Blodgett Forest Research Station

RESEARCH WORKSHOP 2007

BLODGETT FOREST RESEARCH STATION

2007 RESEARCH WORKSHOP

February 2, 2007

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Silviculture

ABSTRACT PRESENTATIONS

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ABSTRACTS
2007 Blodgett Forest Research Workshop

Table of Contents

Title:

HEIGHT-RELATED VARIATION IN PHYSIOLOGICAL PERFORMANCE OF GIANT SEQUOIA TREES.

Authors: Anthony R. Ambrose, Todd E. Dawson, Stephen C. Sillett, and George W. Koch.
Address of Lead Author: Department of Integrative Biology, 3060 Valley Life Sciences Building, University of California, Berkeley, CA 94720.

Abstract:

Large trees are treasured throughout the world for their aesthetic, ecological, and commercial value. However, knowledge of the factors regulating the physiological performance, growth, and maximum height of the tallest and most massive trees remains limited. Current research supports the view that constraints and trade-off's involved with water delivery to the treetop play a primary role in reducing and eventually stopping height growth as trees grow taller. The basis for the decline in height growth may be a decrease in carbon gain of leaves due to greater stomatal limitation of photosynthesis at the treetop. Altered leaf structure with increased height may also play an important role in constraining photosynthesis by limiting the supply of carbon dioxide to sites of carboxylation within the leaf. Finally, other components of carbon balance, most notably respiration, likely change in importance as gravitational constraints on photosynthesis increase toward the treetop. To gain insights into the growth dynamics of large trees and determinants of tree height, we commenced a long-term study in 2005 of key structural, morphological, and physiological characteristics in giant sequoia (*Sequoiadendron giganteum*) trees of different heights at the UC Berkeley Whitaker Forest Research Station and Kings Canyon National Park. Study trees, accessed using rope-based arborist techniques, ranged from 30.0 to 90.9 m in height and 77 to 617 cm in diameter (DBH). Data collected during the 2005 and 2006 field seasons on the functional coordination of leaf-level gas exchange, wood density, leaf area-to-sapwood area ratios, branch hydraulic conductivity, and branch vulnerability to drought-induced cavitation will be presented. Preliminary results generally support the hypothesis that decreased water potential at the tops of tall trees directly and indirectly reduces carbon gain and height growth. Detailed analyses of leaf morphology, gas exchange, stable carbon isotopes, and tree ring growth

are on-going, and additional structural and physiological measurements and analyses are planned for the summer of 2007.

Title:

CHARACTERIZING BIOGENIC EMISSIONS OF SESQUITERPENE AND OXYGENATED TERPENE COMPOUNDS

Authors: Nicole C. Bouvier-Brown, Rupert Holzinger, Katrin Palitzsch, and Allen H. Goldstein

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Abstract:

Evidence for very reactive biogenic VOCs (BVOCs) has been observed at Blodgett Forest, a coniferous forest in the Sierra Nevada Mountains of California. The evidence has included chemical ozone loss in the forest canopy and the presence of BVOC oxidation products in and above the canopy. To measure emission rates of these reactive

BVOCs, we placed enclosures over branches of the dominant species at the site – Ponderosa pine, ceanothus, and manzanita – in the summer of 2005. Zero air, with ambient CO_2 concentrations, flowed through the chamber system and VOC emission measurements were made by proton transfer reaction mass spectrometry (PTR-MS), solid phase microextraction (SPME) on fibers followed by direct injection into a gas chromatograph with an ion trap mass spectrometer (GC-ITMS), and by in-situ GC with a flame ionization detector (GC-FID). Multiple studies have characterized oxygenated BVOC and monoterpene emissions at this site; here we focus on the identification and quantification of sesquiterpene and oxygenated terpene emissions. We report emission profiles over the three month sampling period showing variation among different branches and over time. We suggest that previously undetected

sesquiterpenes and oxygenated terpenes significantly contribute to the total reactive biogenic emission profile from this field site.

Title:

INITIAL CHANGES IN FOREST STRUCTURE AND UNDERSTORY PLANT COMMUNITY FOLLOWING FUEL REDUCTION ACTIVITIES IN A SIERRA NEVADA MIXED CONIFER FOREST

Authors: Brandon M. Collins, Jason J. Moghaddas, and Scott L. Stephens

Address of Lead Author: Wildland Fire-Stephens Lab, Environmental Science, Policy & Management, University of California, Berkeley, 137 Mulford Hall, Berkeley, CA 94720-3114

Abstract:

The widespread attention that has been devoted to wildfires by the public, as well as by state and federal governments, over the last several years in the United States has created a demand for fuel reduction activities aimed at alleviating wildfire hazard. While the appropriateness of these fuel reductions activities has been discussed in detail in previous studies, only a few studies have experimentally examined the effects of fuel reduction on forests. This paper investigates the initial effects of three different fuel reduction strategies on forest structure and understory plant communities using replicated treatments, which are compared to untreated controls. Understory plants are grouped by plant growth form (shrub, forb, graminoid) and by plant origin (native, exotic). The effects of each treatment alternative: mechanical, prescribed fire, mechanical followed by prescribed fire, and untreated control, are reported for each plant group. Each fuel treatment modified forest structure such that growing space increased and allowed for rapid reestablishment of forbs and graminoids, which did not differ in abundance from pre-treatment levels. The mechanical only treatments (thinning from below and rotary mastication) significantly reduced shrub cover relative to the control, however mechanical plus fire and fire only treatments did not. Mechanical plus fire treatments altered forest structure most substantially, which may explain the observed increases in richness and cover of exotic species. However, the magnitude of these differences was small. Both treatments involving fire decreased native species richness significantly, but differences in native species cover were insignificant for any of the active treatments. These results demonstrate a relatively high degree of resilience in these Sierra Nevada mixed conifer understory communities, at least initially, to fuel reduction activities.

Title:

EXTRAPOLATING GROWTH-MORTALITY MODELS OF FOREST TREES: AN ECOLOGICALLY-INFORMED APPROACH

Authors: Adrian Das[(1)], John Battles[(2)], Nathan L. Stephenson[(3)], Phillip J. van Mantgem[(4)]

Address of Lead Author: Department of Environmental Science, Policy, and Management, University of California at Berkeley, 137 Mulford Hall, Berkeley, CA 94720-3114, Phone: 510-643-2450

Abstract:

The generality of growth-mortality models developed using multiple growth indices (average growth rate, growth trend, counts of abrupt growth declines) was tested against the generality of models using only average recent growth rate by transferring both types of models across site and across species. For the cross-site transfer, models for *Abies concolor* and *Pinus lambertiana* that were developed in an old-growth conifer forest in Sequoia and Kings Canyon National Park (SEKI) were used to classify the survival status of con-specific trees from a second-growth conifer forest at the University of California Blodgett Forest Research Station (BFRS). For the cross-species transfer, *Abies concolor* models developed at SEKI were used to classify *Abies magnifica* samples also collected at SEKI. The transfer was performed using both an ecologically-informed and a naïve approach. For the informed approach, models were adjusted to account for predictable differences in size structure, stand age, and baseline survival probability between sites and species before performing the transfer. For the naïve approach no alterations were made to the models before performing the transfer. As a further check, a reverse transfer was done, using models developed from BFRS samples and *A. magnifica* samples to classify SEKI *A. concolor* and *P. lambertiana* samples.

In two out of three cases, multiple-index models outperformed models based on average recent growth after being adjusted for differences in the model and transfer populations. SEKI *P. lambertiana* models showed both good discrimination (Area Under the Receiver Operating Characteristic curve—ROC: 0.728) and good classification (71.7% live and dead trees correctly classified) of the BFRS *P. lambertiana* samples. Additionally, *A. concolor* models demonstrated both good discrimination (ROC: 0.842) and good classification (79.2% correctly classified) of *A. magnifica* samples. In contrast

complex *A. concolor* models from SEKI generally performed more poorly than average recent growth models when classifying samples from BFRS. Reverse transfer results mimicked the results for the primary transfer.

