Blodgett Forest Research Station

RESEARCH WORKSHOP 2005

The CENTER FOR FORESTRY provides leadership in the development of basic scientific understanding of ecosystem process, human interactions and value systems, and management and silvicultural practices that ensure the sustainability of forest land.

The CENTER pulls together interdisciplinary teams of campus faculty, Cooperative Extension specialists and advisors, and staff from various agencies and organizations to develop research projects, outreach and public education activities, and provides policy analysis on issues affecting California's forest lands.

Ongoing research at Center sites aim to provide knowledge to improve management of young growth mixed conifer / oak forests, in such a manner that basic air, water, soil and biological resources are conserved. Management practices are designed to maintain and improve wood production, beneficial uses of water, wildlife habitat, visual quality, forage for livestock and recreation potential. Land units are managed in a duplicable manner, useful for small private landowners, industrial, state and federal forests.

In addition to silviculture activities, Center resources are available for educational workshops, tours and research.

University of California, Berkeley
College of Natural Resources
CENTER FOR FORESTRY

The CENTER FOR FORESTRY manages five research forest properties:

- **UC Forestry Camp/Baker Forest (Plumas County)**
- **Blodgett Forest Research Station (El Dorado County)**
- **Howard Forest (Mendocino County)**
- **Russell Reservation (Contra Costa County)**
- **Whitaker Forest (Tulare County)**

All properties offer field research locations and most have facilities (lodging, meeting rooms) for workshops or research on forestry issues. For information on usage of Center properties, contact:

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2005 RESEARCH WORKSHOP

February 4, 2005

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ABSTRACT PRESENTATIONS

BLODGETT FOREST'S MISSION

Blodgett Forest's principal responsibilities are to provide a location where forest and wildland research may be conducted in a managed forest environment and to demonstrate a wide range of sustainable forest management techniques. The Forest is divided into separate management areas (compartments). These compartments are split into three broad management styles allowing for a broad spectrum of stand conditions: Even-aged (40%), Uneven-aged (40%), and Reserve (20%).

RESEARCH AT BLODGETT

Researchers from all affiliations are encouraged to submit proposals to conduct research projects at Blodgett. New proposals are examined carefully before being accepted to minimize impacting other projects and management activities already underway at the forest. Projects may be rejected if they have the potential to have a large negative impact on the environment or the long term management goals of the forest. However, the vast majority of projects are accepted and these cover a very wide range of environmental and management topics.

FOREST MANAGEMENT AT BLODGETT

Blodgett grows seven main tree species: Ponderosa Pine, White Fir, Douglas' Fir, Sugar Pine, Incense Cedar, Giant Sequoia, and Black Oak. Land management ranges from no human manipulation to intensive even-aged systems. Cultural activities are ongoing.. They include site preparation after harvest, planting, vegetation control (chemical, manual, and mechanical), thinning, and pruning. Some stands also receive regular prescribed fire treatments. When possible, only Blodgett grown seeds are planted on the station. Currently, Giant Sequoia seeds are obtained from the Center for Forestry's Whitaker Forest Research Station.

Water Quality is also a major concern at the station. Blodgett maintains a comprehensive stream inventory that looks at channel condition/impacts, riparian vegetation, water chemistry, water temperature and a variety of other factors. Roads are routinely surveyed to identify and repair potential sedimentation sources before they become significant and all culverts are maintained annually to ensure proper function

HARVESTING AT BLODGETT

Harvesting at Blodgett is done primarily by ground based methods and occurs every year as part of the Forest's silvicultural management practices. An average of 2 million board feet is cut annually. Sustainable timber harvesting is the primary source of Blodgett's operating budget and is the driving force generating the wide range of stand conditions available to researchers.

ABSTRACTS
2005 Blodgett Forest Research Workshop

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Effects of Fire and Mechanical Fuel Treatments on Avian Abundance in a Mixed-Conifer Forest

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ABSTRACT:

