increase potential flame lengths in all treatments. Both the pile and burn and prescribed fire treatments reduce surface fuel loading in all size classes, decreasing potential flame lengths and basal area mortality to below initial conditions. Canopy bulk density is low enough under initial conditions that none of the treatments are sufficient to reduce canopy bulk density, but active crown fire is unlikely, so reductions in canopy bulk density are not necessary in this stand.

Silvicultural and surface fuel treatments—long-term effects

In the prescribed fire only treatment, crown fire potential increases slightly over time as surface fuels accumulate, but predicted fire type remains surface fire for 50 years, and potential flame lengths remain low. Surface fuels accumulate rapidly in the low-density treatments with no surface fuel treatment, and flame lengths exceed 10 ft in 20 years, but canopy base height also increases as the trees grow and the stand self-thins. Canopy base height remains high relative to flame lengths in the 50 tpa treatment with a pile and burn, and in the 100 tpa treatment with no surface fuel treatment and pile and burn, so predicted fire type is surface fire for 50 years. In the 50 tpa treatment without surface fuel treatment the combination of regeneration and high activity fuels creates conditions conducive to passive crown fire in 20 years. Regeneration causes a decrease in canopy base height in the 50 tpa and 100 tpa treatments with prescribed fire in 20 years, and passive crown fire is the predicted fire type for severe and moderate fire weather. In the higher density treatments, canopy base height continues to increase, and the predicted fire type remains surface fire for the 50-year projection.

Table 19a—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	5	5	4	4
		3–6 in	7	1	7	7	7	7
		6–12 in	8	4	7	7	8	8
		>12 in	0	0	0	0	0	0
		Litter	1	1	1	1	1	1
		Duff	15	10	13	14	15	15
	Flame length (ft)	Moderate	2	1	3	3	3	3
		Severe	3	1	5	4	4	4
	Torching index	Severe	50	994	205	144	128	75
	Crowning index	Severe	43	46	43	43	43	43
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	15	9	8	10	12	13
		Severe	15	9	8	11	13	14
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			1	1	1	1
		3–6 in			2	2	2	2
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			12	13	13	13
	Flame length (ft)	Moderate			1	1	1	1
		Severe			1	1	1	1
	Torching index	Severe			1,060	697	522	315
	Crowning index	Severe			43	43	43	43
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			8	10	12	13
		Severe			8	10	12	13
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	5
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			9	10	10	10
	Flame length (ft)	Moderate			1	1	1	1
		Severe			1	1	1	1
	Torching index	Severe			1,015	1,046	972	983
	Crowning index	Severe			46	46	46	46
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			7	8	9	9
		Severe			7	8	9	9

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

Table 19b—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	7	15	20	23	25	1	6	7	8	11	13
		3–6 in	7	7	8	8	10	12	1	3	3	3	3	3
		6–12 in	8	8	9	10	11	12	4	5	6	5	5	5
		>12 in	0	3	10	16	22	28	0	4	10	12	13	16
		Litter	1	1	1	2	2	2	1	1	1	1	1	1
		Duff	15	15	15	15	14	15	10	10	10	10	10	10
	Flame length (ft)	Moderate	2	3	6	7	8	9	1	3	4	4	5	6
		Severe	3	5	8	10	11	12	1	4	5	6	7	8
	Torching index	Severe	50	0	1	1	6	15	994	270	146	74	75	82
	Crowning index	Severe	43	34	27	25	25	26	46	42	39	41	41	42
	Type of fire	Moderate	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Passive	Passive	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	246	472	403	289	259	213	475	42	27	26	27	28
		18–29.9 in	29	32	31	28	27	25	32	29	21	17	15	13
		30–36 in	8	9	11	12	13	14	9	8	7	7	7	7

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	5	7	8	9	10	11	5	6	8	9	12	15
		3–6 in	7	7	6	5	5	4	7	7	6	6	5	5
		6–12 in	7	7	6	5	5	4	7	7	7	6	6	7
		>12 in	0	3	7	8	9	10	0	3	6	8	10	14
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	13	13	13	13	12	12	14	14	14	13	13	13
	Flame length (ft)	Moderate	3	3	4	4	4	5	3	3	4	4	5	6
		Severe	5	5	6	6	6	7	4	5	6	6	7	9
	Torching index	Severe	205	170	0	15	47	69	144	122	98	106	112	117
	Crowning index	Severe	43	40	38	40	42	45	43	38	36	39	40	44
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	40	34	24	17	14	15	41	35	25	26	34	41
		18–29.9 in	26	23	19	14	12	12	26	23	18	16	16	19
		30–36 in	7	7	6	6	6	6	7	7	6	6	7	8

Table 19b—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	1	4	6	8	10	12	1	4	6	9	12	15
		3–6 in	2	2	2	2	2	3	2	2	2	3	3	3
		6–12 in	2	3	3	3	2	3	2	3	3	3	4	5
		>12 in	0	3	6	8	9	11	0	3	6	8	11	14
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	12	12	11	11	11	11	13	12	12	12	12	12
	Flame length (ft)	Moderate	1	2	3	3	4	5	1	2	3	3	5	6
		Severe	1	2	4	5	6	7	1	3	5	5	7	8
	Torching index	Severe	1,060	734	25	244	206	187	697	499	120	25	124	121
	Crowning index	Severe	43	38	36	37	39	41	43	37	35	37	39	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	Surface
	Hard snags (stems/ac)	0–17.9 in	40	34	24	18	19	18	41	35	28	28	34	37
		18–29.9 in	26	23	19	14	12	12	26	23	19	16	16	19
		30–36 in	7	7	6	6	6	6	7	7	6	6	7	10
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	4	6	8	10	11	0	4	6	8	10	11
		3–6 in	2	3	2	2	3	3	2	3	3	3	3	3
		6–12 in	4	5	5	5	4	4	4	6	6	5	5	4
		>12 in	0	4	10	12	13	15	0	4	10	11	13	14
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	9	9	9	9	9	9	13	10	9	9	9	9
	Flame length (ft)	Moderate	1	2	3	4	5	5	1	3	4	4	5	5
		Severe	1	3	5	6	7	7	1	4	5	6	7	7
	Torching index	Severe	1,015	432	0	39	66	71	1,046	325	0	17	42	50
	Crowning index	Severe	46	42	40	42	44	45	46	41	39	40	40	40
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	49	41	28	28	26	22	58	41	28	19	21	20
		18–29.9 in	32	28	22	17	14	12	32	28	22	15	13	12
		30–36 in	9	8	7	7	7	6	9	8	8	7	6	6

