Poster Abstracts

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Fire Severity and Salvage Logging Effects on Exotics in Ponderosa Pine Dominated Forests

Suzanne Acton, Payette National Forest, New Meadows, ID, and Forest Sciences Department, Colorado State University, Fort Collins, CO

The effects of fire severity and salvage logging on the understory vegetation response in ponderosa pine dominated areas of the South Fork Salmon River Drainage of west-central Idaho were examined five years post-fire. The study objectives were to correlate the effects of fire severity and salvage logging on exotic species richness and cover; and to examine the effects of scale in sampling in post-fire understory vegetation. Five years following fire, areas that burned with greater fire severity had increases in total species cover and exotic species richness. Low severity fires had lower exotic species richness compared to high severity and unburned areas. Salvage logging increased exotic species cover, but not exotic species richness. The only result that was consistent at multiple scales was the relationship between low severity fires and low exotic species richness. Measurement scale should be an important consideration when designing future research experiments in this area, with preference to multiple-scale measurements.

Using the FARSITE Model to Predict the Differential Effects of Fuel Treatments on Potential Wildland Fire Behavior in Dry Forests of the Wenatchee Mountains

James K. Agee and M. Reese Lolley, College of Forest Resources, University of Washington, Seattle, WA

A pressing issue in fire management is understanding the differences in the effects of fuel treatments on wildfire behavior. To gain insight into this issue Fire Area Simulator (FARSITE) was used to model fuel treatment effect on short-term wildland fire behavior to test differences between mechanical and prescribed burn fuel treatments. Intensive fuels data were collected as part of the pre-assessment for the Fire and Fire Surrogates Treatments Study at the Mission Creek site in the Wenatchee Mountains of Washington. These data were used to estimate mechanical and prescribed fire treatment effects on forest fuel profile and loadings using quantitative and qualitative methods. Finally, FARSITE was used to predict potential short-term wildland surface and crown fire differences between fuel treatments.

Effects of Seasonal Fire on Mortality and Oleoresin Pressure of Old-Growth Ponderosa Pines

James K. Agee and Daniel D. B. Perrakis, College of Forest Resources, University of Washington, Seattle, WA

This project examines techniques for evaluating the survivorship of old-growth ponderosa pines (*Pinus ponderosa* Laws.) following restorative prescribed burning at Crater Lake, OR. The study area was divided into spring burn units, fall burn units, and control units (no burning). Parameters measured (before and after burning) include tree species and density, understory vegetation, fuel loading, and ponderosa pine crown vigor. Selected pines will be intensively monitored following burning by measuring their oleoresin exudation pressure (OEP) using modified pressure gauges. OEP is considered a reliable indicator of susceptibility to bark beetle attacks, a frequent cause of mortality following burning. Pre-burn data shows considerable woody fuel accumulation, limited understory diversity, and fair to poor vigor in overstory ponderosa pines. It is expected that burning in the spring will result in lower OEP and higher pine mortality compared to burning in the fall. A threshold OEP reading that predicts future bark beetle mortality will hopefully be identified.

Consequences of Wildfire on Understory Vegetation in Untreated Ponderosa Pine Forests

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Heavy fuel loading and high densities of small trees increase the risk for large stand-replacing wildfires in ponderosa pine forests of the Southwest. In addition, there is a concern that these high intensity fires will lead to the spread of a variety of exotic plant species that have been introduced to the region in recent years. A series of wildfires in 1996 in northern Arizona provided an opportunity for us to examine the understory response through time following a large, high intensity fire. In 1997 we established permanent plots on the Hochderffer wildfire and in adjacent unburned sites in northern Arizona. We sampled plant canopy cover and frequency in a total of 38 plots each year through 2001. Our preliminary analyses document dramatic differences in the vegetative composition and diversity between burned and unburned sites, including the presence of multiple exotic species as well as fire-following native shrubs.

Variation in Fuel Loadings Within Existing Ponderosa Pine and Mixed Conifer Forests in the Southern Colorado Front Range

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Assessment of the quantity and type of fuels present in a forest is important for the proper application of fire behavior model predictions. The objective of

this study was to obtain quantitative data on fuel loadings that exist under ponderosa pine and mixed conifer forest types typical of the southern Colorado Front Range. Fuels inventory and stocking data were collected during 2001 from 479 plots on the Manitou Experimental Forest (MEF) in south central Colorado. The plots studied contained a variety of stocking and physiographic conditions and these relationships were explored to determine whether any correlations existed between fuel load and community condition. This poster describes the distribution of fuel loadings and explores relationships between aspect, elevation, stocking, species composition and fuel characteristics.

Forest Health and Tree Removal Equipment in the Wildland-Urban Interface—An Educational Video

David R. Betters and Robert Avera, Department of Forest Sciences, Colorado State University, Fort Collins, CO

Forest health is a key issue in the wildland-urban interface. Operational programs to improve forest health conditions in the interface typically involve thinning, or tree removals, of smaller diameter trees on privately owned lands. Implementing these programs requires 1) persuading private landowners, through education, to adapt and implement tree thinning operations on their properties, and 2) using tree removal equipment that is more cost effective for small diameter tree harvesting and suited for smaller acreages characteristic of private interface land holdings. The objective of this project is to develop a video and an accompanying information packet that addresses the two needs mentioned above. The video / packet will be created, critiqued via a survey, and then finalized. The video / packet will be applied in two wildland-urban interface community case studies concerning the adoption of fire mitigation programs. The finalized video / packet will be made available through Colorado State University Cooperative Extension.

A Community-Level Process for Adoption of Forest Restoration and Fire Mitigation Programs

David R. Betters and Christy L. Higgason, Department of Forest Sciences, Colorado State University, Fort Collins, CO

The National Fire Plan and its emphasis on restoring health to fire-adapted ecosystems and reducing community risk of wildland fires has created an overwhelming need for collaboration at all levels in Colorado. The nature of this problem requires the involvement not only of a variety of local organizations and citizens but also the coordination and participation of a number of resource agencies having separate but somewhat overlapping roles regarding communities and natural resource sustainability and forest health. To facilitate community involvement and reduce confusion in a situation where several agencies offer public service through land stewardship, a process for local community-level decision-making is key. The objective of this study is to develop a process coordinated amongst agencies in Colorado that facilitates community / interest group agreement for adopting and implementing a forest restoration / fire mitigation strategy. The analysis of information collected in

the study includes two separate reviews of process. The first review involves community decision-making processes in general. This entails generalized process and communication theory applicable regardless of problem area. The second review involves existing processes used in fire mitigation in the wildland-urban interface. This information includes an overview of current processes used in fire mitigation programs in western states that include educational packages. These processes and education messages are examined to determine if consistency exists and whether improvement can be made overall by providing the best delivery content and means. The reviews are used to propose an overall process to facilitate adoption of community fire mitigation programs. It is envisioned that the information gathered from this project will also serve as a supplement to related land management planning efforts.