Fire was a natural historical component of California coniferous forests. In the absence of fire, current forests are much denser, have higher fuel loads, and have been invaded by fire-intolerant species. Restoration of forests by fuel reduction can be achieved through both prescribed fire and/or mechanical treatments (fire "surrogates"). Research was conducted at Blodgett Forest Research Station, located near Georgetown, California, from 2001-2004. Twelve mixed-conifer stands (15-25 hectares each) with similar stand structure, composition and management histories were selected randomly from a set of available stands. Each selected stand was randomly assigned to 4 treatment groups: control (no manipulation), prescribed fire only, mechanical only (both thinning and mastication combined), and mechanical/fire combined. Point counts were conducted on 6 points within each replicate and visited 3 times during the breeding season. Data were analyzed by a single-factor ANOVA comparing the change in abundance between controls and treatments for 2001 (pretreatment) and 2004 (second year post-treatment). The following species showed significant increases ($p < 0.10$) relative to controls: American Robin (mechanical+fire), Brown Creeper (mechanical only and burn only), Hammond's Flycatcher (mechanical+fire), and Steller's Jay (burn only). The following species showed decreased abundance relative to controls: Golden-crowned Kinglet (burn only), Red-breasted Nuthatch (mechanical only), and Spotted Towhee (burn only).

Effects of fire and fire surrogate treatments on leaf litter arthropods: initial post-treatment results

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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 disturbances such as fire and timber harvesting. The abundance and diversity of these taxa make them valuable as indicators of forest health. The effects of fire and harvesting on these groups was investigated as part of the interdisciplinary Fire/Fire Surrogate Study from 2001 to 2003. Our goals were to determine baseline levels of diversity and abundance for leaf litter arthropod groups at Blodgett Forest, to determine the effects of prescribed fire and timber harvesting on these arthropods, and to examine the relationships between habitat variables and both individual species and assemblages of species. Three-hundred pitfall traps were placed in 12 forest compartments that experienced one of four treatments: prescribed burning, mechanical treatments (timber harvesting and mastication), mechanical followed by burning treatments, or control. Five traps were placed within each of 5 randomly selected plots in each of the 12 compartments. Insects were collected in propylene glycol over the course of five days each month, from June through September. A complete species list formed based on three years of trapping shows very high diversity of ground active beetles (281 species in 49 families) and ants (23 species) at Blodgett. The catch of beetles was dominated by a few families (Carabidae, Tenebrionidae, and Staphylinidae). Responses to FFS treatments were highly variable; a few species of beetles showed negative responses to treatments but highly variable population levels made detection of an effect difficult for most groups. Burning appeared to reduce the abundance of spiders. Multivariate analyses such as cluster analysis and ordination indicate that while most species-level effects may be hard to detect, some arthropod species assemblages did change as a result of the treatments.

Management to achieve forest sustainability: An assessment based on the long-term record from Blodgett Forest. A proposal submitted to the Division of Agriculture and Natural Resources Core Issues Grant Program.

Authors: **John Battles[1], Gary Nakamura[2], Frieder Schurr[3] and Robert York[1,3]**

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ABSTRACT:

Maintaining the sustainability of California's forests is a goal shared by all stakeholders, including the state and federal governments, the forest product industry, forestry professionals, and environmentally oriented non-governmental organizations (Dicus and Delfino 2003, CDF 2003, Pacific Forest Trust 2004, SAF 2004, USDA Forest Service 2004). The concept of sustainable forestry is a compelling one – forests should be managed to meet current needs without compromising the ability of future generations to meet their needs (*sensu* Brundtland 1987). However as Floyd (2002) noted, sustainable forest management must be specifically defined if it is to be more than just another ambiguous catch phrase like "multiple use" or "ecosystem management." Despite the near universal acceptance of the concept, forest managers, policymakers, and the public are confused about the impact of current actions on the sustainability of the forest (Oliver 2003). This confusion likely stems from the multiple criteria for - and indicators of - sustainability, and the lack of evidence from studies that directly connect management alternatives with these criteria. We propose to capitalize on the capacity of the ANR forestry program to conduct a rigorous evaluation of how current techniques enhance or diminish the sustainability of a California research forest.

The project will exploit the detailed 40-year record of forest metrics available for Blodgett Forest Research Station (BFRS). Specifically, we plan to compare the performance of six management regimes that represent the full range of options

employed in the timber producing zone of the Sierra Nevada. Performance will be assessed across multiple criteria using a diverse array of indicators. The products of this applied research exercise will be used to start a dialog among the stakeholders where specifics can be addressed and complexities explored. Sample questions include: What trade-offs exist among criteria? How can multiple facets of sustainability be incorporated? What are the most effective indicators to measure and monitor? Our hope is that the insights from this intensive study at one well-suited location will inform a comprehensive statewide evaluation.

Project goal: To make tangible the connection between forest management alternatives and their impact on the multifaceted definition of forest sustainability.