Table 19b—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	6	9	11	14	19	4	6	9	12	17	20
		3–6 in	7	6	6	6	6	8	7	7	6	6	7	7
		6–12 in	8	7	7	7	7	9	8	8	8	7	9	11
		>12 in	0	3	7	9	13	18	0	3	7	10	14	20
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	15	14	14	14	14	14	15	15	15	14	14	14
	Flame length (ft)	Moderate	3	3	4	5	6	7	3	3	5	5	7	8
		Severe	4	5	6	7	8	10	4	5	6	7	9	11
	Torching index	Severe	128	113	82	86	78	57	75	66	43	51	45	40
	Crowning index	Severe	43	38	36	38	37	37	43	39	37	41	40	40
	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	44	46	41	37	54	53	49	55	53	68	71	68
		18–29.9 in	26	24	21	17	19	17	26	25	22	20	22	24
		30–36 in	7	7	7	7	9	9	7	7	7	8	10	12
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	1	4	7	10	14	19	1	4	8	11	17	22
		3–6 in	2	2	3	3	4	6	2	2	3	3	5	6
		6–12 in	2	3	3	4	5	7	2	3	4	4	6	9
		>12 in	0	3	7	9	13	18	0	3	7	10	14	21
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	13	13	13	13	12	12	13	13	13	13	13	13
	Flame length (ft)	Moderate	1	2	3	4	6	7	1	2	3	5	6	8
		Severe	1	3	5	6	8	10	1	3	5	6	9	11
	Torching index	Severe	522	423	115	107	83	73	315	256	69	64	50	47
	Crowning index	Severe	43	38	36	38	37	39	43	39	37	41	41	43
	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	44	46	41	37	55	51	49	55	53	69	77	69
		18–29.9 in	26	24	21	17	19	21	26	25	22	20	24	23
		30–36 in	7	7	7	7	9	11	7	7	7	8	10	11

Table 19b—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	5	7	8	10	12	0	5	7	8	11	13
		3–6 in	2	3	3	3	3	3	2	4	3	3	3	4
		6–12 in	4	6	6	5	5	5	5	6	6	5	5	5
		>12 in	0	4	10	11	12	14	0	4	10	11	13	15
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	10	10	10	10	10	10	10	10	10	10	10	10
	Flame length (ft)	Moderate	1	3	4	4	5	5	1	3	4	4	5	6
		Severe	1	4	6	6	7	7	1	4	6	6	7	8
	Torching index	Severe	972	275	145	17	51	68	983	263	141	19	53	64
	Crowning index	Severe	46	42	39	40	41	41	46	41	39	41	41	42
	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	76	41	27	22	23	25	97	41	28	27	26	34
		18–29.9 in	32	28	21	15	14	14	32	28	21	16	14	16
		30–36 in	9	8	7	7	7	7	9	8	7	7	7	8

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

Table 19c—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	1,817	1,306	948	694	461	312	144	143	142	132	122	109
	Quadratic mean diameter (in)	5.4	6.7	8.2	9.9	12.1	14.7	5.4	18.8	20.0	21.6	23.3	25.5
	Total volume (ft^3)	12,433	13,449	14,479	15,479	16,141	16,941	12,295	13,297	15,474	17,365	19,276	21,105
	Merchantable volume (ft^3)	11,325	12,047	12,729	13,468	14,311	15,437	11,386	12,275	14,265	16,081	17,979	19,720
	Basal area (ft^2)	289	322	349	370	369	367	260	276	310	337	364	387
	Stand density index	676	690	692	682	627	578	377	394	432	456	477	490
	Canopy closure (percent)	69	79	80	79	75	71	52	55	59	61	63	65
	Crown competition factor	136	218	193	170	140	119	66	70	77	81	85	87
	Canopy base height (ft)	6	3	10	15	20	26	40	44	45	28	32	38
	Canopy bulk density (kg/m^3)	0.05	0.06	0.08	0.09	0.09	0.09	0.04	0.05	0.05	0.05	0.05	0.05

Table 19c—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	1,817	50	99	98	96	94	89	100	124	121	112	99	84
	Quadratic mean diameter (in)	5.4	30.7	22.8	24.0	25.2	26.2	27.5	22.3	21.2	22.5	24.1	26.2	28.4
	Total volume (ft^3)	12,433	12,951	13,971	15,870	17,932	19,697	21,222	13,284	14,407	16,682	18,510	19,887	20,831
	Merchantable volume (ft^3)	11,325	12,098	13,054	14,848	16,801	18,458	19,910	12,330	13,356	15,517	17,253	18,591	19,549
	Basal area (ft^2)	289	256	282	306	332	352	368	270	302	335	357	369	369
	Stand density index	676	302	373	397	423	441	453	361	412	445	461	462	448
	Canopy cover (percent)	69	48	52	55	58	60	62	53	57	61	62	63	62
	Crown competition factor	136	54	58	66	70	74	76	64	70	78	80	80	77
	Canopy base height (ft)	6	44	48	4	10	21	30	27	33	34	40	47	54
	Canopy bulk density (kg/m^3)	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.06	0.05	0.05	0.04
Pile and burn	Trees per acre	1,817	50	125	124	121	114	108	1,644	137	132	122	109	95
	Quadratic mean diameter (in)	5.4	30.7	20.3	21.3	22.5	23.8	25.0	5.0	20.1	21.5	23.1	24.9	26.6
	Total volume (ft^3)	12,433	12,951	13,971	15,881	17,953	19,602	21,133	13,284	14,407	16,492	18,421	19,935	20,611
	Merchantable volume (ft^3)	11,325	12,098	13,054	14,849	16,788	18,335	19,749	12,330	13,356	15,341	17,161	18,635	19,296
	Basal area (ft^2)	289	256	282	307	334	352	368	361	302	331	355	369	368
	Stand density index	676	302	391	418	444	458	470	64	421	449	468	472	459
	Canopy cover (percent)	69	48	52	57	60	62	63	53	57	60	62	63	62
	Crown competition factor	136	54	58	70	75	77	80	112	70	78	81	81	79
	Canopy base height (ft)	6	44	48	6	56	63	67	27	33	34	10	47	54
	Canopy bulk density (kg/m^3)	0.05	0.05	0.05	0.06	0.06	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05
Prescribed fire	Trees per acre	1,817	50	193	190	180	170	161	100	136	133	131	124	117
	Quadratic mean diameter (in)	5.4	30.7	15.7	16.7	17.8	18.8	20.0	22.3	19.0	20.1	21.3	22.6	23.9
	Total volume (ft^3)	12,433	12,143	13,092	14,924	16,552	18,099	19,849	12,293	13,296	15,187	17,238	18,969	20,637
	Merchantable volume (ft^3)	11,325	11,354	12,259	13,943	15,439	16,833	18,397	11,466	12,398	14,198	16,106	17,724	19,334
	Basal area (ft^2)	289	256	260	289	309	327	350	270	269	295	323	344	363
	Stand density index	676	302	399	432	451	467	488	361	382	410	440	457	472
	Canopy cover (percent)	69	48	49	57	60	62	64	53	51	56	59	61	63
	Crown competition factor	136	54	53	74	77	80	84	64	58	68	73	76	79
	Canopy base height (ft)	6	44	49	4	16	28	36	44	47	4	10	20	29
	Canopy bulk density (kg/m^3)	0.05	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05

