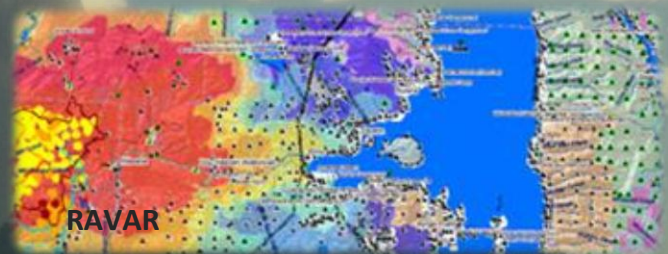


National Fire Decision Support Center

Annual Report 2010



**Rocky Mountain Research Station,
Fire and Aviation Management**

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Introduction

In response to the increasing complexities of fire management the National Fire Decision Support Center (NFDSC) was created in May 2009. The Center, a group of scientists, researchers and practitioners has been operational for the past year. Complexities of fire management have been and continue to increase in response to rising suppression costs, potential resource impacts (air quality, watersheds), numerous values at risk on the landscape (homes, power lines, dams, etc.) as well as mixed perception and attitudes regarding fire management. The efforts of the NFDSC are to:

- Improve the science basis for large fire decision making
- Improve fire management decision support tools and processes
- Improve agency capability to manage fire expenditures
- Maintain centralized decision support capabilities to conduct decision support and analyses for fires
- Continue development of a safety culture that is highly reliable and resilient
- Taking a proactive and systematic approach to managing risk.

The NFDSC provides corporate decision support information and monitoring on wildland fires; directed research on strategic decision making capability and risk modeling; and improved awareness and application of decision support information in risk-informed decision making. The NFDSC is a virtual organization comprised of team members from multiple USFS research and management programs, Department of Interior, and potentially other cooperator organizations. Existing Forest Service units that will provide staff for integration in this effort include, but are not limited to: WFM RD&A (RMRS and DOI involvement); Human Factors and Risk Management RD&A (RMRS); Fire Spread Research (Fire, Fuels, and Smoke Program, RMRS); Fire Economics Research (Human Dimensions Program, RMRS); and Fire and Aviation Management (Headquarters Office) (figure 1); research program areas may be involved as warranted and available.

This report describes the NFDSC's annual accomplishments for fiscal year 2010 and planned activities for FY 2011. Additional accomplishments associated with collaborative efforts among NFDSC groups are also identified. Each unit has made successful efforts to hire personnel, implement projects, write publications, and provide training, while emphasizing a collaborative approach to achieve their goals and objectives. Planned activities for FY2011, as outlined in this report, demonstrate the broad range of activities of continuing development and involvement. FY 2011 will be the second full year in which the NFDSC has been fully staffed, operational, and supporting research, training, large fire decision making, and monitoring on fires.

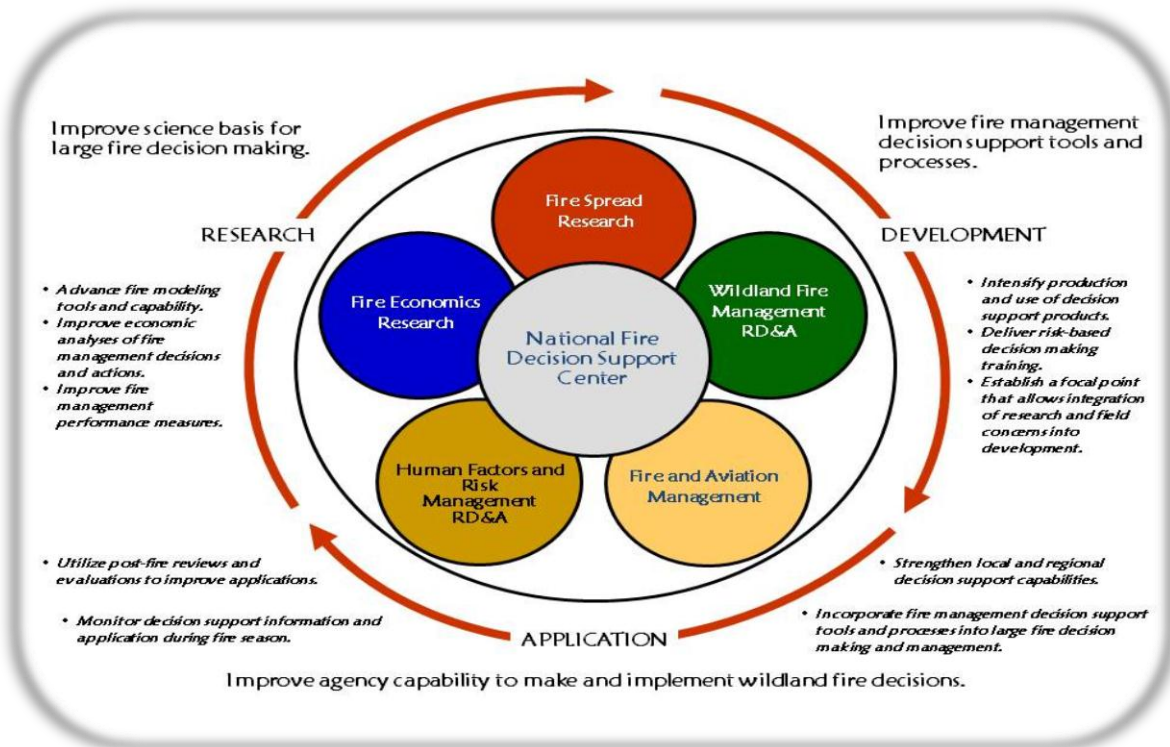


Figure 1: NFDSC composition showing collaborating programs.

Changes to Staffing in 2010

The composition of each NFDSC Unit is:

Fire Spread Research:

- Research Mechanical Engineer - Combustion
- Operations Research Scientist - (unfilled)
- Mechanical Engineer - Fluid Mechanics
- Physical Scientist - Electrical Engineering - New
- Mathematical Statistician
- Physical Scientist
- Machinist
- Physical Science Technician
- Lab Technician - New

Fire Economics Research

- Research Forester
- Data Services Specialist
- Landscape Hydrologist (Collins Contracting)
- 3 GIS Analyst, (Univ. MT cooperator)
- Data Analyst (Univ. MT cooperator)
- Research Analyst (.5 FTE, Collins Contracting) - New

Wildland Fire Management RD&A

- Program Manager
- Fire Management Specialist
- Fire Application Specialists – 8 (2 DOI positions)

Human Factors and Risk Management RD&A

- Social Science Analyst - New

Fire and Aviation Management

- This unit of the NFDSC provides funding and oversight as needed to the other units.

2010 Accomplishments

The NFDSC was tasked with being fully operational by March of 2010. The units were successful in meeting this timeline, although hiring of various NFDSC positions was ongoing through August 2010. The NFDSC was successful in providing decision support assistance to various field users as well as advancing fire spread and economics research. The 2010 fire season was relatively mild, providing ample opportunities for mentoring, and training for field personnel in addition to collaboration among the NFDSC program units.

The primary goals for FY 2010 in the NFDSC were to:

- Provide decision support assistance to wildfire incidents nationally or as requested by regional or local units,
- Provide support for fuels treatment projects as requested.
- Continue to acquire and improve data supporting RAVAR tools, and integrate with WFM-RD&A for overall RAVAR management and support.
- Collaborate with interagency partners on the Development of the National Wildfire Risk Assessment and Cohesive Strategy.
- Evaluate and develop models to help quantify potential fire effects on resources (ie: watersheds).
- Continue research associated with risk management; assessing insurance, incentives and financial accountability.
- Continue research associated with fuel continuity, loadings and fuel moisture values.
- Develop and update agreements and collaborative efforts for ongoing research partnerships.
- Continue to recruit and fill necessary positions.
- Develop the work plan for 2011.

The following sections provide descriptions of accomplishments in 2010 for each participating NFDSC unit and are subdivided into appropriate functional topics.

Agreements, Partnerships and Collaboration:

Fire Economics and Fire Spread Research -

Scientists and professionals from the Fire Economics and Fire Spread Research programs were heavily engaged in the development of a science basis for the Cohesive Strategy for Fire and Fuels Management. Building upon research accomplishments in the development of wildfire risk assessment frameworks, the scientists worked closely with the two threat centers (Eastern Forest Environmental Threat Assessment Center and Western Wildlands Environmental Threat Assessment Center). Participation in several meetings and briefings with the Cohesive Strategy Oversight Committee and the Wildland Fire Leadership Council (WFLC) occurred throughout the spring and summer of 2010. The science team authored an extensive "Science Report" that is currently under review and editing for publication as an RMRS-GTR. An accompanying "Science Brief" will be published along with the Oversight Committee's larger report to Congress.

