Calculating Fire Regime Condition Class, Fire Frequency, and Fire Severity for the Blue Mountains Forest Plan Revision

Bruce Countryman

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This paper will discuss the process for calculating fire regime condition class (FRCC) during the Forest Plan Revision project for the Blue Mountains of Eastern Oregon. The intent of this process was to characterize the landscape for the Malheur, Umatilla, and Wallowa-Whitman National Forests at a variety of scales (primarily HUC 4, 5, and 6) for departure of the current condition from reference values for fire regime condition class, fire frequency, and fire severity. We used information from a variety of sources including: existing vegetation polygon information, current vegetation survey (CVS) data, historic wildfire GIS layer, and the GIS activity layer. Data were processed through the Arc Map FRCC mapping tool extension, the FVS model and fire-fuel extension, and a series of Access database tables. Fire severity and frequency data will be used to adjust the coefficients in the Vegetation Dynamics Development Tool (VDDT). The Revised Forest Plans will utilize existing condition values for fire frequency and fire severity in building desired conditions and monitoring measures by biophysical setting. Departure information and display of existing spatial hazards may also be used in developing strategies and guidelines (sideboards) for moving towards the desired condition. Analysis done at multiple scales for Plan Revision can set the context for project scale work, and provide a basis for long-term monitoring. The summaries are linked to both Landfire and Blue Mountains forest plan revision biophysical settings (potential vegetation groups).

CONDITION CLASS (vegetation-fuel class departure)

The first step was to classify our vegetation polygon and CVS data into the biophysical environments that we would be using for Revision (Table 1). Approximately 500 individual plant associations were grouped into the 21 biophysical settings (appendix A). Each plant association had already been classified into a temperature/moisture matrix by the Area Ecologist. Each individual plant association was also assigned to a fire regime group (exhibit 1). The biophysical settings are being used as the building blocks for developing the Blue Mountains vegetation dynamics development tool (VDDT) model, which will be used to analyze possible outcomes for different management scenarios. The biophysical environment classification was then cross-walked to the Landfire biophysical setting (Table 1 and appendix B).

TABLE 1 – Blues Biophysical Settings and Landfire Biophysical Setting

Blue Mountains Biophysical Setting	**Landfire Biophysical Setting**
Cold forest	spruce – fir (R#SPFI)
Whitebark pine forest	subalpine woodland (R#SAWD)
Moist forest	mixed conifer - eastside mesic (R#MCONms)
Dry grand fir forest	mixed conifer- eastside dry (R#MCONdy)
Dry Douglas-fir forest	mixed conifer- eastside dry (R#MCONdy)
Dry ponderosa pine forest	Ponderosa pine mesic (R#PIPOM)
Hot dry pine forest	dry ponderosa pine – xeric R#PIPOxe)
Juniper woodland	ponderosa pine – xeric and juniper---
Cool/Cold Riparian Forest	spruce – fir (R#SPFI)
Warm Riparian Forest	mixed conifer - eastside mesic (R#MCONms)
Dry herbland	bluebunch wheatgrass (R#AGSP)
Dry shrubland	low sagebrush (R#SBDWlw)
Cold shrubland	mountain big sagebrush (R#SBMT)
Cold herbland	alpine-subalpine meadows and grasslands (R#ALME)
Moist herbland	idaho fescue grassland (R#MGRA)
Moist shrubland	mountain big sagebrush (R#SBMT)
Warm Riparian herbland	Marsh (R#WGRA)
Warm Riparian shrubland	none
Cool/Cold Riparian herbland	alpine-subalpine meadows and grasslands (R#ALME)
Cool/Cold Riparian shrubland	none
Non-vegetated	none

Exhibit 1 Fire Regime Groups
1– 0-35 year frequency and low (surface fires most common) to mixed severity (less than 75% of the dominant overstory vegetation replaced);
2 – 0-35 year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);
3 – 35-100+ year frequency and mixed severity (less than 75% of the dominant overstory vegetation replaced);
4 – 35-100+ year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);
5 – 200+ year frequency and high (stand replacement) severity.