Table 19c—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	1,817	200	201	186	170	135	107	300	291	263	220	179	141
	Quadratic mean diameter (in)	5.4	16.0	16.9	18.4	20.0	22.4	25.5	13.2	14.1	15.6	17.5	19.4	21.9
	Total volume (ft^3)	12,433	13,403	14,425	16,514	18,522	19,163	20,311	13,443	14,361	16,343	17,952	18,696	19,217
	Merchantable volume (ft^3)	11,325	12,284	13,156	15,168	17,066	17,836	18,973	12,260	13,014	14,815	16,464	17,284	17,880
	Basal area (ft^2)	289	280	312	343	369	369	379	284	317	349	369	369	369
	Stand density index	676	426	465	494	515	492	481	467	507	537	541	520	496
	Canopy cover (percent)	69	57	60	63	65	64	63	60	64	66	67	66	64
	Crown competition factor	136	78	83	89	92	87	85	91	97	102	101	94	88
	Canopy base height (ft)	6	19	28	31	36	39	44	11	17	19	25	30	39
	Canopy bulk density (kg/m^3)	0.05	0.05	0.05	0.06	0.05	0.06	0.06	0.05	0.05	0.06	0.05	0.05	0.05
Pile and burn	Trees per acre	1,817	200	206	189	173	137	116	300	298	270	226	181	148
	Quadratic mean diameter (in)	5.4	16.0	16.7	18.2	19.8	22.2	24.2	13.2	14.0	15.4	17.3	19.3	21.3
	Total volume (ft^3)	12,433	13,403	14,425	16,504	18,506	19,144	19,707	13,443	14,361	16,357	17,926	18,744	19,660
	Merchantable volume (ft^3)	11,325	12,284	13,156	15,159	17,049	17,820	18,379	12,260	13,014	14,826	16,437	17,332	18,286
	Basal area (ft^2)	289	280	312	343	369	369	368	284	317	350	369	369	369
	Stand density index	676	426	467	496	517	494	477	467	509	540	545	521	501
	Canopy cover (percent)	69	57	60	63	65	64	63	60	64	66	67	66	65
	Crown competition factor	136	78	83	89	92	87	84	91	97	103	102	96	90
	Canopy base height (ft)	6	19	28	31	36	38	45	11	17	19	25	29	39
	Canopy bulk density (kg/m^3)	0.05	0.05	0.05	0.06	0.05	0.06	0.05	0.05	0.05	0.06	0.05	0.05	0.05
Prescribed fire	Trees per acre	1,817	200	133	131	126	118	110	300	154	151	141	131	116
	Quadratic mean diameter (in)	5.4	16.0	19.4	20.6	22.0	23.4	24.9	13.2	18.2	19.3	20.8	22.4	24.1
	Total volume (ft^3)	12,433	12,345	13,362	15,472	17,524	19,233	20,698	12,352	13,393	15,510	17,348	19,204	20,460
	Merchantable volume (ft^3)	11,325	11,461	12,378	14,354	16,341	17,956	19,359	11,451	12,384	14,337	16,121	17,906	19,135
	Basal area (ft^2)	289	280	274	305	333	353	369	284	276	309	334	358	369
	Stand density index	676	426	387	420	447	463	472	467	400	436	458	477	478
	Canopy cover (percent)	69	57	53	57	60	62	63	60	54	58	61	63	64
	Crown competition factor	136	78	63	72	76	79	80	91	66	75	79	82	82
	Canopy base height (ft)	6	40	46	46	10	23	32	40	46	45	11	25	32
	Canopy bulk density (kg/m^3)	0.05	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 19d—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	60	10	40					8	100						
	10	10	99	12	1					10	54	8	46				
	20	12	79	10	21					10	96	12	4				
	30	12	68	13	32					10	85	12	15				
	40	13	78	12	22					10	65	12	35				
	50	13	100							12	63	10	37				

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*				
None	1	10	65	8	35					10	59	8	41				
	10	10	90	8	10					10	90	8	10				
	20	10	89	12	11					10	89	12	11				
	30	10	82	12	18					10	77	12	23				
	40	10	78	12	22					10	56	12	44				
	`50	10	68	12	32					12	81	10	19				
Pile and burn	1	8	100							8	100						
	10	8	87	10	13					8	85	10	15				
	20	10	57	8	43					10	100						
	30	10	86	8	14					10	99	12	1				
	40	10	91	12	9					10	72	12	28				
	50	10	71	12	29					12	68	10	32				
Prescribed fire	1	8	100							8	100						
	10	8	69	10	31					8	56	10	44				
	20	10	90	8	10					10	99	12	1				
	30	10	90	12	10					10	86	12	14				
	40	10	73	12	27					10	73	12	27				
	50	10	57	12	43					10	56	12	44				

Table 19d—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	8	52	10	48					8	53	10	47				
	10	10	87	8	13					10	89	8	11				
	20	10	80	12	20					10	73	12	27				
	30	10	58	12	42					12	53	10	47				
	40	12	75	10	25					12	98	13	2				
	50	12	68	13	32					12	54	13	46				
Pile and burn	1	8	100							8	100						
	10	8	83	10	17					8	81	10	19				
	20	10	100							10	100						
	30	10	83	12	17					10	73	12	27				
	40	12	55	10	45					12	84	10	16				
	50	12	82	13	18					13	52	12	48				
Prescribed fire	1	8	100							8	100						
	10	10	54	8	46					10	58	8	42				
	20	10	96	12	4					10	94	12	6				
	30	10	87	12	13					10	83	12	17				
	40	10	71	12	29					10	63	12	37				
	50	10	52	12	48					12	60	10	40				