Fire Economics Research

- Extended Research Joint Venture Agreement (RJVA) and Challenge Cost Share Agreement with University of Montana for collaboration and research support on wildland fire risk assessment and RAVAR support.
- Contracted with professors of Actuarial Science at the University of Wisconsin to initiate a study to describe and quantify an insurance- based approach to wildfire suppression funding and budgeting.

- Hosted scientist Tom Holmes (SRS) from June-August 2010 to work with the NFDSC team on suppression resource production studies, other potential performance measurement studies, and choice modeling experiments.
- Continued partnership with the National Cadastral Subcommittee on the acquisition and processing of cadastral data for wildland fire applications such as WFDSS and promotion of strategies to develop and maintain a national cadastral database.
- Data Services Specialist Jessica Haas detailed as a visiting scientist to NASA's Goddard Space Flight Center (GSFC), October-November of 2009, Greenbelt, Maryland. Jessica studied with doctors Molly Brown, Jim Collatz, Jeff Masek and Chris Neigh, leading researchers in large scale disturbance monitoring and remote sensing carbon modeling. She conducted landscape scale post wildland fire vegetation recovery using Landsat datasets and algorithms currently only available at the GSFC. By working with the GSFC lab, she gained a better understanding of the strengths and limitations of various datasets produced at Goddard and widely used in landscape level disturbance analysis. Additionally, she was introduced to new techniques and computer programming methods that will make such research possible at the NFDSC. The collaboration with these scientists and the relationships built within this community will allow the NFDSC to better address issues of forest fire management as it pertains to short and long term carbon storage capacities for US Forest Service lands.
- Worked with USGS scientists to explore new decision support technologies to estimate post-wildfire response on impacted watersheds

Fire Spread Research

- Modified challenge-cost-share agreement with Professor David Lignell (Brigham Young University) for investigating the use of One Dimensional Turbulence for modeling turbulent flame structure.
- Cooperative funding with Joint Fire Sciences of live fuel ignition (W, Matt Jolly, PI).

Wildland Fire Management RD&A

- Collaborative efforts with the Airfire Program, Pacific Northwest Research Station.
- Cooperative work with the LANDFIRE Program to validate fuel models for annual updates into WFDSS.
- Cooperative agreement and development of Board of Directors for oversight of DOI Fire Application Specialists and their participation in the WFM RD&A and NFDSC.
- Continued partnerships with Desert Research Institute (DRI) and Pacific Northwest Research Station (PNW) for development of Smoke forecasting products within WFDSS.

Human Factors and Risk Management RD&A

- Contracted with Renoveling, Inc., to assist with Joint Fire Science Program Project "Using Escaped Prescribed Fire Reviews to Improve Organizational Learning." Identified key learning opportunities and techniques during and following escaped prescribed fire.
- New Research Joint Venture Agreement (RJVA) with Professor Linda Putnam (University California Santa Barbara) to pass Joint Fire Science Program funding to a PhD student to investigate how ground-level fire fighters develop an understanding of 'hazards', 'risk' and 'appropriate response'.
- Renewed and updated of RJVA with Associate Professor Vicki Ebbeck (Oregon State University, College of Health and Human Sciences, Department of Nutrition and Exercise Sciences) to fund PhD studies investigating the concept and application of mindfulness as a technique to focus attention and improve individual performance in a fire environment.
- Updated of RJVA with Professor Toddi Steelman (North Carolina State University), adding additional funding from WO Fire and Aviation Management for social networking analysis to better understand and improve the functioning of information flows on large wildland fires.
- Developed a work order with Digital Visions Enterprise Team to support and develop the Key Decision Log.

Projects

Fire Economics Research

Cohesive Strategy - Research Foresters David Calkin and Matt Thompson were nominated to the Cohesive Strategy for Fire and Fuels Management Team. Calkin, Thompson, and analysts with the fire economics team helped craft the Cohesive Strategy Science Report that demonstrated and recommended a risk-based framework to evaluate current wildfire risk to developed and natural resource values, mitigation opportunities, and relative tradeoffs among alternative management strategies.

Wildfire Risk Assessment - Worked with collaborators in the Western Wildlands Environmental Threat Assessment Center (WWETAC) and the Eastern Forest Environmental Threat Assessment Center (EFETAC) to develop, refine, and publish methods to conduct wildfire risk assessments at multiple scales. The team helped define methods to design and evaluate proposed Collaborative Forest Landscape Restoration Act (CFLRA) projects.

RAVAR - Finalized RAVAR training materials and analyst manual. Planned, implemented, and conducted a series of webinar training sessions. Coordinated with NFDSC to refine, compile and develop a plan to distribute current core RAVAR data. Coordinated with the NFDSC WFM RD&A team to initiate a development plan for the transfer of RAVAR technology to the newly trained RAVAR analysts.

Incentives - Continued research into incentives, financial accountability, and the decision making environment surrounding management of large wildland fires. Proposed an actuarial approach to wildland fire financial planning and demonstrated the approach using fire simulation and fire cost models. Procured contract with actuarial professors from the University of Wisconsin to support development of actuarial methods.

Large Fire Costs - Collaboration between Region 1, RMRS, and PNW-WWETAC established protocols to evaluate cost-effectiveness of fuel treatments for proposal development under the Collaborative Forest Landscape Restoration Act (CFLRA). Initiated the development of a statistical model for estimating expenditure on individual large wildland fires using spatially-explicit fire characteristic information. Provided forecasts of fiscal year suppression expenditures to WO-F&AM throughout the year in cooperation with SRS and NIFC. Conducted cost analysis and provided yearly Stratified Cost Index (SCI) performance measure reports to the FS and DOI and updated models for use in WFDSS and FPA. Continued work on the development of a model for predicting fire costs greater than \$5 million through completed study plan, supervised collection of data, and preliminary analysis using updated data.

Risk to Populated Areas - Improved methods and data to identify structures and populated areas at risk to wildland fire. The team continued to coordinate county parcel acquisition with the National Cadastral Sub-Committee for staging within the WFDSS and other research projects. The team developed methods to interact LandScan population data with fire likelihood from the FSim model to demonstrate a consistent methodology to quantify wildfire risk to populated areas.

Social and Managerial Preferences - Worked with collaborators at the University of Montana and WWETAC to design and implement studies that explore social and managerial preferences for wildland fire outcomes. Studies include a choice modeling experiment of residents of Flathead County Montana, a choice modeling experiment of USFS fire managers, and the initiation of a multi-criteria decision analysis project on the Deschutes National Forest.

Suppression Efficiency - Collaborated on a project to use production theory to evaluate the relative daily efficiency of suppression resources in containing large wildfires from 209 fire reporting data. Spatial analysts with the team participated on 5 large wildfire events collecting spatially explicit fireline production and wildfire outcome data. These data will be used to refine future estimates of fireline efficiency and evaluate environmental and managerial factors that affect efficiency

Aviation - Consulted with RAND Corporation and provided critique of the RAND Corporation's report produced on identifying the appropriate fleet composition of large airtankers. Contracted with Systems for Environmental Management to collect and analyze historic use data (1993 to present) for large airtankers. Collaborated with Bob Roth, Missoula Technology Development Center, to develop requirements and test real-time tanker drop location sensors to improve methods to analyze the effectiveness of drops for initial attack and large fire suppression.

Wildfire Effects - Collaborated with FSPro developer and programmer to add a fire effects prototype to existing FSPro code. Successfully tested and implemented code and produced first demonstration of output with reasonable success and apparently credible results. Worked with NIFC and MTDC Fire Chemicals team to plan and successfully implement demonstration of the use of ICWater to assess the fate and consequence of application of fire chemicals, producing real-time demonstrations. Collaborated with USGS to develop and design methods to predict second-order fire effects on watershed response using first-order effects predicted in FSPro.

Decision Making – Worked collaboratively with Robert Haight (NRS), David Tomberlin (NMFS), and Ken Williams (USGS) to synthesize literature and develop typology of uncertainty for wildfire context. The collaborative group Investigated questions of partial observability and structural uncertainty in modeling.