Project objectives:

1. Assess the sustainability of six management regimes at Blodgett Forest in reference to the criteria established as part of the Montreal Process (Montreal Process 2004)

2. Evaluate methods and procedures to quantify 10 indicators of the productive and environmental status of forest stands.

3. Explore trade-offs in the indicators of sustainability.

4. Use the Blodgett case study to initiate a dialog with forest managers, policy makers, and the public regarding the assessment of the sustainability of California's forests.

Project benefits: Forests compose almost 30% of the Californian landscape (~24 million acres). The majority of these forests are classified as timberlands capable of producing 20 cubic feet of industrial wood per acre per year. Maintaining the productive capacity of these lands while also preserving the ecosystem benefits they provide is an established state priority (CDF 2003). While the Montreal Process shares the broad goal of sustainable forest management with third-party certification systems (e.g., Forest Stewardship Council, Sustainable Forestry Initiative), certification standards are set privately and their audience is the marketplace. In contrast, the Montreal Process is a collaboration among public and private agencies with the ultimate audience being the citizens of California (Washburn and Block 2001, FSC 2004, SFI 2004). Thus it is in the public interest to explore the criteria used in the Montreal Process and to develop the associated indicators as means to assess the sustainability of California's forests.

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Below: Rob York taking Giant Sequoia measurements.

The effects of riparian prescribed fire on lotic habitat and biota in the Sierra Nevada (Blodgett Forest Research Station), California, USA

Authors: **Leah A. Bêche, Scott L. Stephens, Vincent H. Resh**

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ABSTRACT:

Concerns about the effects of fire on ecologically sensitive habitats have limited the use of prescribed fire in riparian management. Using a beyond-BACI (before-after-control-impact) experimental design, the effects of a 26-ha prescribed fire that burned upland and riparian areas of a 1st order watershed was examined in one burn and six control sites for up to seven years pre-fire and one-year post-fire. I monitored pre- and post-fire water chemistry, riparian vegetation, periphyton, large woody debris, sediment,

and aquatic macroinvertebrates. The fire consumed 79% of the pre-fire fuel in the riparian zone, with 34% of total surface fuel consumed and 90% of the total ground fuel consumed. There were increases in some water chemistry parameters (sulfate, total phosphorous, Ca^{2+}, and Mg^{2+}), a decrease in periphyton biomass, and an increase in fine sediment composition post-fire. Each of these changes were short-term, and recovery was documented in less than one year post-fire. Aquatic macroinvertebrate density, diversity and composition did not change post-fire. Likewise, there were no changes in LWD volume, recruitment, or movement. These results suggest that a carefully planned prescribed fire in and near riparian areas will not adversely affect channel structure or stream biota.

A Dendroecological Approach to Predicting Probability of Mortality for Two Tree Species in the Sierra Nevada

Authors: **Adrian J. Das, John J. Battles, Nathan L. Stephenson, Phillip J. van Mantgem**

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ABSTRACT:

Although a key demographic parameter, mortality for trees and other long-lived organisms is still poorly described. Probability of mortality is usually modeled as a function of average recent stem growth, and, while a useful simplification, this approach ignores the fact that tree mortality is a cumulative process. The growth history of a tree is a record of that process and therefore a powerful indicator of the tree's future. Our goal in this paper is to quantify important aspects of this history in order to improve our understanding of mortality.

We investigated the growth-mortality relationships for two long-lived conifer trees growing in the Sierra Nevada of California, *Abies concolor* (ABCO) and *Pinus lambertiana* (PILA). We capitalized on a unique dataset that recorded the death of many recently dead trees. From increment cores, we measured ring widths for sets of live (101 ABCO, 123 PILA) and recently dead trees (79 ABCO, 130 PILA)).

We explored three aspects of a tree's growth history in order to predict death: average growth, growth trend, and the abundance of abrupt growth declines—combining these parameters into a single model for the first time. Each parameter was calculated over varying time intervals. We relied on logistic regression to fit parameters. Models were assessed primarily by their ability to correctly classify live and dead trees from an internal validation set not used in model construction.

For both species, additional parameters significantly improved models and classification over use of average recent growth alone. In the case of *Pinus lambertiana*, the addition of the 35 year growth trend and 5 year counts of abrupt growth declines resulted in a much more balanced model (77.1% dead correctly classified, 74.7% live correctly classified) when compared to the use of average 5 years of growth alone (83.1% dead correct, 54.9% live correct). For *Abies concolor*, the addition of 5 year counts had a similar effect (75.9% dead correct, 76.2% live correct vs. 89.7% dead

correct, 54.8% live correct). In both cases, average recent growth alone classified dead trees effectively but also frequently misclassified live trees as dead. The abrupt growth decline term dramatically reduced live tree misclassification at the cost of modestly increasing dead tree misclassification.