Using an ecologically-informed approach (i.e., taking into account site history and differences in population structure) was necessary to demonstrate the generality of the multi-parameter *P. lambertiana* models. Had only the naïve approach been used (in which the *P. lambertiana* models performed very poorly), similarities in the growth-mortality relationships between SEKI and BFRS would have gone unnoticed, demonstrating the importance of considering differences between model and transfer populations when assessing the generality of model forms.

I conclude that models developed with a more comprehensive use of the growth record can indeed show increased generality in novel circumstances. In addition, knowledge about how mortality risk and measures of mortality risk can vary with site is critical for adequately assessing the generality of a given model. Moreover, the process of transferring models can in and of itself do much to improve our understanding how mortality processes vary both in time and space.

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Title:

OBSERVATIONS REACTIVE NITROGEN OXIDE FLUXES: MECHANISMS CONTROLLING EXCHANGE OVER A PONDEROSA PINE FOREST

Authors: D. K. Farmer, P.J. Wooldridge and R. C. Cohen

Address of Lead Author: Department of Chemistry, University of California Berkeley, Berkeley, CA, USA

Abstract:

Measurements of exchange of reactive nitrogen oxides between the atmosphere and a ponderosa pine forest in the Sierra Nevada Mountains are reported. During winter, we observe upward fluxes of NO_2, and downward fluxes of total peroxy and peroxy acyl nitrates (ΣPNs), total alkyl and multifunctional alkyl nitrates (ΣANs), and the sum of gaseous HNO_3 and semi-volatile NO_3^- aerosol ($HNO_{3(g+p)}$). The signs and magnitudes of these wintertime individual and ΣNO_{yi} fluxes are in the range of prior measurements and indicate net ΣNO_{yi} deposition. However, during summer, we observe downward fluxes only of ΣANs, and upward fluxes of HNO_3, ΣPNs and NO_2 with signs and magnitudes that are unlike most, if not all, previous observations and analyses of fluxes of individual nitrogen oxides. The results imply that the mechanisms contributing to NO_y fluxes, at least at this site, are much more complex than previously recognized. We show that the observations of upward fluxes of HNO_3 and ΣPNs, and downward fluxes of ΣANs, during summer are consistent with oxidation of NO_2 and acetaldehyde by elevated OH within the forest canopy. We discuss the implications of elevated HO_x, and explore the relative importance of deposition, canopy chemistry, and ecosystem emissions in controlling biosphere-atmosphere exchange of reactive nitrogen oxides.

Title:

The Effect of Pruning on the Incidence of White Pine Blister Rust in Sugar Pine

Authors: Lauren Grand and Kevin O'Hara

Lead Author's Address: 1515 ½ Milvia, Berkeley, CA 94709. Email: bigred12@berkeley.edu

Abstract:

White pine blister rust is a major factor causing the dramatic decrease in populations of sugar pine trees in the Sierra Nevada. This work presents pruning as a management tool to decrease the incidence of the blister rust on sugar pine. Pruning was done on uninfected trees in 2000 at Blodgett Forest. The percentage of trees that contracted the disease were recorded. Five years after pruning, the number of infected trees that were pruned was compared to the number of infected trees that were unpruned. The results show that 51% of the unpruned trees were infected and 35% of the pruned trees were infected. This suggests that pruning can decrease the chances of sugar pine contracting blister rust. Tree growth was also recorded in order to study how pruning affects productivity. The productivity results are expected to increase. With these results, this research suggests that pruning may be an important tool in the maintenance and restoration of sugar pine in the Sierra Nevada. However our analysis is continuing and complete results will be available at a later date.

Title:

FUNGAL MEDIATED CARBON ACQUISITION IN THE UNDERSTORY PLANTS *PYROLA PICTA* AND *PYROLA APHYLLA*.

Authors: Nicole Hynson, Valerie Wong & Thomas Bruns

Address of Lead Author(s): Department of Environmental Science Policy and Management, University of California, Berkeley, CA 94720-3102

Abstract:

Myco-heterotrophic plants have been studied since the discovery of mycorrhizal fungi, but the evolutionary origins of these plants remain unknown. In a classical mycorrhizal interaction, plants trade photosynthates with their associated fungi and receive mineral nutrients in return. However, some non-photosynthetic plants cheat this mutualism. Myco-heterotrophic plants depend on their mycorrhizal associates for not only mineral nutrients but also carbon that the fungus acquired from an unrelated photosynthetic plant.

The most well studied group of myco-heterotrophs, the Monotropoideae, are all non-photosynthetic and obligate on specific fungal species. However, monotropes likely descended from generalist photosynthetic plants in the Pyroloid group. To address whether mycorrhizal specificity and loss of photosynthesis are contingent upon each other, we are studying the fungal associates of a pair closely related plants, *Pyrola picta* and *P. aphylla* (Ericaceae), that are photosynthetic and non-photosynthetic, respectively. *P. picta* may be a facultative myco-heterotroph partially dependent on fungal-mediated carbon transfer, while *P. aphylla* appears to be obligately dependent on mycorrhizal fungi to meet its nutritional needs. If *P. aphylla* and *P. picta* associate with the same broad range of fungi, we can conclude that photosynthesis is lost prior to specialization.

To test these hypotheses, we will identify the mycorrhizal fungi associated with *P. picta* and *P. aphylla* in Blodgett Experimental Forest. We are "baiting" the fungi associated with *P. aphylla* using buried packets containing *P. aphylla* seeds in three plots: *P. aphylla*, *P. picta*, and a control plot containing neither species. We harvest the seed packets and examine them for germination. As many myco-heterotrophic plants germinate only in the presence of their specific fungal associates, this enables visual assessment of colonization by a fungal associate. After 25 months, no seeds have germinated. We have also collected root samples from *P. picta* for molecular identification of its associated mycorrhizae. We have collected aerial plant parts from plots containing *P. picta*, *P. aphylla* and other myco-heterotrophic plants for stable isotope analysis to determine the trophic status of both *Pyrola* species. Based on the carbon signatures of *P. picta* individuals it does not appear that this species is obtaining any carbon through its mycorrhizal fungi. Conversely, *P. aphylla* behaves isotopically like known myco-heterotrophs in the Monotropoideae, indicating that this species receives carbon and nitrogen solely via its mycorrhizal fungi. This work will further elucidate the ecology of myco-heterotrophic plants and gain insight into how mycorrhizal networks remain robust to discourage cheaters.

Title:

Tree mortality patterns following prescribed fires in a mixed conifer forest

Authors: Leda Kobziar, Jason Moghaddas, and Scott L. Stephens

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Abstract

In recent years a great deal of effort has been put into wildfire educational campaigns both to promote use of defensible space and to increase acceptance of different fuels treatment methods. However, less effort has gone into understanding what types of outreach efforts are most effective. A number of perspectives suggest that interactive educational efforts are more effective at changing adult behavior and attitudes than unidirectional efforts (e.g. TV, newspapers, etc.). This paper discusses results from a survey of the opinion about the acceptability and fuels treatment preference of participants following a field tour of the University of California Blodgett Forest Fire and Fire Surrogate Study Site. The study found that individuals were reacting to the treatments based on already determined values. Respondents were classified into five professional groups – foresters, environmental groups, entomologists, National Resource Conservation Service employees, and student and teachers. Significant differences were found between these groups on overall acceptability of treatments, treatment preferences based on different land ownership/management types, and what variables were most important in determining treatment preferences.