Fire Spread Research

Flame Structure on Vertical Fuel Sources - Vertical fuel sources are analogous to the combustion interface inside a fuel bed (grasses, shrubs, and tree canopies) where the flame front provides the source of intermittent flame contacts with unburned fuel particles. The research team has constructed two laboratory experiments to allow measurement and analysis of high frequency temperature variations at the leading edge of the fire. Cooperators at Brigham Young University (BYU) are comparing these results with modeling by the One Dimensional Turbulence technique to evaluate the utility of ODT for characterizing convective heating in fire spread. Ultimately, this research will lead to characterizing the convective contribution to particle ignition and fire spread.

Particle Heating in spreading fires - Contrary to most modeling assumptions for crown fires or surface fires, experiments and modeling have shown that fine fuel particles (grass, needles, etc.) are difficult to ignite from thermal radiation emitted ahead of spreading fires. Fuel particles receive radiation but only at very short ranges (cm-to m) because of optical attenuation within the fuel bed. Even when exposed to the full radiant flux, convective cooling offsets the radiant heating of fine particles because only thin boundary layers surround fine particles (meaning increased contact with cool air) compared to thick particles. Experiments are leading to models for predicting heating and ignition of particles of various sizes for different radiant fluxes.

Ignition Requirements for Dead and Live Fuels - Live fuels are not just wet dead fuels. This has been suspected for many years and is critical to understanding and modeling crown fires which burn primarily live material. However, the differences in how moisture is lost during heating and how ignition takes place in the presence of water have been poorly understood. New research is being conducted that identifies the critical mass loss-rates for live and dead fuels of different species, and the mechanisms of moisture loss in live fuels with radiant and convective heating. The chemistry of the live fuel is also explored in terms of the carbohydrate contents and seasonal variations.

Cohesive Strategy and Wildfire Risk Assessment - Research Forester Mark Finney and several members of the NFDSC were members of the Cohesive Strategy Science Team (C.W. McHugh, K. Short, K. Riley). The team helped develop the risk-based framework and national data used to quantitatively compare risks among alternative national management strategies including the historical, current, and increased fuel treatments. Advances in simulation-based fire risk assessment methods are being developed jointly with researchers in the NFDSC Economics team and PNW-WWETAC.

Incentives - Research into the use of simulation-based risk assessment has led to new research on applying standard actuarial risk-management methods to wildland fires, including insurance and incentives. This work involves the Fire Spread team and Economics teams at the NFDSC.

Risk Based accounting of Carbon and Emissions - Along with partners from PNW-WWETAC and Oregon State University, the risk framework and simulation methods are being applied to estimate carbon and emission for the CONUS. These methods offer the chance to estimate carbon and emission consequences in the context of uncertainty and variability in wildfire occurrence and behavior.

Wildland Fire Management RD&A

Decision Support Assistance to Fire Incidents- The WFM-RD&A provided decision support assistance to approximately 75 wildland fire incidents, in addition to supporting various prescribed burning or fuels projects as requested by the regional or local units. Incidents supported by the NFDSC include:

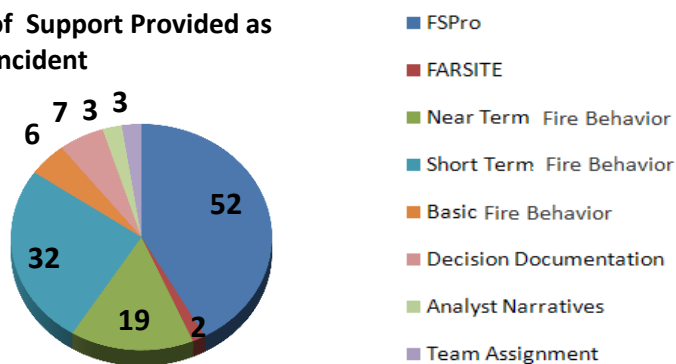
- Alaska Geographic Area Coordination Center (GACC): (State) Turquoise Lake, Gilles Creek, Lone Mountain, Popovich, Chitanatala, Granite Tors, North Fork, South Fork Healy, Big Swede, Applegate, (BLM) Bonnefield, (BLM and State) Toklat, Eagle Trail, Cascaden Ridge, Mississippi Impact, Frying Pan, (FWS) Holonada, Green, Silvia Creek.
- Eastern GACC: (USFS) Shell Island, Brewis.
- Eastern Great Basin GACC: (USFS) Bull, Copper, Eight Mile, Giraffe Creek, Mesquite, Banner, Little Beaver Complex, Boise Complex, Twitchell Canyon, Coffee Pot, Jack Knife, Marshall, Mike Spencer.
- Northern Rockies GACC: (NPS) Beach, Antelope, Dominic Point, (USFS) Jack the Ripper, Little Boulder
- Northwest GACC: (USFS) Rooster Rock, Pyramid, Bull of the Woods, Boulder Creek, Oak Flat, (State) Highway Eight.
- Rocky Mountain GACC: (USFS) Paradise.
- SouthCal Ops GACC: (USFS and NPS) Sheep Complex.
- Southern GACC: (USFS) Holiday, Buck Mountain, Holly Branch, Hanna2 (NPS) Calderwood.
- Southwest GACC: (USFS) Paradise, Boggy, South Fork, Corona, Horseshoe, Cottonwood, Shultz, Eagle Rock, Tecolote, (BLM) Long Canyon, (NPS) New, Yucca, Saffron, Sublett, Crystal.
- Western Great Basin GACC: (USFS) Wolf Creek.

Analysts were able to provide incident support virtually for 91% of the requests.

Type of Analyst Support. Primary analyst support (support to the unit solely to implement fire behavior requests) was requested the majority of the time, although 43% of the time units requested ‘analyst assist’ support. These requests gave the unit an opportunity to identify local specialists for on the job training with NFDSC assigned analysts; giving the WFM-RD&A an opportunity to help the field with coaching, mentoring and training of fire behavior assessment tools.

Type of Support. The pie chart displays the type of support WFM-RD&A provided to various incidents (figure 2).

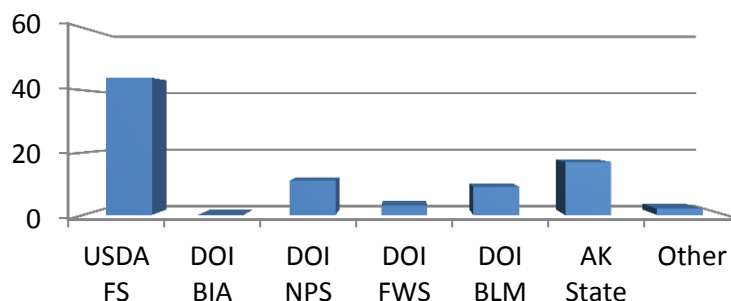
Figure 2. Type of Support Provided as requested per incident



Type of Incident Support – Requests for incident support were received from all incident types, support was provided as requested; Type 3 incidents requested the most support with approximately 27 requests (36%), followed by Type 2 incidents with approximately 17 requests (23%).

Type of Agency Support - Figure 3 displays the agency distribution of requests received to the WFM-RD&A.

Figure 3. Agency Distribution



Type of Geographic Area Support - The WFM RD&A provided support to all Geographic Area Coordination Centers except one; Alaska, Southwest and Eastern Great Basin areas had approximately 70% of the fire behavior requests. The NFDSC was requested to set up Decision Support Centers within the Alaska and Southwest GACCs. Analysts assigned to these support centers coordinated with the GACCs on priorities, and facilitated the completion of priorities through a virtual workforce of fire behavior specialists. The Southeastern area requested Decision Support for the geographic area. They requested that analysts travel to specific units to provide local assistance and training. Webinars were used for training opportunities to reach additional field personnel.

WFM RD&A Website Development – Developed a website for Wildland Fire Management - RD&A to provide external and internal information sharing and communication. The external website hosts information pertaining to the NFDSC, giving an overview of who we are, what we do and how to obtain assistance in addition to providing communication and education among the user communities. Internally, we use web management to communicate among our virtual workforce for task management, calendars, day to day assignments, information/document sharing, archival and training.

Standard Operating Procedures (SOPs) - Developed SOP's for large fire and extended attack support to the field. The 2010 fire season was the first year to implement these SOP's. The NFDSC recognizes there is room for improvement and solicited feedback from the field via a survey, various meetings and direct communication. This is not a static document, suggestions and recommendations from the field or peers will be reviewed and incorporated to assist with future operating procedures. The document is posted on the internet (<http://www.wfmrda.nwcg.gov/docs/NFDSC%20Standard%20Operating%20Procedures.pdf>) for ease of distribution to the field and to provide timely updates as needed.