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

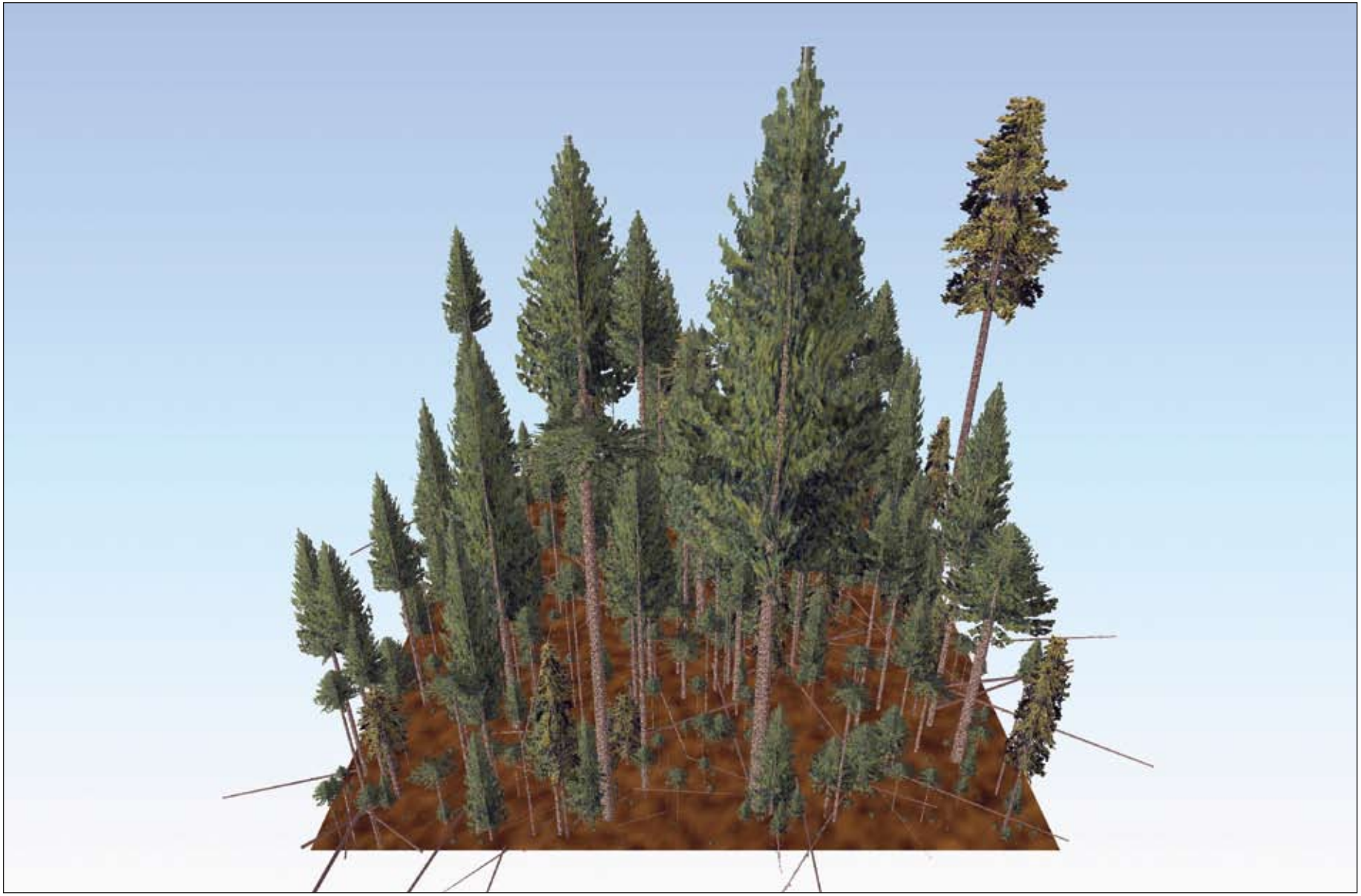
Table 19e—FVS fuel model selection

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	17	83	2	5	10	15	50	100
Moderate—75th percentile	11	72	5	7	15	17	125	150

Table 19f—Prescribed fire weather conditions used in models

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

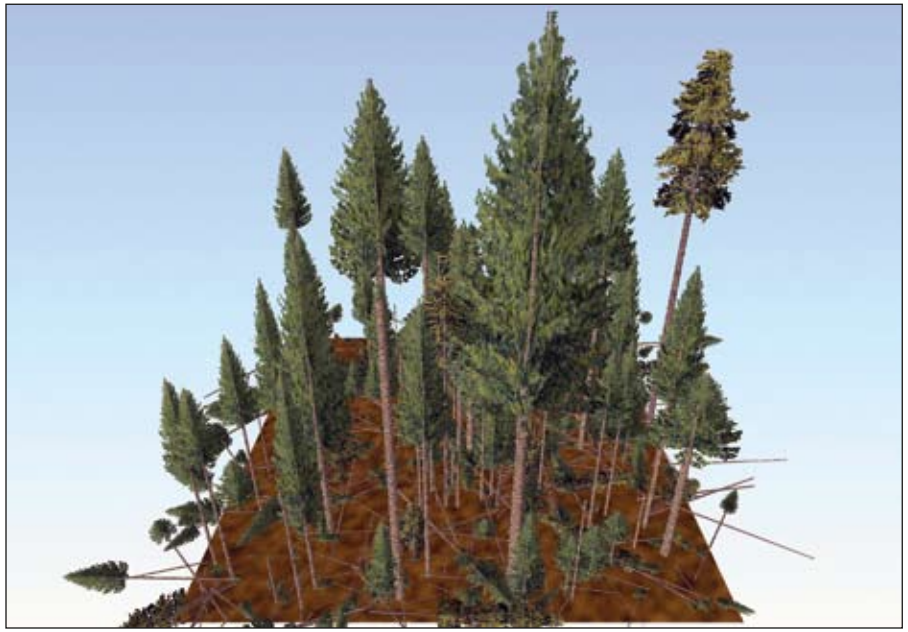
*Moisture categories correspond to variant-specific percentage moisture values from Reinhardt and Crookston (2003).



