ABSTRACT PRESENTATIONS

2002 Blodgett Forest Research Symposium

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TITLE:

Wildlife Response to Fire and Fire Surrogate Treatments at Blodgett Forest

AUTHORS: Andrew Amacher and Reginald H. Barrett

We report on the sample sizes obtained with a field crew of 5 wildlife biologists during the summer of 2001 and provide a pre-treatment picture of the status of terrestrial vertebrates on each of 12 plots. Bird abundance was sampled via variable-radius, circular plots. Bird foraging was sampled by focal animal observations. Bird productivity was sampled by monitoring nest success. Small mammals were detected with live traps and larger mammals by camera traps. Herptofauna were sampled by time-area counts. We illustrate the difficulty of obtaining statistically significant results with the small sample sizes possible given existing funding for this project. It seems likely there will be numerous Type II errors in the wildlife results from the Blodgett Forest Fire and Fire Surrogates Study.

Some mammals were extremely annoyed by the traps!
Photo by Jason Moghaddas

Ingenuity is often required if wildlife crew members expect to release some mammals unscathed!
Photo by Jason Moghaddas

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TITLE:

Single-Tree Selection for Shade Intolerant Species

AUTHORS: Kristen Baker, Rolf Gersonde, Nadia Hamey, Jennifer Heald, Robert Heald, Kevin O'Hara, Mark Spencer, Tudor Stancioiu, Rob York

ABSTRACT:

Single tree selection is often considered a system only for regeneration of shade tolerant tree species. In the western U.S. many of our most desirable tree species are shade intolerant and difficult to manage in single tree selection systems when more shade tolerant species are also present. This is the case of the mixed-conifer type in California where sugar pine and ponderosa pine are often less competitive than white fir and incense-cedar in stands managed with single tree selection systems.

Compartment 130 at Blodgett Forest was selected for development of an alternative single tree system that would maintain a mixed-species stand on the site that included the full range of species in the mixed-conifer type. The target stand was a complex mosaic of patches consisting of one to possibly five cohorts. Patches would range from gaps to mature forest and would be approximately 1/25th ha (1/10th acre). Species composition would include planted ponderosa and sugar pines, and natural regeneration of other species. The system would operate over a 100 - 125-year patch/gap development cycle with trees established in gaps that would grow through four 25-year cutting cycles. Natural regeneration would be expected during all cutting cycles and would be retained and favored through a fifth cutting cycle (Figure 1). After 125 years, the patch would be converted to a gap. Approximately 20% of the stand would be converted to gaps at each cutting cycle.

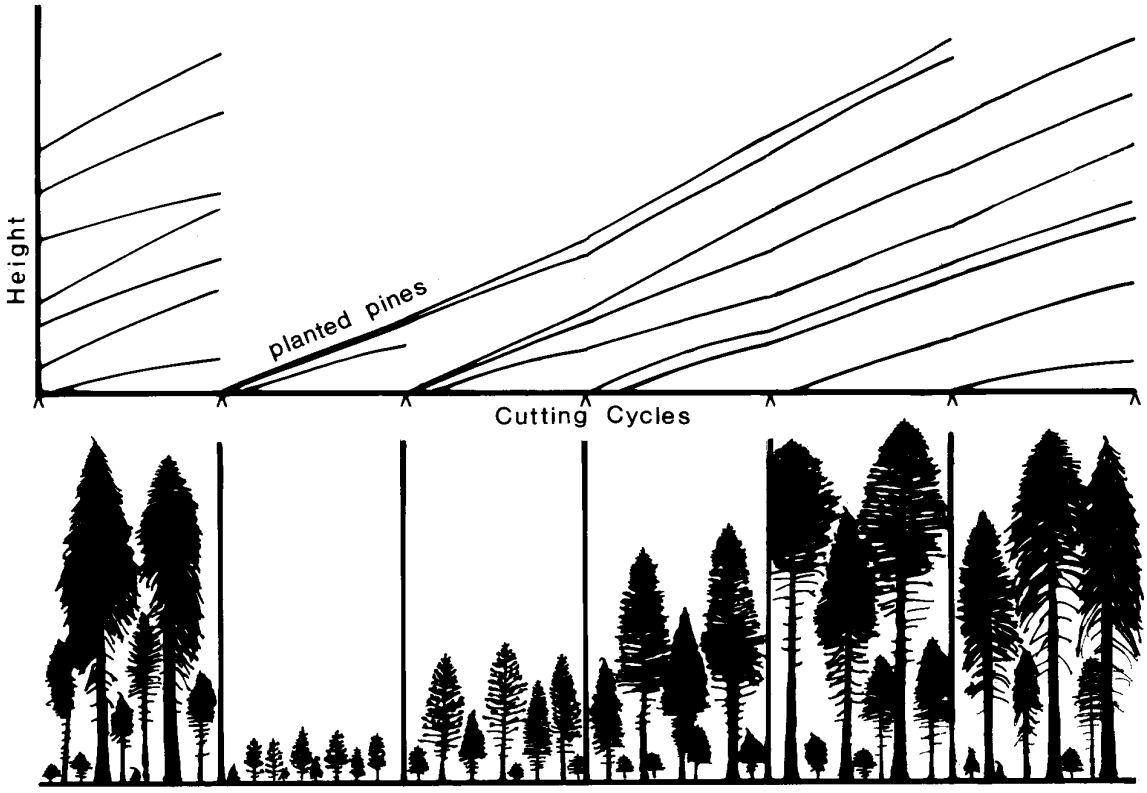

Figure 1. Schematic representation of patch development over time in compartment 130. Approximately 20% of the compartment would be in each of the five structures on the right side of the diagram after complete conversion. The left-most structure is the residual (pretreatment) stand.

The system is much like a group selection except gap/patch size is considerably smaller than typically included in a group system, and below the minimum (0.25 acre) defined by California Forest Practice Regulations. Our expectation is that this gap size, along with planting of pines, will provide sufficient light for survival and growth of these intolerant species. Blister rust sugar pine planting stock will be utilized.

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TITLE:

Systemic effects of Heterobasidion annosum (Basidiomycotina) infection on ferulic acid glucoside and lignin content of ponderosa pine phloem

AUTHORS: Pierluigi Bonello[1], Andrew J. Storer[2], Thomas R. Gordon[3], David L. Wood[4]

ABSTRACT:

A significant (P = 0.01) systemic accumulation of ferulic acid glucoside was observed in the phloem of ponderosa pines inoculated with the pathogen, *Heterobasidion annosum*, over a period of two years in a 35-year-old plantation at Blodgett Forest Research Station. Concurrently, we observed a significant (P < 0.05) 70% reduction in lignin content on one sampling date and a non-significant 20% reduction over all dates in the lignin content of the cell walls of inoculated trees compared to mock-inoculated and control trees. Lignin content was also significantly (P < 0.02) negatively correlated with ferulic acid glucoside concentration. This suggests that ferulic acid, one of the principal building blocks of lignin, is diverted away from lignin synthesis up the stem in *H. annosum*-treated trees.

In pure culture tests, the growth rates of two common fungal associates of ponderosa pine bark beetles, the ascomycetes *Ceratocystis brevicomi* and *Ophiostoma minus*, were negatively correlated with the lignin content of the medium. Since lignification is a common plant defense mechanism against microbial invasion, it is hypothesized that reduced systemic lignification of the phloem induced by basal infection with *H. annosum* may facilitate the growth of beetle-associated fungi, resulting in greater susceptibility of the root-infected host to bark beetle colonization.

On the basis of these preliminary results, we plan to conduct further chemical analyses of the trees over the summer of 2002. We will also inoculate a subset of those trees with the two bark beetle-associated fungi mentioned above to test

the hypothesis that root infection with *H. annosum* renders the host more susceptible to colonization by these fungi and thus more susceptible to bark beetle infestation.

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TITLE:

Fuel Reduction Harvesting Systems at Blodgett Research Forest – A Cost Analysis

AUTHORS: Stuart Chalmers & Bruce R. Hartsough

ABSTRACT:

Fire is a natural and necessary ecological function in United States forests, but fire prevention has led to a historic buildup of fuels. These unnaturally high quantities of both surface and vertical fuels can result in catastrophic fires. A national study (Fire and Fire Surrogates) is being conducted to compare thinning and prescribed burning as methods to reduce fuel loading and therefore reduce the risk of catastrophic fires. The work in this paper examines the economic costs of thinning at the FFS sites in Blodgett Research Forest. Thinning costing is based on measurement of productive/scheduled hours, standard machine costing, plus analysis of volumes of timber harvested, extracted and sold. A novel datalogger is used to calculate scheduled and productive hours. Preliminary costs per Thousand Board Foot (MBF) of timber as presented in the below table. Note these figures are for reference only and have not been finalized.

Unit	Falling $/MBF	Skidding $/MBF	Loading $/MBF	Total $/MBF
180	33.3	12.0	11.7	57.1
190	45.2	8.5	6.5	60.2
350	43.2	9.9	9.2	62.3
380	25.7	2.7	4.5	33.0
490	19.3	9.2	8.9	37.4
531	37.7	12.6	7.6	57.9
570	66.0	34.1	19.3	119.4

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TITLE:

Comparison of the Temperature Adaptation of Sequoiadendron giganteum, Sequoia semperviren, and Pinus ponderosa based on a Respiration Based Growth Model

AUTHORS: John N. Church, Richard S. Criddle, and Lee D. Hansen

ABSTRACT:

Respiration rate (R_{CO2}) and metabolic heat rate (q) were measured four times in in May and June 2001, at 5°C intervals from 5 to 40°C for nine *Sequoiadendron giganteum* (SG)
clones and six *Sequoia semperviren* (SS) clones grown in clonal hedges at the Russell Reservation Lafayette, California. SPECIFIC Growth rate (R_{SG}? H_B) for each clone was predicted based on a respiration based model using the equation $0.455R_{CO2}$ - q = R_{SG}? H_B. SS and GS data were compared with similar measurements on *Pinus ponderosa* (PP). SS and SG clones were selected by source location to study samples from throughout the north-south and elevation limits of the native range of the species. R_{SG}? H_B indicated that the maximum elongation rate of SS occurs below 20°C, while SG and PP reach maximum elongation rates between 20 and 25°C. This data is consistent with PP and SS controlled environment GROWTH studies. The predicted elongation temperature responses were also consistent with temperature data collected on growth at native sites during the elongation season. June and July temperatures were compared for a PP dominated site, Yosemite Valley (YV), a site with PP and GS, Mariposa Grove (MG), a site with GS but not PP, Giant Forest Grove (GF), and a site in the native range of SS, Mad River at Arcata (ARC). June and July 2001 temperatures for YV were the warmest, mean 22.5°C, with the greatest variation 43.6°C. MG had a lower mean 17.8°C and similar variation 36.1°C. GF had a mean temperature similar to MG 16.0°C and less temperature variation 27.2°C. ARC had the lowest mean 13.1°C and the least variation 18.9°C. The data

indicated that, relative to SS and GS, PP is adapted to climates with the warmest and most widely varying temperatures. GS is adapted to cooler climates with less temperature variation. SS is adapted to climates with the lowest temperatures and least temperature variation.

GIANT SEQUOIA

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TITLE:

Observing the deposition of nitrogen oxides

AUTHOR: Erin Conlisk

ABSTRACT:

Industrialization has increased global sources of atmospheric reactive nitrogen, thus affecting ozone and nitric acid cycles on regional and global scales. At high concentrations these species are detrimental to humans, agriculture, and forests. In addition, nitrogen input to nitrogen limited forests (most temperate forests) may enhance growth and carbon storage, thereby, mitigating or delaying the effects of current CO_2 emissions on climate. In both global and regional regimes, the concentrations of these species are determined by a combination of gas phase chemistry and physiochemical interactions controlling deposition and emission (fluxes) from the earth surface.

Measuring nitrogen oxide emissions or dry deposition is extremely difficult because of low concentrations and high surface reactivity. Consequently, there are only a small number of nitrogen oxide deposition studies. We have developed a new approach to measuring nitrogen oxide fluxes using the eddy correlation technique. Concentrations of HNO_3, total alkylnitrates, total peroxynitrates, or PANs, and NO_2 are measured using Thermal Decomposition Laser Induced Fluorescence, TD-LIF. We use four separate detection cells to observe each of four classes of reactive nitrogen simultaneously. This technique possesses several unique advantages: high sensitivity, rapid time response, and unique capability for detection of total PANs, and alkylnitrates. Initial results from flux measurements during the spring and summer 2001 will be presented.