Title:

Frontalin: Production and Response to an Aggregation Pheromone Component by the Red Turpentine Beetle, *Dendroctonus valens* LeConte (Coleoptera: Scolytidae)

Authors: Anna Luxova,[1,2,3] Andrew D. Graves,[4] Regine Gries,[5] Shakeeb M. Hamud, [2] Steven J. Seybold[2]

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Abstract:

The red turpentine beetle, *Dendroctonus valens* LeConte (Coleoptera: Scolytidae)(Fig. 1), is a pine bark beetle that is broadly distributed in North and Central America (Wood, 1982). It has also been accidentally introduced and established in eastern China (Yan et al., 2005), where it has caused widespread tree mortality on more than 500,000 ha of pine forest (Liu et al., 2006). The broad host range and potential of this species to invade new habitats on other continents underscore the need for developing a potent attractant for early detection. Large numbers of live specimens of the species are difficult to obtain as wild populations because they tend to attack the bases of large trees and stumps, making procurement and rearing cumbersome.

Figure 1. An adult red turpentine beetle, *Dendroctonus valens*.

Pioneering work on the behavioral chemistry of *D. valens* has been conducted with populations of the insect from the central Sierra Nevada Mountains at the University of California Blodgett Forest Research Station (BFRS). Electrophysiological assays indicated strong antennal responses to (*S*)-(–)-β-pinene, (*R*)-(+)- and (*S*)-(–)-α-pinene, and (*S*)-(+)-3-carene (White and Hobson, 1993), whereas field studies demonstrated attraction in flight to synthetic (*S*)-(–)-β-pinene, (*R*)-(+)-α-pinene, and (*S*)-(+)-3-carene; (*S*)-(–)-α-pinene was interruptive (Hobson et al., 1993). Although this and other studies have investigated the response of *D. valens* to behavioral chemicals from host pines, very little research effort has been directed toward the response to behavioral chemicals from the beetles (i.e., pheromones).

During the last two years, our group has collected large numbers of *D. valens* for laboratory studies of pheromone production and response from the Salinas, California area in stem sections of Monterey pine, *Pinus radiata* D. Don. In 2006, we conducted a field study of the flight response of *D. valens* to compounds produced by the beetles and from other sources. The choice of compounds to test in the field was guided by chemical analyses of volatiles from beetles, by electrophysiological analyses of the responses by the beetles to synthetic compounds and extracts, and by preliminary field screening of a larger set of combinations of potential behavioral chemicals.

Head-space volatiles from large groups of male or female red turpentine beetle, *Dendroctonus valens* LeConte, feeding on cut logs of Monterey pine, *Pinus radiata* D. Don, and from small groups of juvenile hormone III (JH III)-treated or *P. radiata* phloem-fed males or females were analyzed by GC-FID and GC-MS (Fig. 2). Some samples were analyzed by a relatively novel analytical method: Two-dimensional gas chromatography with mass spectrometric time-of-flight detection. The large-group extracts showed trace quantities of the bicyclic acetal frontalin (Fig. 2B) in the females,

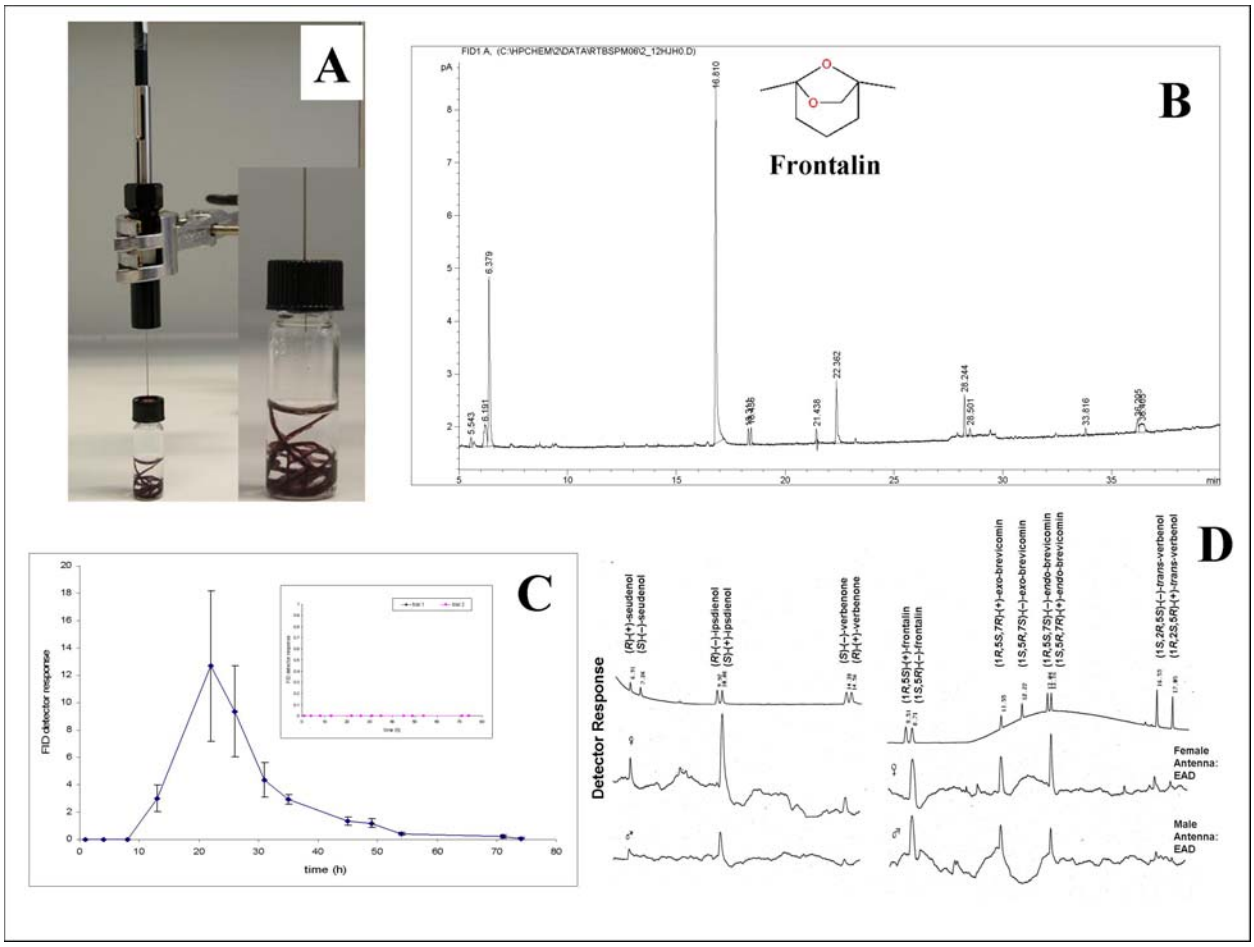

Figure 2. Laboratory studies of the chemical ecology of the red turpentine beetle, *Dendroctonus valens*, showing (A) solid phase microextraction technique (SPME); (B) gas chromatogram of a SPME-collected sample from 15 female *D. valens* taken 22 hours after treatment with juvenile hormone III (20 µg/beetle); (C) time course of production and release of the pheromone component frontalin from four trials in May and June, 2006 of 15 female *D. valens* after treatment with JH III (acetone control treatment is shown in the inset); and (D) antennal responses of male and female *D. valens* to synthetic pheromone compounds of *Dendroctonus* spp.

but not in the males. Small groups of JH III-treated or *P. radiata*-fed females also produced frontalin (20 to 140 ng/beetle over 46 hr); groups of males did not produce frontalin, irrespective of treatment (Fig. 2C). Both sexes in this experiment also produced *cis*- and *trans*-verbenol and verbenone, with females producing more *cis*- and *trans*-verbenol and males generally producing more verbenone. The first trace of frontalin from females was detected by SPME sampling 14 hr after JH III treatment and the majority was released between 20 and 35 hr (Fig. 2C). GC-EAD analyses showed stereospecific antennal responses by both sexes to synthetic (−)-frontalin, and to synthetic (+)-seudenol, (+)-ipsdienol, (−)-verbenone, (+)-*exo*-, and (+)-*endo*-brevicomin, all frequently occurring *Dendroctonus* spp. pheromone compounds (Fig. 2D). Antennal responses of both sexes to the large-group extracts were nearly identical and directed primarily to the host monoterpenes. The host compounds 1.4-cineole, fenchone, β-pinene, and terpinen-4-ol elicited the most pronounced antennal responses from both sexes (data not shown).

