Final Report

Meeting Fire Management Needs for Science Synthesis, Workshops and Online Academic Courses: An Innovative Technology Transfer Approach JFSP 05-4-1-07

Submitted 2 October 2007

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Project Location:

We did not collect field data for this project. Thus, the majority of the work for this project was conducted at the University of Idaho, Latah County, Moscow, ID, First Congressional District (Idaho).

Overview and project objectives

This project was designed to synthesize state-of-the-knowledge on remote sensing of active fire and post-fire effects, and to design and deliver online courses for academic credit. The courses were designed as an innovative technology transfer effort for multiple ongoing and recently completed projects funded by JFSP and other agencies. Our project was designed to address JSFP AFP 2005-4 Task 1, which called for extending technology transfer activities beyond the conclusion of successful current, or recently completed, JFSP-funded projects or other applicable wildland fire research and Task 2, which calls

for producing readily understandable and useable information synthesis or transfer products on key topics of critical interest to the fire and fuels management community.

Our specific project objectives are outlined below followed by our project accomplishments:

a. Develop four 400-level academic short courses to deliver "science and tools" designed specifically to address the educational needs of fire managers under the IFPM Standards for professional GS-0401 Fire Management Specialist positions. The courses are
    - Science-Based Fuels Management Planning, 2 semester credits
    - Assessing Fire Effects and Burn Severity, 2 semester credits
    - Fuels Inventory and Mapping, 2 semester credits
    - Remote Sensing of Active Fire and Post-fire Effects, 1 semester credit
b. Synthesize existing research knowledge on fire-related remote sensing applications to provide decision support for the appropriate uses of various remote sensing technologies. Synthesis will focus on current and ongoing research results, clarify terminology used to describe active fire and post-fire effects and provide comparative analysis of remote sensing tools.
c. Organize a synthesis workshop to bring remote sensing experts together with the user community (i.e., fire and fuel managers). This workshop will provide an opportunity for researchers to share results and organizers to survey managers' conceptual and technological needs to determine critical science and tool deficiencies. The workshop will be offered for 1 semester credit.
d. Conduct a needs assessment to identify additional "science and tools you can use" content that should be synthesized and organized into additional modules/courses for transfer to fire and fuel managers and other personnel. Results will be available online and incorporated to guide future research direction, tool development and technology transfer.
e. Produce one refereed manuscript and two guides for users as described below.

This project will continue well beyond the life of the funding. Following course development funded by this grant, the delivery, updating and maintenance of the courses has been and will be funded, in part, with fees from the courses. Our goal is to continue to offer the courses as long as there is a demand, modifying them as needed, and to update about one third of the content for each one each year (as we have long done with most of our on-campus fire courses). As well, the user's guide to remote sensing of active fire and fire effects will be updated regularly to reflect the findings of ongoing research here at the University of Idaho because that is one of our outreach efforts.

Project accomplishments

Eight courses were developed and taught one or more times online for fire professionals (Table 1).

These courses were all taken for upper-division (400-level) academic credit by fire professionals and other students. We've had people from more than 27 states enroll in these and other fire courses offered online and in hybrid online and workshop format. Many fire professionals and other people take these courses to meet Interagency Fire

Program Management Standards for professional GS-0401 Fire Management Specialist positions. All eight of these courses have been incorporated into both undergraduate and graduate programs at the University of Idaho. Many are included as required or elective courses in our new B.S. degree in Fire Ecology and Management (the first and only degree program in the US where students can major in wildland fire). We have begun enrolling students this fall in this new BS degree, and we expect to have and expect this degree program to have 80-100 students in it within 4 years. In addition, students can use these courses to complete the Certificate in Fire Ecology and Management, the on-campus and web-based Masters of Natural Resources, as well as our current B.S., M.S., and Ph.D. degree programs. Information about these programs is available at http://www.cnr.uidaho.edu/wildlandfire.

Content for these four courses was collected and synthesized from more than 17 ongoing or recently completed projects funded by JSFP, NASA and the US Forest Service projects (Table 2), and from related science and practice. Common threads across all courses and deliverables include bringing "science and tools" to bear on fire and fuel issues through readings, discussion and applied projects, learning from and discussing case studies, issues, techniques and needs with scientists and experts, hands-on field applications, and learning how to access and synthesize the scientific literature. Workshop and course content for these four courses was collected and synthesized from multiple ongoing or recently completed projects funded by JSFP, NASA and the US Forest Service projects, and from related science and practice (Table 2)

Through a related project funded by the Idaho State Board of Education, we also developed and taught additional fire-science courses (Table 1). In these courses we also incorporated findings from ongoing and recently completed JFSP-funded research projects. As well, four complementary, non-credit, web-based modules have been developed with this additional funding to help our students be successful in courses.