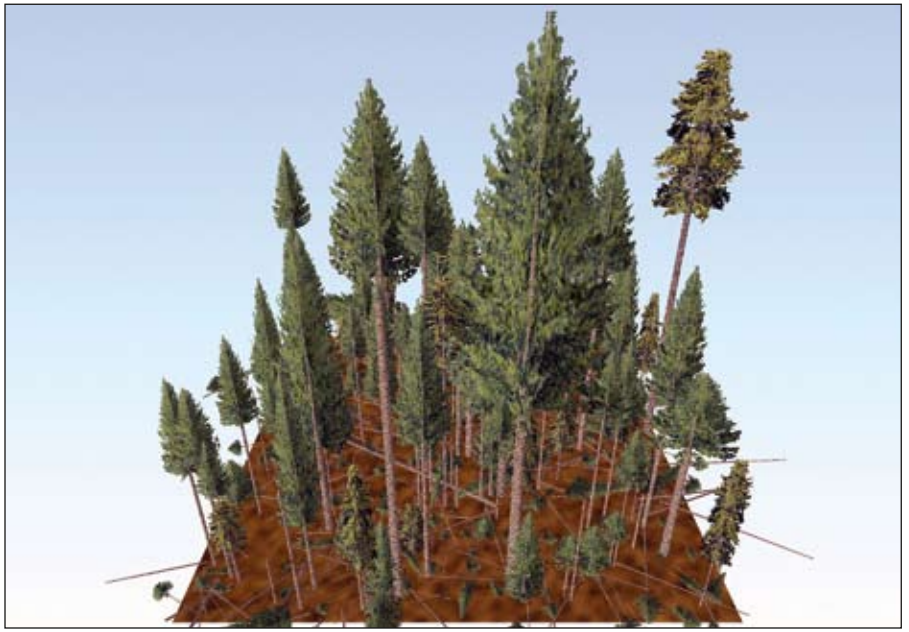
Initial stand conditions

Site: Elevation = 4,600 ft, slope = 20 percent, aspect = 135°.
Species (based on trees per acre): Hardwoods = 58 percent, white fir (*Abies concolor*) = 37 percent, sugar pine (*Pinus lambertiana*) = 3 percent, ponderosa pine (*Pinus ponderosa*) = 2 percent.

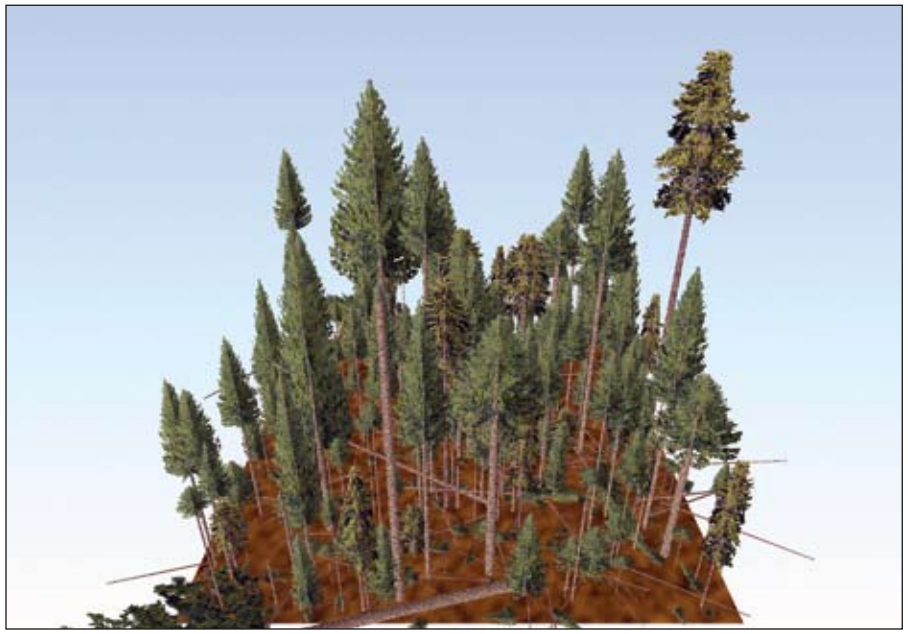
Stand attributes: Stem density = 1,991 tpa, basal area = 272 ft^2/ac, top height = 112 ft, stand density index = 655, quadratic mean diameter = 5.0 in, crown competition factor = 103, canopy cover = 63 percent.



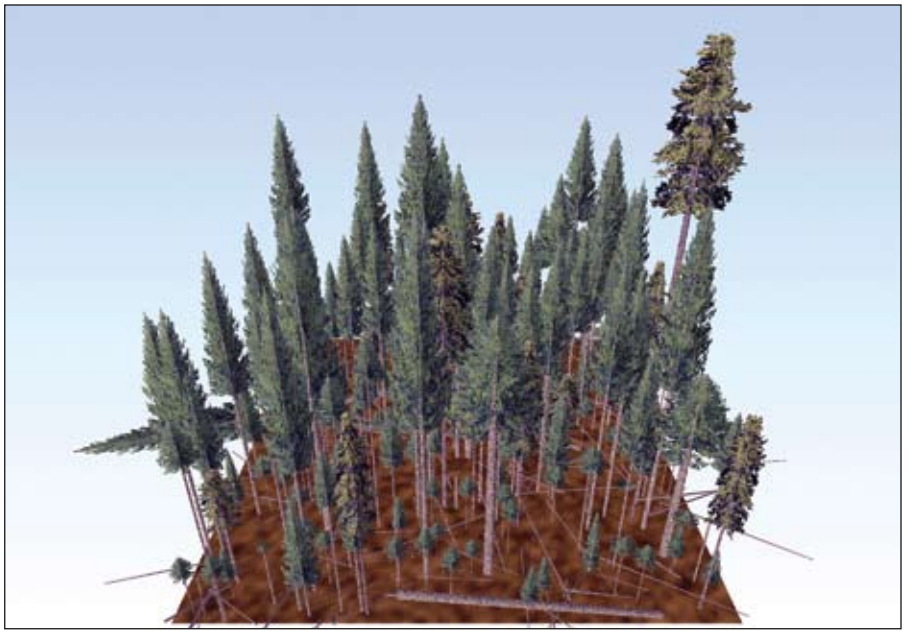
Thin from below to 50 tpa, 18-in d.b.h. limit



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 1,991 trees per acre (tpa) composed primarily of white fir and hardwood understory with ponderosa pine and sugar pine overstory. Canopy bulk density is 0.13 kg/m^3 (0.0081 lb/ft^3), and canopy base height is 6 ft, so ladder fuels are sufficient to enable passive crown fire, but active crown fire spread is unlikely under moderate and severe fire weather. Woody fuel loading is 18 tons/ac, and litter and duff loading is 22 tons/ac. Potential flame lengths are 4 ft, and potential basal area mortality is 87 percent for severe fire. With no action, canopy base height decreases and canopy bulk density increases in 10 years as smaller trees grow into the overstory, and active crown fire is predicted for severe fire weather. As trees grow and the stand self-thins, canopy base height increases and canopy bulk density decreases, so predicted fire type changes to passive crown fire for severe fire weather in 20 years and remains so for the 50-year projection. Surface fuels accumulate rapidly and flame lengths increase over time; in 50 years, flame lengths are 7 ft and 10 ft for moderate and severe fire weather, respectively.