Field bioassays of the flight response of *D. valens* to various combinations of frontalin, *exo*-brevicomin, and host monoterpenes were conducted at BFRS between May and October of 2006. Further, the field response to the host monoterpenes (*S*)-(−)-β-pinene, (*R*)-(+)-α-pinene, and (*S*)-(+)-3-carene with and without 1.4-cineole was also evaluated. Preliminary results of some of these field studies will be described.

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Title:

INCORPORATION OF ^{13}C LABELED *PINUS PONDEROSA* NEEDLE AND FINE ROOT LITTER INTO SOIL ORGANIC MATTER MEASURED BY PY-GC/MS-C-IRMS

Authors: Mambelli S. [(1)], Gleixner G. [(2)], Dawson T.E. [(1)], Bird J.A. [(3)], and Torn M.S. [(4)]

Address of Lead Author: Department of Integrative Biology and Center for Stable Isotope Biogeochemistry, University of California, Berkeley, CA 94720

Abstract:

Developing effective strategies for enhancing C storage in soils requires understanding the influence of plant C quality. In turn, plant C quality impacts the decay continuum between plant residue and humified, stable SOM. This remains one of the least understood aspects of soil biogeochemistry. Beginning in 2001, we designed a multi-investigator project to fill critical gaps in our knowledge about the sequestration efficiency of leaf and fine root inputs, including decomposition and humification rates and pathways. Starting in August 2001, at Blodgett Experimental Forest we established a field experiment in a forest dominated by 90-year-old *Pinus ponderosa* (lot 630). Several microcosms were inserted in the soil and allowed to equilibrate for 120 d before the application of labeled litter. $^{13}C/^{15}N$ labeled needles and fine roots obtained from *Pinus ponderosa* saplings were placed in separate microcosms to either the O or the A soil horizon in November 2001.

Here we present the results from the incorporation of ^{13}C labeled *Pinus ponderosa* needle and fine root litter into SOM after 1.5y from litter addition. We investigated the initial phase of incorporation of 13C labeled *Pinus ponderosa* needle and fine root litter into SOM with the objectives: 1) to relate identified chemical soil constituents to possible origins; 2) to assess the relative importance of transfer of C to SOM directly from plant residues or indirectly through microbial processing; 3) to determine the influence of litter quality on SOM formation.

The soil (< 2 mm) from each microcosms was subjected to a SOM fractionation procedure using a sequential physical and chemical approach to yield 4 operationally-defined SOM fractions. In this paper we are presenting results from the whole soil and humin SOM fraction. The bulk soil had a turnover time of 85 y. The humin fraction

represented 17% of SOC and had the slowest 14C-defined turnover time of all SOM fractions in the A horizon (260 y). Curie-point pyrolysis-gas chromatography coupled with on-line mass spectrometry and isotope ratio mass spectrometry (Py-GC/MS-C-IRMS) were used to determine the identity and the ^{13}C enrichment of pyrolysis products (fragments of carbohydrates, lignin, proteins and lipids). We compared the two initial litter types, needles and fine roots, to samples of the bulk soil (A horizon, < 2mm) and soil humin fraction (from chemical solubility) obtained from each microcosm 1.5y after litter addition.

Pyrolysis of plant material and SOM produced 55 suitable products for isotopic analysis; of them, 15 occurred in both the litter and bulk soil, 7 in both the litter and the humin fraction and 8 in both bulk soil and the humin fraction. The pyrolysis products found in common in the plant and soil were related either to polysaccharides or were non-specific and could have originated from various precursors. The data suggest that the majority of plant inputs, both from needles or fine roots, were degraded very rapidly. In the humin fraction, the most recalcitrant pool of C in soil, with a measured turnover time of 260y (this soil), only products from the fragmentation of polysaccharides and alkyl-benzene compounds were found. Comparisons of the enrichment normalized by input level suggest little difference between the incorporation of C from needles versus fine roots into SOM. The most enriched fragments in the humin fraction were products from polysaccharides degradation, indicating a very important role of microbial processing in the stabilization of C in SOM.

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Title:

What is Public Opinion Concerning Fuel Treatments? Field Survey Results From Fire and Fire Surrogate Fuel Treatments in a Sierran Mixed Conifer Forest, California, USA

Authors: McCaffrey, Sarah[1*], Jason J. Moghaddas[2], and Scott L. Stephens[2]

Address of Lead Author: [1]USDA Forest Service, North Central Research Station, 1033 University Place, Ste 360, Evanston, IL 60201, 847-866-9311, FAX 847-866-9505. Email: smccaffrey@fs.fed.us

Abstract

In recent years a great deal of effort has been put into wildfire educational campaigns both to promote use of defensible space and to increase acceptance of different fuels treatment methods. However, less effort has gone into understanding what types of outreach efforts are most effective. A number of perspectives suggest that interactive educational efforts are more effective at changing adult behavior and attitudes than unidirectional efforts (e.g. TV, newspapers, etc.). This paper discusses results from a survey of the opinion about the acceptability and fuels treatment preference of participants following a field tour of the University of California Blodgett Forest Fire and Fire Surrogate Study Site. The study found that individuals were reacting to the treatments based on already determined values. Respondents were classified into five professional groups – foresters, environmental groups, entomologists, National Resource Conservation Service employees, and student and teachers. Significant differences were found between these groups on overall acceptability of treatments, treatment preferences based on different land ownership/management types, and what variables were most important in determining treatment preferences.

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Title:

Partitioning Forest Carbon Fluxes with Overstory and Understory Eddy-Covariance Measurements: a Synthesis Based on FLUXNET Data

Authors: Laurent Misson; Baldocchi, D.D.; Black, T.A.; Blanken, P.D.; Brune, Y., Curiel Yuste J; Dorsey, J.R.; Falk, M;. Granier, A.; Irvine, M.R.; Jarosz, N.; Lamaud, E.; Launiainen,, S.; Law, B.E.; Longdoz, B.; Loustau, D.; McKay, M.; Paw, U K.T.; Vesala,, T.; Vickers, D.; Wilson, K.B.; Goldstein, A.H.

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Abstract:

Forests are complex ecosystems characterized by several distinctive layers with very different functional properties, both in the overstory and the understory. Each of these layers contributes differently to the CO2 exchange with the atmosphere. Measurements of CO2 and energy fluxes by the eddy-covariance method at different heights can be used to separate these different sources and sinks. However, information on how canopy structure influences canopy micrometeorology is still needed to interpret above canopy and subcanopy eddy-covariance fluxes across a wide range of forest type, structure and climate. In this study we used meteorological and eddy-covariance fluxes data gathered at 10 sites in the FLUXNET network, chosen to cover a range of canopy closure, functional types and climates. We showed that eddy-covariance flux measurements at the forest floor are problematic at night in open forests because of the build up of a strong inversion layer, but are more reliable during the day. Denser forests have higher turbulence at night in the understory because the inversion is weaker. However, the flux footprint above and below canopy is less similar than in more open forests, because wind direction is more deflected while entering the canopy. We showed that GPP of the understory can reach 38% of the total canopy GPP, with an average of 13% across the studied sites. We found that understory respiration contributed an average of 54% to ecosystem respiration, with a range of 39 to 74%. Understory in deciduous forests (62%) had higher contributions to ecosystem respiration than in evergreen forests (47%). The normalized understory respiration fluxes at 20 ºC were negatively related to soil temperature, when differences

in soil moisture across the sites are taken into account. Understory respiration fluxes were positively correlated with gross ecosystem productivity. We showed that drought limited the efficiency of microbial metabolic activity, as well as partial evidence of an acclimation of soil respiration to soil temperature.