To obtain a flux from concentration measurements, we use the eddy correlation approach. Eddy correlation uses the product of the vertical wind, *w*, and the concentration, *C*, to determine the flux through the plane of the sensor. Although the average wind speed in the vertical direction is zero, if a particular

species has a vertical concentration gradient it has a flux. Take nitric acid with high deposition velocity for example, downward eddies have relatively high nitric acid concentrations and upward eddies have lower concentrations. Eddies of various lengths and time scales contribute to total flux, eddy frequencies between 0.0005-2 Hz contributes most. Therefore, we make measurements at 5 Hz averaged for half an hour.

Below:
Atmospheric research lab and tower on Sierra Pacific Industries property adjacent to Blodgett Forest.
Photo by Dave Rambeau

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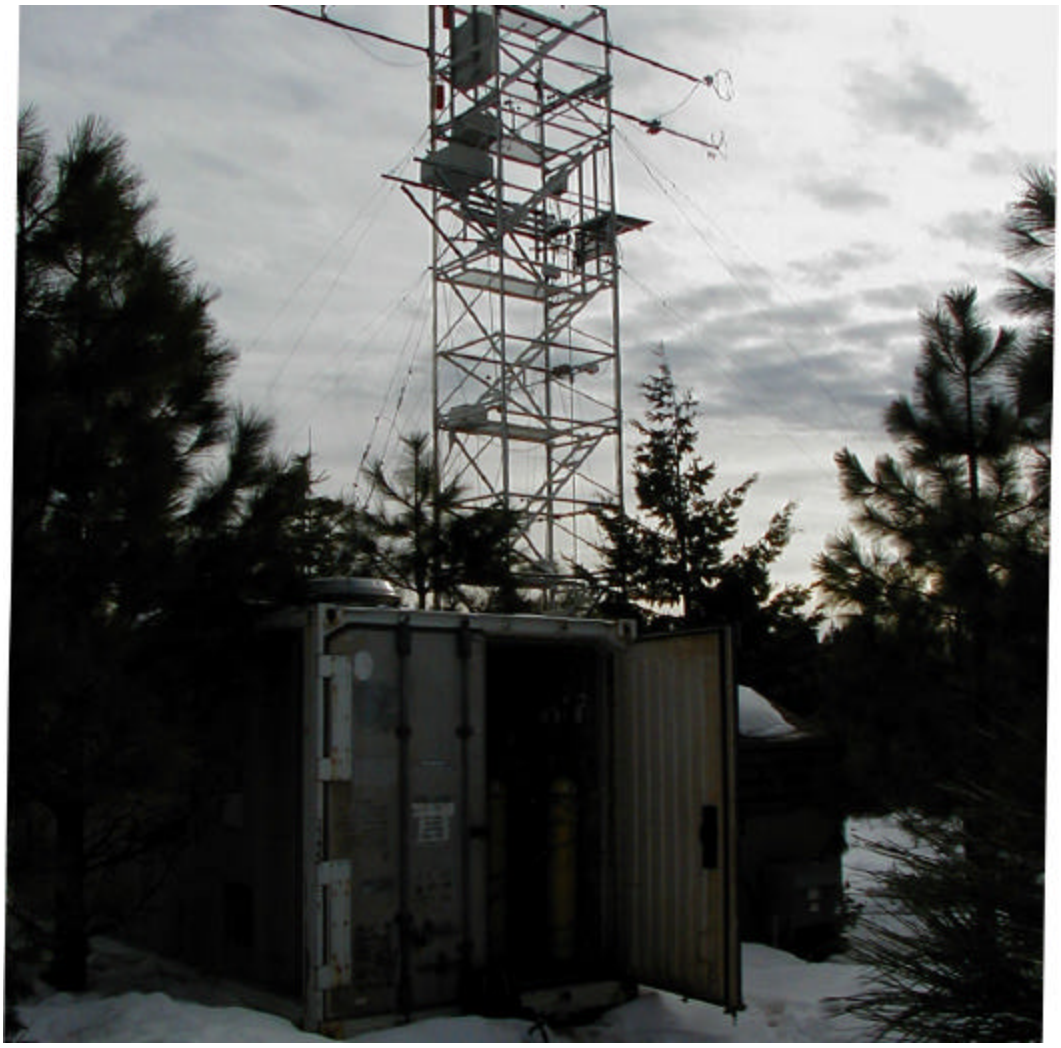

TITLE:

Effects of fire and fire surrogate treatments on leaf litter invertebrates at Blodgett Forest

AUTHORS: Donald L. Dahlsten, Kyle Apigian, David L. Rowney, Nadir Erbilgin

ABSTRACT:

Leaf litter arthropods are important components of all forest ecosystems, serving as predators, detritivores, herbivores, as well as food for higher trophic levels. Some groups, such as ground beetles (Carabidae), spiders (Araneae), and ants (Formicidae) have been studied extensively and have been shown to have variable responses to forest management practices such as prescribed fire and timber harvesting.

The abundance and diversity of these taxa make them valuable as indicators of forest health. We conducted a pre-treatment survey in the summer of 2001 on these taxa in Blodgett Forest using pitfall traps. Three-hundred pitfall traps were placed in 12 forest compartments that, in subsequent years, will be treated with prescribed burning, timber harvesting, both burning and harvesting, or act as controls. Five traps were placed in each of 5 randomly selected plots in each of the 12 compartments (total: 300 traps). Traps consisted of a lidded, plastic container (10 cm. diam., 15 cm. deep) with 14 holes (approx. 2 cm.) drilled around the perimeter to allow entry of the insects, but prevent incidental catches of small mammals or amphibians. Insects were collected in propylene glycol over the course of five days each month, from June through September.

The samples are currently being sorted to family level and selected taxa will later be sent to experts for species-level identifications. Initial results show a high abundance and diversity of Tenebrionid beetles, Carabid beetles, ants, and spiders. We will likely focus our monitoring effort on these groups for post-treatment responses. Additionally, correlations with the abundance and diversity

of these taxa with the volume of large woody debris and various soil characteristics will be examined pre- and post-treatment.

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Control burn at Blodgett Forest, November 2001

Photo by Robert Scott, USFS

TITLE:

The Seasonal Cycle of NO_2, Total Peroxy Nitrates, Total Alkyl Nitrates, and HNO_3 at the U.C. Blodgett Forest Research Station

AUTHORS: Douglas A. Day, Dan A. Deeds, Paul J. Wooldridge, Michael B. Dillon, Gunnar W. Schade, Allen H. Goldstein, Ronald C. Cohen

ABSTRACT:

Measurements of NO, NO_2, total peroxy nitrates, total alkyl nitrates, HNO_3, NO_y, O_3, and CO from the fall of 2000 through the fall of 2001 were made at U.C. Blodgett Forest Research Station. NO_2, total peroxy nitrates, total alkyl nitrates, and HNO_3 were measured using thermal dissociation – laser induced fluorescence (TD-LIF), a new technique developed at Berkeley. NO_x (NO_x = NO + NO_2) plays an important role in the photochemical production of ozone, a greenhouse gas and toxin to plants and animals. NO_x can be converted into other reactive nitrogen (NO_y) species, removing it from the catalytic ozone production cycle. These reservoir species may be quickly deposited or transported to other regions where they may be converted back to NO_x and ensure ozone production. Understanding the partitioning among different reactive nitrogen reservoirs and the processes involved will help us to understand the impact that NO_x will have on ozone production on a regional and global scale. We describe the seasonal cycle of the speciation of NO_y and the seasonal variations in their relationships with CO, O_3 and various meteorological parameters.

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TITLE:

Intercomparison of NO_y chemiluminescence and TD-LIF measurements at the University of California – Blodgett Forest Research Station

AUTHORS: Michael B. Dillon,[1,2] D. A. Day,[1] P. J. Wooldridge,[1] J. A. Thornton,[1] and R. C. Cohen[1,2,3]

ABSTRACT:

An informal intercomparison between a commercial instrument measuring NO and NO_y ($NO_y \equiv NO + NO_2 + RONO_2 + RO_2NO_2 + HNO_3 + \ldots$) and a thermal dissociation – laser induced fluorescence (TD-LIF) instrument measuring NO_2, ΣRO_2NO_2, $\Sigma RONO_2$, and HNO_3 was conducted over the course of 7 months at the University of California – Blodgett Forest Research Station. This rural site in the Sierra Nevada mountains regularly experiences both clean, continental air and the outflow from the Sacramento, CA urban plume. Additions of NO_2, n-propyl nitate, and nitric acid to the air stream sampled by the two instruments at concentrations ranging from 0 to 120 ppb demonstrate that they agree to within 2 % under controlled conditions. Overall, the agreement between the measurements of total NO_y made by the two instruments is within a few percent. However, the average deviation of simultaneous measurements is larger than can be explained by the combined precision of the observations. We find that some of the difference is likely due to a 5 % conversion of NH_3 in the TD-LIF experiment or alternately another compound converted to NO_2 at temperatures above the thermal dissociation point for HNO_3. Diagnostics internal to the TD-LIF instrument are consistent with this explanation. A second difference between the two instruments is an unknown signal observed by the commercial instrument but not by the TD-LIF. This signal is strongly associated with well-aged air masses and ozone concentrations.

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TITLE:

Observational constraints on the contribution of isoprene oxidation to ozone production on the western slope of the Sierra Nevada, CA

AUTHORS: Gabrielle B. Dreyfus[1,2], Gunnar W. Schade[3] and Allen H. Goldstein[3]

ABSTRACT:

Observations of isoprene and its oxidation products methacrolein (MACR) and methyl vinyl ketone (MVK) are used to quantify the impact of isoprene oxidation on ozone production along the western slope of the Sierra Nevada mountains. Regular daytime up-slope wind flow patterns transport anthropogenic VOC and NO_x emissions from the Central Valley towards the Sierra Nevada. A North-South band of oak forests stretching along the foothills and located approximately halfway between Sacramento and our measurement site (Blodgett Forest Research Station; elevation 1315 m) injects isoprene into this mixture. Subsequently, high ozone levels are encountered in these air masses. At Blodgett, daytime mixing ratios of isoprene's oxidation products and ozone were highly correlated. The observed daytime MVK/MACR ratio was used to estimate a mean [OH] of 8 ($\pm$ 2) $\times$ 10^6 molec cm^{-3} between the measurement site and the Sierra foothills. The slope of the correlation between ozone and MVK was analyzed and compared to theoretical yield ratios for the photooxidation of isoprene to estimate the fraction of total ozone production due to isoprene oxidation. On average over 40% of the observed midday ozone formation in this region was attributable to isoprene oxidation. On ozone episode days (maximum $[O_3]$ > 90 ppb) the mean isoprene contribution was 60%. The calculated isoprene contribution to ozone production was variable from day to day, but tended to increase exponentially with both isoprene input and air temperature. NO_x conditions in the up-slope air masses were very important in determining the ozone formation potential of isoprene, and the general dominance of isoprene as

an ozone precursor suggests that summertime ozone abatement strategies for the region must focus on anthropogenic NO_x rather than VOC reductions.