Decision Support Protocols – Developed and implemented protocols for units requesting decision support (fire behavior analyses) through the National Fire Decision Support Center. The 2010 fire season was the beta test for these protocols, in general the request process ran relatively smooth, and the WFM-RD&A recognizes that improvements can be made in regards to future requests. Suggestions from the field and lessons learned from assignments will be incorporated into future protocols (<http://www.wfmrda.nwcg.gov/docs/NFDSC%20Request%20Procedures.pdf>).

Training Support - Provided support to national and regional training courses pertaining to fire behavior and risk assessment tools. The NFDSC WFM RD&A assisted with additional training opportunities at multiple regional or local meetings upon request from the local unit.

Informal Training and Support - Supported field units with technical transfer issues, provided information, hands on training, and remote assistance to incidents to improve analyst capabilities at the field level. Informal training opportunities were provided as requested by regional and local units, typically these training were conducted via

webinars/conference calls to help minimize travel, and to reach a larger audience. Other training was provided through local meetings as requested by the units, or shadowing WFM RD&A analysts through real time fire behavior analyses to provide incident decision support. Feedback received from the field indicated that this was the best type of training for field personnel; it was applicable to a real incident with time sensitive information.

Operational Documentation – Interagency Standards for Fire and Fire Aviation Operations - Updated fire management planning guidance within the “Red Book” to reflect the role of the NFDSC and wildland fire decision support tools. In addition, provided information regarding the types of products the NFDSC could provide, how to contact and request assistance from the NFDSC.

Human Factors and Risk Management RD&A

Pre-season Capacity Building - Provided trainings to interagency fire organizations to build awareness of factors involved in both individual and organizational performance and effectiveness, as well as assist in the development of a shared language for noticing and updating individual, team and organizational situational awareness. Trainings included specific examples of the neuropsychology of attention and why we fail to notice significant changes in our environment, building effective communication skills, updates of social and organizational research in wildland fire, and on the Key Decision Log (KDL). The KDL is a joint research/management effort to support identification and development of highly reliable practices during an incident. By capturing strategic and tactical decision making on incidents, the KDL provides reference during the incident *and* critical perspective on the organizational patterns operating in wildland fire management. It also provides a science-based platform to improve capacity for ‘straight-talk’. The database can be mined to reveal functional and dysfunctional organizational behaviors, identify and sustain best practices, identify decision traps.

Provided assistance as second-line help for the Key Decision Log

Focus on Effectiveness and Performance Assessment –

- Provided social science and subject matter expertise to the Wildland Fire Lessons Learned Center and project contractor for the evaluation of the National Incident Management Organization’s ‘Continuous Improvement in Incident Management’ program.
- Provided human and organizational factors expertise on the team developing a review of the Red Rocks Escaped Prescribed Fire.
- Served as technical specialist to capture and catalogue effective practices, insights and lessons learned for the Sheep Complex, a long-duration, multiple objective fire managed locally and jointly by Sequoia-Kings Canyon National Park and the Sequoia National Forest-Giant Sequoia National Monument.

Social Science Research - The RD&A leveraged people and funds to increase capacity and knowledge in the fire social sciences, specifically individual and organizational learning. We partnered with leading contractors, university researchers, and experienced fire personnel seeking higher education to explore how fire personnel learn best from unwanted outcomes, how information flows affect perceptions of wildland fire management performance, as well as learn how to identify and respond appropriately to fire-line hazards and risks, and to improve safety and performance through application of mindfulness techniques.

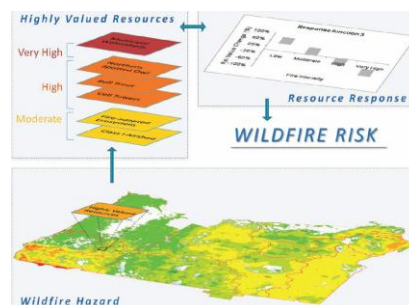
Safety - Provided knowledge-capture assistance to two of the National Leadership Council’s Learning Journeys (Los Alamos National Lab, UPS) and four of Region 1’s Safety Engagement Sessions.

Publications , Reports and Presentations

Fire Economics Research

Publications

- Calkin, D., Gebert, K. 2009. Economics of Wildland Fire Management. *Advances in Fire Practices*. Fall 2009. Available at: <http://www.wildfirelessons.net/Additional.aspx>. Page 284.
- Calkin, D.E., J.D. Rieck, K.D. Hyde, and J.D. Kaiden. Accepted. Structure identification in wildland fire decision support. *International Journal of Wildland Fire*. (Refereed)
- Calkin, David; Ager, A.; Gilbertson-Day, Julie; Scott, Joe; Finney, Mark; Schrader-Patton, C.; Quigley, T.; Stritholt, J.; Kaiden, Jeff. 2010. Wildland Fire Risk and Hazard: Procedures for the First Approximation. RMRS-GTR-235. 62 p.
- Chung, W., T.J. Venn, D. Loeffler, J.G. Jones, H.-S. Han and D.E. Calkin. Accepted. Assessment of the Potential for Log Sort Yards to Improve Financial Viability of Forest Health Restoration and Fuel Reduction Treatments. *Forest Science*.
- Donovan, GH, Prestemon, JP, and Gebert, KM. [Accepted]. The effect of newspaper coverage and political pressure on wildland fire suppression costs. *Society and Natural Resources*.
- Elliot, W., Hyde, K., MacDonald, L. and McKean, J., 2010. Tools for analysis. In: W.J. Elliot, I.S. Miller and L.J. Audin (Editors), *Cumulative Watershed Effects of Fuels Management: A Western Synthesis*. RMRS-GTR-231. U.S. Department of Agriculture, Rocky Mountain Research Station, Fort Collins, pp. 246-276.
- Preisler, HK, Westerling, HL, Gebert, KM, and Munoz-Arriola, F. [Accepted] Spatially Explicit Forecasts of Large Wildland Fire Probability and Suppression Costs for California. *International Journal of Wildland Fire*.
- Stettler, K.M., T.J. Venn, and D.E. Calkin. Accepted. The effects of wildfire and environmental amenities on property values in northwest Montana, USA. *Ecological Economics*. Currently available online at: <http://dx.doi.org/10.1016/j.ecolecon.2010.06.009>. Print copy to follow.
- Stockmann, K., J. Burchfield, D.E. Calkin, and T.J. Venn. 2010. Guiding preventative wildland fire mitigation policy and decisions with an economic modeling system. *Forest Policy and Economics*. 12(2): 147-154.
- Stockmann, K., Hyde, K., Jones, G., Loeffler, D. and Silverstein, R., 2010. Integrating Fuel Treatment into Ecosystem Management: A Proposed Project Planning Process. *International Journal of Wildland Fire*.
- Thompson, M.P. and D.E. Calkin, J.W. Gilbertson-Day, and A.A. Ager. Accepted. Advancing effects analysis for integrated, large-scale wildfire risk assessment. *Environmental Monitoring and Assessment*.
- Thompson, M., Sessions, J., Boston, K., Skaugset, A., and D. Tomberlin. 2010. Forest Road Erosion Control Using Multiobjective Optimization. *Journal of the American Water Resources Association* 46(4): 712-723.
- Thompson, M.P., and J. Sessions. 2010. Exploring Environmental and Economic Trade-offs Associated with Aggregate Recycling from Decommissioned Forest Roads. *Environmental Modeling and Assessment*. DOI: 10.1007/s10666-010-9220-8.
- Venn, T.J. and D.E. Calkin. [Accepted] Accommodating non-market values in evaluation of wildfire management in the United States: challenges and opportunities. *International Journal of Wildland Fire*.



Presentations and Posters

- Calkin, D. 4th International Congress on Fire Ecology and Management. "Toward a common framework for wildfire risk assessment". Savannah GA, November 30 – December 4.
- Calkin, D. 4th International Congress on Fire Ecology and Management. "Wildland fire risk and hazard: Procedures for the first approximation". Savannah GA, November 30 – December 4.

