# FIRE AND FUELS EXTENSION TO THE FOREST VEGETATION SIMULATOR: COMPLETION OF CALIBRATION FOR EASTERN FORESTS, PROVISIONS FOR USER TRAINING, AND PROGRAM MAINTENANCE

## FINAL REPORT TO THE JOINT FIRE SCIENCE PROGRAM

**JFSP Project Number 01-1-7-07**

**BLM Agreement/Task Order Number 1422RAH02-0039 (BLM)**
**Master Agreement No: 1422R220A7-6000 (BLM)**

**10/31/05**


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## Introduction

This project was intended for a 32 month duration starting in November 2001 and lasting through June 2004. The funding decision letter was received in December 2001, however, the Inter-agency Agreement, making the funds available, was not completed until July 2002. As a result, the duration of the project was set at July 2002 through July 2005. All stated deliverables were completed by the original June 2004 target, and we were under our proposed budget by approximately $182,000. Anticipating that we would be under our proposed budget, in July 2003 we proposed additional work that could be accomplished at no additional cost under this agreement. The Board agreed to this additional work. These additional tasks have either been completed or are nearing completion. At the conclusion of this agreement in July 2005, we were still under budget by approximately $60,000. A no-cost extension was requested (copy enclosed) to continue ongoing work with FFE training, testing, development, and field assistance in addition to accomplishing the additional tasks.

This final report is intended to inform the Board of our accomplishments.

## Project Overview

JFSP research produced a simulation system called the Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator (FVS). This software is a valuable tool for forest managers and has been used extensively to assess fire hazard and examine fuel treatment effects in forested ecosystems. With the FVS-FFE system, users can input their own forest inventory data, simulate how these forests will grow over time, and simulate a wide variety of management activities, such as thinning, prescribed burning, regeneration harvests, and planting. FVS and the FFE are used by forest managers to provide quantitative, as well as visual presentations, of their proposed treatment alternatives.

Although the FFE was initially developed thru JFSP funding, additional support was needed to further development and provide for trainings and other technology transfer activities. This project supported FFE training sessions for field personnel, maintenance, enhancement, and error corrections of the computer code, and calibration of the FFE for some areas of the eastern United States. A fire-modeling specialist was hired at the Forest Management Service Center (FMSC) in Fort Collins, Colorado, the staff that maintains and supports the base FVS model, to accomplish these tasks.

## Deliverables

### 1 – Long-term code maintenance and support

The FFE was originally developed by scientists at the USDA Forest Service Rocky Mountain Research Station. Under this project, the Forest Management Service Center

(FMSC) assumed the long-term maintenance and support of the FFE. To facilitate this transition, developers of the FFE trained the FMSC employees in the use and structure of the FFE code in the spring of 2002.

**2 – Increasing awareness and marketing**

An introductory 10-minute movie about FFE was created and distributed in an effort to make those in management positions aware of this tool and introduce natural resource managers to the capabilities of the model. The video plays on most personal computers and approximately 500 copies have been distributed nationally. A copy is enclosed.

**3 - Training**

Training materials were developed for a 3-day FVS-FFE training course. These trainings (10 in all) were held throughout the western United States in the fall of 2002 and the spring of 2003. Specifically, trainings were held in Vallejo CA, Portland OR, Lakewood CO, Missoula MT, Ogden UT, Albuquerque NM (2), Fort Collins CO, Redmond OR, and Boise ID. In addition, FFE was thoroughly incorporated into the basic FVS training sessions. Twenty three of these sessions were held between fall 2002 and spring 2005 in the following locations: Vallejo CA, Portland OR (3), Lakewood CO (2), Missoula MT (4), Ogden UT (2), Albuquerque NM (3), Ellensburg WA, Phoenix AZ (2), Sacramento CA (2), Fort Collins CO (2), and Spokane WA.

Approximately 600 people were trained in the use of FFE-FVS. These include fuels specialists, fire managers, silviculturists, researchers, wildlife managers, and others. They were from a variety of agencies, including the US Forest Service, Bureau of Indian Affairs, National Park Service, Bureau of Land Management, and various state agencies.

These training sessions were particularly helpful in finding model bugs and in determining what changes and improvements needed to be made to better meet the needs of field personnel.

**4 - Project Assistance**

The FMSC provides phone hot-line support for all FVS users. Anyone with questions can call this hotline, talk to an FMSC employee, and get any of their FVS-related questions or software problems resolved. Many FFE users were assisted in this manner.