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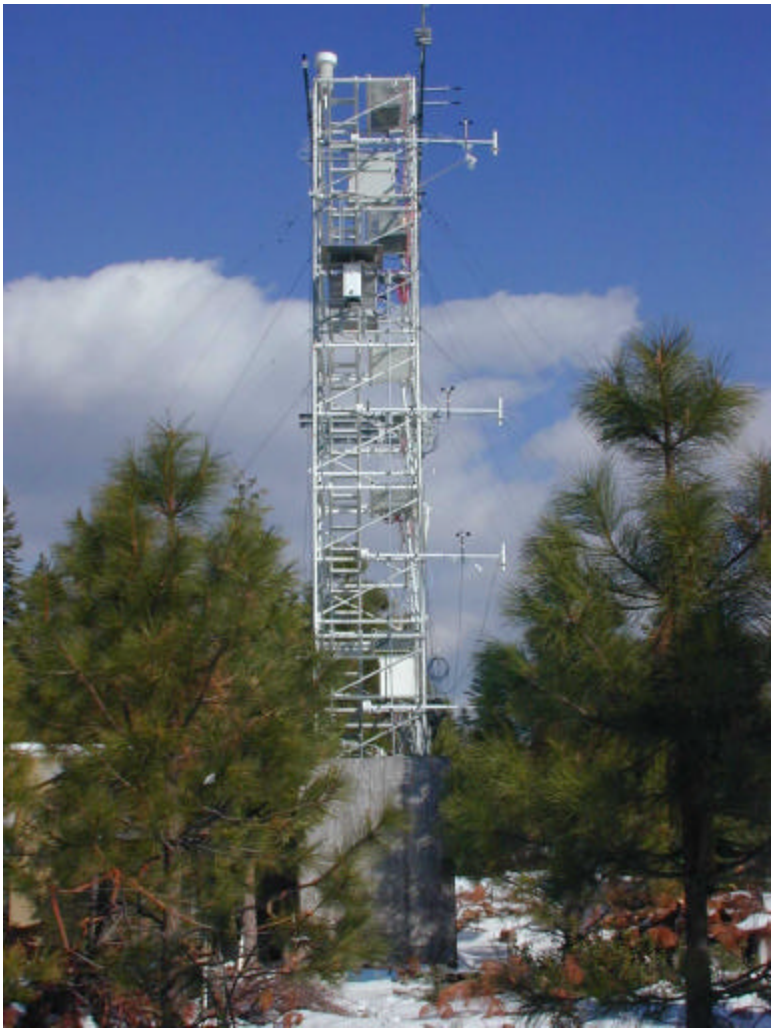

Photo by Gunnar Schade

Atmospheric testing tower

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TITLE:

The Post Burning Response of Bark Beetles to Prescribed Burning Treatments

AUTHORS: David J. Ganz, Donald L. Dahlsten, and Patrick J. Shea

ABSTRACT:

Ecologists and fire scientists recommend reintroducing fire to achieve the twin goals of restoring pre-settlement forest conditions and reducing catastrophic fire risk (McKelvey et al. 1996; Parsons 1995). Early work by forest entomologists (Miller and Patterson 1927; Salman 1934; Miller and Keen 1960, Rasmussen et al. 1996) established a direct relationship between fire injury and subsequent insect attack in burned-over areas. In 1962, a study observed 30 burns around the State of California with the purpose of creating guidelines for estimating the survival of fire-damaged trees (Wagener 1961). Wagener's guidelines are the only criteria that managers have at their disposal to predict tree and stand survival after fire. These management guidelines need to be refined for lower intensity prescribed burns during the two burning windows (spring and fall). The purpose of this study is to measure the extent of tree mortality from different prescribed fires in the East Side pine ecosystem of Northern California and to evaluate the current criteria used for survival marking of fire-scorched timber. These fall and spring prescribed burns around the State of California are being evaluated to determine the severity of tree mortality associated with prescribed fires burned under a wide variety of environmental and fuel conditions.

Initial concern has centered on the primary tree killers *Dendroctonus sps.* and *Scolytus ventralis* Leconte (Struble 1957). This research is also finding that *Dendroctonus valens*, *Ips pini,* and secondary wood borers are major players in tree mortality with both fall and spring burns. The mere presence of *Dendroctonus valens* and wood pecker foraging behavior going after its brood can essentially girdle an otherwise healthy small diameter tree. For ponderosa

and Jeffrey pine trees, mortality in the smaller diameter classes (4-10 inches DBH) caused by *Ips pini* has usually been in combination with *Dendroctonus valens*. Live crown still seems to be the most convenient measure for assessing tree vigor and therefore tree survivorship, especially with pines.

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TITLE:

Fire and Fire Surrogate Study
Treatment Effects on the Soil Environment

AUTHOR: Emily E.Y. Greinke and Scott L. Stephens

ABSTRACT:

Forest thinning and prescribed burning can greatly influence the soil environment. The Fire and Fire Surrogate Study will utilize these forest management techniques to create a forest stand structure that reduces the risk of catastrophic wildfire. Harvesting operations are expected to alter moisture and temperature regimes at the forest floor, due to the reduced evapotranspiration and increased sun exposure resulting from tree removal. Decomposition and nutrient cycling processes, such as N mineralization may be accelerated by these favorable microclimate changes. However, biomass additions to the forest floor from tree limbs may cause patchy, short-term nutrient immobilization by microorganisms. Skidding will increase the exposure of bare mineral soil as well as soil bulk density. Soil texture is not expected to change.

Collecting Forest Soil Samples. **Photo by Dave Rambeau**

Prescribed fire is expected to consume biomass from the forest floor. This loss of surface material may cause soil temperatures to rise, and soil warming to occur earlier in the season. This altered microclimate can result in increased N mineralization in the surface soil. Flaming temperatures may volatilize nutrient elements such as N, and intense heat pulses may cause short-term damage

microbial communities in the soil surface. Nutrients will be released through combustion, and deposited in available form as ash. Soil pH and base saturation are both expected to rise, while soil texture and compaction will remain unchanged by burning.

Forest thinning followed by burning is expected to result in increased forest floor consumption and higher flame temperatures than those obtained by burning alone. Biological and chemical effects are expected to be more pronounced than in the fire-only treatment. Soil physical effects are expected to be similar to those in the thin-only treatment.

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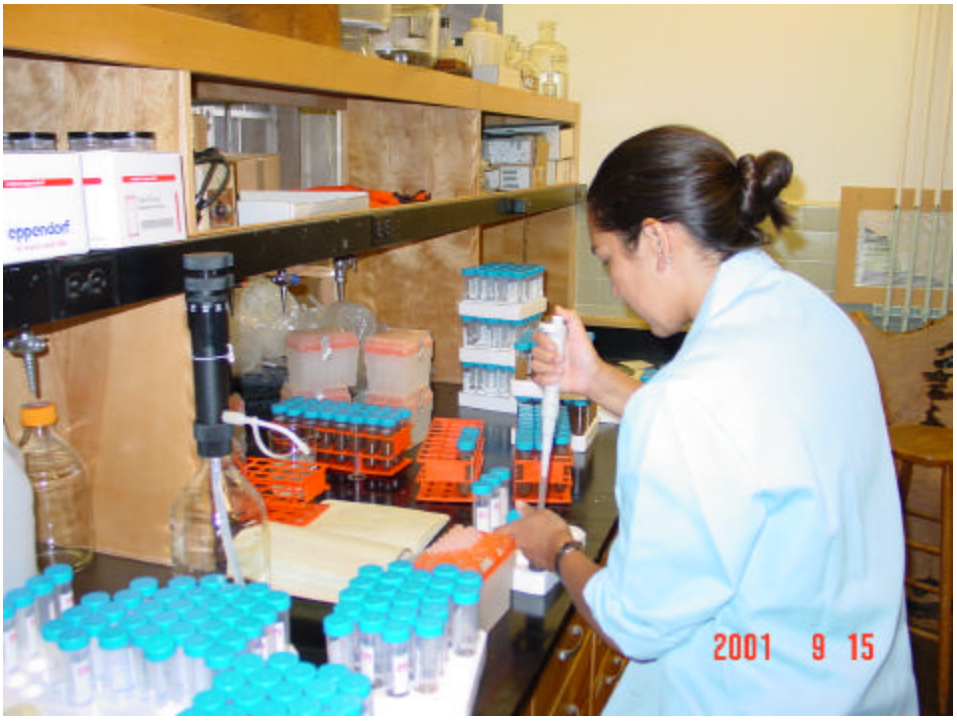


Emily Greinke examining characteristics of soil samples from Blodgett Forest Fire and Fire Surrogate study sites.
Photo by Jason Moghaddas

TITLE:

Mixed Conifer Plantation Growth

AUTHORS: Robert C. Heald, Nadia Hamey

ABSTRACT:

The Sierra Nevada mixed-conifer vegetation type occupies over 10 million acres in California. The vast majority of this land has been harvested several times during this century. Many of the resulting current stand structures are either overstocked young-growth sawtimber or ragged under stocked areas of dubious genetic and physiological quality. These types of stands plus areas swept by wildfire or damaged by pests are extremely difficult to effectively (from either a biological or economic point of view) manage with any uneven-aged silvicultural system. Furthermore, an increasing percentage of California foresters prefer even-aged management for its simplicity of application. Most such foresters also advocate artificial regeneration techniques for their presumed superior site and genetic control capabilities.

Prior to the 1980's nearly all artificial regeneration in the mixed-conifer vegetation type was single species plantings, usually Ponderosa pine (*Pinus ponderosa)*. Improvements in conifer seed and seedling handling from cone collection through storage and transport have made planting at least six native conifers (Douglas-fir (DF-*Psuedotsuga menziesii*), Ponderosa Pine (PP), white fir (WF-*Abies concolor*), sugar pine (SP-*Pinus lambertiana*), giant sequoia (GS-*Sequoidendron giganteum*) and incense-cedar (IC-*Calocedrus decurrens*)) quite feasible. Furthermore, several factors have been influencing foresters towards considering mixed-species plantations. First, pest complexes have devastated some sites previously regenerated with pure Ponderosa pine. Clearly this single species is not the best choice on all sites. This has also lent

credence to the often-stated claim that mixed species stands will experience less growth losses to pests over an entire rotation. Third, uncertainty about future product markets favor maintaining a mix of species, hence market options at various points in time. An example of this approach is the potential for early recovery of regeneration costs via minor product sales (Christmas trees and/or fence boards) from fir, sequoia, or cedar trees. Finally, even though there is a dearth of information on how managed native mixed-species plantations might grow, many foresters speculate greater wood productivity, increased visual quality, and wildlife species diversity from such stands than equal areas of single species plantings.

A multitude of problems beset anyone who attempts mixed-species plantings. The appropriate species mix (both percentages and distribution pattern) and density for each site, product, economic, wildlife habitat, and production objective must be selected. Since most of our knowledge about regeneration is derived from single species plantings, the appropriate site preparation, planting techniques and non-tree vegetation control methods for mixed species are unknown or at least quite confusing. After a successful stand establishment period, the stand densities that can take advantage of suspected different early growth patterns, minor product options and wildlife habitat needs are not known.

The study area was occupied by young-growth (about 70 years old) mixed-conifer and black oak stands regenerated by natural seed fall following commercial harvest (circa 1915). North and East slopes approximately 4500 feet in elevation on Holland and Bighill soil series were selected. Average slopes range from 10% to 30%, from upper to mid-slope positions. Average timber site ranges from

90 to 105 (Bigging and Wensel site index = height in feet at breast height age = 50 years) for pines and firs, 75 for incense cedar, 55 for black oak, and are unknown for sequoia. Pre-harvest average shrub cover was quite modest and variable in composition. Shrub composition on site included (in approximate order of prevalence) deer brush (*Ceanothus integerrimus*), green leaf manzanita (*Arctostaphilos patula*), chinquapin (*Castanopsis sempervirens*), bear clover (*Chameabatea foliolosa*), gooseberry (*Ribes roeslii*), and grasses.

STUDY DESIGN

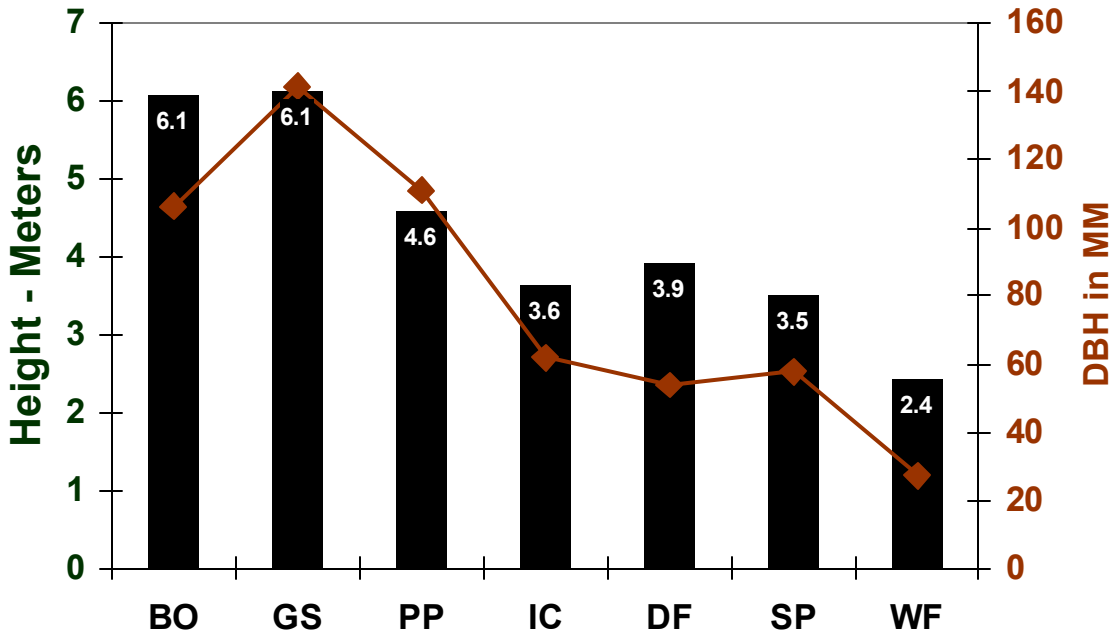
PLANTING AT BLODGETT FOREST
File photo

This study is designed to look at the spectrum of artificial regeneration techniques currently in use or proposed for the west side Sierra Nevada. Normally regeneration activities commence with site preparation and include planting conifers followed by some non-tree vegetation control and pre-commercial thinning. The site preparation was done by rotary mastication in late summer