Response of Understory to Thinning and Prescribed Burning in Northeastern California

Melissa Borsting, Division of Ecosystem Sciences, College of Forest Resources, University of Washington, Seattle, WA

My research explores the short-term response of understory vegetation to silvicultural and fuel reduction treatments in ponderosa pine forests of northern California (Blacks Mountain Experimental Forest). It is important to understand these responses, as understory vegetation contributes significantly to biological diversity, nutrient cycling, wildlife habitat, and fire regime in these forests. The experimental design consists of two thinning treatments (high and low structural diversity), with and without prescribed burning, replicated at each of three locations. In this poster, I discuss the short-term responses of the dominant understory species and growth forms (e.g., annuals vs. perennials, herbs, graminoids, and shrubs). I compared changes in plant cover, species richness, and community composition, and address treatment-level responses, within-treatment heterogeneity, and relationships with burn intensity.

The Effects of Herbivory on Quaking Aspen (*Populus tremuloides*) Regeneration Following Various Treatments in South-Central Utah

Shauna-Rae Brown, Arizona State University, Chandler, AZ

Aspen (*Populus tremuloides*) ecosystems are known for their high biodiversity and are believed to have been a dominant type in the Intermountain West since the early Pleistocene. However, aspen ecosystems have dramatically declined since the 1870s. Over the past eight years, Fishlake National Forest, Utah has been working to stem the tide of aspen decline by treating for aspen restoration. During the summer of 2001 (June - October), 34 sites were surveyed to monitor the success of aspen regeneration following a variety of treatments including wildland fire, clearcutting for aspen regeneration, and clearcutting followed by prescribed fire. All clearcut sites that were monitored had some type of fencing erected to serve as study controls. Sites fenced to preclude all cattle and wildlife herbivory produced the highest number of aspen suckers compared to adjacent unfenced or cattle-excluded sites. Of the thirty-four sites surveyed, only one had no measurable aspen regeneration, which was due to high ungulate utilization.

Cerro Grande Fire Restoration at Los Alamos National Laboratory

Kevin Buckley, Sam Loftin, Jeff Walterscheid, and Mike Alexander, Los Alamos National Laboratory, Los Alamos, NM

The Cerro Grande Fire of 2000 had a huge impact on forests on and around Los Alamos National Laboratory (LANL). Immediately after the fire, there were concerns about increased erosion and flooding and its impacts on contaminated soil. An Emergency Rehabilitation Project was created to evaluate and estimate the impacts of the Cerro Grande Fire on LANL property, design appropriate methods to mitigate the effects of increased erosion and storm water runoff, and implement these measures to prevent further damage to people, property, and the environment. Seeding, raking, contour felling, log erosion barriers, straw wattles, straw mulch, and hydromulching were among the treatments used to stabilize soils and retain water on approximately 648 ha (1,600 acres) of moderately and severely burned hillslopes at LANL. Assessments show a highly successful response from combinations of seeding, raking, and mulching.

Mechanical Fuels Reduction Contract Underway at Richfield Bureau of Land Management

Linda Chappell, Doug Thurman, and Russell Ivie, Richfield Field Office, Utah Bureau of Land Management, Richfield, UT

Continuous pinyon-juniper fuels on the south, east, and north sides of Mayfield in south-central Utah are a potential wildfire threat. The nearby previously chained lands administered by the Bureau of Land Management were divided into three separate units to treat. This was in an effort to allow bidders of any size an opportunity to obtain the contract. Twenty-one hundred acres of pinyon / juniper fuel are now contracted for cutting in 2001-2002. A copy of the contract will be available. Following the treatments some broadcast burning will occur on areas with heavier fuel loads. Pre- and post-cut photos are included.

Definition of a Fire Behavior Model Evaluation Protocol: A Case Study Application to Crown Fire Behavior Models

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Testing and evaluation of models is an important and fundamental component of the scientific method, leading to model understanding and the increase of their credibility. The process of model evaluation has been seen differently by several authors due to the philosophical interpretations of what a model is. An important aspect when considering model evaluation is the

definition of the criteria that should be followed, which depends on the type of model being evaluated and its potential application. When considering fire behavior science, theoretical models developed to understand certain physical and chemical phenomena should be evaluated in a different form than operational models built to support decision-making. In the present paper a model evaluation protocol is proposed to encompass different aspects, such as: (1) model conceptual validity, (2) data requirements for model validation, (3) sensitivity analysis, (4) inter-model comparison, (5) predictive validation, and (6) statistical tests. The proposed protocol was applied to evaluate fire behavior models aimed at predicting crown fire initiation and spread with potential application in fire management decision support systems. The evaluation protocol highlighted the limitations of the discussed models and the implications of such limitations when applying those models to support fire management decision-making. The particular case of definition of fuel treatments aimed at reducing crown fire hazard was analyzed. The model limitations identified through the results reveal deficiencies in the state of knowledge of determinant processes in crown fire behavior and point to pertinent research needs.

Monitoring Fuel Conditions and Predicted Fire Behavior Before and After Varied Fuel Treatments in the Quincy Library Group Area: Site and Landscape Scale Findings and Implications

Jo Ann Fites-Kaufman, USDA Forest Service, Adaptive Management Services Enterprise Team; Bernie Bahro, USDA Forest Service, Pacific Southwest Region; and Larry Hood, USDA Forest Service, Lassen National Forest, CA

A forest health pilot including mechanical treatments (thinning and biomass) and prescribed burning was conducted on portions of three National Forests. We monitored site and landscape scales of fuel conditions. The 85 pilot projects encompassed over 45,000 acres and 993 individual treatment units. All projects were mapped digitally and detailed data were collected on surface, understory, and crown fuels. Vegetation was collected for random units. We evaluated several statistical approaches given constraints of non-random treatment assignments and lack of before and after data. Randomization tests and Impact vs Reference Sites analyses were conducted. Key findings were that sites selected for burning had lower canopy covers, tree densities, and crown bulk than those selected for mechanical fuel treatments. Regardless of treatment, many plots were predicted to have crown fire at high fire weather conditions. At the landscape scale, the pilot resulted in treatment of less than 10 percent of the landscape.