Silvicultural and surface fuel treatments—immediate effects

The prescribed fire only treatment raises canopy base height and reduces crown fire potential, but it creates many snags that contribute to higher surface fuel loadings and potential flame lengths in 10 years. In the short term, all thinning treatments increase canopy base height, reducing crown fire potential. The greater the thinning, the more canopy base height increases, but there is little difference between the 200 and 300 tpa treatments. Only the lower density treatments reduce canopy bulk density. However, they increase surface fuels causing higher potential flame lengths; higher density treatments have little effect on surface fuels and flame lengths. The pile and burn and prescribed fire treatments reduce surface fuels, potential flame lengths, and basal area mortality. Mortality of smaller overstory trees in the prescribed fire treatment also further increases canopy base height. In the 50 tpa treatment, potential flame lengths remain high for severe fire weather despite reduction of activity fuels because the predominant fuel model is 5, suggesting that brush fuels would drive fire behavior in these open stands with low woody fuels. The FFE model does not track brush fuels directly, so results should be interpreted with caution.

Silvicultural and surface fuel treatments—long-term effects

In the prescribed fire only treatment, potential flame lengths increase over time as surface fuels accumulate, but canopy base height also increases, so predicted fire type remains surface fire for 50 years. Regeneration is sufficient to cause a decrease in canopy base height in 20 years in the 50 tpa treatment without surface fuel treatment and with prescribed fire, and in the 100 tpa treatment with prescribed fire. At this time, the predicted fire type becomes passive crown fire, but canopy base height increases again in 30 years and the fire type reverts to surface fire. Surface fuels and potential flame lengths increase over time in the 200 and 300 tpa treatment, but canopy base height also increases as trees grow and the stand self-thins, so crown fire potential remains low for the 50-year projection. Canopy bulk density remains low enough that active crown fire is unlikely in all treatments for the 50-year projection.

Table 20a—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	9	6	4	4
		3–6 in	7	1	6	7	7	7
		6–12 in	7	3	5	6	7	7
		>12 in	0	0	0	0	0	0
		Litter	1	1	1	1	1	1
		Duff	21	15	17	19	20	21
	Flame length (ft)	Moderate	3	1	3	3	3	3
		Severe	4	1	5	4	5	4
	Torching index	Severe	15	444	121	82	53	18
	Crowning index	Severe	20	26	33	27	20	20
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Surface	Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate	19	14	8	12	18	19
		Severe	87	14	10	13	21	22
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in			2	2	1	1
		3–6 in			2	2	2	2
		6–12 in			2	2	2	2
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			15	17	18	19
	Flame length (ft)	Moderate			1	1	3	3
		Severe			5	1	5	4
	Torching index	Severe			208	468	53	18
	Crowning index	Severe			33	27	20	20
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			8	12	17	19
		Severe			9	12	19	20
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in			0	0	0	0
		3–6 in			2	2	2	2
		6–12 in			3	4	4	4
		>12 in			0	0	0	0
		Litter			1	1	1	1
		Duff			12	13	14	15
	Flame length (ft)	Moderate			1	1	1	1
		Severe			5	1	1	1
	Torching index	Severe			166	456	439	444
	Crowning index	Severe			36	32	26	26
	Type of fire	Moderate			Surface	Surface	Surface	Surface
		Severe			Surface	Surface	Surface	Surface
	Potential basal area mortality (%)	Moderate			8	11	13	14
		Severe			9	11	13	14

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

Table 20b—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	11	23	28	30	33	1	8	11	13	15	19
		3–6 in	7	7	7	8	9	11	1	3	3	3	3	4
		6–12 in	7	9	12	15	18	20	3	9	10	9	9	11
		>12 in	0	3	9	14	19	27	0	4	9	11	13	18
		Litter	1	2	2	2	2	2	1	1	1	1	1	1
		Duff	21	21	20	20	20	20	15	14	14	14	14	14
	Flame length (ft)	Moderate	3	3	6	7	7	7	1	3	4	5	5	6
		Severe	4	5	8	9	10	10	1	5	6	7	8	9
	Torching index	Severe	15	0	4	6	13	23	444	134	121	101	118	101
	Crowning index	Severe	20	14	18	20	23	20	26	27	29	29	29	31
	Type of fire	Moderate	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Passive	Active	Passive	Passive	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	354	637	482	305	279	185	566	62	29	30	42	53
		18–29.9 in	18	19	19	18	20	25	21	18	13	11	14	22
		30–36 in	5	5	5	5	6	7	5	5	4	4	4	5

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	9	9	9	10	10	11	6	9	11	13	15	18
		3–6 in	6	5	5	4	4	3	7	6	5	5	4	4
		6–12 in	5	6	7	6	5	5	6	7	7	7	7	8
		>12 in	0	3	6	7	8	8	0	3	6	8	9	14
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	17	16	16	16	15	15	19	18	18	18	18	17
	Flame length (ft)	Moderate	3	3	4	4	4	4	3	3	4	4	5	6
		Severe	5	6	6	6	6	6	4	5	6	6	7	8
	Torching index	Severe	121	127	2	19	49	73	82	118	144	148	185	178
	Crowning index	Severe	33	36	38	39	37	37	27	27	30	29	29	30
	Type of fire	Moderate	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	70	53	21	11	9	9	71	54	23	21	28	43
		18–29.9 in	17	15	11	8	6	6	17	15	11	9	11	19
		30–36 in	5	4	4	4	3	3	5	4	4	4	4	4

Table 20b—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	5	6	8	9	10	2	5	9	12	14	17
		3–6 in	2	2	2	2	2	2	2	2	2	2	2	3
		6–12 in	2	3	4	4	3	3	2	3	4	4	5	6
		>12 in	0	3	6	7	7	7	0	3	6	7	9	13
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	15	15	14	14	14	14	17	17	16	16	16	16
	Flame length (ft)	Moderate	1	2	2	3	3	3	1	2	3	4	4	5
		Severe	5	4	4	4	5	5	1	3	4	5	6	8
	Torching index	Severe	208	250	20	281	109	116	468	389	233	26	194	185
	Crowning index	Severe	33	34	36	36	35	34	27	27	29	29	29	32
	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	53	20	9	8	11	71	54	21	23	29	42
		18–29.9 in	17	15	11	6	6	6	17	15	10	9	11	21
		30–36 in	5	4	4	3	3	3	5	4	4	4	4	5
Prescribed fire	Surface fuel loadings (tons/ac)	0–3 in	0	4	6	8	9	11	0	5	8	10	12	14
		3–6 in	2	2	2	2	2	2	2	3	3	2	2	2
		6–12 in	3	5	6	5	5	4	4	7	8	7	7	7
		>12 in	0	4	9	10	10	10	0	4	9	11	12	13
		Litter	1	1	1	1	1	1	1	1	1	1	1	1
		Duff	12	11	11	11	11	11	17	13	13	13	12	12
	Flame length (ft)	Moderate	1	2	3	3	3	4	1	2	4	4	4	5
		Severe	5	5	5	5	5	6	1	4	6	6	7	7
	Torching index	Severe	166	189	11	44	77	85	456	219	2	16	36	46
	Crowning index	Severe	36	38	39	38	38	37	32	31	32	32	32	32
	Type of fire	Moderate	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
		Severe	Surface	Surface	Passive	Surface	Surface	Surface	Surface	Surface	Passive	Surface	Surface	Surface
	Hard snags (stems/ac)	0–17.9 in	72	53	25	12	12	19	86	62	28	17	22	22
		18–29.9 in	21	19	13	8	7	7	21	19	13	9	9	10
		30–36 in	5	5	4	4	3	3	5	5	4	4	4	3