- Calkin, D. National BAER coordinators annual meeting. "Application of WFDSS tools within the BAER environment". Albuquerque, NM. February, 3 2010.
- Calkin, D. RMRS All Scientists Meeting. "Economic Research within the National Fire Decision Support Center. Fort Collins, CO. March 23, 2010.
- Gebert, K. 4th International Congress on Fire Ecology and Management. "The effect of newspaper coverage and political influence on wildland fire suppression expenditures". Savannah GA, November 30 – December 4.
- Gebert, K. 2nd Human Dimensions of Wildland Fire Conference. "The effect of newspaper coverage and political influence on wildland fire suppression expenditures", San Antonio, TX, April 27-28, 2010.
- Gebert, K. NOAA/NWS Societal Impacts of Weather Workshop. The Economics of Wildland Fire: The use of weather information in cost forecasting and risk assessment. Salt Lake City, UT, May 18-20, 2010.
- Gebert, K. BLM-WFDSS meeting. Stratified Cost Index: Performance measure and cost estimation. April 29, 2010.
- Gilbertson-Day, J. (UM Cooperator) presenter at Intermountain GIS Conference "Geospatial data uncertainty in a wildfire risk model." Bozeman, MT. April 19-22, 2010.
- Haas, J. RMRS Fire Sciences Lab Seminar Presentation "Monitoring post – fire vegetation recovery: Integrative indices to tell the carbon story." May 13, 2010.
- Hyde, K. National BAER coordinators annual meeting "Integrating post-fire needs into WFDSS and RAVAR" Albuquerque, NM (via teleconference). February 3, 2010.
- Hyde, K. NOAA Montana Hydrology Workshop "Gully Rejuvenation following wildfire: Formation and process." Helena, MT. July 28, 2010.
- Rieck, J. (UM Cooperator) presenter at Intermountain GIS Conference "Structure Identification for Wildland Fire Management" Bozeman, MT. April 19-22, 2010.
- Thompson, M. RMRS All Scientists Meeting, "Barriers to Implementation of Risk Management for Federal Wildland Fire Management Agencies." Fort Collins, CO. March 23-25, 2010.
- Thompson, M. 4th International Fire Ecology and Management Congress, "Wildland Fire Suppression Planning and the Tragedy of the Commons." Savannah, GA. November 2009.
- Thompson, M. INFORMS Annual Meeting, "Addressing Sources of Uncertainty in Strategic Fire Planning." San Diego, CA. October 2009. Won ENRE-Forestry Best Presentation Award.
- Thompson, M. Presentation on wildfire risk analysis to WFDSS staff, "Uncertainty and Risk: Theory & Practice." Missoula, MT. May 2010.

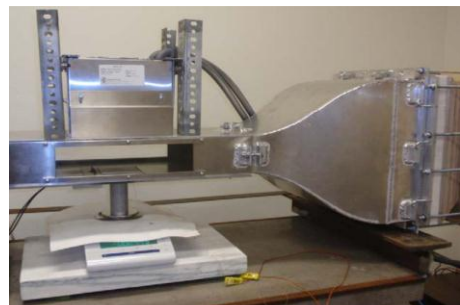
Workshops in Attendance

- Cohesive Strategy Science Management Review, Salt Lake City, UT March 4-5, 2010; Washington DC April 22, 2010; Missoula, MT April 29- May 3, 2010; Denver, CO June 20 and 21, 2010; and Salt Lake City, UT July 14, 2010.
- Meeting with employees and external stakeholders involved in fuel treatment planning on Deschutes National Forest, Bend, OR, February, 2010.
- Wildfire Performance Measures Science Team, Salt Lake City, UT, March 2-4, 2010
- Meeting with State and Private Leadership (Jim Hubbard, John Phipps, and Tom Harbour) to discuss a variety of ongoing wildfire economics studies. Washington, D.C., April, 2010.
- Forest Leadership team meeting for fuel treatment assessment and prioritization, Beaverhead-Deerlodge National Forest, Butte, MT, April 27, 2010.
- NOAA/NWS Societal Impacts of Weather Workshop, Salt Lake City, UT, May 18-20, 2010.
- Meeting with RAND Corporation (consultants Keating, Woods, and Price) to discuss large air tanker effectiveness study, Missoula, MT, May, 2010.

Fire Spread Research

Publications

- Cohen J.D. and M.A. Finney. 2010. An examination of particle heating during fire spread. Proc. 6th Intl. Conf. Forest Fire Research.
- Finney, M.A., D. Jimenez, J.D. Cohen, I.C. Grenfell, C. Wold. 2010. Structure of diffusion flames from a vertical burner. Proc. 6th Conf. Forest Fire Research.
- Finney, M.A., I.C. Grenfell, C.W. McHugh, R.D. Stratton, D. Trethewey, and S. Brittain. In press (2011). An ensemble method for wildland fire simulation. Environmental Modeling and Assessment.
- Finney, M.A., J.D. Cohen, K.M. Yedinak, and I.C. Grenfell. 2010. An examination of fire spread thresholds in discontinuous fuelbeds. Intl. J. Wildl. Fire 19:163-170.
- Grenfell, I.C., M.A. Finney, W.M. Jolly. 2010. Simulating spatially and temporally variable fire weather. 6th Conf. Forest Fire Research.
- Jimenez, D. M.A. Finney, J.D. Cohen. 2010. Design and construction of gas-fed burners for laboratory studies of flame structure. Proc. 6th Conf. Forest Fire Research.
- Jolly, W.M., S.S. McAllister, M.A. Finney, A.M. Hadlow. 2010. Time to ignition is influenced by both moisture content and soluble carbohydrates in live Douglas fir and Lodgepole pine needles. Proc. 6th Conf. Forest Fire Research.
- Lignell, D.O., E.I. Monson, M.A. Finney. 2010. Modeling Flame Structure in Wildland Fires Using the One-Dimensional Turbulence Model. Proc. 6th Conf. Forest Fire Research.
- McAllister, S.S., M.A. Finney, J.D. Cohen. 2010. Critical mass flux for flaming ignition of dead, dry wood as a function of external radiant heat flux and oxidizer flow velocity. 6th Conf. Forest Fire Research.
- McAllister, S.S., M.A. Finney, and J.D. Cohen. 2010. Critical mass flux for flaming ignition of dead, dry wood as a function of external radiant heat flux. Proc. Western States Combustion Conference, Boulder Colorado, March 21, 2010.
- McAllister, S.S., W.M. Jolly, M.A. Finney, J.D. Cohen, A.M. Hadlow, and I.C. Grenfell. 2011. Piloted ignition of live forest fuels. Intl. Assoc. Fire Safety Science. in press.
- Yedinak, K, J.D. Cohen, J. Forthofer, and M. Finney. 2010. An examination of flame shape related to convection heat transfer in deep-fuel beds. Intl. J. Wildl. Fire. 19:171-178.



- Experiment apparatus: small-scale wind tunnel with high precision balance

Presentations and Posters

- Cohen, J.D. M.A. Finney, and S.S. McAllister. Fire Lab Seminar Series. "Fundamental fire spread research".
- Cohen, J.D. Seminar to College of Natural Resources, University of Idaho, "Particle heating during spreading fires".
- Cohen, J.D., M. Finney, S. McAllister, J. Forthofer, I. Grenfell, M. Jolly. Poster presentation at the RMRS All Scientists Meeting. "Fundamental wildland fire spread research"
- Finney, M.A. 4th International Congress on Fire Ecology and Management. "Fire Behavior Research: Status and Future Directions". Invited paper.
- Finney, M.A. RMRS All Scientist Meeting. "On the need for theory in fire behavior research".
- Finney, M.A., C.W. McHugh, and L.S. Bradshaw. Presentation to the Inland Empire Soc. Am. For. 2010 annual meeting, May 20-21 Wallace ID. An analysis of factors contributing to the 1910 fires.
- Forthofer, J. Gave an oral presentation and associated proceedings paper about a new diurnal wind model in WindNinja at the Eighth Symposium on Fire and Forest Meteorology on 10/13/2009.
- Forthofer, J. Gave an oral presentation and associated proceedings paper about fire whirls at the Eighth Symposium on Fire and Forest Meteorology on 10/13/2009.

- Forthofer, J. Gave an update on WindNinja wind modeling to the NWCG Fire Behavior Committee by phone on 12/15/2009.
- Forthofer, J. Presentation about wind and fire whirl research at the annual Incident Meteorologist (IMET) meeting on 3/2010, Region 1 Fire Behavior Conference on 4/2010, National Weather Service's Great Divide Workshop on 10/2009, Region 2 Fuels and Fire Use Workshop on 1/26/2010, NWCG Fire Behavior Committee by phone on 12/15/2009.
- McHugh, C.W. Invited presentation to the Fire Weather Subcommittee, Fire Environment Working Team: National Analysis of RAWS Station Location Discrepancies: WIMS vs. ASCADS
- McHugh, C.W. April 5, 2010. Presentation to the Northern Rockies Fire Behavior Workshop. Title: "National Analysis of RAWS Station Location and Metadata."
- McHugh, C.W. April 6, 2010 - Presentation to the Northern Rockies Fire Behavior Workshop. Title: "Using FSPRO Appropriately."