Applying and Evaluating Ecosystem Reinvestment A Case Study of the Bitterroot Watershed, Montana

Stephanie Gripne, Crockett Wildlife Conservation Program, School of Forestry, University of Montana, Missoula, MT

Ecosystem reinvestment is one of the emerging frameworks associated with ecosystem management. Ecosystem reinvestment describes any activity that increases the value of ecosystems and communities by directing revenues from natural resource activities toward efforts to restore and maintain these systems. Ecosystem reinvestment builds off the premise that ecosystem goods and services can be thought of as sources of capital. Natural and social capital, just like physical capital, can degrade over time and needs investments of resources in order to maintain their value / function. My research objectives are to apply the ecosystem reinvestment framework to the Bitterroot Watershed ecosystem and evaluate the potential of this framework to actually increase the level of resources that are reinvested back into the ecosystem. Specifically, I propose to determine 1) the market and nonmarket economic value of several ecosystem goods and services generated in the Bitterroot Watershed, 2) the cost of restoring different scenarios of ecosystem goods and services, 3) the individuals who benefit from these ecosystem goods and services, and 4) the available mechanisms for providing the support needed to maintain these forest ecosystems using a economic analyses, a contingent valuation willingness-to-pay survey, stakeholder analysis, and literature review. My proposed study will provide one of the first formal evaluations of the application of ecosystem reinvestment as a model for maintaining and restoring ecosystems. Additionally, this study will improve the state of knowledge about market and nonmarket economic values of forest ecosystem goods and services in the Bitterroot Watershed, which to date, has not been comprehensively been explored.

Demonstration Plots for Comparing Fuel Complexes and Profile Development in Untreated Stands Vs. Stands Treated for the Management of Spruce Beetle Outbreaks

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The activity of insects, diseases, and abiotic agents is known to contribute to changes in the characteristics of fuels complexes and associated fire behavior. Landscape-scale density management strategies have been proposed as viable alternatives to sanitation or salvage for managing insect and disease outbreaks. The effect of various density treatments on fuels complexes, or fuels development, however, is not known. An important agent of disturbance in Intermountain Region National Forests of the United States is the spruce beetle. Outbreaks have caused extensive mortality resulting in significant loss

of timber, recreational opportunities, and aesthetics. Mortality resulting from outbreaks has also resulted in increased dead fuel loads and will likely alter the fuels complex of infested stands over time. The Fishlake National Forest in cooperation with the Utah State Division of Forestry, Fire and State Lands will implement two density management treatments in several spruce-fir forests with the purpose of reducing susceptibility of these stands to spruce beetle infestation while enhancing tree vigor. This situation provides an excellent opportunity to establish permanent demonstration plots in treated versus untreated stands. Fuels inventories and appraisals will be conducted to determine changes in the fuel complex and profile over time. Based on the fuel inventory and appraisal data fuels treatment strategies including a combination of mechanical and biomass, utilization will be implemented on the demonstration plots. Prescribed fire will also be considered for treating fuel provided all prescription variables are met. Other benefits derived from this information include the demonstration of strategies for managing insect outbreaks and fuel development and manipulation.

The Effects of Long-Term Repeated Prescribed Burning on Nutrient Regimes in Loblolly Pine Stands in the Gulf Coastal Plain in Arkansas

Jennifer J. Henry and Hal O. Liechty, School of Forest Resources, University of Arkansas, Monticello, AR; and Michael S. Shelton, USDA Forest Service, Southern Research Station, Monticello, AR

Nutrient levels of various forest components were measured in loblolly pine stands within the Gulf Coastal Plain of Arkansas. The stands evaluated had either been burned every 2-3 years for the past 20 years or had not received any prescribed burning. Comparisons were made between stand types (burned and unburned) to assess the long-term effects of repeated prescribed fire on nutrient regimes. Due to low fuel loadings and wet / cool weather conditions, fires were of low to moderate intensity. Pine litterfall collected in the burned stands was higher in K, Ca, and Mg but lower in C than in the unburned stands. Although nutrient levels of the forest floor, live foliage, and the soil did not generally differ between stand types, N concentrations were lower in the understory vegetation of the burned compared to unburned stands. Additional research is being conducted to determine the nutrient dynamics from the latest prescribed fire.

The Citizen's Call for Ecological Forest Restoration: Forest Restoration Principles and Criteria

Timothy Ingalsbee, Western Fire Ecology Center, Eugene, OR

In February 2001, a diverse group of conservationist and community forestry groups from around the country held a Restoration Summit in Boulder, Colorado to develop scientifically sound and socially progressive restoration principles. Their goal was to create a document to help grassroots conservationists and forest practitioners advocate for Congressionally funded restoration programs, and evaluate federal restoration policies and projects. The Boulder

Summit initiated a year-long process resulting in a consensus-based document called "The Citizen's Call for Ecological Forest Restoration: Forest Restoration Principles and Criteria." This document and the growing coalition of organizations and individuals who endorse it and plan to utilize it have the potential to affect forest restoration programs, policies, and practices on federal lands in the near future. This poster presents some of the core principles concerning ecological restoration, ecological economics, and community and workforce development, with a special focus on fire restoration and fuels treatments.

A Decision Support System for Spatial Analysis of Fuel Treatment Options and Effects at Landscape Scales

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We present an approach for analyzing fuel treatment activities both spatially and temporally at the landscape scale that employs strengths of both simulation and optimization modeling. SIMulating Vegetative Patterns and Processes at Landscape ScaLEs (SIMPPLLE), a stochastic simulation modeling system, is used for projecting vegetative change in the presence of interacting natural processes, with or without management treatments. The Multi-resource Analysis and Geographic Information System (MAGIS), an optimization modeling system, integrates biophysical and socioeconomic information and schedules management practices spatially and temporally. The combination of SIMPPLLE and MAGIS provides a powerful analytical methodology for: 1) analyzing the extent and likely location of insects, disease, and fire both in the presence and absence of treatments, 2) developing spatial and temporal treatment alternatives for addressing fuels treatment along with other resource objectives, and 3) evaluating those alternatives in a manner that captures the combined effects of treatments and disturbance processes.

Invasive Plants and Wildfire on the Cerro Grande Fire, Los Alamos: Integration of Spatial Information and Spatial Statistics

Mohammed A. Kalkhan, Natural Resource Ecology Laboratory; Philip N. Omi and Erik J. Martinson, Department of Forest Sciences; Thomas J. Stohlgren and Geneva W. Chong, Natural Resource Ecology Laboratory; and Molly A. Hunter, Department of Forest Sciences, Colorado State University, Fort Collins, CO

The integration of spatial information and spatial statistical modeling can be used to investigate the spatial relationships among fuels, wildfire severity, and post-fire invasion by exotic plant species through linkage of multi-phase sampling design and multi-scale nested sampling field plots, and pre- and post-fire. This technique provides useful information and tools for natural resource managers, especially in describing landscape-scale fire regimes, invasive plants, and ecological and environmental characteristics for the Cerro Grande fire site, Los Alamos, NM, USA. We integrated filed data and spatial information

(Landsat TM Data, transform TM Data, and topographic data) with spatial statistics for modeling large-scale and small-scale variability to predict the distribution, presence, and patterns of native and exotic species. All models were selected based on lowest values of standard errors, AICC statistics, and high R^2.