This project also provided for on-site project assistance. This type of assistance can be especially useful for users that feel uncomfortable using the software on their own or for rather large landscape-level projects. Twenty three fuel mitigation projects received significant assistance from FMSC employees and are listed below.

1. Black Hills National Forest, SD, Forest Plan revision (Blaine Cook)
2. Bighorn National Forest, WY, Forest Plan revision (Bernie Bornong)
3. Beaverhead/Deerlodge National Forest, MT, Fuels treatment project

(Lee Harry, Erin Paddock)
4. Sequoia National Forest, CA, McNally/Sherman Pass Fire restoration project (Randy Hall)
5. University of Washington, WA, Eastern Cascades fire study (Reese Lolly)
6. Siskiyou National Forest, OR, Biscuit fire recovery project (Dennis Delack)
7. Tahoe National Forest, CA, NEPA analysis (Michelle Reugabrink)
8. Tahoe National Forest, CA, Red Star fire recovery (Gary Fildes)
9. Apache-Sitgreaves National Forest, AZ, Fuels treatment project (Dana Bagnoli, Judy Palmer)
10. Ken Caryl Ranch open space program, CO, Fuels treatment project (Gary Norton)
11. Los Alamos National Laboratory, NM, Long-term fire strategy (Randy Balice)
12. Flathead National Forest, MT, Fuels treatments project (John Ingebretson)
13. Rio Grande National Forest, CO, Fuels treatment project (Jim Griffin)
14. Kaibab National Forest, AZ, Fuels treatment project (Vic Morfin)
15. Ozark National Forest, Arkansas, Forest Plan Revision (Jack Davis and Sarah Melville)
16. Shawnee National Forest, Illinois, Forest Plan Revision (Steve Hupe and Dick Johnson)
17. Lincoln National Forest, NM, Fuels treatment analysis (Dennis Dwyer)
18. Bureau of Land Management, UT, Salvage analysis (Mark Williams)
19. Lake Tahoe Basin Management Unit, CA, Fuels treatment project (David Fournier)
20. Coronado National Forest, AZ, Landscape-level fuels project (Sherry Tune and Bob Lefevre)
21. Kaibab National Forest, AZ, Landscape-level fuels project using INFORMS (Brandon Sheehan)
22. Gila National Forest, NM, Fuels treatment project (Katie Hetts)
23. Black Hills National Forest, SD, Fuels treatment project (Randy Chappell)

**5 - Code Maintenance, Testing, and Validation**

Extensive testing of the FFE code has been conducted by the FMSC fire modeling specialist. This has led to significant error corrections, model changes, and refinements. Feedback received at training sessions and during site visits has also led to some changes and refinements. Some of the enhancements are additional user capabilities, such as the ability to salvage a particular species, the ability to export all of the FFE tables directly to a database, greater flexibility in simulating fires and modeling canopy fuels, and additional event monitor functions. Corrections and improvements were made to various keywords, the volume-to-biomass conversion factors, surface fuel defaults, decay rates, fuel model selection, and other model components.

Two existing FFE variants were also expanded. The northern Idaho and the southern Oregon variants were expanded to include additional species and the associated FFE code changes were completed.

Validation workshops were held in several locations in an effort to meet with local FFE users and get their feedback and suggestions on model performance. The first validation workshop was in Vallejo, CA and focused on changes needed in the Western Sierra Nevada variant of FFE. Ten local fire and fuels specialists and silviculturists attended. At the same time, the initial calibration for the Northern California and Inland California variants was done. A second validation meeting was held in Missoula, MT to focus on changes needed in the Northern Idaho, Kookantl, and eastern Montana variants. This was attended by 14 fire and fuels specialists and silviculturists from Idaho and Montana. A third validation workshop was held in Fort Collins, CO and focused on the Central Rockies variant of FFE. Seven natural resource specialists from Arizona, Colorado, and New Mexico attended. A fourth validation meeting was held in Bend, OR which reviewed the performance of the southern Oregon variant. Thru these meetings, discussions were held about model performance and significant changes were made to the fuel model selection logic, decay rates, and other model components.