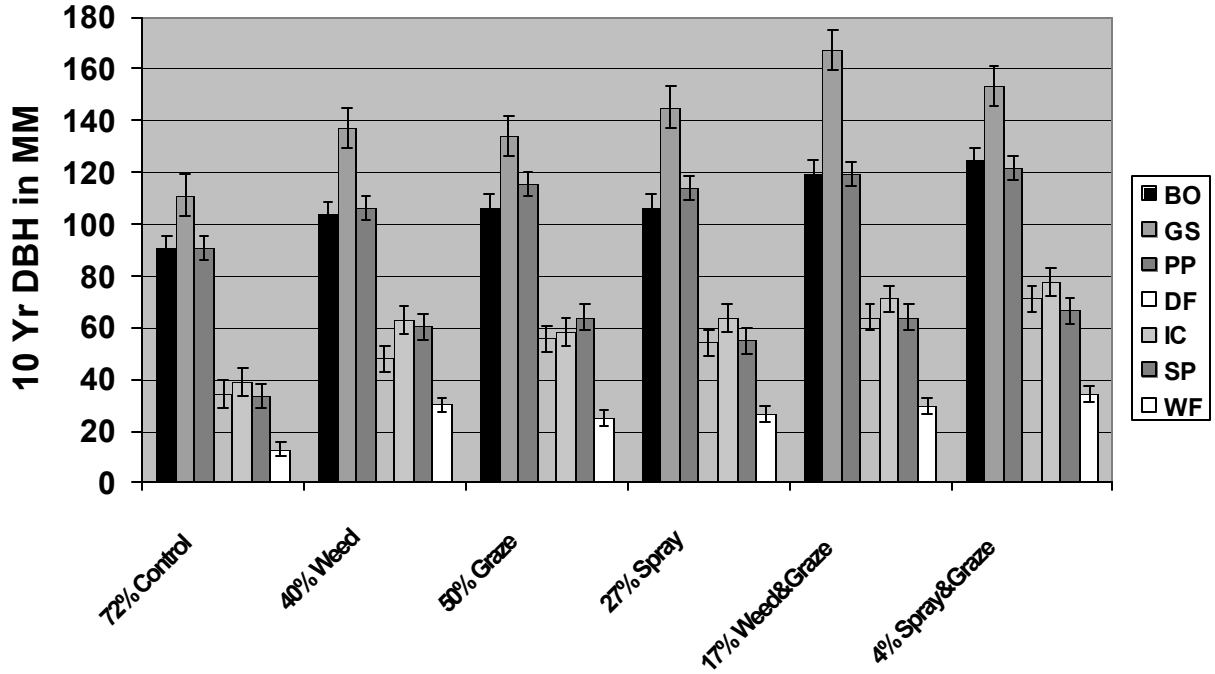
following harvest. Only sawlogs were removed in the commercial harvest. All other woody material was masticated and left in place on site. Each plot was planted in April 1992 with an equal mix of six conifer species (PP, SP, WF, IC, DF, and GS) on 2.5 meter square spacing (1600 trees/ha). This plantation study included two levels of direct post-planting non-tree vegetation control, each with and without seasonal cattle grazing, and a control untreated area. In a replicated random block design, units were alternatively treated with hand weeding for shrub control, 1% Roundup for herbicide shrub control, and no post-planting shrub control. Six replications of each of these treatments were open to grazing by range cattle for four months each summer (June through September). An additional eighteen similar treatment areas were surrounded by an exclosure to prevent grazing by range cattle. All areas in this study are open to browsing by seasonal deer herds. One plot (0.1 ha) in each of these thirty-six areas was established. Each plot was pre commercially thinned after the fifth year measurement to a residual density averaging 800 trees per ha. Hand weeding and chemical spray treatments were repeated the year following thinning. Seasonal cattle grazing (and the exclosures) continued throughout the study.

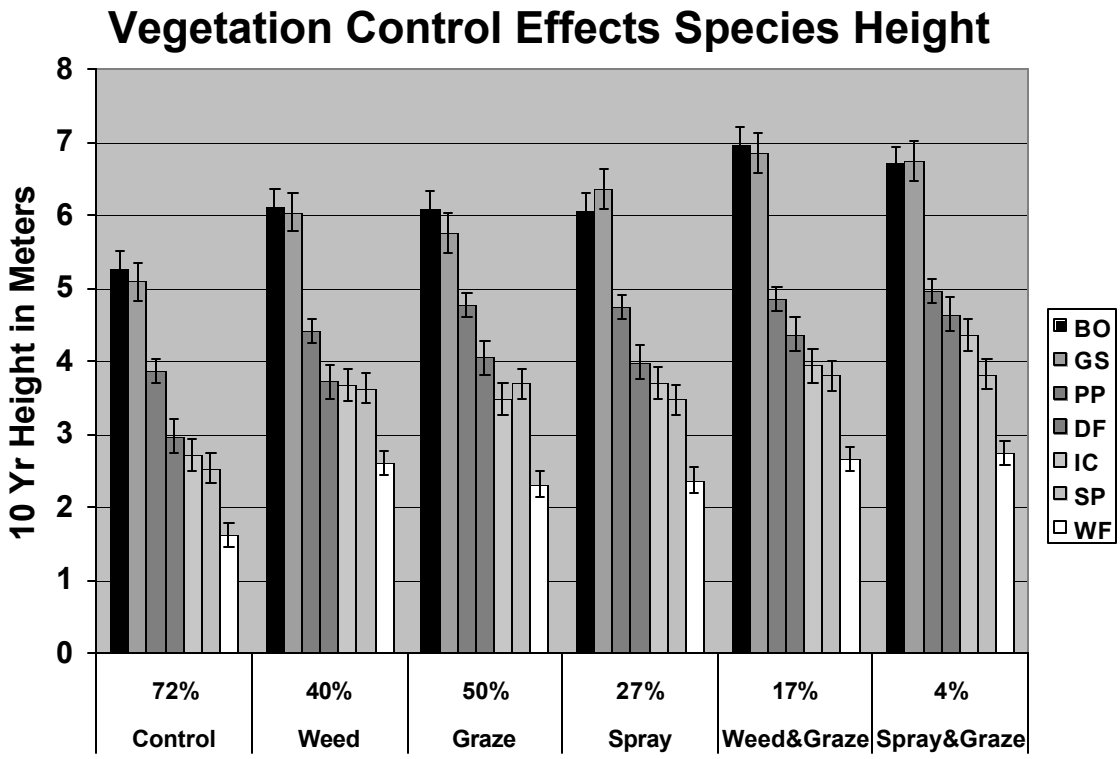
All trees were measured in Fall 2001 at the end of their tenth growing season. Tree height, diameter at breast height as well as shrub and forb cover was measured. Trees heights and diameters varied by species, treatment type, density and species of shrub cover. Treatments produced substantially different shrub communities at age ten.

Ave. 10 Year Tree Size



Vegetation Control Effects Species DBH





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TITLE:

Sequoia Pruning Timing Study

Authors: Robert C. Heald, David Rambeau

ABSTRACT:

PROBLEM ISSUE:

Recent growth and yield data for young growth Giant Sequoia (*Sequoiadendron giganteum*) (Heald/Barrett) has demonstrated the wide variation in early (4-10 yr.) growth rates of sequoia as affected by planting density. The species has excellent potential wood quality for various high value end products (fence posts, decking, interior and exterior trim) quite similar to Coastal Redwood (*Sequoia sempervirens*). A vast area of the middle elevation West Side Sierra Nevada mixed-conifer vegetation type seems suitable for sustainable production of Sierra Sequoia young growth. This potential could drastically reduce the market demand pressure for increasingly short rotation management of coastal redwood stands.

However, much of the high value redwood end products require clear heartwood. Sierra Sequoia exhibits virtually no self-pruning even at the closest spacing (2 meters) in planted stands through age 30. Naturally regenerated extremely high-density (2,000 TPA) stands (Metcalf) also show little effective self-pruning for their first century of growth.

The number of branches per unit of stem length seems not effected by early stand density in planted stands. Average branch diameters at age 10 range from about 1.2 to 2.2 cm in diameter as spacing increases from 2 m to 6.5 m. Thus, while spacing does affect stem diameter and height, branch sizes remain well within the range that can easily be pruned by standard lopper and saw pruning tools. In this study, >99% of all pruned branches were removed with loppers.

Little is known about the stem growth, epicormic branching potential, heartwood formation and stem taper effects of pruning Giant Sequoia. Studies

underway at Blodgett Forest (1996 Heald/ Schurr) indicate very little epicormic branching after pruning 15-year-old planted sequoia to 2 m., 3.5 m. and 5.5 m. in one lift where plantation canopies were nearly closed and trees averaged 10 m. in height. Anecdotal observations of other sequoia pruning show a wide range of epicormic branching response to pruning.

ECOLOGICAL SETTING:

The study was located with an existing sequoia density study in its 13th growing season. The site is within Blodgett Forest Research Station managed by the Center for Forestry of the University of California, Berkeley. The research station is located in the American river watershed on the western slope of the Sierra Nevada mountain range. The nearest natural groves of giant sequoia are located 10 miles north of the study area. However, the soils, climate, ecology, and associated species of the study area are quite similar to those found in natural groves. Topography is nearly flat. Soil is a 2 to 3 meter deep well-drained Cohasset series formed in place from andesitic lahar parent material. This sandy clay-loam stores about 18 cm of water at field capacity. In this Mediterranean climate, fully vegetated forest depletes water available for plant growth between August and September in a typical precipitation year.

METHODS:

This study pruned plantation sequoias over a wide range of spacing and pruning intensities throughout an entire calendar year. A random selection of existing study trees were measured as controls. The perimeter rows of the existing sequoia density study treatments in each of 3 replications of 9 initial spacing were randomly selected for pruning. All study and control trees are from the same bulk seed lot, planted at the same time and managed with identical treatments throughout their life. Fifteen trees in each of three height classes (3-5m, 5-6m, 6-8m) were selected for each month of the year. The various heights resulted from the nine densities created by the existing study. Three variables were introduced:

- Time of pruning, replicated each calendar month.
- Pruning intensity: 2 m, 3.5 m, 5.5 m pruned.
- Control- No treatment utilizing existing study trees.

Study trees were pruned toward the end of each month beginning in October 2000. Snow prevented access to the site in March 2001. Pruning and measurements were accomplished under direct supervision of the same person every month. Pruning was accomplished with loppers and tree ladders. All existing live and dead stem branches and branch collar epicormic branches were removed up to the designated prune height. All main stem branches were live at the time of pruning. The same set of control trees were paired with each month's pruned trees by repeatedly remeasuring the control trees each month.

Measurements included tree height and stem diameter at base, breast height, 2, 3.5, 5.5, and 7 meters height as appropriate including one diameter measurement above the pruned height. Location and quantity of existing epicormics were noted. The state of leaf recession along stem branches at the prune point was noted. Measurements of crown radius and branch diameter were taken.