Abies concolor mortality showed a stronger relationship with recent growth, while *Pinus lambertiana* showed a stronger association with long-term growth trend. Notably, one of the best models for *Abies concolor* required only 5 years of growth for best classification (while *Pinus lambertiana* required 35 years) However, other models using 25 years of growth performed equally well for this species, indicating that mortality signals can appear many years before actual death.

Our results suggest that trees often survive average slow growth and that additional measures are needed to assess mortality vulnerability. Use of average recent growth alone therefore risks a marked over-prediction of mortality.

A view of Sierra Nevada tree species

Fluxes of the reactive nitrogen oxides above a ponderosa pine plantation

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ABSTRACT:

The exchange of nitrogen between the biosphere and atmosphere affects ecosystem nutrient dynamics and forest health, as well as tropospheric ozone production and the atmospheric budget of reactive nitrogen oxides. Despite the importance of understanding the magnitude and mechanisms of this exchange, few direct measurements of reactive nitrogen oxide fluxes have been made due to the stringent instrumental requirements for eddy correlation analysis.

During the summer and fall of 2003 and 2004, we measured eddy covariance fluxes of NO2, total peroxy nitrates, total alkyl nitrates, and nitric acid using a new technique, thermal dissociation-laser induced fluorescence (TD-LIF). Preliminary analysis and results will be presented.

Above: downloading data from the atmospheric tower.

Collaborative Research: Microbial Communities as Biochemical Inputs to Forest Soil Humification Processes

Authors: **Mary Firestone, William Horwath**, **Richard Hagashi, Teresa Fan, and Jeffrey Bird**

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ABSTRACT:

Humic substances result primarily from a complex suite of biotic and abiotic processes acting on plant materials. While microorganisms are known to be involved in humification processes, little information exists on how microbes regulate the conversion of plant material into humic substances. An often-overlooked influence of soil microorganisms on C stabilization processes is that their bodies, or biomass, are primary building blocks in the formation of humic substances. Since microbial communities can differ substantially in their biochemical composition and metabolic capacities across ecosystems, we hypothesize that soil microbial community composition influences rates of humification and the amount and stability of humic substances formed. Defining the role of microbial community composition will thus enhance our conceptual understanding of C humification processes.

This research will follow the fate of ^{13}C-labeled microbial bodies from four groups (fungi, gram-positive bacteria, gram-negative bacteria and actinomycetes) in a temperate and a tropical forest soil. The ^{13}C substrate groups (whole dead cells) will be applied reciprocally to each soil to compare the effect of the microbial metabolic capacity in two very different forest soils. The fate of ^{13}C microbial litter will be tracked for 5 yr by measuring total recovery, utilization by indigenous microbial communities and their biomarker components (phospholipid fatty acid - PLFA), conversion to CO_2, and ultimately humification products (soil organic matter fractionation). The macromolecular biochemical composition of the starting substrates and the fate of added ^{13}C substrates in humic substances will be determined over the course of the field study using the complementary tools of $^{13}C/^{1}H$ NMR spectroscopy and pyrolysis GC/MS. In 2004, the first year of this project, the temperate forest site was established at Blodgett Forest. We

are evaluating the microbial community composition and culturing organisms isolated from both forest soils using ^{13}C substrates. The ^{13}C-labeled microbial bodies will be applied to both sites in 2005.

The results of this research will define microbial controls on humification processes that are critically important to agricultural and forestry issues of productivity and sustainability. The resulting data set will identify key characteristics of the microbial community that influence humification processes and its products, thereby substantially increasing our understanding of the mechanisms involved in C stabilization and sequestration.