Title:

Fire and Fire Surrogate treatment effects on soil properties in a Sierran mixed conifer forest

Authors: Emily Moghaddas[1] and Scott Stephens

Address of Lead Author:
ESPM Dept, Division of Ecosystem Science, University of California at Berkeley, 137 Mulford hall #3114, Berkeley, CA 94720-3114

Abstract:

The Fire and Fire Surrogate Study utilizes forest thinning and prescribed burning in attempt to create forest stand structures that reduce the risk of high severity wildfire. Replicated fuel treatments consisting of mechanical tree harvest (commercial harvest plus mastication of sub-merchantable material), mechanical harvest followed by prescribed fire (mechanical+fire), prescribed fire alone, and no-treatment controls, were completed at the Blodgett Forest Research Station in the central Sierra Nevada in fall 2002. We conducted pre-treatment and post-treatment assessments of soil physical, chemical, and biological characteristics. The fire and mechanical+fire treatments accounted for the majority of differences in soil properties. Burning treatments decreased pools of carbon and nitrogen in the forest floor, increased soil pH, and increased the pool of inorganic nitrogen in the soil relative to the mechanical and control treatments. The mechanical+fire treatment had greater effects on nitrogen cycling, with NH_4-N concentrations increased more than 40-fold compared to the control mean value. Nitrification rates were also increased in the mechanical+fire treatments. Harvest operations influenced the heterogeneity of the prescribed fire treatments and their effects. The majority of unburned areas were occupied by skid trails. Skid trails in many managed stands cover upwards of 30 percent of stand area, and can have substantial influence on soil properties. Understanding the effects of fuel treatments on soil properties and processes will better help managers develop long-term treatment strategies that address both stand structure and ecosystem function.

Title:

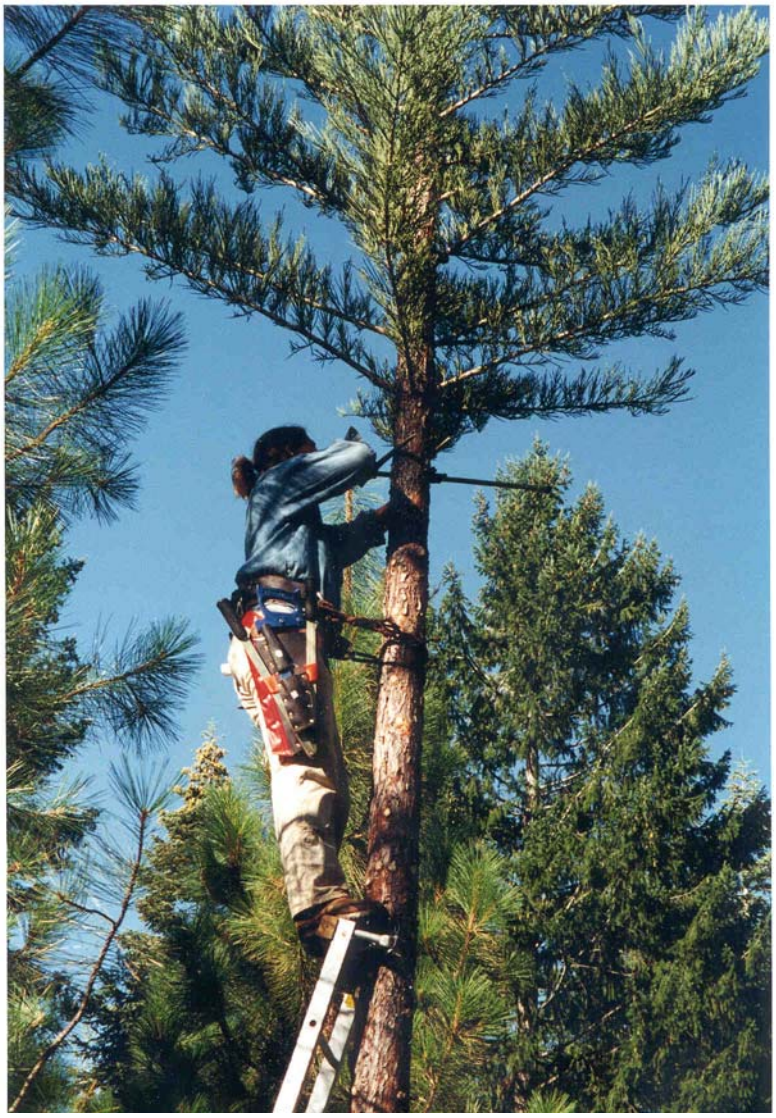
EFFECTS OF PRUNING INTENSITY AND SEASONALITY ON EPICORMIC SPROUTING IN GIANT SEQUOIA

Authors: Kevin L. O'Hara, Robert A. York, and Robert C. Heald

Address of Lead Author: Department of Environmental Science, Policy and Management, University of California, Berkeley, 145 Mulford Hall, Berkeley, CA 94720-3114.
Email: ohara@nature.berkeley.edu

Abstract:

Pruning trees can potentially provide various ecological and economic benefits to managers of plantations. Because of the long time period between a pruning treatment and the realization of its benefit, it is essential to understand the impacts of pruning timing and intensity on treatment objectives. Giant sequoia has exceptional potential to benefit from pruning treatments because of its rapid growth. However, pruning influences on giant sequoia growth and physiology have not been formally studied. The degree to which pruning causes epicormic sprouting on the pruned section of stems is



of special consideration since such sprouting can negate the desired effects of branch pruning. We experimentally pruned 12 year old planted giant sequoia trees at Blodgett Forest Research Station. There were two treatments: pruning intensity (0 to 80% of crown removed), and pruning season (trees were pruned during each month over the course of a year). Response variables include sprouting frequency, location of sprouts on the stem, and sprout size. Data are currently being analyzed. Preliminary analyses suggest that both timing and pruning intensity influence epicormic sprouting.

Title:

GIANT SEQUOIA STEM DENSITY INFLUENCES ON WOOD QUALITY

Authors: Stephen L. Quarles, Robert A. York, and Robert C. Heald

Address of Lead Author: University of California at Berkeley, Forest Products Lab, Richman Field Station, Berkeley, CA. Email: steve@nature.berkeley.edu

Abstract:

Giant sequoia has exceptional potential to provide forest products because of its rapid growth rate and adaptations to high stocking levels. We used an existing spacing study at Blodgett Forest Research Station to assess wood quality as a function of initial planting density. Samples are being collected from trees that range in growing space at time of planting from 3.7 to 28.4 m^2.

The advantage of plantation grown timber is the ability to increase volume production on a given site. Addition of wood volume, however, is accomplished at the expense of wood quality. The faster growth rate tends to have a negative influence on most critical physical properties that affect performance of solid wood products. This is due to the fact that the juvenile region in plantation grown timber constitutes a larger proportion of the total cross section. Density, and therefore strength, is reduced. Because of increased longitudinal shrinkage, solid wood products have a greater tendency to exhibit warp (crook, bow, and twist) when dried to in service moisture contents. Resistance to biological organisms (fungi and insects) is also reduced.

Certain species, including redwood, and potentially giant sequoia, that are noted for their service performance characteristics (e.g., high dimensional stability and decay resistance) can benefit from studies such as this one to better understand the tradeoff between these two attributes - the value associated with the quality of solid wood products compared to the volume of timber produced.

Initially we will be evaluating the density distribution between the pith and bark as a function of spacing. These samples could also be used to evaluate change in the microfibril angle in the S2 layer of the cell wall. This measurement would provide information on longitudinal shrinkage, and therefore dimensional stability. Additional

funding would have to be found for these measurements. The objective, from a wood quality perspective, would be to identify the spacing (or other combination of silvicultural practices) that maximizes selected physical properties, and evaluate the effect on volume production.