Vegetation data for each vegetation polygon was then classified into one of the 5 Landfire vegetation-fuel classes (Table 2) using a combination of dbh and canopy closure for each PNVG. Parameters for veg/fuel classes were gleaned from the Rapid Assessment Reference Condition Model documentation for each biophysical setting. See Appendix C for the query parameters used to classify the data.

TABLE 2- Vegetation-fuel Class	
Class	**Description**
A	Early seral
B	Mid seral closed
C	Mid seral open
D	Late seral open
E	Late seral closed
U	Uncharacteristic

Each vegetation polygon call for the biophysical setting and veg-fuel class was stored in an Access database that linked to a GIS polygon coverage. A raster coverage (200 meter) was created for the vegetation polygon and analysis area reporting units. HUC 4 (subbasin) analysis units were used for fire regime 4 and 5 biosettings, HUC 5 was used for fire regime 3, and HUC 6 was used for fire regime 1 and 2. Tables 4 and 5 summarize the distribution of biophysical settings and fire regimes on the three forests. Information was run through the FRCC mapping tool and summarized by biophysical setting and biosetting veg-fuel class at each scale (Table 6&7). Table 3 summarizes the reference condition values that were used to generate the departure values (condition class). Table 8 summarizes the percent condition class within each biophysical setting by forest. See appendix D for more detailed FRCC output tool results.

Table 3-Landfire Reference Condition (percent in veg-fuel class A-U)

Code	Name	A	B	C	D	E	U	HFR	
RIPA	riparian	15	5	10	50	20	0		
R#AGSP	bluebunch wheatgrass	5	70	25	0	0	0	1	
R#ALME	alpine-subalpine meadows and grasslands	5	90	5	0	0	0	5	
R#MCONdy	mixed conifer- eastside dry	15	1	30	40	14	0	1	
R#MCONms	mixed conifer - eastside mesic	15	40	15	10	20	0	3	
R#MGRA	idaho fescue grassland	10	70	20	0	0	0	2	
R#PIPOm	dry ponderosa pine - mesic	10	10	35	40	5	0	1	
R#PIPOxe	ponderosa pine - xeric	25	5	25	40	5	0	3	
R#SBDWlw	low sagebrush	35	15	50	0	0	0	3	
R#SBMT	mountain big sagebrush	20	10	35	30	5	0	2	
R#SPFI	spruce - fir	3	22	25	20	30	0	4	
R#WGRA	marsh	15	80	5	0	0	0	2	
R#SAWD	subalpine woodland	25	20	55	0	0	0	3	

HFR = fire regime

Table 4- Current Percent distribution by fire regime

Fire regime	Malheur	Umatilla	Wallowa-Whitman	Blues
1	60	55	53	60
2	23	3	5	4
3	15	28	25	24
4	2	14	17	12
5	0	0	0	0

TABLE 5 – Current Percent Total Area For All Biophysical Settings

Biophysical Setting	Malheur NF	Umatilla NF	Wallowa-Whitman NF	Total Blue Mountains NFs (weighted by acres)
Cold forest fr4	2	13	14	10
Whitebark pine forest fr3	<1	<1	2	1
Moist forest fr3	13	27	19	19
Dry grand fir forest fr1	24	15	13	17
Dry Douglas-fir forest fr1	16	17	12	15
Dry ponderosa pine forest fr1	21	6	7	11
Hot dry pine forest fr1/3	10	4	2	5
Juniper woodland fr3	3	1	1	1
Cool/Cold Riparian Forest fr4	<1	0	0	<1
Warm Riparian Forest fr1	<1	<1	<1	<1
Dry herbland fr1	3	13	15	11
Dry shrubland fr3	6	1	2	3
Cold shrubland fr2	<1	<1	1	<1
Cold herbland fr5	<1	<1	2	<1
Moist herbland fr2	<1	1	3	<1
Moist shrubland fr2	<1	2	1	<1
Warm Riparian herbland fr2	1	<1	<1	<1
Warm Riparian shrubland fr2-3	<1	<1	<1	<1
Cool/Cold Riparian herbland fr5	<1	0	<1	<1
Cool/Cold Riparian shrubland fr2-3	<1	0	0	<1
Non-vegetated	<1	<1	5	2

