A Web-based Information System for Estimating Fuel Characteristics, Fire-Hazard, and Treatment Effectiveness and Costs in Montana and New Mexico

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ABSTRACT

This report summarizes the activities and products associated with the JFSP project "A Web-based Information System for Estimating Fuel Characteristics, Fire-Hazard, and Treatment Effectiveness and Costs in Montana and New Mexico."

Objectives – The general objective of this project was to integrate various fire hazard models, computer visualizations, fuel classifications, treatment algorithms, harvest/treatment cost models, and product value databases into an easy-to-use tool that evaluates treatment effectiveness and cost at the project level.

Description - Specific models embedded or "wrapped" within this interactive web-based tool "*Webofire*" include the Fuel Characteristic Classification System (FCCS), the Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator, the Stand Visualization System, hazard reduction/restoration treatment algorithms, treatment cost models, tree height/crown ratio models, pinyon and juniper firewood volume equations, and pulpwood/timber product value databases.

Target audience – *Webofire* is designed for use by field foresters, community forestry representatives, extension agents, NGO representatives, forestry consultants, restoration contractors, tribal forestry personnel, state service foresters, and landowners – folks who typically do not use models. These are the people who are planning, conducting, or overseeing much of the hazard reduction work, yet they currently do not have the wherewithal to objectively evaluate existing fire hazard, prioritize treatment needs, or estimate the potential effectiveness and costs of proposed treatments before they carry them out. *Webofire* was developed to address this need.

Deliverables – "Product" deliverables for project 04-4-1-21 include: 1) a web-based information system for assessing hazard (described above), 2) a summary of acres of ponderosa pine, Douglas-fir, and dry mixed conifer forest types in Montana classified into appropriate Fuel Characteristic Classes (i.e., classified by fire behavior potential, crowning potential, and available fuel potential), 3) a summary of acres of ponderosa pine and dry mixed conifer forest types in New Mexico classified into appropriate Fuel Characteristic Classes (i.e., classified by fire behavior potential, crowning potential, and available fuel potential), 4) a matrix of acres of Fuel Characteristic Classes by density and structure for ponderosa pine, Douglas-fir, and dry mixed conifer forest types in Montana, and 5) a matrix of acres of Fuel Characteristic Classes by density and structure for ponderosa pine and dry mixed conifer forest types in New Mexico.

"Activity" deliverables for this project include conducting beta-test workshops to identify problems and solicit suggestions for improving the model, presentations at professional meetings, and integration into short course trainings.

"Additional Accomplishments" not anticipated or included in the project budget:

1) We developed two variants of the *Webofire* model for Montana – one tailored to conditions east of the Continental Divide and one to conditions west of the Divide,
2) We developed the capability to create computer visualizations (SVS) or images "on the fly" to illustrate existing stand conditions and modified stand conditions after treatment,
3) We developed the capability to model cottonwood and juniper growing in mixture with the ponderosa pine forest type (Montana variant)
4) We developed the capability to model pinyon/juniper woodlands growing in mixture with the ponderosa pine forest type (New Mexico variant)
5) We developed the capability to estimate average tree heights and crown ratios for major tree species in Montana and New Mexico growing on low, medium, and high sites, and in open, moderate, and dense stand conditions. Tree heights and crown ratios are required inputs for FFE and the FCCS models.
6) A primer or tutorial is being developed, and should be available by the end of September.
7) We have developed the capability to estimate pinyon/juniper firewood volumes potentially recoverable from proposed treatments (New Mexico variant), but extensive programming will be required before this workshop-requested option is functional.

NEED

Field foresters, community forest reps, extension agents, consultants, natural resource NGOs, and forest landowners need the capability to assess forest conditions for wildfire hazard – both to identify high-hazard areas and to prioritize stands for treatment. They also need ways to evaluate treatment effectiveness and costs for a range of forest types, stand conditions, and treatment scenarios, preferably *before* treatments are implemented. This need provided the impetus for developing *Webofire*.