Two Web sites for this project

One website, http://401series.net is designed to help people searching for fire-related courses available online. Courses from multiple universities are included. This website has had over 6,000 visitors between April 2006 and September 2007. In addition, there are websites for each of the individual courses (Table 1). Course web sites are used to deliver information about the course as well as course content, some of which is password-protected and only available to students enrolled in the class.

The other website, http://www.cnr.uidaho.edu/fire_rs_synthesis/, is designed to give a project overview as well as to deliver the user's guide to remote sensing of active fire and fire effects. The latter web site is in the process of being transferred to the FRAMES web site: http://frames.nbii.gov as we originally proposed.

Synthesis of research on remote measures of active fire and post-fire effects

An article, "Remote sensing techniques to assess active and post-fire effects", by Leigh Lentile and others was published in the International Journal of Wildland Fire in 2006. In this paper we define burn severity, discuss current approaches to using remote sensing to infer the perimeter and behavior of active fires and to infer the ecological changes to vegetation and soils as a result of wildland fires. This paper has been downloaded from the journal web site more often than any other paper in the last 12

months, and one of the 20 papers most downloaded since 2001 (http://www.publish.csiro.au/nid/115/aid/4640/date/1.htm).

Synthesis workshop and needs assessment

A user's workshop was conducted to assess user's needs for remote sensing technologies. It was held during the "New Remote Sensing Technologies for Resource Managers", the Eleventh Biennial Conference (http://www.fs.fed.us/eng/rsac/RS2006/) coordinated by the USDA Forest Service Remote Sensing Applications Center (RSAC), the University of Idaho, and the ForestPARC (http://www.cnr.uidaho.edu/measurements/extension.htm). Alistair Smith and Leigh Lentile coordinated and hosted an afternoon session focused on Remote Sensing of Post-Fire Effects. The session included a synthesis of the current status of remote sensing methods to monitor active fire behavior and post-fire effects, a series of researcher presentations and a panel, all designed for managers to identify data needs and information gaps, for researchers to identify current challenges for providing this information, and both managers and researchers to identify ways to work together to overcome these challenges. Caty Clifton, Colin Hardy, Randy McKinley, Annette Parsons, Brian Schwind, Henry Shovic, and Dean Sirucek were members of the panel. Their comments generated much discussion and interaction amongst managers and researchers. In preparation for the session, the organizers conducted an informal needs discussion.

Both the panel discussion and the results of the informal needs assessment as well as recommendations for addressing those needs are included in the proceedings paper by Lentile et al. (2006) (complete citation is listed in Table 1). The roundtable discussion was recorded in video and audio. To facilitate ease of download audio experts of several of the panelists' responses are available from the project website: http://www.cnr.uidaho.edu/fire_rs_synthesis/.

User's guides

The user's guide to remote sensing of active fire and post-fire effects is available on http://www.cnr.uidaho.edu/fire_rs_synthesis/. We hope this site will prove useful to managers and scientists alike as they wrestle with choosing the best approach for remote sensing of fires and fire effects. We are in the process of moving this site to FRAMES (http://www.frames.nbii.gov) as we originally proposed. We anticipate that that move will be completed by December 2007.

We did not complete the second product which was to be a field guide to visually assess and quantify burn severity, and the second was to be a reference guide to identify appropriate uses of various remote sensing technologies. Despite our best intentions, we were so busy accomplishing (and exceeding) our other project objectives that we did not complete this user's guide. This is disappointing to all of us. However, we feel that we have accomplished a great deal in this project. In many other respects, we have accomplished more than we originally proposed to do. We think this is still a good idea.

Table 1. Products of this research relative to what we originally proposed.