The spatial scale of local adaptation in a host-parasite interaction

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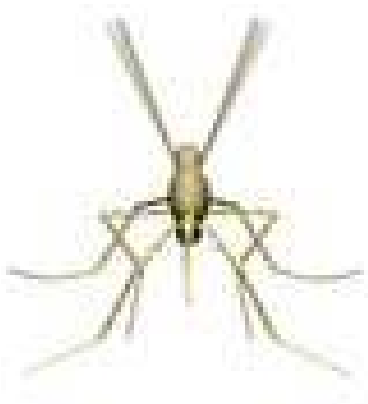
ABSTRACT:

Geographic patterns in local adaptation provide insight into the spatial scale at which coevolutionary processes occur. I used a hierarchical spatial structure to investigate patterns in host resistance in the interaction between a treehole mosquito (*Ochlerotatus sierrensis*) and a protist parasite (*Lambornella clarki*). California host populations were sampled at the regional scale and one host population (UC Hopland RES) was sampled more intensively to address variation at the local scale. In a common garden laboratory experiment, host susceptibility to infection decreased with increasing distance from the parasite source population. At the regional scale, host populations exhibited substantial variation in susceptibility to infection. Overall, host populations in the south were highly resistant to infection while northern populations were more susceptible to infection, including the Blodgett population. Parasites were locally adapted in that they were more infectious of local hosts but parasite load did not differ between sympatric and allopatric hosts.



Soil moisture and temperature constraints on fine root dynamics and plant growth in a Mediterranean forest in the Sierra Nevada, CA.

Authors: **Alexander Gershenson, Laurent Misson, Ralph Boniello, Jianwu Tang, Allen Goldstein, and Weixin Cheng**

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ABSTRACT:

The inter-annual dynamics of plant growth at Blodgett Forest, Western Sierra Nevada, CA, appear to be tightly controlled by the prevailing climatic conditions. The timing of precipitation and temperature changes seems to control the duration of growth by limiting it to a two month period between the initial warming of the soil and the rapid decrease of available soil moisture after the end of the rainy season. Our preliminary results suggest that favorable moisture and temperature conditions play a significant role in setting the duration of the growing season. It appears that the rise of daily minimum temperatures above 5º C initiates above- and belowground production in the middle of May (DOY 130), coinciding with the last rain event of the season (DOY 124). This rise in temperature is accompanied by a rapid decrease in soil moisture, from approximately 35% down to less than 20% at 50-cm soil depth, and close to 10% at 10-cm soil depth, in less than two months. Subsequently, above- and below-ground production strongly declines after this two-month period (DOY 200), and does not resume when the fall rains arrive in late September (DOY 280). Fine root production co-occurs with shoot elongation, trunk thickening and needle growth. Snowfall in early October precluded further measurements, and daily minimum temperatures rapidly decreased to below 5º C. These results show the potential for significant changes within the observed plant communities in the face of predicted climate change.

Emissions of highly reactive biogenic volatile organic compounds from the forest

Authors: **A.H. Goldstein[1]; R. Holzinger[1]; A. Lee[1]; M. McKay[1]; M.M. Lunden, [2]**

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ABSTRACT:

Biogenic emissions of VOCs play important roles in the chemistry of the atmosphere, with terpenes and isoprene affecting regional air quality, atmospheric radiation, and global climate through secondary organic aerosol formation. In 2002 we began field and laboratory measurements with a fast response Proton-Transfer-Reaction Mass Spectrometer (PTR-MS) of biogenic terpenes, and their oxidation products. Measurements were made in a California pine forest at the Blodgett Forest Research Station. Field measurements of vertical concentration profiles through the forest canopy of terpene oxidation products revealed the presence of large amounts of previously unreported compounds consistent with those recently observed in smog chamber studies. In addition, we have recently shown that about half the ecosystem scale ozone flux in summer is actually due to chemical reactions occurring between terpenoid compounds and ozone within the forest canopy. Taken together, this new information suggests that the flux of terpenes leaving the forest canopy represents at most 10% of the terpenoid compounds actually emitted, and the rest is chemically processed within the forest canopy. Branch enclosure measurements confirm more than 100 BVOCs are emitted but not typically observed above the forest. The implication is that the source of secondary aerosols from biogenic terpene oxidation is likely much larger than previously estimated. We have also consistently observed fine aerosol growth events at the Blodgett Forest site, which we believe are related to the terpene oxidation occurring in the forest canopy. Similar observations of aerosol growth events, non-stomatal ozone deposition, and missing OH reactivity at forested sites around the world suggest unmeasured reactive BVOC emission is common. The unmeasured BVOCs represent a previously unquantified carbon loss from ecosystems and a potentially major source of secondary organic aerosols, oxygenated VOCs (OVOCs), and OH radicals.