WHAT IT IS

Webofire is an interactive, web-based system for assessing fire hazard in ponderosa pine/dry mixed conifer forests in Montana and New Mexico. The system allows users to evaluate the hazard associated with existing forest conditions, "game" alternative hazard reduction treatments, and assess potential treatment effectiveness. Users do not have to be modelers; *Webofire* seamlessly links stand inventory data (or visualizations) with fuel and fire hazard assessment models to estimate fire behavior potential, crowning potential, and available fuel potential. It also provides users the means to implement (computer log) different treatment scenarios, and then reevaluate the treated stands for hazard and estimate associated treatment costs.

HOW TO USE IT

Webofire is a data- and query-based interactive system. It leads the user through the steps of data entry (or selection of an illustration and description that approximates the forest conditions of interest) and processing, and then provides estimates of several measures of hazard. Users can choose fuel reduction treatments from a menu or design their own and "game" them to compare their potential effectiveness for reducing hazard. The user can also estimate treatment costs based on size of project area. general size/type of material removed, harvest/treatment system employed, and location.

HOW TO INTERPRET RESULTS

Hazard estimates – *Webofire* is most appropriately used to provide relative comparisons of treatment efficacy, rather than precise (absolute) estimates of various fuel and fire hazard parameters. For example, *Webofire* can provide estimates of Fire Behavior Potential, Crowning Potential, and Available Fuel Potential before and after treatment. Because the specificity of input data and assumptions are the same for running both pre- and post-treatment stand scenarios, differences or changes in these fire and fuel potentials should provide a reasonable estimate of treatment effectiveness The most precise estimates will come from entering or uploading recent stand inventory data from the stand(s) of interest – specifically trees per acre by species and diameter class, and associated average height and average crown ratio for each class. Estimates derived using the stand description/computer visualization option for providing inputs to the model will necessarily have more uncertainty associated with them.

HOW TO INTERPRET RESULTS (continued)

Cost (net revenue) estimates – *Webofire* provides a generalized estimate of net revenues/acre associated with treatment. The net revenue estimate is calculated as revenue (if any) received for timber products, specialty products, pulpwood, firewood, or biomass, minus the actual costs of doing the treatment. Treatment costs include the costs of cutting (or masticating) unmerchantable trees and removing them from the stand or piling-and-burning, broadcast burning, or chipping them on-site. Project layout and road-building costs (if any) are not included. Other factors can significantly increase overall costs beyond the costs of the actual treatments themselves, including project development and layout costs -- and sometimes litigation costs. Given the great variation in location, infrastructure, and ownership, net revenues are provided as very general estimates only. Similar to estimates of treatment effectiveness for reducing hazard, net revenues (+ or -) associated with treatment are most appropriately used for relative comparisons between and among treatments (more than or less than), rather than as actual expected costs of a specific project, per se.

PRODUCTS

1) A web-based information system "*Webofire*" for assessing hazard. The link to this web tool is: **http://webofire.cfc.umt.edu/webofire/**
   Login: User ID: webofire Password: webofire

2) A summary of the acres of ponderosa pine, Douglas-fir, and dry mixed conifer forest type in Montana classified by Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 1, attached).

3) A summary of the acres of ponderosa pine and dry mixed conifer forest type in New Mexico classified by Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 2, attached).

4) A summary of the acres of ponderosa pine forest type in Montana classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 3, attached).

5) A summary of the acres of Douglas-fir forest type in Montana classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 4, attached).

6) A summary of the acres of dry mixed conifer forest type in Montana classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 5, attached).

7) A summary of the acres of ponderosa pine forest type in New Mexico classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 6, attached).

PRODUCTS (continued)

9) A summary of the acres of dry mixed conifer forest type in New Mexico classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). (Appendix 7, attached).

10) A summary of the date, location, attendees, and comments/suggestions associated with each of the six *Webofire* beta-test workshops. (Appendix 8, attached).

11) Presentations at professional meetings. (Appendix 9 attached).

12) Integration into short course trainings. (Appendix 10, attached).