Guidelines for Restoring an Unlogged Ponderosa Pine/Douglas-Fir Landscape in the Colorado Front Range After a Century of Fire Suppression

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Current forests in the unlogged ponderosa pine / Douglas-fir landscape at Cheesman Lake in the Colorado Front Range are denser with fewer and smaller openings and more young Douglas-fir trees than occurred historically, largely the result of fire suppression. We estimate from spatial maps and temporal patterns of historical fires that four significant fires would have occurred since the last major fire in 1880. The ages of old trees were used to estimate the severity of past fires. Fire and tree age data were used to estimate plausible locations and severities of excluded 20th century fires. Landscape structure for 1900 was estimated by "de-growing" forest polygons derived from recent aerial photos and field plot data. FVS was used to estimate landscape structure during the 20th century with the simulated effects of 20th century fires. A frame model depicts changes in the structural components of the landscape from around 1500 to the present, and compares the effects of fire suppression with a plausible 20th century natural fire scenario.

A Device and Method for Conducting Small-Plot Experimental Burn Treatments

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Large prescribed burns are valuable tools in assessing fire effects on soils and vegetation, but administrative and safety concerns may require smaller-scale efforts. We constructed a 3.4 m diameter fire enclosure for conducting experimental burn treatments on small (~10 m^2) circular plots, using sheetmetal, electrical conduit, and other commonly available materials. We field tested the enclosure in a sagebrush-grass ecosystem in central Nevada, and evaluated peak fire temperatures using small metal tags striped with temperature sensitive paint. Under-shrub microsites averaged 381°C, significantly hotter than under-grass (307°C) and bare-ground (310°C) microsites. Subsurface (2 cm depth) temperatures rarely exceeded 79°C, the lowest temperature detectable by our method. The fire enclosure contained the fire and did not permit escape of embers or firebrands. The fire enclosure, burn technique, and temperature monitoring method we use here are inexpensive, easily deployed, and desirable for experiments where larger-scale burns are impractical.

Direct Fire Effects Following the Jasper Fire, Black Hills National Forest, SD

Leigh Lentile and Skip Smith, Department of Forest Sciences, Colorado State University, Fort Collins, CO; Wayne Shepperd, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO; and Tricia Balluff, Department of Forest Sciences, Colorado State University, Fort Collins, CO

In late August 2000, the Jasper Fire burned 33,000 ha of the Black Hills in South Dakota. The Jasper Fire burned under a variety of fuel and weather conditions creating a mosaic pattern of tree mortality within patches of varying size and extent. Remotely sensed canopy reflectance indicates that 39, 32, and 24 percent of the fire burned under high, moderate, and low severity conditions. Within the context of a larger monitoring design, we will provide an initial characterization of severity by quantifying direct fire effects on the overstory and the forest floor. An understanding of why particular trees die and what we can expect in terms of recovery based on different fire effects may be useful in planning.

We observed an increase in the proportion of crown, bole, and forest floor affected by fire along a severity gradient from low to high. In low and moderate severity treatments, 21-70 percent of the crown was scorched. In high severity treatments, 92 percent of the crown was consumed. We indexed fire severity as the product of the proportion of the ground area charred and the severity of char scaled from low (1) to high (3). Fire severity was 115 for low and 236 for high treatments on a scale from 100-300. Forest floor litter depths decreased from 2.54 cm in unburned stands to 0.15 cm in high severity treatments. Litter mass decreased from 1265 g m^{-2} in unburned areas to 82 g m^{-2} in high intensity treatments.

Tree mortality due to direct fire effects increased from low to high fire severity. Fire selectively killed smaller trees in low and moderate severity treatments. However, no trees, independent of diameter, survived in high severity treatments. This observation suggests that a threshold may exist between diameter and fire survivability in low and moderate severity fires in ponderosa pine systems in the Black Hills.

Experimental Approach for Monitoring the Jasper Fire, Black Hills National Forest, SD

Leigh Lentile and Skip Smith, Department of Forest Sciences, Colorado State University, Fort Collins, CO; Wayne Shepperd, Anna Schoettle, José Negrón, and Kevin Williams, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO; and Tricia Balluff, Department of Forest Sciences, Colorado State University, Fort Collins, CO

In late August 2000, the Jasper Fire burned ~33,000 ha or 7% of the Black Hills National Forest, South Dakota. This was the largest recorded fire in the Black Hills. The Jasper Fire burned under a variety of vegetative, topographic,

and meteorological conditions creating a mosaic of vegetative mortality in patches of varying size and extent. This fire appears to be similar to other historical fires in interior forests of the Black Hills in that it was an extensive, late season burn. The heterogeneity of fire effects suggests that fire behavior was spatially and temporally variable, exhibiting characteristics of surface, crown, and a combination of these fire types.

As part of a five-year effort, we established a network of permanent sites within the burn to monitor the influence of pre-fire vegetative conditions, fire size, and consumptive patterns on post-fire ecological succession. Direct fire effects on overstory, understory, forest floor, and soil components were assessed in 2001. Measurements of direct fire effects on soil and vegetation will be translated to quantitatively-based severity indices. Given the spatial extent and heterogeneity of the burn we can address questions relating to fire behavior and the timing and response of vegetation recovery. An assessment of mixed fire behavior within the signature of the Jasper Fire may provide a more unified and plausible idea of common fire behavior that has shaped landscapes within the Black Hills ecosystem.

Non-Structural Value Added Application of SDU Materials in Landscape Architecture Applications

Kurt H. Mackes and David G. Buech, Department of Forest Sciences, Colorado State University, Fort Collins, CO

Most materials culled from densely packed, even-aged stands are small-diameter trees (4- to 8-in. stems). Material of this size is difficult to process and extract economic value from. Most of this material is limited to nontraditional markets because of lack of grading standards/rules and reliable mechanical properties. There is demand for markets that require minimal material processing, are local, do not require grading and can be used without building code approval. This paper outlines applications in Landscape Architecture and the opportunities that they present. Applications include: fencing, retaining walls, walkways, nonstructural decks, and other “garden structures.”

Wood Utilization and Marketing Strategy for Small Diameter Wood in Boulder County

Kurt H. Mackes and Julie E. Ward, Department of Forest Sciences, Colorado State University, Fort Collins, CO; and Craig Jones, Winiger Ridge Ecosystem Management Pilot Project, Colorado State Forest Service, Boulder District

The Winiger Ridge Ecosystem Management Pilot Project in Boulder County, Colorado is one of 28 demonstration sites that are part of an innovative land management initiative between public agencies and landowners to collaboratively manage resources to improve overall conditions of the ecosystem. The purpose of this research is to develop a marketing strategy for utilizing the characteristically small diameter wood (<12" d.b.h.) that would be removed from this project and other fuel hazard reduction projects in Boulder County. This will be accomplished by characterizing the resource being

harvested (quality, quantity, availability, etc.), identifying existing markets for materials, and exploring the potential for new markets that could utilize this resource.