Wildland Fire Management RD&A

Publications

- Larkin, N.S., T. Brown, P. Lahm, and T. Zimmerman. 2010. Fire Management Today. 70(2):36-40. Forest Service, US Department of Agriculture, Washington, D.C.
- Zimmerman, Thomas and Tim Sexton. 2010. Organizational Learning Contributes to Guidance for Managing Wildland Fires for Multiple Objectives. Fire Management Today. 70(1): 9-14. Forest Service, US Department of Agriculture, Washington, D.C.

Presentations and Posters

- Fire Equipment Committee/Working Group, NFDSC and WFDSS. Missoula, MT
- Predictive Services Working Group, WFDSS and NFDSC. Lake Tahoe, NV.
- Northwest Regional Decision Support Round Table, WFDSS and NFDSC. Redmond, OR.
- Northwest Regional After Action Review. Portland, OR.
- Northern Rockies Dispatcher Workshop, WFDSS. Great Falls, MT.
- NPS National Fire and Aviation Meeting. San Antonio, TX.
- International Fire Ecology Conference, NFDSC and WFDSS. Savannah, GA.
- R3 IMT Meeting, WFDSS, NFDSC, and Complexity Ratings. Prescott, AZ.
- NWCG Meeting, WFDSS and NFDSC, Boise, ID.
- National IC/AC Meeting. WFDSS and NFDSC, San Diego, CA.
- RMRS All Scientist Meeting. WFDSS and NFDSC, Fort Collins, CO.
- R4 IMT Meeting, WFDSS and NFDSC, Reno, NV.
- Northeast Forest Supervisors' Fire Meeting, Overview of Decision Support. Portsmouth, NH.
- 2nd Human Dimensions Conference. International Association of Wildland Fire. Advancing fire management program effectiveness through improved decision making. San Antonio, TX.

Human Factors and Risk Management RD&A

Publications

- Fuentes, S. et al. 2010. Continuous Improvement Program Evaluation Plan Report. Inventivo Design, LLC report to the Lessons Learned Center, under contract from the National Incident Management Organization.

Publications reported for FY2009 that were published in FY2010

- Black, A. E. 2009. Some observations on the Red Rock escape through the lens of high reliability and organizational learning. White paper for the Klamath National Forest.
- Marceron, T., Murphy, K., Black, A., Duncan, P. 2009. Red Rock Prescribed Fire Klamath National Forest Escaped Prescribed Fire Review.

- Black, A.E., K. Sutcliffe, and M. Barton. 2009. Assessing the practice of After Action Reviews - who conducts them? *Fire Management Today* 69(3) 15-17.
- Holt, J. T.; Christenson, D.; Black, A.E.; Fay, B.; and K. Round. 2009. Lessons from the Northern California 2008 Lightning Siege: a report by a Wildland Fire Lessons Learned Center Information Collection Team. Wildland Fire Lessons Learned Center, Tucson, AZ.

Presentations and Posters

- Gebert, K. 4th International Congress on Fire Ecology and Management. "The effect of management objectives and strategies on fire expenditures". Savannah GA, November 30 – December 4.
- NIMO Annual Planning Meeting (Jan 12, Boise, ID) Key Decision Log – outcomes for 2009 and what to expect in 2010.
- USFS Region 2 Inter-agency Fuels and Fire Use Workshop and Burn Boss Refresher (Jan 26, Lakewood CO). Module on 'Change Blindness' J. Saveland and A. Black.
- S482 "Advanced Wildland Fire Management Applications" module on "Social & Organizational Issues" for the NRTC. (Feb 9, Missoula, MT).
- National Area Command/Incident Commanders meeting, (Mar 8-11, San Diego, CA). Key Decision Log.
- Gebert, K. RMRS All Scientists Meeting. "The effect of management objectives and strategies on fire expenditures", Fort Collins, CO. March 23, 2010.
- Region 5 Incident Management Teams Spring meeting, (Mar 29-Apr 1, Reno, NV) Developed and ran 2 special skills development sessions for the Public Information Officers break out - on Team Building (1.25 hr) and Working with the Public (.75 hr).
- Region 5 Incident Management Teams Spring meeting (Mar 29-Apr 1, Reno, NV). Key Decision Log 3 separate meetings – General Session, Incident Commander's break out, and Planning Section Chiefs break-out.
- 2010. Northern Rockies Geographic Area Type 2 and Wildland Fire Management Team meeting, April 7, Billings, MT.
- Gebert, K. 2nd Human Dimensions of Wildland Fire Conference. "Costs from the Perspective of Cooperators & Stakeholders", San Antonio, TX, April 27-28, 2010.
- Gebert, K. 2nd Human Dimensions of Wildland Fire Conference. "The effect of management objectives and strategies on fire expenditures", San Antonio, TX, April 27-28, 2010.
- 2010. Black, A.E. Key decisions in incident management: the IMT's perspective. 2nd International Conference on Human Dimensions in Wildland Fire, April 26, 2010, San Antonio, TX.
- 2010. Black, A.E. Nurturing organizational self-awareness to support continuous improvement: the Key Decision Log. 2nd International Conference on Human Dimensions in Wildland Fire, April 26, 2010, San Antonio, TX.
- 2010. Black, A.E. Improving wildland fire management by understanding incremental decision-making. Rocky Mountain Research Station, All Scientists meeting Mar 23-24, 2010, Fort Collins, CO.
- Wildfire Performance Measures Science Team, (Workshop) Salt Lake City, UT, March 2-4, 2010.
- Cohesive Strategy Stakeholder Meeting (Workshop), San Antonio, TX April 29, 2010.
- Region 1 Safety Engagement Sessions (Workshops), Missoula, MT, September 1, 2010; Orofino, ID September 2, 2010; Bismark, ND September 3, 2010.

Training

Fire Economics Research

- Staff provided 10 training sessions (3 different courses) on WFDSS RAVAR to 137 unique field fire managers and professionals (288 total attendees over the 10 courses). This training was conducted through a virtual environment.

- Staff provided multiple training sessions (approx. 6 hours) for members of the newly formed National Fire Decision Support Center (NFDSC – WFM RD&A) in Missoula, MT. May 5 and 6, 2010. The WFM RD&A NFDSC group will become the primary support group for RAVAR products in 2011.
- Calkin and Thompson taught forest and wildfire economics at the Technical Fire Management program through the Washington Institute, Bothell Washington. The economics course is equivalent to upper level undergraduate forest economics and is accredited by Humboldt State University. The course was conducted January 6 to 17 2009, to a class of 40 Federal wildfire managers.

Fire Spread Research

- McHugh, C.W. S-495, Geospatial Fire Analysis, Interpretation, and Application; Tucson, AZ April 2010.
- Forthofer, J. Presentation on wind and fire whirl research for the S590 Fire Behavior Analyst Class on 3/16/2010.
- Forthofer, J. Presentation on fundamental fire research to a group of math students from the University of Montana on 2/23/2010.

Wildland Fire Management RD&A

NFDSC WFM RDA staff provided formal training at the following meetings, workshops or classroom sessions.

- Technical Fire Management, WFDSS Decisions and Fire Behavior Training. Bothell, WA.
- Pacific Northwest WFDSS Workshop. Portland, OR.
- Northern Rockies Fire Behavior Workshop. WFDSS Short Term Fire Behavior. Missoula, MT.
- Idaho Panhandle NF Fire Behavior Tool Review. Coeur d'Alene, ID.
- Payette National Forest WFDSS Training. McCall, ID.
- FS Region 2 & 4 Fire Behavior Workshop. Denver, CO and Salt Lake City, UT.
- Southern Area Advanced Fire Academy, WFDSS Training. Jacksonville, FL.
- FS Region 3 Fire Behavior Workshop. Albuquerque, NM
- S495 Geospatial Fire Analysis, Interpretation, and Application. WFDSS & Fire Behavior tools. NAFRI, Tucson, AZ.
- S490 Advanced Fire Behavior Calculations, Fire Behavior tools. Las Cruces, NM.
- Fire Management Leadership. Tucson, AZ.