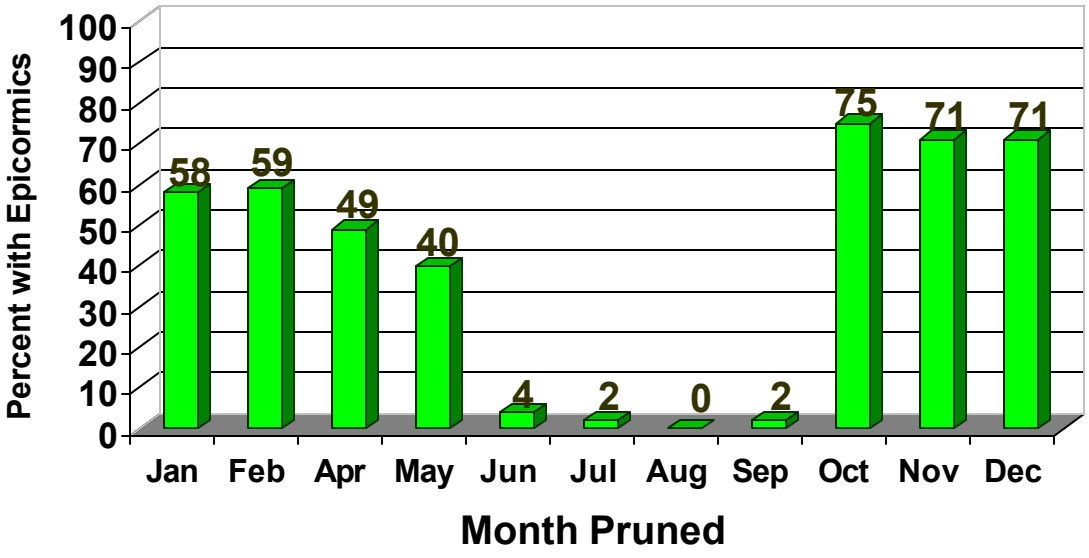
PRELIMINARY FIRST YEAR RESULTS:

After pruning, Sequoia produce epicormic branches only at pruned branch collars.

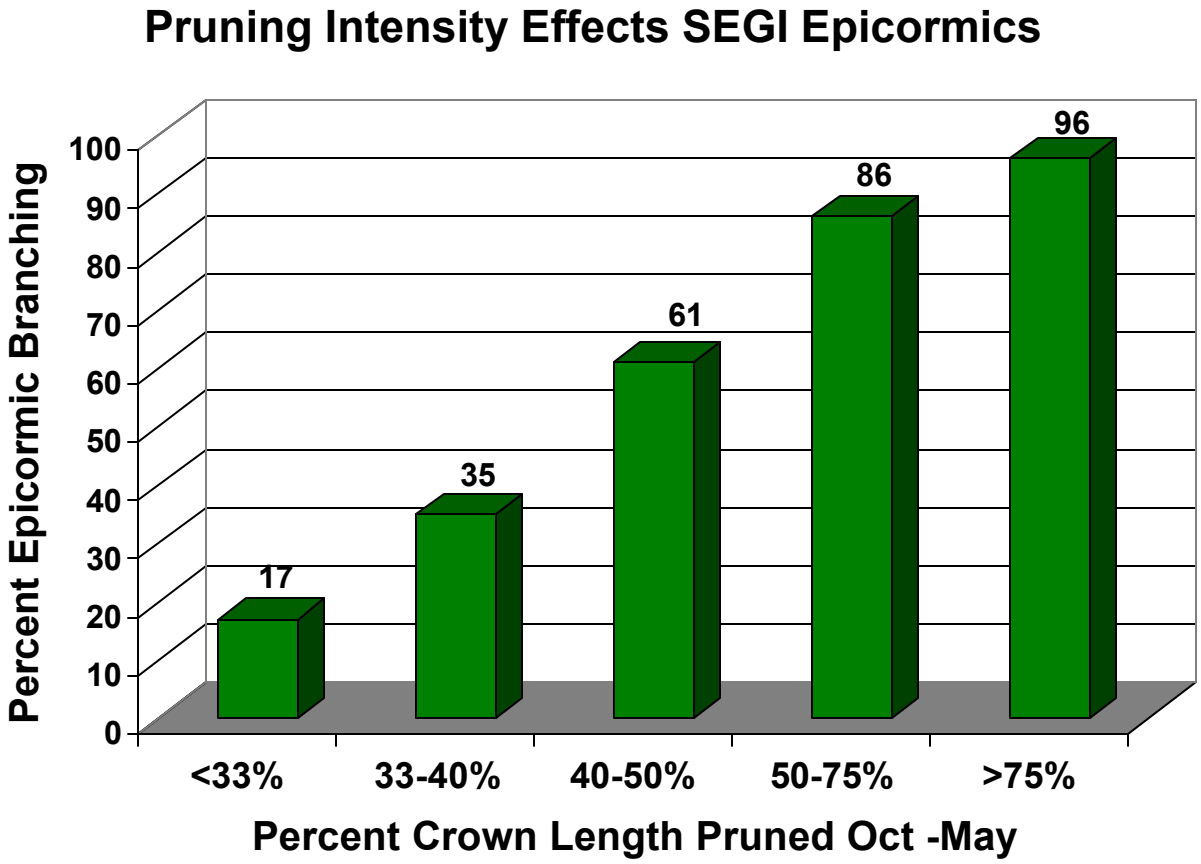
Sequoia pruned from late October through late May frequently develop epicormic branches. Regardless of month of pruning, these sprouts first appear in conjunction with new leaf development and height growth in June.

Sequoias pruned late June through late September rarely develop epicormic branches the year they are pruned.

Seasonal Probability of First Year SEGI Epicormic Branching



Branch Collar Epicormics Before Pruning



Proportion of trees sprouting, quantity and length of epicormic branches produced increase as October through May pruning intensity increases.

Frequency, quantity and length of epicormic branches produced following late June through late September pruning was unrelated to pruning intensity.

Access as well as worker safety and comfort issues aside, pruning was more difficult December through February due to substantial hardening of branch wood. Hardening was observed to be a result of reduced branch wood moisture, not frozen conditions.

Larger epicormic branches began to grow vertically beginning early in July. Smaller (<8 cm) epicormics usually grew horizontally.

During the late August and September measurements, some very small (<2cm) epicormic branches were visually pale and brittle.

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Sequoia Pruning Timing Study

Stem growth and epicormic branching is being studied in a Blodgett Forest sequoia plantation to add to growth and yield data for this species. Top photo shows epicormic growth in a recently pruned tree.

Photos by Bob Heald

Title:

Shelterwood Regeneration of Planted Mixed Conifer Species

AUTHORS: Robert C. Heald, Jennifer K. Heald, Andrew Corr

ABSTRACT:

Shelterwood is a modestly used method of even-aged regeneration in the Sierra Nevada. It is classically thought of as a means of natural (seedfall) regeneration. This study compares the survival and growth of conifer seedlings planted under a shelterwood in various forest floor conditions. Successful natural shelterwood regeneration of the large variety of specie in Sierra Mixed Conifer Vegetation requires a considerable amount of bare mineral soil and a diverse set of seed trees. Site preparation is accomplished utilizing either broadcast burn or tractor pile and burn techniques. In both cases the forest floor is a mosaic of unburned litter and duff, ash, partially burned litter and duff, as well as mineral soil.

Artificial regeneration by planting is contemplated under shelterwood for several reasons. First, the available seed trees may not include one or more of the desirable regeneration species. This is often the case where previous harvests have removed the best of valuable pine species. Second, improved genetic stock may be available as seedlings developed from other locations. A typical example would be insertion of sugar pine (*Pinus lambertiana*) stock resistant to white pine blister rust (*Cronartium ribicola*).

In compartment 440, at Blodgett Forest Research Station, a shelterwood regeneration harvest was initiated in 1997. An average of twelve seed trees (average DBH of 28") per acre were retained. The site preparation method was tractor pile and burn. The piles are created as far away from overwood as possible to prevent damage to the seed trees. This makes the center of these piles the best (farthest distance from the growth reduction effects of retained seed trees) potential growth sites, and the least likely to be stocked by natural seedfall. One hundred burn piles were selected for this study. The burned piles

were planted in Spring 1998 with three seedlings per specie each in burn pile ash, burn pile edge, and adjacent unburned area. All units were planted with R_R sugar pine (SP). Half of the units contained Douglas-fir (DF *Psuedotsuga menziesii*) and Ponderosa Pine (PP *Pinus ponderosa*), while the other half of the units contained giant sequoia (GS *Sequoidendron giganteum*) and incense-cedar (IC *Calocedrus decurrens*).

In 1999 the distance and azimuth to the closest overwood trees were taken from each plot center (burned pile), as well as the diameter and crown radius of the seed trees. This was to ensure that all plots were comparable, and to assist in relocating plot centers in future years. In 1999 each study tree was also measured with distance and azimuth to plot center. The specie, basal diameter, height, damage and disease, family (sugar pine only) and substrate of each seedling were recorded. Percent shrub cover, and average shrub height were measured for a mil acre plot at each seedling tree. These measurements were again recorded in 2001.

The preliminary review of the 2001 data indicates that both the average basal diameter and the height of both GS and PP are larger than that of SP, IC, and DF. The data also indicates that shrubs grow more vigorously along the edge of the burn piles than in either ash or mineral soil, while trees grow faster when planted in the ash.

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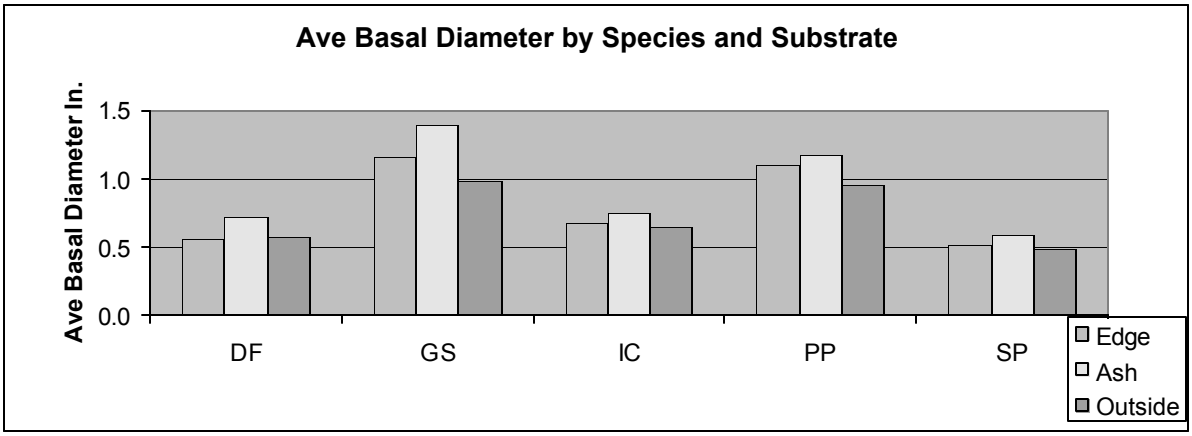
Ave Basal Diameter by Species and Substrate
Ave Basal Diameter In.
1.5
1.0
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DF
GS
IC
PP
SP
Edge
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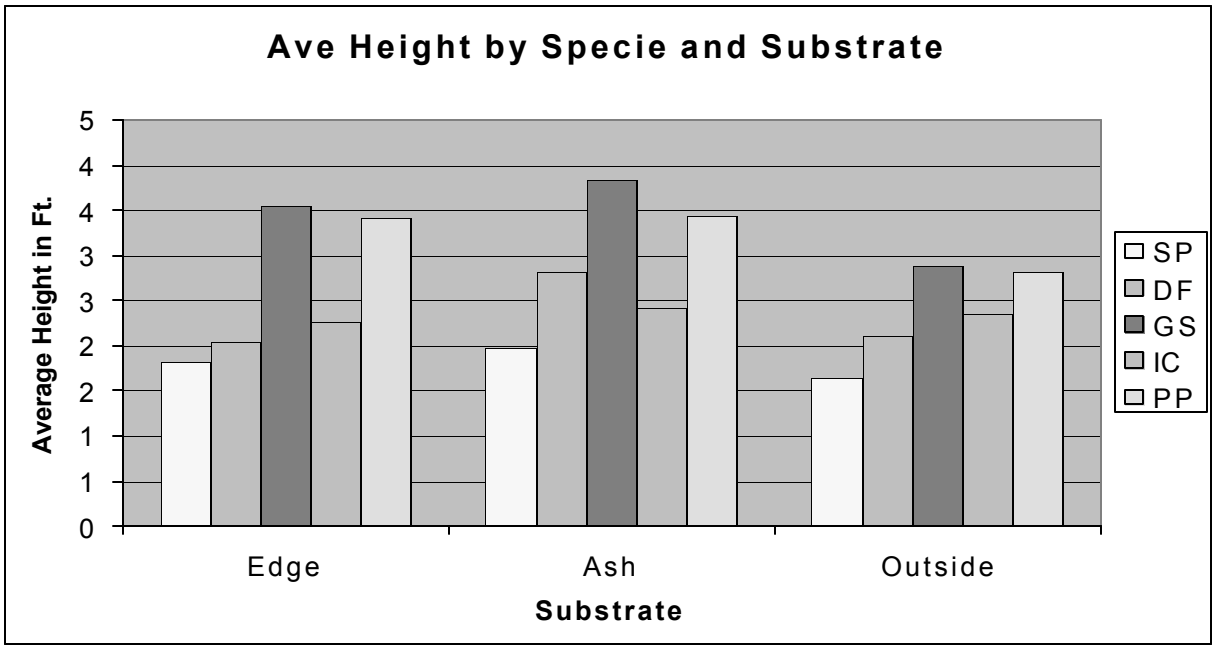
Ave Height by Specie and Substrate
Average Height in Ft.
5
4
4
3
3
2
2
1
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Edge
Ash
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Substrate
SP
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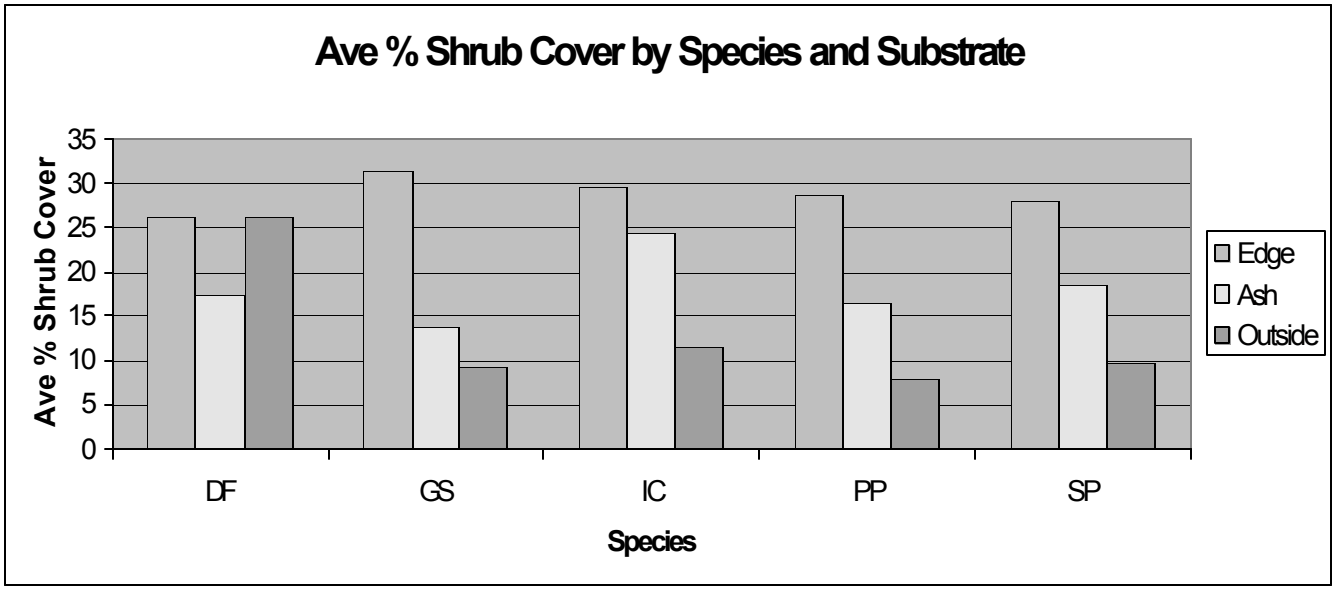
GS
IC
PP