Research on Stand Management Options for Reducing Fuels and Restoring Two-Aged Lodgepole Pine Communities on the Tenderfoot Creek Experimental Forest

Ward McCaughey, Forestry Sciences Lab, USDA Forest Service, Rocky Mountain Research Station, Bozeman, MT

Fire-dependent lodgepole pine stands comprise significant acreages of mid- and upper-elevation forests in the Northern Rockies, providing wood products, wildlife habitat, livestock forage, water, recreational opportunities, and expansive viewsheds. Many lodgepole pine stands are in late-successional stages and at risk to pests and catastrophic-scale fires. Tenderfoot Creek Experimental Forest is located on the Lewis and Clark National Forest in the Little Belt Mountains of Central Montana. Twenty percent of the lodgepole pine stands on the experimental forest were found to be two-aged and another 30 percent were in an indistinct mosaic of a duel-fire complex. This paper describes preliminary results of the Tenderfoot Research Project designed to evaluate two-aged harvest methods in lodgepole pine stands by integrating silviculture and prescribed fire. Research studies evaluate the effects of harvesting and prescribed fire on several resources such as water quality and quantity, wildlife, forest fuels, and vegetation response.

The Role of Wildland Fire and Subsequent Insect Attack on Ponderosa Pine Mortality

Joel McMillin, Linda Wadleigh, and Carolyn Hull Sieg, USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ; José Negrón, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO; Ken Gibson, USDA Forest Service, Region 1; Kurt Allen, USDA Forest Service, Region 2; and John Anhold, USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ

The unprecedented fire year of 2000 provided an opportunity to quantify cumulative impacts of wildland fires and subsequent insect attack on ponderosa pine mortality over a large region. In 2001 we established plots in four National Forests: Black Hills in South Dakota, Custer in Montana, Arapaho-Roosevelt in Colorado, and Coconino in Arizona. In each area, we sampled 1500+ trees in burned areas and 500 trees in unburned areas. For each tree, we measured height, dbh, pre-fire live crown ratio, percent crown scorch, percent crown consumption, percent scorched basal circumference, scorch height on the bole, and insect presence. In addition, we collected four phloem samples from each of 200+ additional trees in each area to quantify the relationship between exterior signs of fire-caused damage and cambium damage. Tree mortality will be monitored for three years post burn. Our goal is to provide land managers with quantitatively based guidelines for assessing potential tree mortality following wildland burns.

Roundheaded Pine Beetle, *Dendroctonus adjunctus*, and Fuel Loads in the Sacramento Mountains, New Mexico

José F. Negrón and John Popp, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO

The roundheaded pine beetle (RPB), *Dendroctonus adjunctus*, is one of the most important bark beetles associated with ponderosa pine, *Pinus ponderosa*, in the Southwest. Outbreaks of this insect have caused extensive mortality in the Lincoln National Forest, NM, in the 1970s and in the 1990s. During the mid-1990s a network of plots was established in infested and uninfested stands to develop models to estimate the probability of infestation by the RPB. During remeasurement of these plots during the summer of 2001, we quantified fuel loads associated with tree mortality caused by the RPB. We used Brown's method to inventory coarse woody debris (cwd) in the plots. Transects were placed in a randomly selected direction but with the center of the transect coinciding with the center of our plots. We observed no differences in cwd in the 0 – ¼ inch or the ¼ to 1.0 inch size classes between the infested and the uninfested stands. We observed significantly higher cwd debris levels in the 1.0 to 3.0 inch class; in the >3.0 inch sound and rotten size classes; and in total cwd in the infested stands. We used BehavePlus (USDA Forest Service) to simulate spread and flame length using default values for the timber with litter and understory fuel model but adjusting the 1-, 10-, and 100-hour fuels to the levels we observed. We obtained increases in flame length and rate of spread with corresponding increases in 100-hr fuels. The largest increases in fuel loads are associated with cwd >3.0 inches. These increases will likely result in increased fire severity. These findings suggest that bark beetle outbreaks can cause significant increases in fuel loads, influence fire behavior, and perhaps increase the severity of the fires. These findings can have profound implications for managing dead trees resulting from extensive bark beetle outbreaks.

Historic Fire-Vegetation Relationships and the "Reference Conditions" Concept

Steve Norman, USDA Forest Service, Redwoods Sciences Lab, Arcata, CA; and Alan H. Taylor, The Pennsylvania State University, University Park, PA

In the Interior West, historic stand densities and disturbance histories have been reconstructed to describe how vegetation has changed due to a century or more of livestock grazing, logging, and fire suppression. We provide reconstructions for the ponderosa pine / Jeffrey pine forests of Lassen National Forest, California, using tree ring-based analyses from multiple half-hectare plots. We show that pre-Euroamerican fire regimes and vegetation dynamics varied both spatially and temporally. Changes in fire intervals, season, and extent varied among sites in part from the destabilizing effects of climate. Tree establishment was often episodic and only somewhat consistent with changes in disturbance. These results suggest that reference conditions, as defined by either reconstructed vegetation structure or fire intervals, may be contingent on both the

time period and location considered. In complex landscapes, such landscape heterogeneity may limit the application of the reference condition concept for fire and fuel reduction strategies.

Sustainability of Thinning and Prescribed Fire Programs to Improve Forest Condition Along the Front Range of Colorado

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Fire suppression initiatives of the 20th Century have contributed to unprecedented fuel loadings and subsequent wildfire severities. The fires of 2000 will long be remembered for their social, economic, and ecological impacts, as well as the $1.8 billion presidential initiative that resulted. While this initiative is well-intended, many information gaps exist relative to the acceptability of the expanded thinning and prescribed burning programs included under this initiative to improve forest condition in Colorado. The two primary objectives of the proposed project are to (1) conduct an interdisciplinary examination (hypothesis tests) of the sustainability of expanded thinning and burning programs to improve forest condition along the Front Range of Colorado and (2) conduct a series of collaborative workshops involving professional land managers and affected publics, based on knowledge gained from hypothesis tests. Four primary information sources (i.e., agency records, field sampling, survey, focus groups) will be used to test a series of hypotheses related to the social, economic, and ecological concerns associated with the proposed thinning and burning programs. The collaborative workshops will also be used to evaluate additional hypotheses. This project will attempt to fill the information voids that exist by developing social, economic, and ecological criteria that can be used to evaluate the sustainability of expanded thinning and burning programs. The collaborative workshops, to be held during the final stages of the study, will use knowledge gained during the study to involve professional land managers and affected publics. The project will provide information and criteria that could be used by county faculty to develop forest restoration programs that are socially, economically, and ecologically sustainable. The results will be relevant to all current and proposed programs that involve mechanical thinning and / or prescribed fire treatments.

Using RX Fire to Maintain Shaded Fuelbreak Areas in Southern Spain

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The use of broadcast burning as fuel treatments is not used in Southern Spain nowadays. This is especially due to the characteristics of the vegetation in these Mediterranean areas, such as an absence of fine fuels or existence of multiple strata. However, the use of prescribed fire could be an interesting alternative for the maintenance of shaded fuelbreak areas. With the aim of studying the viability of such fuel treatment, eight shaded fuelbreak areas were

burned in Malaga province. All of them were *Pinus pinaster* stands, but with different understory structures and species, and using different firing techniques. The objectives were specially focused on comparing fuel consumption among the plots and defining the minimum base crown height to secure the survival of the trees as well as maintain the burn within prescription. The results will ease the use of RX-fire as a fuel treatment in forest fire prevention in Southern Spain.