Title:

INCENSE CEDAR GROWTH STUDIES AND OBSERVATIONS AT BLODGETT FOREST RESEARCH STATION

Authors: Frieder Schurr and Rob York

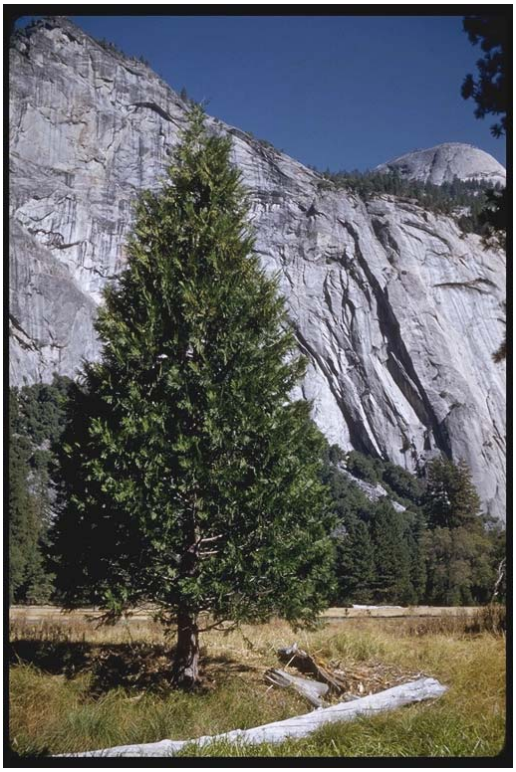
Address of Lead Author: Center for Forestry, 4501 Blodgett Forest Road, Georgetown, CA 95634. Email: freschur@nature.berkeley.edu

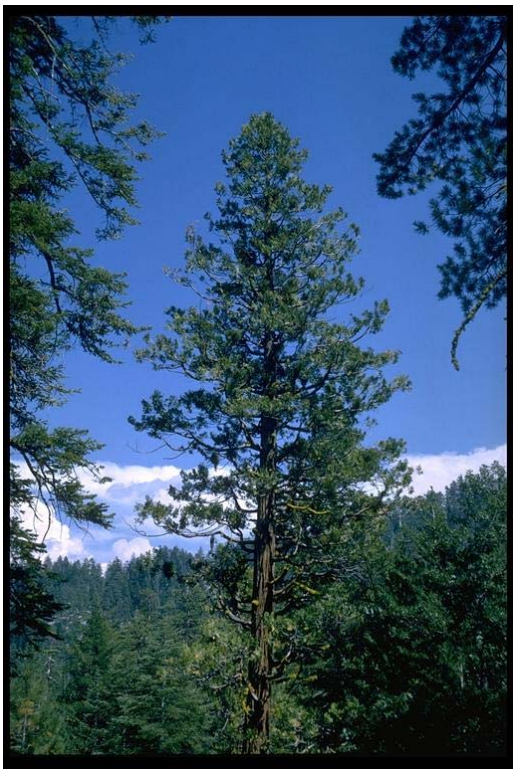
Abstract:

Incense cedar is a commercial conifer species that grows on the western slopes of many mountain ranges from Oregon to Baja Mexico where dry summer conditions are common. It has recently garnered more interest from the timber products industry as a "Redwood Substitute" due to its decay resistant properties as its value has increased partially due to the increasing rarity of high-quality redwood lumber. As a result, more interest has developed in using cedar as a component in the seedling mix of commercial plantations. Blodgett forest has been using cedar in its planting mixes for over 20 years and has also used it as a part of several mixed conifer planting research studies for almost as long. Results form these studies indicate that cedar can initially grow as well as many of the other conifers commonly used in planting schemes in the region. In addition, cedar

seems to be less susceptible to disease and pest related defects and mortality than many of its forest cohorts. Incense cedar establishes easily from natural seed fall throughout its range, but grows best in low density stand conditions. In dense stands it tends to become easily suppressed and stagnates quickly. However, it can retain a high potential for release even after several decades of suppression if appropriate stand conditions develop.

Long term growth data for Incense cedar in even-aged, managed stands does not exist at this time and further research is needed as to its economic feasibility in intensively managed silvicultural systems. However, if it retains its relative market value into the future, it can be an interesting and potentially valuable addition to plantation and other management systems for commercial operators.





Title:

RE-INTRODUCTION OF PRESCRIBED FIRE IN MANAGING THE UC CENTER FOR FORESTRY PROPERTY: RUSSELL RESEARCH STATION

Authors: Scott Stephens, Rick Everett

Address of Lead Author: Wildland Fire Lab, Environmental Science, Policy and Management, College of Natural Resources, University of California at Berkeley, 137 Mulford Hall MC 3114 Berkeley, CA 94720, email: stephens@nature.berkeley.edu

Abstract:

As a Lands Reserve within the Center for Forestry Properties, the Russell Research Station property is a mix of coniferous research plantations, California coastal scrub and Oak woodland vegetation nestled in the Briones Hills area 12 miles east of the UC Berkeley campus. This property adjoins the East Bay Municipal Utilities District (EBMUD) properties, East Bay Parks Briones Regional Parks, and the cities of Pleasant Hill, Lafayette, Orinda, and small private holdings. Excellent growth conditions leading to stand overcrowding within plantations areas has led to seeking a low-cost, high-research-investment return solution to an increasingly critical fuels hazard problem at the Station.

During December 2006, three research plantation areas within the 115 ha University of California Center for Forestry, Russell Research Station, were treated with the first applications of prescription fire in the area within the last 15 years. Fuels hazard reduction of research-completed Monterey and Guadalupe Pine areas, as well as one redwood stand, was the primary goal of these prescribed fires. Additional research concerning fire-scarring probabilities was performed during the fuels-reduction prescription fire. Hazard reductions from preliminary post-fire inspections include the reduction of 1-hour and 10-hour fuel loadings. Fire-related damage to duff, deeper soils, and post-fire mortality of plantation trees has been minimal.

Continued prescription fire treatments are proposed as a test bed to demonstrate the use of fire as an essential part of managing University lands at the Russell Research Station. This form of fire management provides an excellent template for demonstration of Fire-Safe Practices in a local vegetation type, and has also gained interested from local cooperating fire agencies as a possible training venue. The permitting process has led to an integration of the prescription fire plan as a portion of the introduction to Wildland Fire (ESPM 18) curricula. As such, UC Berkeley has one of only two such forestry courses incorporating active prescription fire in the western United States. Lowering on-site fuel loads and increasing the heterogeneity of fuels in the area provides a much-needed hazard reduction in an area laced within the WUI concerned. Data collected during these burns can, and will, be incorporated into a larger vegetation management plan for the entire area. Overall stand health, growth potential, and better site preparation for future studies are all outcomes of re-introduction of fire into this management scenario.

Title:

MECHANISMS AND PROBABILITY OF FIRE SCAR FORMATION IN MONTEREY PINE TREES.

Authors: Scott Stephens and Rick Everett

Address of Lead Author: Wildland Fire Lab, Environmental Science, Policy and Management, College of Natural Resources, University of California at Berkeley, 137 Mulford Hall MC 3114 Berkeley, CA 94720. Email: stephens@nature.berkeley.edu)

Abstract:

This research addresses a number of fundamental questions about how and when forest trees are scarred by wildfire: what is the mechanism of fire-scar formation, what is the probability of scarring occurring on a tree which has never been previously subjected to fire, and what is the probability of recording another fire compared to neighboring unscarred trees? Radiant transfer of sufficient heat to damage or kill the cambial tissues beneath bark as the mechanism of scarring is well known, and is employed here to test the research hypothesis that significantly increased levels of scarring will occur when 1000 hour fuels are emplaced adjacent to trees during prescription fire treatments in otherwise uniform fuel loads. Our null hypothesis is that fire scar formation will not differ between trees subject to prescription fire, irregardless of species, slope, or fuels manipulations.