APPENDIX 1 – Acres of ponderosa pine, Douglas-fir, and dry mixed conifer forest type in Montana classified by Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Forest type	Low	Medium	High	Very High	Extreme
Ponderosa pine	0	1,488,240	1,317,086	0	0
Douglas-fir	0	30,370	6,121,472	0	0
Dry mixed conifer	0	16,171	249,517	0	0

Crown Fire Potential

Forest type	Low	Medium	High	Very High	Extreme
Ponderosa pine	1,758,724	323,063	212,289	196,062	315,188
Douglas-fir	1,899,717	761,632	564,843	560,181	2,365,469
Dry mixed conifer	160,541	22,495	12,533	37,848	32,271

Available Fuel Potential

Forest type	Low	Medium	High	Very High	Extreme
Ponderosa pine	185,691	2,064,713	444,633	68,855	41,434
Douglas-fir	0	731,764	3,013,555	1,849,267	557,256
Dry mixed conifer	0	128,774	75,581	61,333	0

APPENDIX 2 – Acres of ponderosa pine and dry mixed conifer forest type in New Mexico classified by Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Forest type	Low	Medium	High	Very High	Extreme
Ponderosa pine	2,472,383	12,253	0	0	0
Dry mixed conifer	230,212	1,279,681	0	0	0

Crown Fire Potential

Forest type	Low	Medium	High	Very High	Extreme
Ponderosa pine	2,035,969	209,231	104,354	87,165	47,917
Dry mixed conifer	522,949	281,639	181,240	204,887	319,178

Available Fuel Potential

Forest type	Low	Medium	High	Very High	Extreme
Ponderosa pine	2,285,699	193,086	5,851	0	0
Dry mixed conifer	214,895	942,302	331,521	21,175	0

APPENDIX 3 – Acres of ponderosa pine forest type in Montana classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	0	119,694	518,484	0	0
One-story, moderate	0	40,770	17,178	0	0
One-story, high	0	7,729	11,633	0	0
Two-story, low	0	145,750	198,621	0	0
Two-story, moderate	0	278,256	245,006	0	0
Two-story, high	0	191,369	61,790	0	0
Multi-storied, low	0	39,541	29,500	0	0
Multi-storied, moderate	0	187,003	93,597	0	0
Multi-storied, high	0	472,320	119,617	0	0
All	0	1,482,432	1,295,426	0	0

Crown Fire Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	631,903	0	6,275	0	0
One-story, moderate	34,833	17,616	5,499	0	0
One-story, high	13,672	0	5,690	0	0
Two-story, low	344,371	0	0	0	0
Two-story, moderate	308,720	157,689	56,853	0	0
Two-story, high	71,474	52,393	53,539	53,209	22,544
Multi-storied, low	69,041	0	0	0	0
Multi-storied, moderate	212,559	42,490	11,997	13,554	0
Multi-storied, high	44,683	52,875	72,436	129,299	292,644
All	1,731,256	323,063	212,289	196,062	315,188

Available Fuel Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	179,822	447,039	6,010	0	5,307
One-story, moderate	0	55,266	2,682	0	0
One-story, high	0	19,362	0	0	0
Two-story, low	5,869	302,809	23,828	11,865	0
Two-story, moderate	0	486,568	30,684	0	6,010
Two-story, high	0	157,994	83,616	11,549	0
Multi-storied, low	0	69,041	0	0	0
Multi-storied, moderate	0	220,514	38,321	5,869	15,896
Multi-storied, high	0	278,652	259,492	39,572	14,221
All	185,691	2,037,245	444,633	68,855	41,434

APPENDIX 4 – Acres of Douglas-fir forest type in Montana classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential).
Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	0	0	906,502	0	0
One-story, moderate	0	0	47,779	0	0
One-story, high	0	0	0	0	0
Two-story, low	0	0	703,805	0	0
Two-story, moderate	0	0	451,081	0	0
Two-story, high	0	0	234,381	0	0
Multi-storied, low	0	0	499,588	0	0
Multi-storied, moderate	0	10,606	1,415,947	0	0
Multi-storied, high	0	19,764	1,844,923	0	0
All	0	30,370	6,104,006	0	0

Crown Fire Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	736,007	84,709	47,949	25,598	12,239
One-story, moderate	19,190	7,178	0	0	21,411
One-story, high	0	0	0	0	0
Two-story, low	437,163	54,193	55,193	76,460	80,796
Two-story, moderate	110,878	80,153	62,503	12,115	185,432
Two-story, high	0	14,294	28,342	39,212	152,533
Multi-storied, low	272,255	19,065	52,220	37,606	118,442
Multi-storied, moderate	253,127	404,683	155,779	70,011	542,953
Multi-storied, high	53,631	97,357	162,857	299,179	1,251,663
All	1,882,251	761,632	564,843	560,181	2,365,469