Cerro Grande Rehabilitation Project

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Following the Cerro Grande Fire of May 2000, the Facility and Waste Operations at Los Alamos National Laboratory (LANL) received emergency funding to develop and support the Cerro Grande Rehabilitation Project. The project is responsible for landscape level mitigation of catastrophic wildfires on 10,000 acres of LANL property. A LANL moratorium on prescribed burning exists, so thinning utilizing site-specific defensible space, fuel break, and general thinning prescriptions are being used to reduce tree density and mitigate fuels. In general, prescriptions are based on prior piñon-juniper restoration and fuel mitigation research and on historical ponderosa pine density and expected fire behavior. Site-specific fuel mitigation implementation plans were developed that protect threatened and endangered species, the wildland urban interface, forest health and sustainability, streamside management zones, soil, air quality, cultural sites, utility corridors, and public safety. The goals of the site-specific implementation plans include the creation of defensible space and fuel breaks around structures, ecologically sound slash disposal and fuel reduction methods, utilization of equipment and performing operations at the appropriate time and place, and maintaining or improving aesthetic quality. Desired future conditions include a reduction of the risk of catastrophic wildfire and its associated effects on ecosystem health and the urban interface to a politically and socially acceptable level, improved and maintained forest health and wildlife habitat, and support of fuel mitigation efforts across the southwest. Management tools presently in development include building a post-treatment continuous forest inventory and a comprehensive modeling package to guide adaptive management and maintenance of desired future conditions. The project is in its second year and scheduled for completion in 2003.

Mapping Fuels and Fire Regimes Using Remote Sensing, Ecosystem Simulation, and Gradient Modeling

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Maps of fuels and fire regimes are essential for understanding relationships between fire and landscapes and for enlightened restoration of fire regimes to within historical ranges. We present an approach to fuels and fire regime mapping using gradient-based sampling, remote sensing, ecosystem simulation,

and statistical modeling to create maps of fuels and fire regimes. We developed a database including 40 variables describing indirect, direct, resource, and functional gradients of physiography, spectral characteristics, weather, and biogeochemical cycles for a 5,830-km^2 area in Northwestern Montana. Using a variety of statistical techniques we created maps of fuel loads, fuel model, fire interval, and fire severity with independently assessed accuracies from 50 - 80 percent. Incorporating direct, resource, and functional gradients significantly improved map accuracy over maps based purely on indirect gradients. These maps provide information to assess the hazards and risks of fire when deciding how best to restore forests to within historical ranges of variation.

Role of Fire in the Future of White Pine Populations in Colorado

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Limber pine (*Pinus flexilis* James) and Rocky Mountain bristlecone pine (*Pinus aristata* Engelm.) are two white pine species that grow in Colorado. Limber pine is distributed throughout western North America while bristlecone pine's distribution is almost entirely within Colorado. Limber pine grows from lower treeline to upper treeline (1600 m to 3400 m) in Colorado while bristlecone pine is restricted to the subalpine and upper treeline areas (2750 m to 3670 m). Both species are seral on mesic sites and form persistent stands on xeric sites. White pine blister rust (*Cronartium ribicola*) was introduced to the Vancouver area of North America in the early 1900s and is spreading southward through the white pine ecosystems. White pine blister rust was identified in Colorado in 1998 on limber pine and has not yet been reported on bristlecone pine.

Fire may provide a management tool to aid in the coexistence of white pine populations with the rust. Both pines are pioneer species that depend on fire to open sites for regeneration. In the presence of blister rust, these colonization sites offer opportunity for selection of rust-resistant genotypes. The balanced application of fire to increase colonization opportunities while preserving seed sources may accelerate the development of rust-resistant white pine populations. The incomplete understanding of the ecology of limber and bristlecone pine constrain our ability to rapidly develop and implement management and conservation programs. An interdisciplinary research program applying ecological, physiological, and meta-population approaches has been initiated to improve our understanding of the regeneration dynamics, population genetics, rust resistance, and adaptive variation of high elevation white pines to facilitate our ability to develop potential management and conservation options.

Effects of Fall Vs. Summer Prescribed Burns in SW Ponderosa Pine Forests: A Case Study from Saguaro National Park, Arizona

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Two years of fire effects monitoring data are analyzed to evaluate changes in ponderosa pine forest structure, composition, fuel loading, and vegetation

characteristics of Saguaro National Park in southeast Arizona. In June of 1993 and 1996 two prescribed burns were conducted in the Rincon Mountains of Saguaro National Park. In October 1996, 1997, and 1998, three more prescribed burns were implemented in the same mountain range. All five burns were in ponderosa pine forests between 7000 and 8600 ft elevation. The burn units were ignited using strip-firing techniques. Minimal mechanical treatment was applied around the burn perimeters to secure the fire line. Twenty-five 50x20m fire effects monitoring plots were installed throughout the burn units to monitor trends and evaluate objectives. These plots were burned in the same manner as the rest of the burn unit and no mechanical treatment was applied in or within 50 m of each plot. Preliminary data have shown similar results for both summer and fall burns in reducing fuels and measurable differences in reducing pole sized trees and overstory tree mortality. Preliminary herbaceous data have shown an increase in herbaceous cover with fall burning and a reduction with summer burning.

Building the Scientific Basis for Fuel Treatments and Restoration in the Southwest

Martha Schumann and Tori Derr, Southwest Community Forestry Research Center, Forest Trust, Santa Fe, NM

We are undertaking a project to describe and compare fuel reduction and restoration treatments implemented in ponderosa pine forests in New Mexico, Arizona, and Colorado. The analysis will evaluate whether the prescription and outcome meet the treatment objectives. Preliminary data from sites show a wide range of site conditions, prescriptions, and treatments. This project will contribute to the development of appropriate prescription guidelines for the Southwest. We have also developed a protocol for community-based assessments of fuel reduction projects, composed of a framework of monitoring questions, and methods for data collection and analysis. Protocols will be piloted in two areas on the Cibola National Forest. The goal of assessing and monitoring treatments is to build a regional knowledge base shared between communities, scientists, and managers to inform forest management.

First Year Postfire Erosion Rates on the Bitterroot National Forest

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Accelerated runoff and erosion are common occurrences following forest fires due to loss of protective forest floor material. The combustion of organic forest floor material may cause high percentages of bare soil exposed to overland flow, raindrop impact, and water repellent soil conditions. Twenty-four silt fences were installed to study postfire erosion on a storm-by-storm basis on the Bitterroot National Forest in Western Montana after the 2000 fire season. This study focused on erosion rates on steep slopes between two burn severities and two stand densities. Erosion rates were determined from sediment trapped behind the silt fences from a contributing area of 100 m^2. Sediment collected was weighed onsite and a sub-sample taken for further

analysis. Short duration high intensity thunderstorms (10-min max. intensity 79 mm hr^{-1}) caused the highest erosion rates (80 t ha^{-1}). Whereas the long duration low intensity rain events produced little erosion (0.01 t ha^{-1}).