FR= fire regime

Table 6 Percent in each condition class (biosetting/veg-fuel strata)

Condition Class	Malheur	Umatilla	Wallowa-Whitman	Blues
1	35	32	41	37
2	22	20	21	21
3	43	48	38	42

Condition class 1 (within natural/historical range of variability) = < 33% departure; condition class 2(moderate departure) = > 33% to 66%; condition class 3 (high departure) = > 66%.

Table 7 Percent in each condition class (biosetting strata)

Condition Class	Malheur	Umatilla	Wallowa-Whitman	Blues
1	10	20	40	25
2	78	41	30	48
3	12	39	30	27

TABLE 8 – Percent condition class within each Biosetting veg-fuel strata				
Biophysical Setting (Blues)	**Malheur NF**	**Umatilla NF**	**Wallowa-Whitman NF**	**Total Blues**
Cold forest (fr4)				
Condition class 1	17	18	82	57
Condition class 2	47	81	18	41
Condition class 3	36	0	0	2
Whitebark pine (fr3)				
Condition class 1	0	0	52	45
Condition class 2	88	0	47	51
Condition class 3	12	100	1	4
Moist forest (fr3)				
Condition class 1	64	55	90	72
Condition class 2	34	45	10	27
Condition class 3	2	0	0	1
Dry grand fir forest & Douglas-fir (fr1)				
Condition class 1	0	1	0	0
Condition class 2	94	38	45	63
Condition class 3	6	61	55	37
Dry ponderosa pine forest (fr1)				
Condition class 1	0	0	1	0
Condition class 2	78	37	42	60
Condition class 3	22	63	57	40
Hot dry pine forest & juniper (fr1-3)				
Condition class 1	0	0	0	0
Condition class 2	86	58	98	85
Condition class 3	14	42	2	15

Table 9 Percent veg-fuel class (existing Blues total)							
Name	**A**	**B**	**C**	**D**	**E**	**U**	**FR**
Cold forest	16	26	8	9	39	-	4
Whitebark pine forest	55	12	31	0	0	-	3
Moist forest	13	32	21	10	25	-	3
Dry Douglas-fir, grand fir	9	50	21	3	18	-	1
Dry ponderosa pine forest	12	56	17	2	14	-	1
Hot dry pine and juniper	14	53	24	0	8	-	1-3

A= early seral
B= mid seral closed
C=mid seral open
D= late seral open
E= late seral closed
U= uncharacteristic

FIRE FREQUENCY
We utilized the Forest GIS layer for wildfires and activities to determine the existing fire frequency by biophysical setting and the departure from reference condition (landfire values). The wildfire layer was also used to determine the probabilities for severe wildfire years to input into the VDDT model.

The GIS vegetation polygon layer was intersected with the watershed, wildfire, and activity layers. The result was exported to an Access database. The files are extremely large, for example; the Wallowa-Whitman intersect ended up containing over 300,000 polygons. Acres were then accumulated by watershed, burn type, and biophysical setting. Total acres burned by watershed was divided into the time period of analysis, to determine the average acres burned per year by watershed for the biophysical strata. The current fire return interval was calculated by dividing the analysis area size, by the average acres burned per year for each strata (Table 10, appendix E). Fire frequency values in the following tables represent wildfire plus activity related fuels burning. Including management burning in the totals did not significantly change the frequency. The fire return interval was analyzed for several different time periods (25 and 100 years) to highlight potential changes occurring due to management, stand structure changes, or climate change. Existing condition by National Forest and biophysical setting can then be compared to the reference values contained in Table 10. The frequency of low, moderate, and severe fire years is summarized in Table 11 and appendix F. Values in Table 11 include a summary for the last 25 years. Fire managers believe that the time period from 1980-2005 represents the current potential for future fires better than the data for the last 100 years due to the build-up of fuels and recent climate change patterns.