Available Fuel Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	0	433,056	429,709	24,539	19,198
One-story, moderate	0	0	35,461	12,318	0
One-story, high	0	0	0	0	0
Two-story, low	0	169,179	394,834	110,660	29,132
Two-story, moderate	0	20,268	252,009	159,098	19,706
Two-story, high	0	0	144,038	70,812	19,531
Multi-storied, low	0	56,124	337,956	105,508	0
Multi-storied, moderate	0	35,713	733,752	490,283	166,805
Multi-storied, high	0	11,616	674,138	876,049	302,884
All	0	725,956	3,001,897	1,849,267	557,256

APPENDIX 5 – Acres of dry mixed conifer forest type in Montana classified by structure, density, and Fuel

Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential). Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	0	6,112	42,030	0	0
One-story, moderate	0	0	14,324	0	0
One-story, high	0	0	2,039	0	0
Two-story, low	0	0	11,908	0	0
Two-story, moderate	0	10,059	41,731	0	0
Two-story, high	0	0	22,788	0	0
Multi-storied, low	0	0	14,819	0	0
Multi-storied, moderate	0	0	39,862	0	0
Multi-storied, high	0	0	60,016	0	0
All	0	16,171	249,517	0	0

Crown Fire Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	48,142	0	0	0	0
One-story, moderate	0	0	0	14,324	0
One-story, high	0	2,039	0	0	0
Two-story, low	11,908	0	0	0	0
Two-story, moderate	40,242	0	0	5,499	6,049
Two-story, high	11,799	4,752	6,237	0	0
Multi-storied, low	14,819	0	0	0	0
Multi-storied, moderate	33,631	6,231	0	0	0
Multi-storied, high	0	9,473	6,296	18,025	26,222
All	160,541	22,495	12,533	37,848	32,271

Available Fuel Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	0	29,340	6,275	12,527	0
One-story, moderate	0	0	0	14,324	0
One-story, high	0	0	2,039	0	0
Two-story, low	0	11,908	0	0	0
Two-story, moderate	0	45,741	6,049	0	0
Two-story, high	0	5,503	17,285	0	0
Multi-storied, low	0	8,438	6,381	0	0
Multi-storied, moderate	0	21,548	18,314	0	0
Multi-storied, high	0	6,296	19,238	34,482	0
All	0	128,774	75,581	61,333	0

APPENDIX 6 – Acres of ponderosa pine forest type in New Mexico classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential).

Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	174,839	12,253	0	0	0
One-story, moderate	5,365	0	0	0	0
One-story, high	0	0	0	0	0
Two-story, low	197,896	0	0	0	0
Two-story, moderate	174,729	0	0	0	0
Two-story, high	83,873	0	0	0	0
Multi-storied, low	417,215	0	0	0	0
Multi-storied, moderate	626,453	0	0	0	0
Multi-storied, high	792,013	0	0	0	0
All	2,472,383	12,253	0	0	0

Crown Fire Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	187,092	0	0	0	0
One-story, moderate	5,365	0	0	0	0
One-story, high	0	0	0	0	0
Two-story, low	197,896	0	0	0	0
Two-story, moderate	166,113	8,616	0	0	0
Two-story, high	64,867	7,058	11,948	0	0
Multi-storied, low	417,215	0	0	0	0
Multi-storied, moderate	626,453	0	0	0	0
Multi-storied, high	370,968	193,557	92,406	87,165	47,917
All	2,035,969	209,231	104,354	87,165	47,917

Available Fuel Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	187,092	0	0	0	0
One-story, moderate	5,365	0	0	0	0
One-story, high	0	0	0	0	0
Two-story, low	197,896	0	0	0	0
Two-story, moderate	166,113	8,616	0	0	0
Two-story, high	83,873	0	0	0	0
Multi-storied, low	417,215	0	0	0	0
Multi-storied, moderate	626,453	0	0	0	0
Multi-storied, high	601,692	184,470	5,851	0	0
All	2,285,699	193,086	5,851	0	0

APPENDIX 7 – Acres of dry mixed conifer forest type in New Mexico classified by structure, density, and Fuel Characteristic Class component (fire behavior potential, crowning potential, and available fuel potential).