Human Factors and Risk Management RD&A

- S-482 Social and Organizational Issues, Missoula MT.
- Sheep Complex - Sequoia-Kings Canyon NP/Sequoia National Forest/Giant Sequoia National Monument; Technical Specialist, Lessons Learned.

Organizational Representation

Fire Economics Research

- Membership of Federal Geographic Data Committees National Cadastral Sub-Committee.

Fire Spread Research

- Associate Editor International Journal of Wildland Fire.

Wildland Fire Management RD&A

- S-490 Advanced Fire Behavior Calculations course cadre members.

- S-495 Geospatial Fire Analysis, Interpretation, and Application Steering. Committee Chairmen, members of training cadre, and mentors.
- Rx-510, Advanced Fire Effects Steering Committee member.
- S-590 Advanced Fire Behavior Interpretation Steering Committee Co-chair, cadre and mentors.
- Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) group liaisons.
- Predictive Services/Intelligence liaison.
- Air Fire Group liaisons.
- Geospatial Equipment and Technology Applications (GETA) group liaison.
- National Incident Management Organizations (NIMO) liaison.
- NWCG Forest Service Executive Board Representative
- NWCG Fire Reporting subcommittee and 209 reporting liaison.
- Cohesive Strategy Science Team member.
- National Performance Measures Task Group member.
- NWCG Fire Behavior Committee Co-Chair.
- NWCG Fire Planning Committee liaison.
- Disaster Assistance Support Program liaison.

2011 Planned Activities

Planned Staffing

Fire Economics Research

- Recruit to fill Research Scientist (Vice Gebert) - This position is funded by RMRS Human Dimensions and is part of the stations contribution to the NFDSC. Research activities will focus on large fire cost modeling and improving the understanding of factors that influence fire management programmatic costs.

Fire Spread Research

- Recruit to fill Operations Research Scientist – This is one of the original positions described in the charter, recruitment efforts were unsuccessful in 2009. Darek Nalle, was hired January 2, 2011 as a post-doctorate researcher. The primary research role is to use operations research tools to evaluate how fire management activities affect outcomes. The scientist will work to further integrate research activities between the Fire Spread and Fire Economics work group.

Wildland Fire Management RD&A

- Detail opportunities throughout the fire season in support of training and mentoring opportunities – funding allocated from DOI.

Human Factors and Risk Management RD&A

- There have been no additional staffing needs identified for FY 2011.

Cooperative Agreements with University and Research Partners

Fire Economics Research

- Maintain agreements with University of Montana.
- Explore partnerships to expand wildfire risk assessment capacity for the Cohesive Strategy with additional research institutes including Oregon State University.
- Maintain partnerships with WWETAC and EFETAC.
- Maintain relationships with scientists from Southern Research Station, Pacific Southwest Research Station, Pacific Northwest Research Station, USGS, and Scripps Institute of Oceanography.

Fire Spread Research

- Explore cooperative agreement for live fuel combustion and burning rate experiments.

Wildland Fire Management RD&A

- Collaboration will continue with partners at the Desert Research Institute (DRI) and Pacific Northwest Research Station (PNW) to develop national forecast products for smoke management in WFDSS.

- Cooperation with the DOI Office of Wildland Fire Council to continue funding two positions that work within the WFM RD&A and support the DOI through the NFDSC.

Human Factors and Risk Management RD&A

- Continue collaborations with Oregon State University, University California Santa Barbara, and Renoveling.

Planned Activities

Fire Economics Research

- **Cohesive Strategy** - Participate on the science team and associated implementation teams that will work to develop region specific wildfire risk assessments. The team will evaluate tools to assess tradeoffs among alternative investment strategies among programs and regions and explore new science opportunities.
- **Wildfire Risk Assessment and Multi-Resource Tradeoff Analysis** - Continue research efforts on multi-scale wildfire risk analyses with focused research into appropriate tools to consider tradeoffs among multiple non-commensurate resource values. Additional research will explore appropriate tools to incorporate temporal and spatial considerations within these frameworks.
- **Incentives** - Continue refinement of actuarial methods and develop premium estimates for all National Forests. Explore opportunities for additional collaboration with actuarial professionals.
- **Suppression Efficiency** - Collaborate with Tom Holmes to co-author and submit for peer review a manuscript describing results from the study using production function methodology to identifying suppression efficiency. Future spatial resource data will be acquired during the 2011 fire season to enhance data collected during the 2010 fire season for spatially explicit modeling of suppression efficiency.
- **Large Fire Cost** - Improve upon existing large fire cost models such as the Stratified Cost Index (SCI). In FY2011 the team will explore how spatial factors obtained by acquiring over 600 large fire final perimeters affect final fire cost. Continue exploration of models that allow for early identification of high cost fires based on ignition characteristics.
- **Decision Making** - Collaborate with University of Montana, The Nature Conservancy, and WWETAC on multi-criteria decision analysis applied to fuel treatment planning on the Deschutes National Forest. Comparison of developed national and Deschutes risk assessment data. Continue to engage with other federal collaborators (NFMS, USGS) on application of Partially Observable Markov Decision Processes to questions of forest and natural resource management. Expand upon research into identification and quantification of uncertainty, and integrate into wildfire risk assessment frameworks.
- **Wildfire Effects** - Test working concept and computational solution using a series of recent past fires (target, n=24), evaluating predicted vegetation disturbance against disturbance measured in BARC maps. Complete and publish review of current computational solutions to predict fire effects and advance plan for developing advanced solutions (tentative collaboration with Matt Dickinson (Northeast Research Station) and Kevin Ryan (Fire Sciences Lab)). Advance development of ICWater: Fire (pending funding by DOD of approved proposal). Prepare and publish article presenting demonstration of ICWater (completed during 2010 fire season) to evaluate fate and consequence of misapplication of fire chemicals. Collaboration with MTDC/NIFC Fire Chemicals and USGS advisors. Demonstrate first application of fire effects predictions using debris flow erosion models developed by Sue Cannon of the USGS, building on existing collaboration with Cannon.
- **Aviation** - Evaluate current large tanker usage history to improve understanding of current fleet utilization and help parameterize future large tanker effectiveness study. Explore opportunities to use FPA initial response simulator to evaluate efficient tanker fleet design.
- **Economic Analysis of Fuel Treatments** - Collaborate with Alan Ager and Nicole Vaillant, of WWETAC, and Keith Stockmann and Krista Gebert, of R1, to examine methods to estimate suppression costs

avoided due to fuel treatment. Demonstrate analytical approaches for use with Collaborative Forest Landscape Restoration projects.

Fire Spread Research

- **Flame Structure on vertical surfaces** - Experiments and data analysis will continue with explorations of statistical changes for turbulent flames entering a porous medium. Modeling using One Dimensional Turbulence (ODT) by Prof. David Lignell at BYU will continue.
- **Wind Effects on Flame Structure** - Wind tunnel experiments using a stationary gas-fired burner will continue and be extended from constant winds to artificially perturbed wind fields. ODT Modeling will be extended to compare with these wind-driven situations.
- **Dead Fuel Critical Mass Flux** - Critical mass flux on dead woody samples will continue for the purpose of establishing base line relationships for different wood densities, sample thicknesses, moisture contents, and heat fluxes.
- **Live Fuel Ignition & Chemistry** - The live fuel research experiments will be expanded to include more convective heating, and specific experimental work on mechanisms of moisture loss and flammability of atomized expelled cell contents.
- **Particle Heating during fire spread** - Experiments will continue into the thermal response of fuel particles of different geometries and densities for radiant heating and natural and forced convective cooling of individual and clusters of fuel particles. Modeling of fuel particle responses will be completed.
- **Burning Rate of Live and Dead Fuel Complexes** - New investigations will be initiated to establish the relevance of published laboratory crib-burning research on wildland fuel complexes, including live and dead fuels. Cooperators in this effort will be sought.
- **Fluid Dynamics of the flame front** - New experiments and modeling will be initiated to examine theoretical bases for flame structure at the fire front, including flame attachment, slope and wind effects.
- **Cohesive Strategy** - Continue to participate as members of the science team and work with regional assessments.
- **Wildfire Risk Assessment** - With partners in Economics research and PNW-WWETAC, continue developing methods and researching improvements into simulation-based methods for wildland fire risk assessments.