Ave % Shrub Cover by Species and Substrate
Ave % Shrub Cover
35
30
25
20
15
10
5
0
DF
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PP
SP
Species
Edge
Ash
Outside

Title:

The influence of understory vegetation on soil organic matter dynamics in California forest plantations

AUTHOR: William R. Horwath

ABSTRACT:

The growing emphasis on plantation forestry as a primary source of forest products requires that forest managers maximize timber yields through frequent rotations on relatively small acreage. Studies have shown that active soil organic matter was a more sensitive indicator of management impacts than tree growth. This result suggests that careful management of soil organic matter is thus critical to ensure long-term, sustainable yields from these intensively managed systems. However, few experimental studies have addressed the impacts of current management practices on soil organic matter quality and maintenance, and thus the relationship between soil organic matter dynamics and long-term productivity in managed forests remains poorly understood. Removal of understory vegetation and non-commercial tree species to facilitate replanting and increase tree yield is a common practice in plantation forestry. Understanding the effects of harvest and site preparation practices on long-term nutrient dynamics in forest plantations is required to ensure long-term sustainability in these intensively-managed systems. We compared C and N dynamics in litter mixtures (ceanothus and ponderosa pine) with pine litter alone to determine whether the presence of mixed litters promotes the long-term accrual and retention of soil C and N. The litters were reciprocally labeled with carbon-13 and nitrogen-15 to determine the source (ceanothus, pine or soil) of soil respiration and nitrogen mineralization. Ceanothus litter is enriched in N relative to pine and has a much lower C-to-N ratio (18 compared to 30), and would thus be considered the more labile or easily-decomposable of the two. In

our study, within each soil type the addition of ceanothus residues has increased total C mineralization but decreased CO_2 production from soil C. The presence of ceanothus also resulted in a significant increase in the mineralization of pine-derived C. The availability of nutrients in forest systems has been studied primarily from the perspective of plant residue quality of single litters. This research shows that the behavior of single litters cannot be used to predict carbon and nitrogen mineralization of mixed litters. Therefore, to fully understand soil organic matter dynamics and nutrient cycling the effect of mixed litters must be examined. In addition, these results are required to more accurately predict the impact of forest management practices on the potential to sequester soil carbon in forest systems and to understand long-term nutrient cycling.

NON-TECHNICAL SUMMARY

The growing emphasis on plantation forestry as a primary source of forest products requires that forest managers maximize yield through intensive management and frequent rotations. Careful stewardship of soil quality is thus critical to ensure long-term sustainable yields. Removal of understory vegetation and non-commercial tree species to facilitate replanting and increase tree yield is a common practice to reduce competition for moisture and nutrients. However, recent research suggests that changes in litter composition due to understory removal may lead to a decrease in soil quality. Our central hypothesis is that mixed-species litters have a beneficial influence on the decomposer community (soil microorganisms and fauna) resulting in enhanced soil quality by increasing the amount of SOM and its nutrient content. Our overall objective is to apply our data to the development of practicable strategies to preserve soil quality and enhance productivity of forest plantations.

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TITLE:

Mycorrhizal diversity across Blodgett Forest

AUTHORS: A.D. Izzo, P. Kennedy, J. Kemp, and T.D. Bruns

ABSTRACT:

The objective of our research is to understand how different forest management techniques affect the evenness and richness of ectomycorrhizal (ECM) fungi. While most studies have focused on single host ECM communities we will be taking a "whole forest" approach by including all ECM roots. The wide range of ECM hosts available within our sites at Blodgett include *Pseudotsuga menzieseii, Abies concolor, Pinus lambertiana, Pinus ponderosa, Castanopsis chrysophylla, Quercus kelloggii, and Lithocarpus densiflorus.* With the this range of hosts available ECM diversity is expected to be extremely high with few clear dominant species. In June 2001, soil was collected from 6 plots X 4 treatments (control, fire only, thinning only, fire and thinning) X 3 replications. At each plot, 5 soil cores were taken in a 1 m array at a set distance from the treatment plot markers and pooled. Six ECM root tips were selected randomly from the soil for molecular analysis. DNA sequence and RFLP patterns will be used to identify both the fungal and plant component of each sample.

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TITLE:

The potential effects of monoterpene oxidation products on particle formation and growth

AUTHORS: Anita Lee, Gunnar Schade, and Allen Goldstein

ABSTRACT:

Oxidation of monoterpenes by OH, O_3, and NO_3 results in the formation of low vapor pressure products that can partition into the aerosol phase, forming secondary organic aerosol (SOA) that impacts regional visibility and human respiratory health. Theoretically and experimentally based models describing absorptive gas-particle partitioning were applied to monoterpene flux measurements from a coniferous forest in California to determine potential SOA fluxes from the ecosystem. The theoretical model slightly over-predicted SOA fluxes and yields compared to the experimental model. Both methods produced SOA fluxes that ranged from 0.05 to 1.5 ng m^{-2} s^{-1}, and yields that ranged from 0.7 to 2 %. Sub-saturated concentrations of oxidation products during the period of study suggest that absorption of vapor into the particle phase dominated SOA flux, and that condensation and nucleation would not contribute to SOA producion. Thus, condensation and nucleation were examined under hypothetical supersaturation to elucidate the potential importance of these two processes in the production of SOA.

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Anita Lee working in the atmospheric lab.
Photo by Dave Rambeau

TITLE:

The role of mycorrhizal mutualisms in seedling establishment within the mixed-conifer forest.

AUTHORS: A.L. Levin, J.J. Battles, and T. D. Bruns

ABSTRACT:

A widespread mutualism that potentially has a significant impact on species interactions and plant community composition is the mycorrhizal symbiosis. In temperate forests, all forest tree species engage in this symbiosis in which the fungus increases the nutrient and water supply to the plant in exchange for carbon provided by the plant's photosynthate. Many types of mycorrhizal fungi form extensive hyphal networks that can physically link plants and transport nutrients, water, and carbon. We hypothesized that, in natural regeneration settings within the mixed-conifer forest, the ability of 1st and 2nd year seedlings to connect to an established hyphal network of mycorrhizal fungi would have a significant positive effect on the growth and survival of these seedlings. To test this hypothesis, we experimentally altered the ability of seedlings in forest treefall gaps to connect to an established mycorrhizal network by growing them in containers with differential permeability to fungal hyphae. At Blodgett Forest Research Station, we planted seeds of one *Pseudotsuga menziesii* in containers that were "planted" in the forest floor. These containers either allowed the seedlings to hyphally connect to established fungi in the forest floor or prevented such connections. Treatments were monitored for seedling germination and survival and at the end of each of two growing seasons, seedlings were collected and analyzed for shoot and root biomass and mycorrhizal colonization and species. Mycorrhizal fungi on the roots of study seedlings were analyzed and identified by polymerase chain reaction (PCR), restriction fragment length polymorphism (RFLP), and, ultimately, DNA sequencing.

We found that both seedling growth and survival were highest in treatments that allowed seedlings to connect to hyphal networks in the soil. Growth and survival of seedlings were lowest in the treatment that prevented

seedlings from connecting to hyphal networks. While fungal diversity on roots did not significantly differ among the treatments, very different species of fungi colonized the seedlings in the various treatments. There was only approximately 20-30% similarity between the fungal species colonizing seedlings in the different treatments. The species richness of the mycorrhizal community was higher than expected, with 138 species of colonizing fungi found. These results show that the ability to connect to a network of mycorrhizal symbionts is an important part of the regeneration and establishment of *Pseudotsuga menziesii* seedlings in mixed conifer forest gaps.

Above:
Cortinarious mushroom growing near research plots in Compartment 292

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TITLE:

Drought-imposed limitations on ozone uptake in ponderosa pine forests: measurements and models.

AUTHORS: Panek, Jeanne A.[1], Laurent Misson[2], Meredith Kurpius[1], Allen Goldstein[1]

ABSTRACT:

Tropospheric ozone is a pollutant which is responsible for forest damage worldwide. Ozone must enter foliage through stomatal pores to cause damage. In the seasonally-droughted forests of California and the Pacific Northwest, water limitations can close stomata for long periods of the growing season. Therefore, although ozone concentrations are typically used to assess forest ozone exposure, ozone better represents forest ozone exposure here. We are measuring ozone flux to ponderosa pine forests, directly at Blodgett Forest (through eddy covariance methods) and indirectly at 4 sites (from measures of leaf-level stomatal conductance), along an ozone concentration gradient in the Sierra Nevada Mts., CA to develop a model to predict ozone flux based on meteorology. Environmental variables which control stomatal conductance such as soil moisture, atmospheric humidity, solar radiation, and air temperature have been found to influence ozone uptake. Because ponderosa pine forests are water-limited, however, soil moisture and atmospheric humidity were the primary climatic variables which controlled ozone uptake. As soil moisture dropped over time, leaf water potential became increasingly negative and stomatal conductance dropped, constricting ozone flux into the foliage. Although ozone concentrations were higher at the end of the growing season than at the beginning, stomatal conductances and thus ozone fluxes were much smaller, demonstrating a decoupling between ambient ozone concentration and ozone flux. A model has been developed to predict ozone flux from site meteorological variables using these relationships.

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Jeanne Panek taking measurements.