Proposed	Delivered	Status
Website (we proposed one and produced two websites)	http://www.cnr.uidaho.edu/fire_rs_synthesis/. This site includes project overview as well as user's guide for remote sensing of active fire and post-fire effects	Completed in 2007, Updated at least monthly
Website	http://401series.net. This site is designed to help fire professionals and others find courses available online for academic credit to help them meet new IFPM standards.	Completed in 2005, Updated at least monthly
Course	Science-Based Fuels Management Planning (FOR 433), 2 credits http://www.cnr.uidaho.edu/for433 In this course, we discuss the roles, uses and limitations of quantitative and qualitative modeling in fuels management and planning. The topics covered in this class include the role and uses of models to make predictions in fuels management, validation and evaluation of models, and communication and interpretation of modeling results for planning and decision making.	Taught as web-enhanced, 2-credit workshop in 2006 to 14 students; taught online in spring 2007 to 23 students; will be taught annually
Course	Assessing Fire Effects and Burn Severity (FOR 434), 2 credits http://www.cnr.uidaho.edu/for434/ Terminology and methods for assessing fire effects and burn severity in the field and from airborne and satellite remote sensing. Quantitative analysis and interpretation of the ecological effects of fire on plants and soils. Critically review and synthesize relevant scientific literature.	Taught twice, once online and once on-campus
Course (proposed as a 2-credit course, will become a 3-credit course)	Fuels Inventory and Mapping (FOR 451), 2 credits, http://www.cnr.uidaho.edu/for451/ Fuels inventory, including in-depth analysis of recent development in remote sensing, as well as tools to support fuels planning, including potential and limitations of mapping fuels with Lidar and satellite imagery. Critically review and synthesize relevant scientific literature.	Taught twice in spring 2006 (once online and once on-campus); scheduled for spring 2007 as a 3-credit class Fuels Inventory and Management; will be taught annually
Course	Remote Sensing of Active Fire and Post-fire Effects (FOR 435), 1 credit, http://www.cnr.uidaho.edu/for435/ Application, potential and limitations of methods for the remote sensing of active fire and post-fire effects, and interpretation of the results. Clarification of definitions of fire descriptors (fire intensity, fire severity and burn severity) and	Expanded and taught in 2006 as a 2-credit course, scheduled to expand to 3 credits for spring 2007; will be taught annually

	relative merits of remote sensing tools for addressing them. How to identify mapping tools appropriate for different types of imagery (depending on the specific questions to be addressed and provide decision support to user community. Critically review and synthesize relevant scientific literature	
(This course wasn't in our original proposal)	Wildland Fire Ecology and Management (FOR 426), 3 credits http://www.cnr.uidaho.edu/for426online/ In this course, students learn about the effects of fire on plants, animals, soil, water and air. They discuss current issues in fire management, read scientific literature and apply these skills to real world problems. This course emphasizes fire as an ecological process in ecosystems, how to characterize and predict the effects of fire over time and space and how to apply these principles to restoration ecology	Taught 3 times (2005, 2006 & 2007) both online and on-campus to a total of more than 160 students, will be taught annually
(This course wasn't in our original proposal)	GIS Applications in Fire Ecology and Management (NR 406), 1 credit http://www.cnr.uidaho.edu/nr406/, Introduces applications of GIS in fire ecology, research, and management including incident mapping, fire progression mapping, GIS overlay analysis, remote sensing fire severity assessments, fire atlas analysis and the role of GIS in the Fire Regime Condition Class concept and the National Fire Plan	Taught in spring 2007 to 11 students; will be taught annually with increased enrollment
(This course wasn't in our original proposal)	Rangeland Ecology (RNGE 459), 2 credits, http://www.cnr.uidaho.edu/range459bunting, Application of ecological principles in rangeland management; stressing response and behavior of range ecosystems to various kinds and intensity of disturbance and management practice	This course was converted from an existing, traditional course to an online 2-credit class; taught in fall 2006 to 19 students and in fall 2007 to 41 students; will be taught annually
(This course wasn't in our original proposal)	NR 402: GIS Applications in Natural Resources (1 credit) Taught by: Eva Strand Website: http://www.cnr.uidaho.edu/nr402/ Application of GIS principles to natural resource problems. Topics include GIS/GPS integration, habitat inventory, site suitability studies, risk assessment, sources of spatial data, map accuracy, etc, with hands-on exercises using GIS software	Taught in fall of 2006 to 25 students; is being taught in fall 2007; will be taught annually