Table 10	**Fire Frequency (fire return interval- in years)**				
Biophysical Setting (Blues)	**Landfire Frequency Reference (years)**	**Blues Plan revision Frequency Reference (years)**	**Malheur Fire frequency (100 yr period)**	**Umatilla Frequency (Last 100 yrs)**	**Wallowa-Whitman Frequency (Last 100 yrs)**
Cold forest	113	100-200	96	213	296
Whitebark pine forest	63	30-120	122	487	667
Moist forest	71	30-150	416	483	410
Dry grand fir forest	16	15-25	648	287	335
Dry Douglas-fir forest	16	5-10	742	407	223
Dry ponderosa pine forest	7	5-10	512	402	294
Hot dry pine forest	48	10-20	413	515	524
Juniper woodland	48	80-160	490	518	522
Cool/Cold Riparian Forest	-	-	401	-	-
Warm Riparian Forest	-	-	98	-	72
Dry herbland	8	5-20	210	683	142
Dry shrubland	74	75-125	361	962	158
Cold shrubland	20	30-60	173	703	718
Cold herbland	239	30-80	153	331	335
Moist herbland	30	20-40	263	444	186
Moist shrubland	20	10-40	175	384	558
Warm Riparian herbland	-	-	985	276	626
Warm Riparian shrubland	-	-	1753	287	472
Cool/Cold Riparian herbland	-	-	2639	703	100
Cool/Cold Riparian shrubland	-	-	-	-	-
Non-vegetated					

Table 10 continued Frequency (fire return interval)						
Biophysical Setting (Blues)	**Malheur frequency (last 25 yrs)**	**Umatilla Frequency (Last 25 yrs)**	**Wallowa-Whitman Frequency (Last 25 yrs)**	**Blues Fire frequency (last 25 yrs)**	**Blues Fire frequency (last 100 yrs)**	
Cold forest	38	158	141	126	225	
Whitebark pine forest	45	-	301	182	431	
Moist forest	186	665	332	338	380	
Dry grand fir forest	334	165	175	219	364	
Dry Douglas-fir forest	445	166	83	144	325	
Dry ponderosa pine forest	356	159	139	224	364	
Hot dry pine forest	236	294	214	242	396	
Juniper woodland	265	1667	161	250	466	
Cool/Cold Riparian Forest	--	-	-	-	-	
Warm Riparian Forest	-	-	-	27	81	
Dry herbland	70	364	42	61	194	
Dry shrubland	169	1175	71	125	264	
Cold shrubland	56	608	781	310	526	
Cold herbland	115	-	175	180	318	
Moist herbland	86	329	52	60	202	
Moist shrubland	52	223	841	149	322	
Warm Riparian herbland	628	209	-	396	596	
Warm Riparian shrubland	1232	-	-	-	760	
Cool/Cold Riparian herbland	115	-	-	-	-	
Cool/Cold Riparian shrubland	56	-	-	-	-	
Non-vegetated						

Table 11 Blue Mountains Frequency of normal, high, and severe fire years *							
Fire Year Type	**Malheur (last 45 yr period)**	**Umatilla Last 45 yrs**	**Wallowa-Whitman Last 45 yrs**	**Mal Last 25 yrs**	**UMA Last 25 yrs**	**WAW Last 25 yrs**	**Blues Last 25 yrs**
Normal	89	78	67	81	65	54	67
High	9	20	18	15	31	19	22
severe	2	2	15	4	4	27	11

* Percent of years where wildfire acres burned was normal, high, or severe.
Normal = < 2500 acres burned per year
High = >=2,500 and < 50,000 acres per year
Severe = >= 50,000 acres per year

Fire Severity

Current Vegetation Survey (CVS) plot data was run through the forest vegetation simulator and fire-fuels extension to generate fire metrics for each stake point. Data includes crown fire and torching index, potential fire type (active, passive, crown), and potential percent basal area mortality. The calculation for potential basal area loss in the event of a fire is the one that best represents our attempt to describe fire severity in relationship to the Landfire reference estimates. The summary of CVS data for percent stand replacing fire at the scale of the Forest is summarized in Table 12. Appendix G summarizes current severity based on CVS plot data for all of the combinations of VDDT models, structural condition, density class, size class, and species composition. VDDT model coefficients for fire severity will be derived from this information.