Fire and Fire Surrogate Treatments for Ecosystem Restoration

Scott Stephens, Division of Forest Science, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA; and James McIver, USDA Forest Service, Pacific Northwest Research Station, La Grande, OR

Compared to presettlement times, many dry forests of the United States are now more dense and have greater quantities of fuels. Widespread treatments are needed in these forests to restore ecological integrity and to reduce the risk of uncharacteristically severe fires. Among possible treatments, however, the appropriate balance among cuttings, mechanical fuel treatments, and prescribed fire is often unclear. Resource managers need better information on the comparative effects of alternative practices such as prescribed fire and mechanical "fire surrogates." An integrated national network of 13 long-term research sites has been established to address this need, with support from the U.S. Joint Fire Science Program and the National Fire Plan. Four alternative treatments will be applied in replication at each site: (1) cuttings and mechanical fuel treatments alone; (2) prescribed fire alone; (3) a combination of cuttings, mechanical fuel treatments, and prescribed fire; and (4) untreated controls. Response to treatment will be determined through the repeated measurement of a comprehensive set of core variables at each site, including aspects of fire behavior and fuels, vegetation, wildlife, entomology, pathology, soils, and economics. The experiment is designed to facilitate inter-disciplinary analysis at the site level and meta-analysis for each discipline at the national level. The inter-disciplinary nature of the study will provide managers with information on how their practices affect whole ecosystems, while meta-analysis will provide insight on which responses are general, and which are dependent on specific environmental conditions. At present, two sites have collected post-treatment data, five are in the midst of treatment application, and the remaining six have collected all pre-treatment data and are poised to apply treatments.

Identifying the Most Appropriate Decision Framework for Assessing Fire and Fuel Management Options

David A. Tallmon, Danny C. Lee, Steve Norman, and Christine May, USDA Forest Service, Redwood Sciences Lab, Arcata, CA

Fire and fuels management decisions can be very complex. The complexity inherent in these decisions often comes from the ecological, social, and economic issues that surround them. We identify and describe a number of different decision processes or frameworks that are available to decision-makers to help them articulate and explore the possible effects and risks of management actions for competing issues. The decision processes vary in terms of their complexity, sophistication, and underlying philosophies. We evaluate several

of these different decision processes using simple criteria and suggest which ones are most appropriate for each of the institutional levels at which fire and fuels management decisions must be made.

Fuel Load Changes Associated With Pinyon-Juniper Woodland Expansion in Central Nevada

Robin J. Tausch, USDA Forest Service, Rocky Mountain Research Station, Reno, NV; and Alicia Reiner, Department of Environmental and Resource Sciences, University of Nevada-Reno, Reno, NV

Since European settlement there has been a pronounced increase in distribution and dominance of Great Basin pinyon-juniper woodlands. Two-thirds to three-quarters are post-settlement in age. Largely attributed to the reduced occurrence of fire resulting from the heavy livestock grazing that followed settlement, this expansion is impacting a wide range of sagebrush ecosystems. Dramatic changes in the levels and types of fuels present, and increases in fire size and severity, are resulting. Fuel load changes responsible for these changes have not been quantified. Studies of the expansion and growth of woodlands at a central Nevada location provide a first look at the patterns of increasing fuel loads over time. At mid successional stages, fuel loads can be increased by 500 lbs. per acre per year. At full tree dominance, total fuel loads can be 10 or more times those of the former sagebrush ecosystem.

Using Prescribed Fire for Fuel Reduction and Ecological Restoration

Laura Trader and Sarah DeMay, Bandelier National Monument, Los Alamos, NM

Research shows that fire suppression has resulted in dramatic changes in the fire regimes at Bandelier National Monument, NM, and has produced significant ecological effects on the fire-prone landscapes. High accumulations of woody fuels and increased tree densities are a few of these effects. These unnatural conditions have resulted in catastrophic fire events in areas, such as Bandelier's ponderosa pine forests, where they were once anomalous. In 1977, the stand-destroying La Mesa Fire consumed 16,000 acres in Bandelier's ponderosa pine forest. This fire event has changed the landscape from a pine forest to a grass / shrubland. In 1998, 21 years post fire, Bandelier fire and resource managers decided to use fire in this area to reduce the accumulations of woody fuels, reduce seedling tree densities, and increase native plant cover. Our poster presents the 2-year post burn results from data collected on permanent vegetation plots in this area. It appears that prescribed fire has been effective in reducing woody fuels and promoting forest health.

Importance of Fire Occurrence in Simulation of Fuel Landscapes on the Angeles National Forest, Southern California

David R. Weise, M. Arbaugh, USDA Forest Service, Pacific Southwest Research Station, Forest Fire Laboratory, Riverside, CA; J. Chew, G. J. Jones, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT; M. Wiitala, USDA Forest Service, Pacific Southwest Research Station, Forest Fire Laboratory, Riverside, CA; J. Merzenich, USDA Forest Service, Portland, OR; J. van Wagtendonk, USGS, Western Ecological Research Center, Yosemite Field Station, El Portal, CA; M. Schaaf, Air Sciences, Inc, Portland, OR; S. Schilling, USDA Forest Service, Pacific Southwest Research Station, Forest Fire Laboratory, Riverside, CA; J. Sullivan, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT; and R. Kimberlin, USDA Forest Service, Pacific Southwest Research Station, Forest Fire Laboratory, Riverside, CA

Understanding the trade-offs between short-term and long-term consequences of fuel treatments on ecosystems is needed before a comprehensive fuels management program can be implemented nationally. We are evaluating three potential trade-off models at eight locations in major U.S. fuel types. The selected models / modeling approaches are (1) the Fire Effects Trade-off Model (FETM), (2) sequential use of the SIMPPLLE and MAGIS models, and (3) the Vegetation Dynamics Development Tool (VDDT). Each model simulates natural succession and vegetation changes following various disturbances including wildfire. We are evaluating the sensitivity of these models to various inputs including description of fire occurrence. Fire occurrence rates estimated from data for the Angeles National Forest were multiplied by 0.25, 0.5, 2, and 4. One hundred years of vegetation change were simulated by each model using the modified fire occurrence rates. The effects of change in fire occurrence rate on simulated wildfire acreage, vegetation composition, and smoke emissions will be presented.