Values for crown fire potential should be interpreted cautiously because this component of the FCCS model is still being refined.

Fire Behavior Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	5,367	31,039	0	0	0
One-story, moderate	0	0	0	0	0
One-story, high	0	0	0	0	0
Two-story, low	25,151	48,907	0	0	0
Two-story, moderate	12,053	25,078	0	0	0
Two-story, high	0	0	0	0	0
Multi-storied, low	18,372	129,537	0	0	0
Multi-storied, moderate	137,579	540,261	0	0	0
Multi-storied, high	31,690	504,859	0	0	0
All	230,212	1,279,681	0	0	0

Crown Fire Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	36,406	0	0	0	0
One-story, moderate	0	0	0	0	0
One-story, high	0	0	0	0	0
Two-story, low	61,894	12,164	0	0	0
Two-story, moderate	23,256	0	5,985	7,890	0
Two-story, high	0	0	0	0	0
Multi-storied, low	133,910	13,999	0	0	0
Multi-storied, moderate	242,562	184,628	117,563	118,590	14,497
Multi-storied, high	24,921	70,848	57,692	78,407	304,681
All	522,949	281,639	181,240	204,887	319,178

Available Fuel Potential

Structure/Density	Low	Medium	High	Very High	Extreme
One-story, low	23,718	12,688	0	0	0
One-story, moderate	0	0	0	0	0
One-story, high	0	0	0	0	0
Two-story, low	29,821	44,237	0	0	0
Two-story, moderate	12,053	25,078	0	0	0
Two-story, high	0	0	0	0	0
Multi-storied, low	18,372	123,428	6,109	0	0
Multi-storied, moderate	112,333	439,859	125,648	0	0
Multi-storied, high	18,598	297,012	199,764	21,175	0
All	214,895	942,302	331,521	21,175	0

APPENDIX 8 – Workshops

Date	Location	Attendees	Comments/Requests
January, 2007	Missoula, MT	State of Montana S&K Tribal Forestry Crow Tribal Forestry Forestry consultants Lubrecht Forest	Generic treatment option menu Increase flexibility for estimating costs
March, 2007	Las Vegas, NM	Forest Service State of New Mexico Forestry consultants NM Restoration Institute Questa RFD Taos Rural Comm. Asst. NM Highlands Univ.	Develop capability to model pinyon/juniper Add visualization capability
March, 2007	Santa Fe, NM	Forest Service State of New Mexico Nature Conservancy Forest Guild Valles Caldera Regenesis Group Jemez Pueblo NM For/Watershed Hlth Forestry consultants Forest health contractor Private landowners El Rito Economic Dev.	Ability to estimate PJ firewood volumes Ability to estimate tree heights and crown ratios
June, 2007	Helena, MT	Montana DNRC BLM FireSafe Montana Forestry consultants Loggers/contractors Park County RFD York RFD L&C County planners Helena FD	Ability to estimate tree heights for specific site conditions Need to revise costs for small parcels with buildings/dvlpmts Need to include mastication treatment option

APPENDIX 8 – Workshops (continued)

Date	Location	Attendees	Comments/Requests
June, 2007	Helena, MT	Forest Service FireSafe Montana Montana NG Forestry consultants Loggers/contractors L&C County planners L&C County GIS Jefferson County planner Private landowners City of Helena Helena Water Dept Wolf Creek RFD	Need user tutorial/primer Need to conduct these workshops throughout Montana
August, 2007	Missoula, MT	MSU Forestry Ext.	Integrate into stewardship training series for landowners and operators

APPENDIX 9 – Presentations

Poster presentation – JFSP Annual Meeting, San Diego, CA November, 2005

Presentation – New Mexico Restoration Institute, Las Vegas, NM, June, 2007

APPENDIX 10 – Integration into short courses

Uneven-aged Management Short Course, Missoula, MT, June, 2006

Forest Stewardship Training Series – MSU Extension Forestry, various locations in MT, 2007+

Designing Successful Forest Restoration and Fuel Reduction Projects – BLM Short Course, Lubrecht Forest, MT, October, 2007 (demo)