Values were extracted from the FVS- fire/fuel extension, potential fire report (severe fire) percent basal area loss reports. The values for severe conditions used in the model include; wind speed of 20mph, temp of 70f, 0-.25 inch fuel moisture of 4%, 2.5-1 inch fuel moisture of 4 percent, 1-3 inch fuel moisture of 5 percent, >3 inch fuel moisture of 10 percent, duff of 15 percent, and live fuel moisture of 70 percent.

TABLE 12 – Potential percent stand replacing fire (CVS Plot Data) *

Biophysical Setting (Blues)	Malheur NF	Umatilla NF	Wallowa-Whitman NF	Total Blues	Landfire Reference Value (percent stand Replacing fire)
Cold forest	55	52	55	54	84
Whitebark pine forest	90	65	74	75	21
Moist forest	38	40	32	36	35
Dry grand fir forest	39	45	35	39	14
Dry Douglas-fir forest	41	44	42	42	14
Dry ponderosa pine forest	47	53	57	50	5
Hot dry pine forest	61	71	64	63	37
Juniper woodland	89	100	94	92	37

*Value = percent of the biophysical environment that has the potential (based on CVS data) for greater than 75 percent basal area loss in the event of a fire at 90th percentile conditions. Greater than 75 percent basal area mortality is defined as a stand replacing fire.

Summary

Trends and existing condition in this information resemble those previously identified in reports such as the 1996 Status of the Interior Columbia Basin- Summary of Scientific Findings, and the recent Nature Conservancy report on the condition of Oregon's Forests and woodlands. Our data show that the Blues are dominated by ecosystems that evolved with frequent, low intensity and mixed intensity fire. Approximately 88 percent of the Blue Mountains are classified as historic fire regime 1, 2, or 3; which are the short to mixed return interval systems (Table 4). Much of this landscape is currently moderately to highly departed from reference conditions for vegetation-fuel conditions, with 63-75 percent classified as condition class 2 or 3 (Table 6&7). Most of the condition class 1, or areas not significantly departed, show up in the cold or moist forest types (Table 8). The warm-dry types are those that show the most amount of departure from reference conditions. The departure is caused by an abundance of stands classified as mid seral closed canopy and a deficit of stands in the late seral open condition (Table3&9).

Fire return intervals are now much longer than those estimated to have occurred historically (Table 10). These changes are most apparent in the warm-dry biophysical settings. Table 10 displays fire return intervals for the last 100 years, as well as for the last 25 years. The data indicates that the amount of fire has increased in the last 25 year period, which has decreased the fire return intervals when compared to looking at the intervals for the last 100 years. Data in Table 10 only represents wildfire; including activity burning in the totals only slightly decreased the return intervals. Much of the fire that has occurred recently in the warm-dry systems is high intensity fire, as opposed to the low intensity fires that historically dominated these areas.

Fire severity data indicates that under severe fire weather conditions, much of the area has the potential for stand replacing fire (Table 12). The areas that show the least amount of departure from the current potential for stand replacing fire versus reference values are in the cold and moist forests (Table 12). Even though the cold and moist types show the potential for a moderate to high (36-54%) amount of stand replacing fire, this amount of fire is consistent with the mixed to infrequent stand replacing that historically dominated these systems. Departure values (Table 12) for the warm-dry types for fire severity range from 30-60 percent, which indicates a moderate to high increase in high severity fires over reference conditions.