Simulation of Historical Fires and Their Impact on Fuels in Yosemite National Park

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Understory Vegetation Response to Fire and Overstory Reduction in Black Hills Ponderosa Pine Stands

Cody L. Wienk, USDI National Park Service, Wind Cave National Park, Hot Springs, SD and School of Renewable Natural Resources, University of Arizona, Tucson, AZ; Guy R. McPherson, School of Renewable Natural Resources, University of Arizona, Tucson, AZ; and Carolyn Hull Sieg, USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ

The role and extent of fire in ponderosa pine forests in the Black Hills, South Dakota, has been reduced in the last century. In some dense stands, a thick layer of pine needles has replaced understory vegetation. We experimentally addressed the effects of prescribed burning and overstory reduction on

understory vegetation, and examined the extent to which lack of a soil seed bank constrained understory recruitment. Response of understory vegetation during the first growing season post-treatments was sparse. There were, however, significant treatment effects during the second growing season. Total understory biomass ranged from 5.8 kg / ha on untreated plots to 1724 kg / ha on clearcut, unburned plots. Herbaceous dicots comprised over 90 percent of the total understory biomass. Only 57 individual plants, or 186 seeds / m^2, emerged from 1080 soil samples. Nonetheless, paucity of viable seeds in the soil seed bank does not appear to constrain recruitment of understory vegetation in dense ponderosa pine forests of South Dakota.

Equipment to Reduce Submerchantable Biomass in Anticipation of Future Prescribed Fire Treatments

Keith Windell, Missoula Technology & Development Center, Missoula, MT; and Sunni Bradshaw, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT

The USDA Forest Service's Technology and Development Center in Missoula, Montana, was asked to identify or develop equipment and techniques that would help managers prepare difficult sites for future prescribed fire treatments. These difficult sites have fuel loadings and distributions that increase the chance of fire escape and unacceptable resource damage. Much of the equipment identified during this project has direct application for fuels reduction in the wildland urban interface. The results of this project have been documented in two publications: Understory Biomass Reduction Methods and Equipment (0051-2828-MTDC), and Understory Biomass Reduction Methods and Equipment Catalog (0051-2826-MTDC). The reports document operational characteristics, capabilities, and limitations of equipment with potential to reduce biomass.

Restoring the Mixed-Oak Forest With Prescribed Fire and Thinning

Daniel Yaussy and Mary Boda, USDA Forest Service, Delaware, OH

The oak forest type is one of the largest endangered ecosystems. Central hardwoods ecosystems dominated by an oak overstory are seldom replaced with oak regeneration, regardless of harvesting method. This failure in oak development is the result of changed disturbance regimes, in particular, the suppression of human-caused fire since the 1930s. Studies of prescribed fires have established that fire alone will not remove the larger midstory trees that inhibit oak regeneration. As part of the national Fire and Fire Surrogate (FFS) study, four treatments have been implemented: control, fire only, thinning only, and fire plus thinning. In addition to the integrated ecosystem studies required by the FFS study protocols, collateral investigations include the effects of the treatments on: acorn production and predation by weevils and deer, bats, and flying squirrels; mycorrhizae; fire intensity; and soil moisture.

Modernizing Fire Weather Data Collection: The RAWS Review

John Zachariassen and Karl F. Zeller, USDA Forest Service Rocky Mountain Research Station, Fort Collins, CO; Thomas McClelland, USDA Forest Service, National Weather Program, Washington, DC; and Richard W. Fisher, USDA Forest Service Air Program, Washington, DC

The Remote Automated Weather Station (RAWS) network has been providing weather data to the United States Forest Service (USFS) and other land management agencies for the past 23 years. Prior to that, most fire weather observations were taken manually and a few made automatically with a RAWS prototype. Current USFS requirements for weather information have grown from strictly fire support – for which RAWS was originally designed and deployed – to significantly broader applications and uses. For example: physical and regional climatology, weather forecasting, support of air quality and pollutant monitoring in the atmospheric boundary layer, aerosol and trace gas flux measurements, environmental aerodynamics, and ecosystem (process) modeling. Even though current and future fire applications will continue to be the primary use for RAWS data, the growing list of uses for weather data presents an urgent need to assess the RAWS network. Such an assessment will include reviewing the individual stations themselves for density, distribution, redundancy, and overall function in addition to the RAWS system's ability to provide the Forest Service with the meteorological data and weather intelligence products it needs now and into the future. Preliminary results indicate that the RAWS network is a national asset and functioning fairly well given that it is a multi-agency network and with many user / owner choices for funding and operating individual stations. Individual stations meeting National Fire Danger Rating System standards are providing data in support of fire weather forecasting and for calculating fire danger rating indices and components. The entire network is in perpetual transition, undergoing hardware and software upgrades as well as streamlining data transmission.

Measuring, Modeling, and Tracking Western Spruce-Fir Forest Water Vapor Fluxes as a Fire Danger Indicator

Karl Zeller, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO; Ned Nikolov, USGS, Fort Collins, CO; and John Zachariassen, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO

Measurements of vertical water vapor flux made by eddy covariance were taken at 23-meter height above a subalpine spruce-fir forest in the USDA Forest Service's Glacier Lakes Ecosystem Experiment Site, Snowy Range, Wyoming.

Seasonal and diurnal water-vapor fluxes were studied. Seasonally during the growing season, water fluxes had much larger amplitudes. The FORFLUX

biophysical model was used to analyze eddy covariance flux measurements and track water availability in different components of the ecosystem (e.g. soil, ground litter, and vegetation) on an hourly basis. Seasonal and inter-annual variations of ecosystem water fluxes and water content in vegetation and litter can provide indications for critical ecosystem drying and help improve assessments of potentially fire danger.

The FORFLUX model mechanistically couples all major ecosystem processes and predicts seasonal dynamics of water vapor, carbon dioxide (CO2), and ozone (O3) exchange between a terrestrial ecosystem and the atmosphere. FORFLUX consists of four interconnected modules: leaf photosynthesis; canopy flux; soil heat-, water- and CO2- transport; and snowpack. All biophysical interactions are computed hourly while model projections can be output for either hourly or daily time steps.

FORFLUX requires input for: climate, soils, vegetation structure, species physiology (20 parameters); hourly ambient temperature, relative humidity, incident short-wave radiation, precipitation, above-canopy wind speed; soil texture, depth, and volumetric rock content; and canopy leaf area index and foliage clumping factor. Output: net ecosystem water, carbon, and ozone fluxes and their components, such as vegetation net primary production (NPP), plant ozone uptake, canopy photosynthesis and stomatal conductance, woody respiration, soil CO2 efflux, canopy transpiration and rainfall interception, soil evaporation, snow melt and sublimation, surface runoff, and subsoil drainage.

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RMRS
ROCKY MOUNTAIN RESEARCH STATION

The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of the forests and rangelands. Research is designed to meet the needs of National Forest managers, Federal and State agencies, public and private organizations, academic institutions, industry, and individuals.

Studies accelerate solutions to problems involving ecosystems, range, forests, water, recreation, fire, resource inventory, land reclamation, community sustainability, forest engineering technology, multiple use economics, wildlife and fish habitat, and forest insects and diseases. Studies are conducted cooperatively, and applications may be found worldwide.

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