As an initial test of both protocol & hypothesis, pilot studies have been placed within research-completed portions of Western Gall Rust study plantations, at the UC's Center for Forestry Russell Research Station (RRS), Lafayette, California. These studies co-ordinate with prescription fire plans for inactive research plots. The species to be investigated is Monterey Pine. The subject trees are a mix of subspecies, all 20-22 years of age, greater than 20cm dbh, and all within similar topographical constraints. Pre-treatments were performed prior to the December 2006 prescription fires at RRS. Stand inventory and fuels inventory was performed prior to prescription treatment using stand forestry and fuels protocols. Specific volumes of 1000-hour fuels were placed randomly along compass directions of the boles of subject trees, 4cm from the base. Fine fuels were left intact within the unit, but problematic 10-, 100-, and 1000-hour fuels, as well as shrubs, were removed. Strip firing of the unit occurred normally, altering prescription

protocol only to assure ignition of the emplaced 1000-hour fuels. Initial post-fire data is still being collected and analyzed. Re-burns of this unit, as well as additional scarring tests, are now planned for inclusion in prescription fire treatments for the Russell Research area.

ABOVE: CUTTING FIRE SCARS AT BLODGETT FOREST, ANOTHER CENTER FOR FORESTRY PROPERTY.

Title:

The fate of microbial products in tropical and temperate forested ecosystems

Authors: Heather M. Throckmorton[1], Jeffrey A. Bird[2], Mary K. Firestone[3], William R. Horwath[1]

Address of Lead Author: [1]University of California, Davis

Abstract:

Soil organic matter (SOM) is an amorphous material derived from plant, animal or microbial products, but is no longer recognizable as such. SOM benefits flora and fauna because it greatly improves soil quality through its unique physical and chemical properties. It greatly influences nutrient cycles in either the free or unassociated state and adsorbed to minerals to form organo-mineral complexes. SOM maintenance and turnover is also relevant to climate and global change because it is a major component of the carbon cycle. Thus understanding SOM dynamics is important for resource management and environmental sustainability.

Microorganisms play a key role in the formation of SOM in two ways. Microbial bodies represent a significant proportion of the source material for SOM. In addition, microorganisms catalyze SOM processes through decomposition and synthesis of biochemical compounds in soil. The metabolic capacity of a soil microbial community can vary, depending on certain parameters. Environmental factors such as temperature, moisture, soil chemistry and plant community govern the microbial community composition and function, and correspondingly SOM dynamics.

Our research attempts to investigate how the biochemical composition of microbial substrates affects carbon humification rates, and to compare these processes in two climatically different forested ecosystems. Our field sites include Blodgett experimental forest, a temperate coniferous forest in the Sierra Nevada, and Luquillo experimental forest, a tropical forest in Puerto Rico. These sites represent diverse ecosystems that are known to support substantially different microbial communities. The soil microbial community at Blodgett forest is dominated primarily by fungi, while the microbial community at Luquillo forest is dominated by bacteria.

We separately added four groups of carbon-13 enriched microorganisms to soil at both sites: bacteria gram+, bacteria gram-, fungi, and actinomycetes. We are following the fate of these microorganisms over the next several years. Whether these substrates are immediately respired as CO_2; incorporated into the labile fraction of SOM; or humified into the stable SOM pool may depend on the biochemistry of the added substrate or on the native environment to which they were added. Preliminary results show that one month after the addition of the microbial substrates for the Blodgett soils, the percentage of carbon recovered as dissolved organic carbon (DOC) ranged from 0.0148% (+/-0.00223) in the gram- treated soils to 0.0307% (+/- 0.00692) in the fungi treated soils. Five months after treatments the microbial carbon recovered as DOC decreased significantly for all treatments, amounting to less than one thousandth of a percent of the added carbon. In contrast, the percentage of input-carbon recovered as microbial biomass did not significantly differ when analyzed at one and five months. This fraction represented less than 0.2% (+/-0.0812) of the added microbial C.

Future research will investigate the fate of the microbial carbon in the soil, and humification pathways associated with C from the different microorganisms. We hope to elucidate some of these relationships and to better understand the biogeochemical processes associated with soil organic matter dynamics.

[2]City College of New York
[3]University of California, Berkeley

Title:

RESOURCE USE EFFICIENCY IN YOUNG GIANT SEQUOIA (*SEQUOIADENDRON GIGANTEUM*) STEM GROWTH

Authors: Robert A. York and John J. Battles [(1)]

Address of Lead Author: Center for Forestry, 4501 Blodgett Forest Road, Georgetown, CA 95634. Email: ryork@nature.berkeley.edu

Abstract:

Light use efficiency for producing stem volume (LUE_s) and intrinsic water use efficiency (WUE) were assessed for giant sequoia individuals in a density-controlled monoculture 10 and 17 years after planting. Despite large increases in stem size with initial growing space, light use efficiency for producing stem volume (LUE_s) did not change with growing space during the 10^{th} year but showed a slight increase with growing space during the 17^{th} year. WUE, assessed using carbon isotope analysis, was slightly higher for stems that had less volume growth during year 17, but not during year 10 when rainfall was above average. The results suggest that either nutrient limitations and/or physiologic adjustments made for tolerating drought conditions are important factors driving the observed growth differences in this giant sequoia monoculture.

[(1)] Environmental Science, Policy, and Management, UC Berkeley

Title:

SPECIES ADJACENCY STUDY: EARLY GROWTH RESPONSES TO INTER-SPECIES COMPETITION

Authors: Robert A. York and John J. Battles

Address of Lead Author: 4501 Blodgett Forest Road – Georgetown, CA 95634
ryork@nature.berkeley.edu

Abstract:

Mixed species plantations have many potential benefits over single species plantations (e.g. higher resistance to insects/pathogens, greater productivity, and hedge-betting against future down-turns in lumber values for individual species). To help advise future implementation efforts of mixed species plantations, we set up a long-term experiment to explore basic and applied questions about how species of different life-history strategies influence growth of neighboring trees. At two locations (Compartments 91 and 152), plots in open conditions were planted with focal trees and surrounded by planted neighbor trees of another species. These were paired with plots where focal trees were surrounded by trees of the same species. In 2006, tree morphology was measured along with measurements assessing light and water competition between species. Interactions between two-species combinations of three species, ponderosa pine, giant sequoia, and Douglas-fir, are being assessed currently. Ponderosa pine appears relatively insensitive to neighboring species in terms of basal diameter growth. Douglas-fir trees grew less when surrounded by ponderosa pine and giant sequoia neighbors compared to trees growing next to other Douglas-fir trees. Giant sequoia grew less when surrounded by other giant sequoia, compared to when neighbors were either Douglas-fir or giant sequoia. Given the species' life-histories, the results suggest that early competition for water and/or nutrients are causing the differences. Light, water, and nutrient use measurements will be analyzed in 2007.

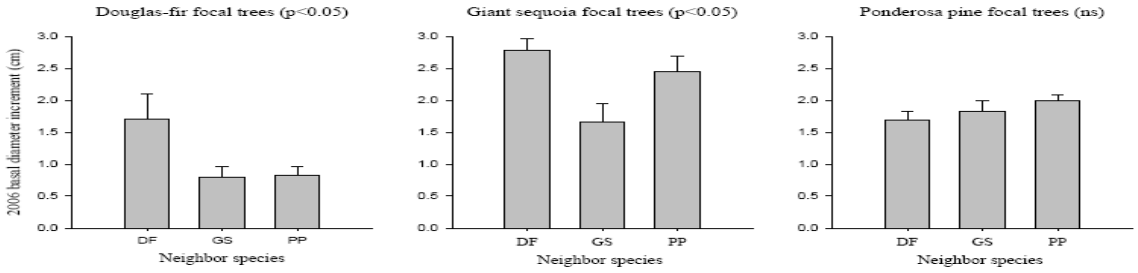


Figure caption. 2006 basal diameter increment of 8-year old seedlings planted at Blodgett Forest Research Station. Focal trees of each species were surrounded by seedlings of either the same species or a different species. P values are given from a preliminary analysis using ANOVA. Whiskers are standard errors.

ABOVE: A GIANT SEQUOIA IS SURROUNDED BY PONDEROSA PINE IN A SPECIES ADJACENCY PLOT.