Because of all of these code changes and updates, a new FFE reference document was created. The original FFE publication (RMRS-GTR-116) was published in September 2003. As errors in the documentation and code were found, as enhancements were made, and as new FFE variants were created or expanded, all of this was documented thru a second publication, called the FFE addendum to RMRS-GTR-116. It is currently posted to the FVS website (http://www.fs.fed.us/fmsc/fvs/documents/gtrs.php) and is updated any time a code change is made. A copy of this document is enclosed.

**6 – Expansion of FFE to the Ozarks – Ouachita Mountains region**

The expansion of the FFE to the Ozark – Ouachita Mountains region in the eastern United States was a three step process. First, a preliminary meeting was held in Columbia, MO in July 2002 to meet with local experts, introduce them to the FFE-FVS system, discuss model calibration needs, and solicit their help in contacting the appropriate people needed and in gathering the material needed to begin development. A development meeting was then held in Springfield, MO in November 2002 to get specific information about how to adjust the model for the Ozarks. The Ozarks FFE model was programmed and released in October 2003. Finally, a training session was held in Russellville, AR in December 2003 to train local users and get additional feedback.

**7 - Extension of FFE to another other area of the Eastern United States**

An additional task was to calibrate the FFE for another area in the eastern United States. The Lake States region was selected because they showed the most interest and had a critical need for the FFE in modeling habitat needs for the Kirtland Warbler, a threatened and endangered species. Model development followed the same template as done with previous FFE expansion efforts. Three pre-development meetings were held in October 2004 in Grand Rapids, MN, Rhinelander, WI, and St. Ignace, MI to give a model demonstration to potential users, as well as gain information for model development and

calibration, and enlist help in getting the appropriate individuals involved. A 1.5-day development workshop was held in Grand Rapids, MN in April 2005 to get input on specific model calibration. Computer code development for the Lake States FFE was completed and the model was released in September 2005. A Lake States FFE training session is currently planned for December.

**8 – Efforts to reach JFS partners other than the Forest Service**

To date, most of the people expressing interest in FFE have been with the Forest Service. Although the Forest Service is still the predominant user of FFE, other agencies are using it more and more. The Bureau of Land Management and Washington Department of Natural Resources have hosted FVS trainings the past few years. The fire modeling specialist on the FVS staff has given presentations to the National Park Service fire ecologists and at the EastFire eastern fire conference. Interest in the upcoming Lake States-FFE model has been expressed by other agencies, such as the Bureau of Indian Affairs and Minnesota Department of Natural Resources.

**9 – Work in Progress**

Since all of the original deliverables were complete by June 2004, additional work was taken on in the past year. Some of these new deliverables, such as additional training sessions, additional project assistance, and code maintenance, were completed and discussed above. The following section describes the work on additional deliverables that is still in progress.

**9a - Coarse woody debris research and model updates**

This project funded research at Oregon State University to examine coarse woody debris decomposition rates of seventeen tree species in the western United States. A final report was received in March 2005 and submitted to the JFSP Board. This work will serve to improve and refine the existing FFE models for Oregon and Washington. Model improvements based on this research will be incorporated this winter. Results of this work have also been posted on the following website:

http://www.fsl.orst.edu/lter/pubs/webdocs/reports/decomp/cwd_decomp_web.htm

**9b -Integration of other JFSP funded research that may be beneficial to FVS-FFE**

Incorporation of other JFSP research, such as the FCCS system or natural fuels photo series, will be done this winter. This will provide FFE users with an additional way to set the initial fuel loadings in simulations.

**Summary Comparison of the Proposed Deliverables and Those Actually Completed**

The following is the list of proposed deliverables, with comments about their status in bold italics.