Wildland Fire Management RD&A

- Manage the National Fire Decision Support Center.
- Provide decision support to the field for large or ongoing incidents as requested.
- Continue to provide training and mentoring opportunities with the fire behavior assessment tools.
- Evaluate the need for formalized refreshers and training of fire behavior assessment tools.
- Update as necessary user protocols to obtain decision support assistance and training.
- Conduct an evaluation of 2011 activities, review procedures, and develop improvements as appropriate.
- Continual monitoring of field use, outputs, performance issues/successes; provide feedback to research.
- Continually update standard operating procedures for external entities and internal management guidelines to better support the field users.
- Provide WFDSS technical support to national help desk for migration of fire application help desk to national IBM contract (end user support).
- Provide ongoing updates and testing to fire behavior assessment tools.
- Evaluate the effectiveness of RAVAR analysis and future applications of the tool.
- Provide training and mentoring opportunities with RAVAR products and assessments.
- Provide incident specific RAVAR assessments.

Human Factors and Risk Management RD&A

- Develop and implement long-term plan for the Key Decision Log. Identify elements to integrate with current WFDSS, identify and develop products for other audiences (Regional, National fire managers).
- Complete publication process for Key Decision Log products.
- Continue to support the USFS's Safety effort, through trainings, facilitation, and project work.
- Provide technical support and assistance as to incidents requested.

Planned Publications, Reports and Presentations

Fire Economics Research

Planned Publications and Reports

- Calkin, D.E., M.A. Finney, A.A. Ager, M.P. Thompson, K.G. Gebert. Progress towards and barriers to implementation of a risk framework for Federal wildland fire policy and decision making in the United States. Submitted to Forest Policy and Economics.
- Thompson, M.P. and D.E. Calkin, M.A. Finney. Addressing sources of uncertainty in strategic wildland fire planning. Submitted to Journal of Environmental Management.
- Thompson, M.P., D.E. Calkin and M. Finney. A risk-based premium approach to wildland fire finance and planning. Submitted to Forest Science.
- Thompson, M.P., D.E. Calkin, M.A. Finney, A. Ager, J.W. Gilbertson Day. Integrated National-Scale Assessment of Wildfire Risk to Human and Ecological Values.
- Han, H.-S., T. Bilek, R. Dramm, D. Loeffler, and D. Calkin. In Review. Financial feasibility of a log sort yard handling small-diameter logs. Submitted to Western Journal of Applied Forestry

Planned Presentations

- Thompson, M. Energizing the Future- INFORMS Annual Meeting, "Wildfire Suppression with Imperfect Information." Austin, TX. November 7-10, 2010.

Fire Spread Research

Planned Publications and Reports

- Finney, M.A., C.W. McHugh, R.D. Stratton, K.L. Riley. In review. A Simulation of Probabilistic Wildfire Risk Components for the Continental United States. Stochastic environmental research and risk assessment
- Finney, M.A. and S.S. McAllister. A review of fire interactions and mass fires. Journal of Combustion
- Finney, M.A., J.D. Cohen, S.S. McAllister, and others. On the need for theory in fire behavior research.

Planned Presentations and Posters

- Workshop on "Front Propagation in Heterogeneous Media: Mathematical, numerical, and statistical issues in Modeling a forest fire front" at the Banff International Research Station, Banff, Alberta Canada.
- Present paper at Symposium for Systems Analysis in Forest Resources, Maintencillo, Chile. "A Simulation and Statistical Modeling Approach to Including Large Fires in a Wildland Fire Planning System"

Wildland Fire Management RD&A

Planned Publications and Reports

- Pence, Morgan, and Thomas Zimmerman. In Press. The Wildland Fire Decision Support System: Integrating Science, Technology, and Fire Management. *Fire Management Today*. 71(1): Forest Service, US Department of Agriculture, Washington, D.C.
- Zimmerman, Thomas, Laurie Kurth, and Mitchell Burgard. In Development. The Howling Prescribed Natural Fire – Long-Term Effects on the Modernization of Planning and Implementation of Wildland Fire Management. Proceedings 3rd Fire Behavior and Fuels Conference, International Association of Wildland Fire. Spokane, WA.
- Zimmerman, Thomas. In Press. Advancing fire management program effectiveness through improved decision making. Proceedings 2nd Conference on human dimensions in fire management. San Antonio, TX. April 2010.

Planned Presentations and Posters

- The Howling Prescribed Natural Fire- Long –Term Effects on the Modernization of Planning and Implementation of Wildland Fire, T. Zimmerman. 3rd Fire Behavior and Fuels Conference, Spokane WA, October 2010.
- Season Ending Events, A Matter of Perspective, L. Kurth. 3rd Fire Behavior and Fuels Conference, Spokane WA, October 2010.
- Science application in support of fire management decision making. T. Zimmerman. Society of American Foresters 2010 National Convention. Albuquerque, NM.
- Improving Decision Support in 2010- Accomplishments and Lessons Learned from the National Fire Decision Support Center, M. Pence. 3rd Fire Behavior and Fuels Conference, Spokane WA, October 2010.
- National Fire Decision Support Center- Supporting Decision Making Poster Presentation - 3rd Fire Behavior and Fuels Conference, Spokane WA, October 2010.
- WFDSS Poster Presentation - 3rd Fire Behavior and Fuels Conference, Spokane WA, October 2010.
- National Fire Decision Support Center- Supporting Decision Making Poster Presentation - Society of American Foresters National Convention Albuquerque, New Mexico October 27-31, 2010.
- NWCG National Predictive Services Subcommittee Portland, Or, October 5-7, 2010.
- NWCG Fire Weather Subcommittee Missoula, MT, October 2010.
- NWCG National Predictive Services, Burbank, CA, November 16-18, 2010.
- Geographic Editor After Action Review, Portland, OR, November 16-18, 2010.
- Region 3 Fire Behavior and Fuels Workshop, Flagstaff, AZ, February 2011.
- Regional Fire Director Meeting Sacramento, CA, November 2-5, 2010.
- Incident Management Team Meetings locations to be determined, 2011.

Human Factors and Risk Management RD&A

Planned Publications and Reports

- Lewis, A.; Hall, T.E.; Black, A. (In Press) Career stages in wildland firefighting: implications for voice in risky situations *Int. Journ. Wildland Fire*.
- Black, A. E. Sheep Complex 2010 -Lessons Learned. Compilation of 20 interviews with key players in the long-duration, multiple objective incident co-managed by the Sequoia-Kings Canyon National Park and Sequoia National Forest and Giant Sequoia National Monument.
- Peer-review paper drafted on the Key Decision Log will be submitted to either *Journal of Forestry* or *International Journal of Wildland Fire*.
- Complete descriptive statistics and narrative analysis results from the KDL2009 are being submitted for publication as a GTR.

Planned Presentations and Posters

- Abstract will be submitted to the 11th International Wildland Fire Safety Summit: "Promoting the Story of Wildland Fire Safety" April 4-8, 2011, Missoula, MT

Planned Training

Fire Economics Research

- Attend IAWF 3rd Fire Behavior and Fuels Conference, October 25-29, 2010, Spokane WA
- Attend 2010 INFORMS Annual Conference, November 7-10, Austin TX.
- Attend 6th International Conference on Forest Fire Research, November 15-18, 2010, Coimbra, Portugal
- Attend Symposium for Systems Analysis in Forest Resources, March 8-11, 2011 in Maitencillo, Chile

Fire Spread Research

- S-495, Geospatial Fire Analysis, Interpretation, and Application 2011

Wildland Fire Management RD&A

- S-490 Advanced Fire Behavior Calculations course cadre members, Missoula, MT; Albuquerque, NM.
- S-495 Geospatial Fire Analysis, Interpretation, and Application. Steering. Committee Chairmen, members of training cadre, and mentors.
- S-482 Advanced Fire Management Applications-Missoula, MT; Tucson, AZ.
- Local Fire Management Leadership, Boise, ID.
- Humboldt State University Course – IFPM, McCellan, CA.
- S-580, Advanced Wildland Fire Use Applications. Serve as member of training cadre.
- Rx-510, Advanced Fire Effects Steering Committee member.
- Technical Fire Management lesson instructors.
- Fire Management Leadership – cadre member, Tucson, AZ.
- Region 3 Fire Behavior Workshop – Flagstaff, AZ.
- Rapid Assessment of Values At Risk (RAVAR) training as needed to field users.

Human Factors and Risk Management RD&A

- USFS Region 3 Prescribed Fire Workshop – January 12-13, 2011.
- S482 Advanced Wildland Fire Management Applications