Table 20b—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	9	14	18	21	22	4	9	14	19	24	25
		3–6 in	7	6	6	6	7	7	7	6	6	6	8	8
		6–12 in	7	8	9	11	14	18	7	8	9	11	16	21
		>12 in	0	3	7	10	15	23	0	3	7	10	17	25
		Litter	1	1	1	2	1	1	1	1	2	2	1	1
		Duff	20	20	20	19	19	19	21	20	20	20	20	20
	Flame length (ft)	Moderate	3	3	5	6	7	7	3	3	5	6	7	8
		Severe	5	5	7	8	10	10	4	5	7	8	10	11
	Torching index	Severe	53	75	71	79	102	89	18	57	51	45	39	41
	Crowning index	Severe	20	22	24	26	26	28	20	22	23	28	28	29
	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	75	70	52	72	85	62	84	81	62	95	103	90
		18–29.9 in	16	15	13	14	14	22	17	16	13	18	19	21
		30–36 in	5	4	4	4	5	5	5	4	4	5	5	6
Pile and burn	Surface fuel loadings (tons/ac)	0–3 in	1	7	13	17	21	22	1	7	13	18	23	25
		3–6 in	2	2	3	3	4	5	2	2	3	4	5	6
		6–12 in	2	4	6	8	12	16	2	4	6	8	13	19
		>12 in	0	3	7	10	15	23	0	3	7	10	17	25
		Litter	1	1	1	2	1	1	1	2	2	2	1	1
		Duff	18	18	18	17	17	17	19	18	18	18	18	18
	Flame length (ft)	Moderate	3	3	4	5	6	7	3	3	4	5	7	8
		Severe	5	4	6	7	9	10	4	4	6	8	10	11
	Torching index	Severe	53	91	87	85	113	93	18	69	64	53	42	57
	Crowning index	Severe	20	22	24	26	26	29	20	22	23	28	29	30
	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	75	70	53	80	86	61	84	81	63	96	104	98
		18–29.9 in	16	15	13	13	14	23	17	16	13	19	19	20
		30–36 in	5	4	4	4	5	5	5	4	4	5	5	5

Table 20b—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	7	10	13	15	17	0	7	10	13	15	18
		3–6 in	2	4	4	3	3	4	2	4	4	4	4	4
		6–12 in	4	9	10	10	10	11	4	10	10	10	10	12
		>12 in	0	4	9	11	14	17	0	4	9	11	14	18
		Litter	1	1	1	1	1	2	1	1	1	1	1	1
		Duff	14	14	14	14	13	13	15	14	14	14	14	14
	Flame length (ft)	Moderate	1	3	4	5	5	6	1	3	4	5	5	6
		Severe	1	5	6	7	8	9	1	5	6	7	8	9
	Torching index	Severe	439	136	122	15	141	128	444	133	124	16	130	103
	Crowning index	Severe	26	26	29	29	29	31	26	26	28	29	29	31
	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	101	62	34	34	41	47	124	62	38	36	46	62
		18–29.9 in	21	19	14	11	13	21	21	18	14	11	14	24
		30–36 in	5	5	4	4	4	7	5	5	5	4	4	5

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

Table 20c—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	1,991	1,312	914	677	453	352	139	138	135	122	106	89
	Quadratic mean diameter (in)	5.0	6.6	8.2	9.8	12.0	13.6	5.0	18.8	20.5	22.6	24.9	27.2
	Total volume (ft^3)	10,448	12,846	14,967	16,818	17,804	18,189	10,597	12,351	15,948	18,736	20,441	21,058
	Merchantable volume (ft^3)	9,483	11,605	13,472	15,034	15,907	16,440	9,751	11,393	14,828	17,482	19,158	19,765
	Basal area (ft^2)	272	313	337	358	358	357	241	264	310	342	357	358
	Stand density index	655	675	668	660	610	580	352	378	428	454	457	442
	Canopy closure (percent)	63	78	78	77	72	69	50	52	57	59	59	58
	Crown competition factor	103	204	174	154	128	115	65	69	78	81	81	77
	Canopy base height (ft)	6	3	10	14	19	25	19	43	53	47	55	58
	Canopy bulk density (kg/m^3)	0.13	0.22	0.16	0.13	0.11	0.13	0.09	0.09	0.08	0.08	0.08	0.07

Table 20c—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	140	135	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	18.4	19.0
	Total volume (ft^3)	8,192	5,961	6,089	6,298	6,514	6,734	6,947	7,540	7,782	8,193	8,528	8,850	9,152
	Merchantable volume (ft^3)	7,490	5,820	5,946	6,152	6,381	6,597	6,790	7,321	7,550	7,970	8,305	8,626	8,894
	Basal area (ft^2)	252	163	167	173	178	184	189	210	221	232	241	249	257
	Stand density index	532	213	268	273	279	284	289	295	332	344	352	359	366
	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	39	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	0.10
Pile and burn	Trees per acre	947	55	203	199	194	190	185	100	173	169	164	159	153
	Quadratic mean diameter (in)	7.0	23.4	12.3	12.6	13.0	13.3	13.7	19.6	15.3	15.8	16.4	17.0	17.6
	Total volume (ft^3)	8,192	5,961	6,089	6,297	6,524	6,733	6,964	7,540	7,782	8,161	8,527	8,868	9,174
	Merchantable volume (ft^3)	7,490	5,820	5,946	6,152	6,390	6,597	6,799	7,321	7,550	7,939	8,304	8,642	8,913
	Basal area (ft^2)	252	163	167	173	179	184	189	210	221	231	241	250	258
	Stand density index	532	213	283	289	295	301	307	295	343	353	363	371	378
	Canopy cover (percent)	62	36	36	37	37	38	40	46	47	48	48	49	49
	Crown competition factor	215	117	120	123	126	132	137	151	156	161	166	170	174
	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	0.10	0.11
Prescribed fire	Trees per acre	947	55	351	342	335	327	319	100	238	232	227	220	213
	Quadratic mean diameter (in)	7.0	23.4	9.1	9.4	9.7	10.0	10.2	19.6	12.6	13.1	13.6	14.0	14.5
	Total volume (ft^3)	8,192	5,691	5,813	6,011	6,228	6,450	6,667	7,109	7,330	7,701	8,090	8,414	8,729
	Merchantable volume (ft^3)	7,490	5,557	5,677	5,876	6,103	6,316	6,504	6,908	7,120	7,499	7,881	8,204	8,488
	Basal area (ft^2)	252	163	160	165	170	177	183	210	207	217	228	236	245
	Stand density index	532	213	303	309	317	325	332	295	347	358	370	379	387
	Canopy cover (percent)	62	36	35	36	37	39	41	46	45	46	47	47	48
	Crown competition factor	215	117	115	117	121	131	146	151	147	152	157	162	166
	Canopy base height (ft)	3	55	55	54	54	4	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	0.07	0.08	0.09	0.09	0.09	0.10