Photo by Gunnar Schade

TITLE:

The effects of prescribed burning on Sierra Nevada stream and riparian ecosystems

AUTHOR: Leah Rogers

ABSTRACT:

Prescribed burning is being promoted both as an efficient forest management tool and an ecosystem restoration mechanism in areas that historically experienced frequent wildfires, such as the mixed-conifer forests of the Sierra Nevada in California. However, prescribed burning has been limited in its application for both environmental and economical reasons. Concerns about endangered species, escaped fires and effects on sensitive habitats (such as streams and riparian areas) have limited their use in forest management. For this reason, riparian zone burning is generally not permitted under current prescribed burning guidelines, for the preservation of sensitive and aquatic habitats. Despite these restrictions, the effects of prescribed burning practices on streams and riparian forests have not been closely examined, especially in the Sierra Nevada.

Post fire, control burn unit 292, November 9, 2001 [photo by Leah

To quantify the impacts of both riparian and upland prescribed burns on stream ecosystems, three plots will be burned at the Blodgett Forest Research Station (BFRS) in fall 2001 and fall 2002. Early November 2001, a low to moderate intensity prescribed burn (4 hectares) was completed in an upland area approximately 300 meters from the stream channel of Dark Canyon Creek. In fall 2002, the riparian zone adjacent to Dark Canyon Creek will be burned (8 ha). In addition, another prescribed burn encompassing both riparian and upland areas (10 ha) in a different watershed will be conducted in fall 2002. Each plot will be burned at moderate intensity, with the goal of reducing surface fuels and fire

hazard in dry upland and riparian zones. By staggering the burning of the riparian and upland areas of Dark Canyon Creek, it will be possible to separate the immediate effects of upland and riparian burning on stream ecosystems.

Streams are intimately linked with adjacent riparian forests and valleys. Riparian zones function as important interfaces between forests and streams, controlling in-stream temperatures and providing both allochthonous detritus and large woody debris to the stream. Thus, the changes in riparian areas as a result of a disturbance, such as fire, must be documented to understand the effects of such disturbances on in-stream dynamics.

Aquatic macroinvertebrates have been collected annually as part of a biomonitoring program and a study on the annual variability of aquatic macroinvertebrate populations that began at BFRS in 1995. This data can be used to characterize pre-burn aquatic macroinvertebrate communities, which has not been done in other studies of fire effects on streams. Aquatic macroinvertebrates will continue to be sampled each October, and an additional sampling period will be added in June of each year. Changes in (1) water quality, (2) channel morphology, (3) macroinvertebrate communities, (4) algal production, (5) large woody debris dynamics and (6) riparian forest community dynamics, in small streams draining both prescribed burned and unburned catchments, will be documented. Multiple control and impact sites will be used to compare pre-impact and post-impact data from both burned and unburned streams (a beyond-BACI experimental design).

Leaf-litter trap in Dark Canyon Creek, used to monitor seasonal changed in leaf-litter input before and after prescribed fire. [photo by Leah Rogers]

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TITLE:

Seasonal VOC measurements at a rural site in the Sierra Nevada Mountains, California: A focus on acetone and methanol

AUTHORS: Gunnar W. Schade and Allen H. Goldstein

ABSTRACT:

Methanol and acetone significantly influence the odd hydrogen budget of the upper troposphere. We have measured the seasonal cycle of these oxygenated volatile organic compounds (VOCs) and several other biogenic and anthropogenic VOCs along with carbon monoxide (CO) at Blodgett Forest Research Station, elevation 1300 m, on the western slope of the Sierra Nevada mountains continuously since spring 2000. Owing to their long atmospheric lifetimes and local emissions, methanol and acetone are the most abundant VOCs throughout the seasons, with highest levels in summer (methanol ~40 ppb, acetone ~8 ppb) and lowest levels in winter (methanol ~0.4 ppb, acetone ~0.1 ppb). Their mixing ratios were always highly correlated, and were influenced by air mass origin, direct emissions, and, mostly for acetone, photochemical production fromanthropogenic and biogenic precursors. Factor analysis associates acetone with 2-methyl-3-buten-2-ol (MBO, biogenic emissions), toluene (anthropogenic emissions), and a local, temperature-driven emission factor. Using air temperature as proxy for direct emissions, and mixing ratios of MBO and toluene or CO as proxies for photochemical production from biogenic and anthropogenic precursors, respectively, two thirds of acetone's variability can be explained in summer, and one half in winter. The remaining factor, air mass origin, plays a

Goldstein lab interior. [photo by Dave Rambeau]

larger role in winter because of less stable synoptic meteorological conditions compared to the more regular summer up-slope transport scheme. Nevertheless, surprisingly little differences were found for the relative contributions to acetone's mixing ratio: In both summer and winter, local emissions were the dominant source, as inferred from the temperature correlation and MBO mixing ratios. In winter, acetone mixing ratios above the "background" appear to be completely of biogenic origin. However, the acetone background was much higher in summer (~1 ppb) compared to the winter (~0.2 ppb), and contributions form anthropogenic hydrocarbon photooxidation are important in summer. Similar arguments hold for methanol.

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TITLE:

Update on Whitaker Forest 2001

AUTHOR: Frieder G. Schurr

ABSTRACT:

Whitaker Forest was the site of a lot of activity during the past year. Most of the spring and summer was spent writing and submitting a Timber Harvest Plan aimed at reducing stand density and establishing a group opening regeneration study which will concentrate on determining minimum environmental conditions required for successful Giant Sequoia regeneration.

Below: Harvest Operations underway at Whitaker Forest **Photo by Bob Heald**

Several archeological sites and wildlife activity centers were identified during the preparation of the THP. These locations have been identified and appropriate protection measures have been applied to minimize adverse impacts from the harvesting activities. Two Spotted Owl pairs and a Northern Goshawk site have been identified. Five Archeological sites have been identified which contain both historic and pre-historic elements.

Five sets of 4 varying size (1/8, ¼, ½, and 1 acre) group openings have been located for the regeneration study and initial measurements have been taken by

John Battles and his associates. Ten of these openings along with approximately 80 acres of surrounding stands were harvested in September and October. The other ten groups and approximately 50 more acres of surrounding stands will be harvested during mid to late summer 2002 after any new hatchlings from the owls or hawks have fledged.

left: Old Growth Giant Sequoia at Whitaker Forest **Photo by Bob Heald**

In addition to the harvesting efforts, more information on previous research done by Harold Biswell on the forest has also been located. This research covers an area of approximately 80 acres which has been set aside from the initial harvesting efforts. This research concentrated on stand response to manipulations with and without fire. Scott Stephens (PI of the Fire and Fire Surrogate Study at Blodgett Forest) has shown interest in reviving and continuing this research in some form during the 2002 field season and beyond.

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TITLE:

Demography of the spotted owl in the central Sierra Nevada

AUTHORS: Mark E. Seamans, and R .J. Gutiérrez

ABSTRACT:

We studied the population dynamics of California spotted owls (*Strix occidentalis occidentalis*) in the central Sierra Nevada. We assessed reproductive status at 62 territories on 317 occasions over an 11 year period and recorded 985 captures of 396 individuals over a 15 year period (1986-2000). Reproduction varied temporally but did not exhibit any noticeable trends whereas survival followed a quadratic pattern, with owls experiencing higher survival during the middle of the study. Reverse Jolly-Seber estimates of population rate of change indicated, on average, the population was stable over the period of study. However, there was a negative linear trend in annual estimates of population rate of change. Although conditions behind this trend may change in the future, these results suggest a conservative approach to management of spotted owls and their habitat in the central Sierra Nevada is warranted.

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TITLE:

Fire-Fire Surrogate Study: An Entomological and Pathological Pre-Treatment Analysis

AUTHORS: D.T. Stark[1], A.J. Storer[2], D.L. Wood[1], S.L. Stephens[3]

ABSTRACT:

The Fire-Fire Surrogate Study (FFS) is a national, multi-disciplinary study funded by the Joint Fire Science Program (USDI-USDA). There are 13 sites located throughout the United States and all represent forests with a historically short-interval, and low- to moderate-severity fire regime. Eight of these sites are in western coniferous forests and share ponderosa pine, *Pinus ponderosa,* as an important tree component. The objective of the study is to quantify the short- and long-term effects of fire and fire surrogate treatments on: vegetation, fuel and fire behavior, soils, wildlife, insects, pathogens, and cost and utilization economics. The project consists of four treatments, each replicated three times: control, fire only, mechanical only, and fire plus mechanical. Treatment areas range from 13 to 29 hectares and each contains twenty 0.04-hectare (0.1-acre) plots. Plots were established on a grid pattern, 60.4 meters (198 feet) apart. At Blodgett Forest Research Station located in El Dorado County, CA, entomological and pathological pre-treatment data were obtained for each plot in each treatment in June and July 2001. In addition, 360-degree scans were taken from each plot center to identify symptomatic trees (discolored foliage) outside of the plot area. Pretreatment data has been collected for the following insect and disease conditions: red turpentine beetle, *Dendroctonus valens*, western pine beetle, *D. brevicomis*, mountain pine beetle, *D. ponderosae*, fir engraver beetle, *Scolytus ventralis*, engraver beetle, *Ips* spp., defoliators, scale insects, root diseases (annosus root and butt rot, *Heterobasidion annosum* and black stain, *Leptographium wageneri*), mistletoes (true and dwarf), rusts (white pine blister rust, *Cronartium ribicola*, western gall rust, *Peridermium harknessii*, and Incense-

cedar rust, *Gymnosporangium libocedri*), and other diseases (true fir needle cast, *Lirula abietis-concoloris*, and Elytroderma disease, *Elytroderma deformans)*.

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POST CONTROL BURN. **Photo by Robert Scott, USFS**

TITLE:

A LONG-TERM NATIONAL STUDY OF THE CONSEQUENCES OF FIRE AND FIRE SURROGATE TREATMENTS: **An assessment of treatment effects on Ground and Surface Fuels**

AUTHORS: Scott L. Stephens[1] and Jason J. Moghaddas[2]

ABSTRACT:

One of the primary objectives of the Fire and Fire Surrogate Study is to quantify the initial effects of 4 fire and fire surrogate treatments (control, mechanical, mechanical plus fire, & fire only) on several core response variables within the disciplines of (a) vegetation, (b) fuels and fire behavior, (c) soils and forest floor, (d) wildlife, (e) entomology, (f) pathology, and (g) economics & utilization. The goals of the fuels component of the Fire and Fire Surrogate study at Blodgett Forest are to: 1) Quantify changes in ground fuel (litter and duff) loading pre-treatment and in response to treatments (Control, fire only, mechanical plus fire, & mechanical only) implemented for the Fire and Fire Surrogate Study, 2) Quantify changes in surface (1, 10, 100, & 1000 hour) fuel loading pre-treatment and in response to treatments implemented for the Fire and Fire Surrogate Study, 3) Model potential fire behavior in response to the 4 treatment types. Measurements will be repeated (2002, 2003 & 2004) on 20 1/10th-acre circular sample plots located within in each treatment unit. We will present pre-treatment fuels data and discuss hypothesis of treatment effects on surface and ground fuels.

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A STUDY OF THE CONSEQUENCES OF FIRE AND FIRE SURROGATE TREATMENTS

The Fire and Fire Surrogate study will assess the economic and ecological consequences for four fuel reduction treatments. The 5 year study applies a common experimental design on 13 sites across the United States, including Blodgett Forest.