(This non-credit course module was not in our original proposal)	Non-credit module on how to use electronic databases, electronic journals, and other research support tools, designed to help students in online courses be successful, http//www.cnr.uidaho.edu/learn/research	Available online since 2006
(This non-credit course module was not in our original proposal)	Non-credit module on ecology terminology, designed to help students in online courses be successful, http//www.cnr.uidaho.edu/learn/ecology	Available online since 2006
(This non-credit course module was not in our original proposal)	Non-credit module on statistics and interpreting quantitative data in graphs and tables, designed to help students in online courses be successful, http//www.cnr.uidaho.edu/learn/statistics	Available online since 2006
(This non-credit course module was not in our original proposal)	Non-credit module to help students refresh their math skills, designed to help students in online courses be successful, http://www.cnr.uidaho.edu/learn/math/	Available online since 2006
User's workshop and needs assessment	Two sessions and a Panel Discussion held at the "New Remote Sensing Technologies for Resource Managers", Eleventh Biennial Remote Sensing Applications Conference, April 24-28, 2006 Salt Lake City, UT	Completed
Two user's guides	User's Reference Guide: Appropriate Uses of Remote Sensing to Assess Active Fire and Post-Fire Effects http://www.cnr.uidaho.edu/fire_rs_synthesis/ Site contains an online tutorial on how to use Landsat data for production of dNBR imagery	Reference guide to remote sensing completed in 2007. The other one is not and will not be completed as part of this project
Publication in Refereed Journal Synthesis	Lentile, L. B., Z. A. Holden, A. M. Smith, M. J. Falkowski, A. T. Hudak, P. Morgan, P. E. Gessler, and N. C. Benson. 2006. Remote sensing techniques to assess active fire characteristics and post-fire effects. International Journal of Wildland Fire. 15(3) 319–345. Feature Paper	Completed
Publication in Refereed Journal (not in our original proposal) Case Study: Fractional Cover I	Smith, A.M.S., .Lentile, L.B., Hudak, A.T. and Morgan P., Evaluation of linear spectral unmixing and dNBR for predicting post-fire recovery in a N. American ponderosa pine forest, International Journal of Remote Sensing	Completed (in press)
Publication in Refereed Journal (not in our original	Lentile, L.B., Smith, A.M.S., Hudak, A.T., Morgan, P. and Bobbitt, M, Remote sensing for prediction of 1-year post-fire ecosystem condition,	In Review

proposal) Case Study: Fractional Cover II	International Journal of Wildland Fire, in review	
Publication in Refereed Journal (not in our original proposal) Case Study: Burned Area Mapping Methods	Smith A.M.S., Drake, N.A., Wooster, M.J., Hudak, A.T., Holden, Z.A. and Gibbons C.J. (2007) Production of Landsat ETM+ Reference Imagery of Burned Areas within Southern African Savannahs: Comparison of Methods and Application to MODIS, International Journal of Remote Sensing 28: (12):2753-2775.	Completed
Proceedings article (not in our original proposal)	Lentile, L. B., A. M. Smith, P. Morgan Z. A. Holden, M. J. Falkowski, P. E. Gessler, S. A. Lewis, A. T. Hudak, and P.R. Robichaud. 2006. Panel discussion: challenges and recommendations for the mapping of fire and post-fire effects. Proceedings, New Remote Sensing Technologies for Resource Managers", Eleventh Biennial Remote Sensing Applications Conference, April 24-28, 2006 Salt Lake City, UT.	Completed
Audio Excerpts from Roundtable/needs assessment (not in our original proposal)	http://www.cnr.uidaho.edu/fire_rs_synthesis/ Site Contains: Audio clips from panel members	Completed

Table 2. Research projects from which material was drawn for the four courses originally proposed and for one other. For all of these projects, these courses are an innovative technology transfer mechanism.