Table 20c—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	181	170	300	308	291	274	252	228
	Quadratic mean diameter (in)	7.0	15.0	14.9	15.6	16.3	16.9	17.5	12.4	12.5	13.2	13.9	14.5	15.2
	Total volume (ft^3)	8,192	8,257	8,559	8,957	9,438	9,724	9,771	8,444	8,749	9,222	9,669	9,695	9,738
	Merchantable volume (ft^3)	7,490	7,655	7,876	8,455	8,910	9,139	9,188	7,751	7,954	8,600	9,027	8,970	8,913
	Basal area (ft^2)	252	245	254	264	276	283	283	250	264	276	288	287	286
	Stand density index	532	383	399	406	418	421	416	422	443	454	464	455	445
	Canopy cover (percent)	62	56	57	57	58	57	57	59	60	60	61	60	59
	Crown competition factor	215	189	192	195	201	203	200	203	209	214	219	215	210
	Canopy base height (ft)	3	9	16	23	27	32	35	5	5	5	5	5	5
	Canopy bulk density (kg/m^3)	0.13	0.13	0.11	0.11	0.12	0.13	0.14	0.13	0.12	0.12	0.13	0.13	0.14
Pile and burn	Trees per acre	947	200	224	210	202	192	180	300	321	304	287	264	243
	Quadratic mean diameter (in)	7.0	15.0	14.4	15.2	15.8	16.4	17.0	12.4	12.3	12.9	13.5	14.1	14.6
	Total volume (ft^3)	8,192	8,257	8,559	8,955	9,440	9,732	9,782	8,444	8,749	9,243	9,533	9,582	9,633
	Merchantable volume (ft^3)	7,490	7,655	7,876	8,453	8,912	9,146	9,198	7,751	7,954	8,618	8,888	8,853	8,787
	Basal area (ft^2)	252	245	254	264	277	283	283	250	264	277	284	284	284
	Stand density index	532	383	404	411	423	427	421	422	446	459	463	456	448
	Canopy cover (percent)	62	56	57	57	58	57	57	59	60	61	61	60	59
	Crown competition factor	215	189	192	195	201	203	200	203	209	215	217	213	210
	Canopy base height (ft)	3	9	16	23	27	32	35	5	5	5	5	5	5
	Canopy bulk density (kg/m^3)	0.13	0.13	0.11	0.11	0.12	0.13	0.14	0.13	0.12	0.12	0.13	0.13	0.14
Prescribed fire	Trees per acre	947	200	235	221	213	205	198	300	262	247	232	217	197
	Quadratic mean diameter (in)	7.0	15.0	13.7	14.4	15.0	15.6	16.2	12.4	12.9	13.5	14.2	14.9	15.7
	Total volume (ft^3)	8,192	7,856	8,164	8,539	8,988	9,460	9,910	7,688	8,021	8,407	8,752	9,090	9,270
	Merchantable volume (ft^3)	7,490	7,362	7,601	8,121	8,560	8,987	9,445	7,205	7,463	7,979	8,321	8,599	8,766
	Basal area (ft^2)	252	245	241	250	262	273	285	250	237	247	255	264	266
	Stand density index	532	383	390	397	409	420	431	422	393	402	408	412	408
	Canopy cover (percent)	62	56	54	54	55	55	56	59	54	54	54	54	54
	Crown competition factor	215	189	179	183	189	194	200	203	180	184	187	190	189
	Canopy base height (ft)	3	9	16	23	27	32	35	9	6	6	6	6	35
	Canopy bulk density (kg/m^3)	0.13	0.10	0.10	0.10	0.11	0.12	0.12	0.09	0.09	0.10	0.10	0.11	0.11

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

Table 20d—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	100							8	100						
	10	10	78	12	22					10	98	12	2				
	20	12	69	13	31					10	60	12	40				
	30	13	92	12	8					12	59	10	41				
	40	13	100							12	80	10	20				
	50	13	100							12	77	13	23				

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	10	99	5	1					10	70	8	30				
	10	10	92	12	8					10	94	12	6				
	20	10	82	12	18					10	71	12	29				
	30	10	82	12	18					10	57	12	43				
	40	10	81	12	19					12	62	10	38				
	`50	10	80	12	20					12	98	13	2				
Pile and burn	1	5	65	8	35					8	100						
	10	8	47	5	33	10	20			8	70	10	30				
	20	10	63	8	32	5	5			10	90	8	10				
	30	10	83	8	17					10	83	12	17				
	40	10	94	8	6					10	57	12	43				
	50	10	96	12	4					12	83	10	17				
Prescribed fire	1	5	73	8	27					8	100						
	10	5	46	8	29	10	26			10	59	8	41				
	20	10	82	8	12	5	6			10	84	12	16				
	30	10	95	12	5					10	69	12	31				
	40	10	89	12	11					10	54	12	46				
	50	10	80	12	20					12	64	10	36				

Table 20d—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	10	100							10	100						
	10	10	91	12	9					10	91	12	9				
	20	12	59	10	41					12	63	10	37				
	30	12	100							12	92	13	8				
	40	12	51	13	49					13	71	12	29				
	50	13	85	12	15					13	100						
Pile and burn	1	10	100							10	100						
	10	10	100							10	100						
	20	10	74	12	26					10	70	12	30				
	30	12	74	10	26					12	86	10	14				
	40	12	66	13	34					13	55	12	45				
	50	13	72	12	28					13	100						
Prescribed fire	1	8	100							8	100						
	10	10	100	8						10	98	12	2				
	20	10	60	12	40					10	60	12	40				
	30	12	63	10	37					12	61	10	39				
	40	12	85	10	15					12	84	10	16				
	50	12	87	13	13					12	76	13	24				

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

Continue to Part D

Table 20e—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	17	83	2	5	10	15	50	100
Moderate—75th percentile	11	72	5	7	15	17	125	150

Table 20f—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).