One silvicultural treatment focuses on stands using harvesting and mechanical fuel treatments in absence of fire

Photo by Jason Moghaddas

Studies at Blodgett Forest are underway in the following disciplines:

SITE MANAGEMENT & TREATMENT IMPLEMENTATION
ENTOMOLOGY AND PATHOLOGY
FUELS, FIRE BEHAVIOR, & FIRE HISTORY ANALYSIS
SOILS AND SOIL MICROBIOLOGY
VEGETATION
WILDLIFE
UTILIZATION

Photo by Dave Rambeau

Soil samples are collected an analyzed as part of the pre-treatment data;
Left: Emily Greinke in the field
Right: Emily performing lab analysis

Photo by Jason Moghaddas

Brandon Collins cutting fire scars for analysis of Blodgett Forest fire history

Brandon Collins cutting fire scars for analysis of Blodgett Forest fire history

FIRE AND FIRE SURROGATE STUDY

Photos by Jason Moghaddas

Four Silvicultural Treatments will be used in this study:

- Harvesting and mechanical fuel treatments in the absence of fire
- Fire alone, with no harvesting or mechanical treatment
- A combination of harvesting, mechanical fuel treatments, and prescribed fire
- A control, with no treatments

Doug Bushey and Danny Fry beginning field vegetation measure-ments

Photos (left and above) by Rob Scott, USFS

Photos (above, below and right) by Frieder Schurr

TITLE:

A LONG-TERM NATIONAL STUDY OF THE CONSEQUENCES OF FIRE AND FIRE SURROGATE TREATMENTS: **An assessment of treatment effects on Overstory and Understory Vegetation**

AUTHORS: Scott L. Stephens[1], John J. Battles[2] and Jason J. Moghaddas[1]

ABSTRACT:

One of the primary objectives of the Fire and Fire Surrogate Study is to quantify the initial effects of fire and fire surrogate treatments (control, mechanical, mechanical plus fire, & fire only) on several core response variables within the disciplines of (a) vegetation, (b) fuels and fire behavior, (c) soils and

forest floor, (d) wildlife, (e) entomology, (f) pathology, and (g) economics & utilization. The goals of the vegetation component of the Fire Surrogate Study at Blodgett Forest are to: 1) Quantify changes in overstory vegetation

characteristics (Species composition, DBH, height, height to crown base, productivity, regeneration, & mortality) pre-treatment and in response to treatments (Control, fire only, mechanical plus fire, & mechanical only) implemented for the Fire and Fire Surrogate Study & 2) Quantify changes in understory vegetation characteristics (species diversity, percent cover) pre-treatment and in response to treatments implemented for the Fire and Fire Surrogate Study. Measurements will be repeated (2003 & 2004) on 20 1/10th-acre circular sample plots located within in each treatment unit. We will present pre-treatment vegetation data and discuss hypothesis of treatment effects on overstory and understory vegetation.

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TITLE:

Bark Beetle Landing Rates As Indicators of Future Tree Mortality

AUTHORS: Andrew J. Storer, David L. Wood[1], Daniel T. Stark[1], Pierluigi Bonello[2], and Thomas R. Gordon[3]

ABSTRACT:

In preparing a timber harvest or other forest management plan, the decision making framework for prioritizing management activities involves many complex factors. Bark beetle (Coleoptera: Scolytidae) infestations usually only become a part of this framework if there is an epidemic, and the entry is for sanitation or salvage purposes. If bark beetle landing rates could be simply monitored, and related to the probability of mass attacks on individual trees, or outbreaks on a stand scale, these could be utilized as an additional tool in the decision making framework.

The Fire and Fire Surrogate study provides us with populations of trees that will be exposed to different pressures from bark beetles as a result of the management methods used in the different treatment areas. We will be monitoring the landing rates of bark beetles on trees in these areas and correlating these rates with future bark beetle activity on individual trees and in the stands as a whole.

Our studies with the root pathogen *Heterobasidion annosum*, suggested that artificial inoculation of trees did not lead to elevated landing rates of bark beetles, though it is unclear the extent to which disease development occurred in this study. The trees used in the study with *H. annosum* will be revisited to determine whether our landing rate information collected from 1997-1999 was predictive of bark beetle associated tree mortality in future years.

In addition, we will be addressing a more fundamental issue in bark beetle ecology, and that is the extent to which prelanding behavior is involved in the

host selection behavior of bark beetles. In the case of twig beetles (*Pityophthorus* spp.), landing rates on traps containing cut branches that would normally be colonized by these species were no different from landing rates on empty traps. This suggests that some level of random searching behavior occurs in these species to locate weakened, dying or cut pine branches, and olfactory and/or gustatory stimuli operate after landing (Bonello et al. 2001). In studies of smog injury in southern California, data were collected that suggest that western pine beetle (*Dendroctonus brevicomis*) is able to discriminate between host and non-host trees prior to landing. We are continuing these investigations in the Sierra mixed conifer system with two studies that determine the landing rates of bark beetles on apparently healthy ponderosa pines and white fir, as well as on logs of these species.

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TITLE:

Comparison of Soil Respiration Before and After Thinning in a Sierra Nevada Forest

AUTHORS: Jianwu Tang, Ye Qi, and Ming Xu

ABSTRACT:

Soil respiration is controlled by soil temperature, soil moisture, fine root biomass, microbial biomass, and soil physical and chemical properties. The thinning of forests will change soil temperature, moisture and other factors, and thus affect the soil CO_2 efflux. Using a LI-6400 Soil CO_2 Flux System we measured soil surface CO_2 efflux in an 8-year-old ponderosa pine plantation, 58% of which is covered by trees, in the Blodgett Forest in the Sierra Nevada Mountains, California from June 1998 to April 2000 before a pre-commercial thinning, and from April 2000 to August 2001 after the thinning. We established two 20m by 20 m sampling plots and measured soil CO_2 efflux and soil temperatures and moisture on a 3 by 3 matrix of sampling points in each plot. We found although soil temperature and moisture explain most of the temporal variations in soil CO_2 efflux, they explain only a little part of the spatial variation of soil CO_2 efflux. A thinning with intensity of 60% of the trees significantly changes the microclimate in the forest, and decreases the spatial variation of soil CO_2 efflux, but the magnitude of efflux does not vary significantly before and after the thinning.

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Only two prior timber harvest operations have ever been conducted at Whitaker Forest, the Center for Forest property in the Redwood Mountain grove of Giant Sequoia, Tulare County. In the 1870s, harvest removed old growth pines and sequoia. In the 1940s, large trees of mixed species (over 36 inches dbh) were cut. No sequoias of any size were harvested.

Increased risk of catastrophic wildfire, endangering the over 200 living Ancient Sequoias (over 1,000 years old), increased erosion hazard, and negative impact from prior usage prompted the Center for Forestry to begin timber harvest activities in 2001.

In accordance with usage guidelines and restrictions, no living sequoias have been cut. Incense cedar, ponderosa pine and white fir have been harvested.

Whitaker Forest Restoration and Research Timber Harvest Plan

Photos by Bob Heald

TITLE:

Quantifying the Importance of Belowground Plant Allocation for Sequestration of Carbon In Soils

AUTHORS: Margaret S. Torn[1], Todd Dawson[2], Julia Gaudinski[2], Jeff Bird[2] and Stefania Mambelli[2]

ABSTRACT:

The recent DOE road map for Carbon Sequestration Science highlights the potential for sequestration by increasing plant allocation of C to belowground biomass and thus reducing decomposition losses. However, to design or evaluate such strategies, we must greatly improve measurements of the rates of C allocation belowground and the subsequent residence times of carbon in the root and soil system.

We propose to fill essential gaps in quantifying the efficacy of sequestration through belowground plant allocation by: (1) Quantifying the stocks and lifetime of live fine and coarse roots; (2) Determining the lower bound of NPP "pumped" into soil carbon through these roots; (3) Comparing leaf and root decomposition including rates, microbial communities and humification products; (4) Characterizing the turnover times of soil organic matter pools, and (5) Tracking the partitioning of recent plant photosynthate to rapidly lost root respiration and exudate mineralization, and more slowly lost root tissues and soil organic matter (SOM).

Our approach will take advantage of several new methods (radiocarbon analysis of roots and SOM, 13C tracking of decomposition products, and isotope-label PLFA analysis). The radiocarbon method in particular allows direct determinations of root age, a measure not currently possible with any other technique. At four northern latitude forest research stations, including Blodgett Forest, we will make comparisons of belowground allocation sequestration

potential based on species and forest type, including deciduous vs. conifer and re-growing vs. mature managed forests.

Ultimately this work should allow us to develop a template for more rapid assessment of the best ecosystems and species to target for future carbon sequestration efforts.

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TITLE:

EFFECTS OF FIRE AND FIRE SURROGATE TREATMENTS ON FISHER HABITAT.

AUTHORS: Richard L. Truex and William J. Zielinski

ABSTRACT

The fisher (*Martes pennanti*) historically occurred throughout mid-elevation forests of the Sierra Nevada but currently appears to be limited in distribution to the southern Sierra from Yosemite National Park south to the Greenhorn Mountains. The population's isolation, size and association with mature forest conditions have raised concern for its long-term viability. Prominent among the factors influencing fisher population viability in the southern Sierra Nevada and recolonization of its historic range in the central and northern Sierra is the risk of catastrophic fire. Land management activities implemented to reintroduce fire as an ecological process in the Sierra may ultimately benefit the fisher population by reducing the likelihood of large fires. There are, however, short-term risks associated with these activities (e.g., loss of large snags and logs) and accordingly a need to better understand how different land management activities will affect fisher habitat suitability. During 2001 we initiated research at the Blodgett Forest Research Station (BFRS) and Sequoia-Kings Canyon (SEKI) Fire and Fire Surrogate (FSS) Treatment Study sites to examine the short-term effects of several land management activities on fisher habitat quality. At the BFRS and SEKI FFS sites, 10 plots within each treatment unit will be sampled before and 1 year after treatment implementation. Changes in fisher habitat suitability will be assessed using a Resource Selection Function developed for fisher in California from radio telemetry research. To date we have collected pre-treatment data at 6 treatment units at BRFS (3 mechanical only and 3 mechanical plus fire) and 6 treatment units at SEKI (3 spring burn and 3 fall burn). Pre-treatment sampling will be completed at the BRFS fire only treatment units during 2002 and post-treatment sampling will be conducted for fully-

implemented treatments. Sampling of control plots will occur for both BFRS and SEKI during 2002 and 2003.

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Control Burn in progress, November 2001

Photo by Rob Scott, USFS

TITLE:

Stand Susceptibility to Bark Beetle Infestation as Determined by Oleoresin Exudation Pressure in a Westside Forest of the Sierra Nevada

AUTHORS: David L. Wood, Ronald W. Stark[1] and Andrew J. Storer[2]

ABSTRACT

In 1961, oleoresin exudation pressure (OEP) measurements were initiated in 506 ponderosa pines (*Pinus ponderosa*) on the Blodgett Forest Research Station. The plot was increased by 200 in 1963. All trees were measured during the first week of May, July and September. Measurements were taken through 1965. Analyses are underway to determine the relationship of OEP to tree mortality caused by the western pine beetle (*Dendroctonus brevicomis*) and the mountain pine beetle (*D. ponderosae*).

We have made a brief survey of the living ponderosa pine in the Gaddis Creek plots and have observed the original tags used to number the trees in the 1960s. We will recover all tag numbers in these plots and determine the OEP record of these surviving trees. A metal detector will be used to locate tags that have become overgrown by the bark of the tree. If resources permit, we will remeasure the OEPs of these trees, and compare the range of OEPs with the 1960s measurements, and with those of trees in younger stands that have not been exposed to bark beetles for as long a period. This is an unique opportunity to determine the relationship between OEP measurements and long term assessments of tree mortality some 35 years after the first measurements were made.

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TITLE:

Living on the edge: Is there a positive edge-effect for group selection boundary trees?

AUTHORS: Robert A. York, John J. Battles, Robert C. Heald, Jennifer D. McElhaney

ABSTRACT:

The group selection method of regenerating forests results in a patchwork of canopy openings where within-group growing conditions for seedlings are different than in the surrounding matrix forest. Structural and microclimate differences between group openings and matrix forests are especially distinct when the group selection regime is first implemented where an intact, mature forest was formerly present. Compared to a single, large clearcut, a collective of group selection cuts has a higher edge-to-interior ratio. This comparatively high amount of edge area has been of concern for forest managers considering implementing the group selection regime. The concern is founded on the fact that within group edge areas, a negative edge effect on seedling growth usually occurs varying with species, group size, and within group location. For a forest manager whose objective is maximizing yield across an entire forest, any loss in growth should be considered in the context of any possible tradeoffs in growth that may occur spatially or temporally within the forest. In a multi-cohort stand, growth within one cohort can be considered as a tradeoff with another cohort. In the case of group selections, decreased growth of seedlings in edge-effect areas may be a tradeoff with increased growth for surrounding matrix trees that make up the boundary of the opening.

To explore this possibility, we are studying edge trees at Blodgett Forest Research Station, where 12 experimental group openings were harvested within a mature second-growth forest in 1996. During the winter of 2001/2002, we will sample trees from the group perimeters and from the matrix forest as a control. From increment cores, we will measure growth for the five years since harvest to

Forest Canopy **Photo by Bob Heald**

test for differences in growth between edge and matrix trees. Differences will be tested for trees grouped by species, group size, and group position (north v. south sides). We hope to quantify the effect of any growth response from edge trees, which will assist forest managers in weighing silvicultural benefits and costs of the group selection management regime.

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