Course	Research Project Title	Principal Investigator(s)	Funding Source
FOR 433 Science-Based Fuels Management Planning			
	Applied Wildland Fire Research in Support of Project Level Hazardous Fuels Planning http://www.fs.fed.us/fire/tech_transfer/synthesis/synthesis_index.htm	Russ Graham and Sarah McCaffrey	Washington Office, USDA Forest Service
FOR 434 Assessing Fire Effects and Burn Severity			
	Assessing the Causes, Consequences and Spatial Variability of Burn Severity: A Rapid Response Proposal http://www.cnrhome.uidaho.edu/burnseverity	Penny Morgan, Andy Hudak Kevin Ryan, and Pete Robichaud	JFSP Project 03-2-1-02
	Post-fire Erosion and the Effectiveness of Emergency Rehabilitation Treatments over Time	Pete Robichaud and others	JFSP Project 03-2-3-22
	Risk Assessment of Fuel Management Practices on Hillslope Erosion, Phase II http://forest.moscowfsl.wsu.edu/fswepp	P. Robichaud, W. Elliot, F. Pierson, P. Wohlgemuth.	JFSP Project 01-3-2-08
	Impact of Fuel Management Treatments on Forest Soil Erosion and Productivity	Bill Elliot and others	National Fire Plan. RMRS-MCW-1a
FOR 451 Fuels Inventory and Mapping			
	Training Package for Land Management Tools Sponsored by the JFSP: Photo Series, FCCS, Consume 3.0, and FEPS (and related JFSP projects) http://www.fs.fed.us/pnw/fera/jfsp/fcc/ http://www.fs.fed.us/pnw/fera/jfsp/photoseries/	Roger Ottmar and others	JFSP Projects 04-4-1-19, and 01-1-7-02, 98-1-1-06, 98-1-1-05
	Quantification of Canopy Fuels in Conifer Forests, and Additional Work for Quantification of Canopy Fuels in Conifer Forests	Elizabeth Reinhardt and others	JFSP Projects 99-1-3-12 and 01-S-06
	Impact of Fuel Management Treatments on Fire Behavior and Forest Vegetation	Dennis Ferguson and others	NFP. RMRS-MCW-1a
FOR 435 Remote Sensing of Active and Post-fire Effects			
	Assessing the Causes, Consequences and Spatial Variability of Burn Severity: A Rapid Response Proposal, http://www.cnrhome.uidaho.edu/burnseverity	Penny Morgan, Andy Hudak Kevin Ryan, and Pete Robichaud	JFSP Project 03-2-1-02
	Forest Public Access Resource Center: A consortium of federal and university researchers promoting research and outreach actively participating with RSAC and EROS data centers	Alistair Smith, Paul Gessler, and Lee Vierling	UMAC/NASA
	Evaluating high resolution hyperspectral images for determining postfire burn severity	Pete Robichaud	JFSP Project 01C-2-1-02
	Efficacy of remote sensing for mapping post-burn severity Landscape assessment. In: Fire Effects Monitoring and Inventory Protocol.	Carl Key and Nate Benson	JFSP Project 00-1-3-19
	Demonstration and integration of systems for fire remote sensing, ground-based fire measurement, and fire modeling.	Colin Hardy, Phil Riggan and others	JFSP Project 03-S-01

FOR 426 Fire Management and Ecology			
	Assessing the Causes, Consequences and Spatial Variability of Burn Severity: A Rapid Response Proposal, http://www.cnrhome.uidaho.edu/burnseverity	Penny Morgan, Andy Hudak Kevin Ryan, and Pete Robichaud	JFSP Project JFSP 03-2-1-02
	Invasive Species Response to Fire and Post-fire Rehabilitation Following the 2005 School Fire, Umatilla National Forest: A Rapid Response Proposal	Pete Robichaud Andy Hudak Leigh Lentile Sarah Lewis Penny Morgan	JFSP 06-1-02-03
	Training Package for Land Management Tools Sponsored by the JFSP: Photo Series, FCCS, Consume 3.0, and FEPS (and related JFSP projects) http://www.fs.fed.us/pnw/fera/jfsp/fcc/ http://www.fs.fed.us/pnw/fera/jfsp/photoseries/	Roger Ottmar and others	JFSP Projects 04-4-1-19, and 01-1-7-02, 98-1-1-06, 98-1-1-05
	Climate drivers of fire & fuel in the Northern Rockies: Past, Present & Future	Penny Morgan, Emily Heyerdahl, Carol Miller and Matt Rollins	JFSP 03-1-1-07
ALL courses also use tools available from the following projects			
	An Expert System and New Web Interface For Tools on the Fire Research and Management Exchange System (FRAMES),: http://www.frames.gov	Penny Morgan, Greg Gollberg, Robert Keane, Wayne Cook, Lloyd Queen, and Mark Twery	JFSP Project 03-4-1-02
	Monitoring Fire Effects at Multiple scales: Integrating Standardized Field Data Collection with Remote Sensing to Assess Fire Effects, http://www.fire.org/firemon/default.htm	Bob Keane	JFSP Project 00-1-3-19