Title:

LIMITED PRODUCTIVITY AND SPECIES COMPOSITION CHANGES FOLLOWING REPEATED DIAMETER LIMIT CUTTING IN A CALIFORNIA MIXED CONIFER FOREST

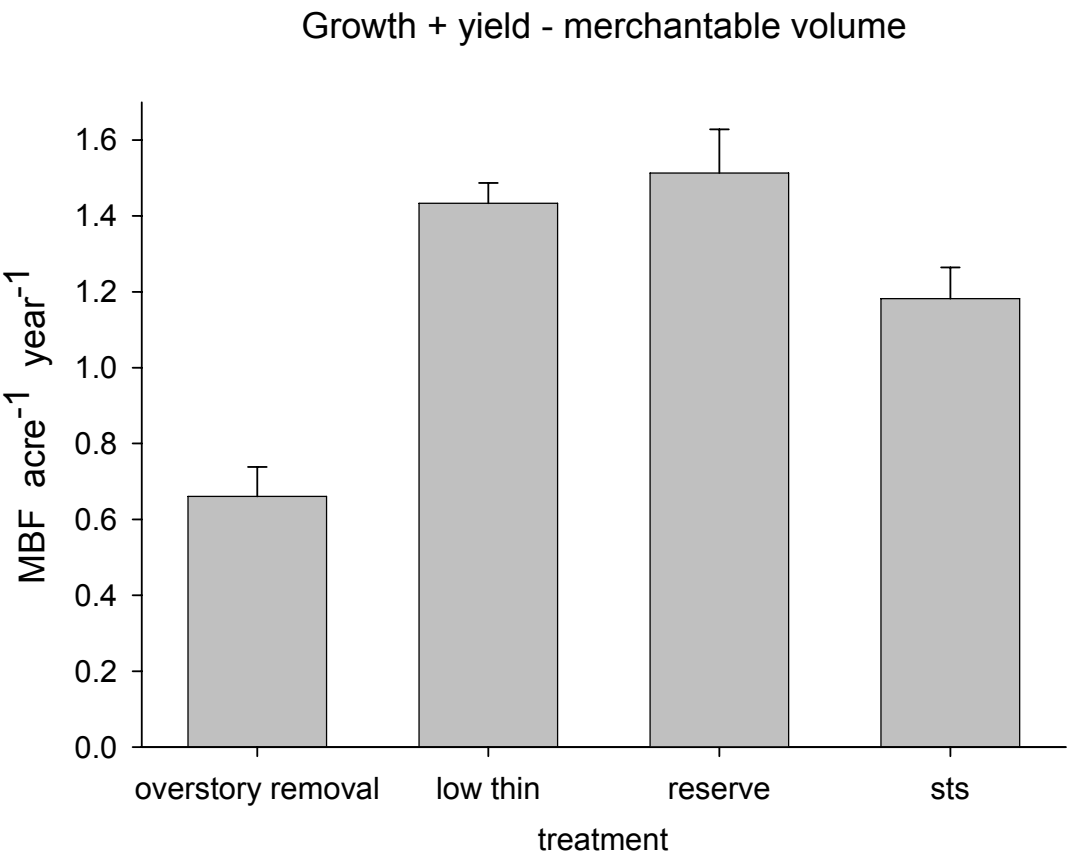
Authors: Robert A. York, Frieder G. Schurr[(1)] and John J. Battles[(2)]

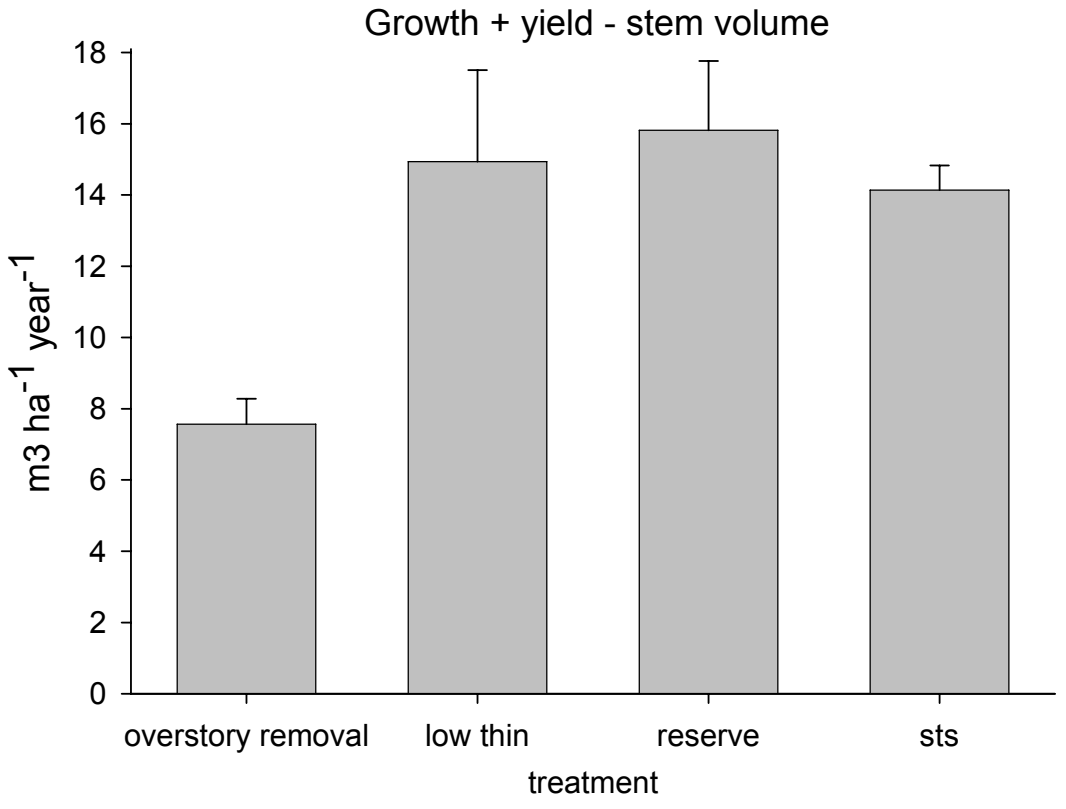
Address of Lead Author: Center for Forestry, Properties Division, 4501 Blodgett Forest Road, Georgetown, CA 95634. Email: ryork@nature.berkeley.edu

Abstract:

Removing the largest trees while leaving smaller trees is a common harvesting method used by land owners seeking short-term revenue. This method, known as diameter limit cutting, is often thought to have negative impacts on long-term productivity, but results from various forest types are mixed and few long-term experiments exist. At an experimental forest in the Sierra Nevada in California, diameter limit cutting has been practiced for 30 years as part of a long-term experiment comparing different regeneration methods. We used permanent plots from three stands that had diameter limit cuts and compared them to stands managed using three alternative methods: thinning from below (removing smaller and poor vigor trees), single-tree selection (removing trees of all size classes), and no-cut reserve. We compared changes in overstory species composition and volume production (growth + yield) both in terms of total and merchantable volume. Diameter limit cutting was the least productive, generating less than half as much volume than the most productive method, the no-cut reserve. The most distinct change in species composition took place in the diameter limit cut stands, which increased in abundance of white fir (*Abies concolor)* and decreased in abundance of ponderosa pine (*Pinus ponderosa)*. Although attractive as a source of short-term revenue, diameter limit cutting resulted in low productivity and species composition change after two cutting entries and over a relatively short time period of two to three decades.

[(1)]Center for Forestry, UC Berkeley, Georgetown, California, USA
[(2)]Environmental Science, Policy, and Management, UC Berkeley, Berkeley, California, USA


Growth + yield - merchantable volume
MBF acre-1 year-1
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
overstory removal
low thin
reserve
sts
treatment


Growth + yield - stem volume
m3 ha-1 year-1
18
16
14
12
10
8
6
4
2
0
overstory removal
low thin
reserve
sts
treatment