| **Deliverables from the original proposal** | | |
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| **1** | Provide one training session at 6 sites throughout the areas where FFE is operational. There will be at least 3 training sessions for field technical staff. | ***In addition to integrating FFE thoroughly into the regular FVS training, 10 3-day FFE trainings were held that were geared toward fire and fuel specialists.*** |
| **2** | Prepare an introductory video to be distributed to executive level management. | ***This video was created and distributed. A copy is enclosed.*** |
| **3** | Regular FVS training will be enhanced to include FFE-FVS in the curriculum. | ***This has been completed. FFE was incorporated into 16 basic and intermediate FVS training sessions from 2002 – 2004.*** |
| **4** | Work individually with six fire mitigation projects. | ***18 fuel mitigation projects were assisted (6 a year for 3 years).*** |
| **5** | Suggest proper use of the FFE-FVS modeling procedures. | ***This was completed thru the training sessions, phone assistance and on-site project assistance visits.*** |
| **6** | Incorporate lessons learned in these one-on-one sessions into the training materials. | ***Each year the training exercises are revised to better meet user needs. Many of the examples were created and revised over the past three years to represent actual treatments that were simulated during these one-on-one sessions.*** |
| **7** | Model enhancements will be suggested to developers based on feedback from special project users. | ***Many model enhancements came about because of feedback from users. Two examples are the ability to export all of the FFE tables directly to a database and the ability to modify the calculation of canopy fuels.*** |
| **8** | Work with 3 fire specialists to evaluate FFE-FVS model accuracy. | ***Fire specialists from various parts of the west were involved in FFE validation workshops. Four of these workshops were held and led to various model improvements.*** |
| **9** | Provide a localized version(s) of FFE for the Ozark/Ouchita Highlands Ecoregion of the United States. | ***This was completed and released in October 2003.*** |
| **10** | Collaborate with researchers from the USDA Forest Service, Southern Research Station working on a similar project for the Longleaf Pine ecosystem. | ***This project was not funded so collaboration was not possible.*** |
| **Additional deliverables proposed since we were under budget and the original deliverables were all completed by June 2004** | | |
| **1** | Fund coarse woody debris work at Oregon | ***Model improvements based on this work will*** |

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| | State University (as outlined to the Board in July 2003). This work will serve to improve and refine the existing FFE extensions for Oregon and Washington. | ***be incorporated this winter.*** |
| **2** | Continue maintenance and enhancement of existing FVS-FFE code, hot-line user assistance, and incorporation of other JFSP funded products that could be beneficial to FVS-FFE such as the Fuel Characteristic Classification System. | ***Code maintenance and enhancement has been done. Many FFE users have been assisted thru the hot-line. Incorporation of other JFSP research will be done this winter.*** |
| **3** | Continue FVS-FFE training program: hold 7 training sessions in FY05 and provide training materials. | ***Seven of these sessions were held.*** |
| **4** | Continue FVS-FFE testing and validation. 1 formal review session, possibly in the Pacific Northwest or Intermountain region. Continue to solicit input from working with field personnel involved in fuels and fire. | ***This has been completed.*** |
| **5** | Continue assistance to fuel mitigation projects. Assist 5 additional projects. | ***This has been completed.*** |
| **6** | Attend JFSP PI meetings. | ***A project member will attend the meeting in fall 2005.*** |
| **7** | Expand the effort to reach JFS partners other than the Forest Service. | ***This has been completed.*** |
| **8** | Extend the Fuels and Fire Extension to 1 (or more) other areas of the Eastern United States. | ***The Lake States FFE was released in September 2005.*** |

**Conclusion and Some Lessons Learned**

There were three main objectives of this project – to train and assist field personnel in the use of FFE-FVS, to maintain, support, and enhance the FFE-FVS compute code, and to adapt the FFE model for the Ozark-Ouachita Highlands region. Thru numerous training sessions, on-site field visits, and hotline calls, many natural resource specialists now know how to use FFE-FVS. Long-term FFE code maintenance was successfully passed from the original FFE developers at Rocky Mountain Research Station to the staff at the Forest Management Service Center. After holding scoping and development meetings, the first FFE model for the eastern US was successfully built for the Ozarks region. We feel that all of the original project objectives were met.

Since this project was predominantly a technology transfer project, most of the lessons learned deal with this topic. First, the need for some sort of service center for all of the fire and fuels-related tools is necessary. Field personnel are much more able to successfully use these tools when there is someone to talk to about their questions and

concerns. Because people know they can call the Forest Management Service Center with questions, we sometimes get asked about other models, simply because field users aren't sure who else to contact. A service center would also help field personnel get a handle on all of the tools that are out there and how they can use them. Many types of technology transfer were a part of this project, from training sessions to hotline assistance to on-site project assistance. This is really valuable because different people learn in different ways. Some of the students at training sessions did really well in this environment, but others needed some additional one-on-one help to get to the next level. The technology transfer itself needs to be adaptive. Parts of our training sessions have been altered and revised from year to year as we figure out what works and what doesn't work from a teaching standpoint. As field personnel change from year to year, and class to class, their level of computer know-how changes, and training courses and other assistance needs to reflect that in order to effectively meet user needs.