Ecology and epidemiology of sudden oak death: Host-pathogen interactions

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ABSTRACT:

Phytophthora ramorum is an oomycete pathogen responsible for the emergent forest disease sudden oak death (SOD). While a great many plant species are susceptible, it is particularly lethal to true oaks (*Quercus* spp.) and tanoak (*Lithocarpus densiflora*). Tanoak is especially endangered; its range is limited to a portion of the western U.S. coastline, the entirety of which is, if not already infested, at high risk for further expansion of the pathogen's naturalized range. Tanoak is highly susceptible to SOD; individual sites show up to 70% of trees infected. However, multiple researches have noted that on a small scale, patches of healthy tanoak are often observed immediately adjacent to patches with heavy mortality, suggesting that there may be variability for resistance in the system.

In 2004, we performed a preliminary study on tanoak saplings that demonstrated there are significant differences among individual trees in resistance to the pathogen, as measured by lesion size in under-bark and detached-leaf inoculations. In 2005, we will extend this study to a range-wide survey of resistance within and among populations of tanoak in California and Oregon. One study population will be located at Blodgett Forest Research Station; the others will range from Big Sur, California in the south to Curry County, Oregon, in the north. We will use both field-collect leaves and trees grown in a common garden to compare resistance structure to genetic structure, assay resistance for strain-specificity, and determine the usefulness of laboratory-determined resistance for predicting natural infection in the field.

Effects of planting density on early growth of giant sequoia (*Sequoidendron giganteum*)

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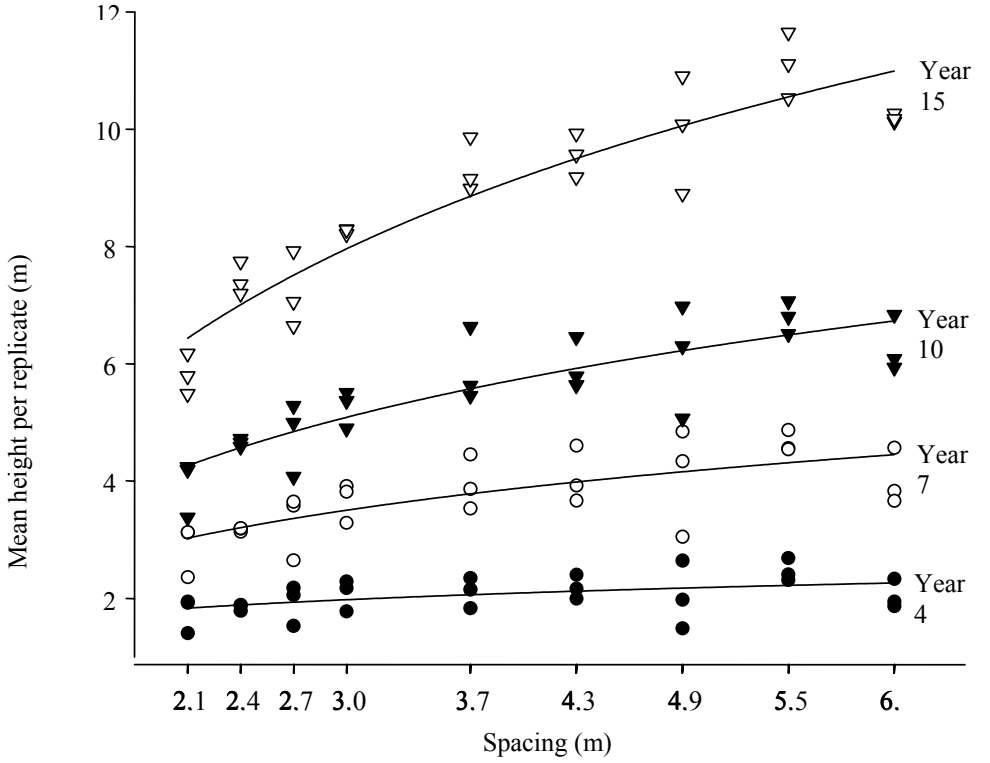
ABSTRACT:

Very little information exists for stocking and growth of young giant sequoia plantations. This study measured 2026 giant sequoia trees, planted at equlateral spacings of 7 to 20 ft, over a period of fifteen years. Nine spacings were replicated once in each of three blocks. Compared to other species that have been studied, giant sequoia shows remarkably early and extensive effects of intertree competition. Unlike results for other species, spacing substantially affects early height growth of sequoia. A general least squares model using spacing treatment as the level of inference showed that crown width, stem diameter, and height increased linearly with the natural log of spacing distance at 4, 7, 10 and 15 yrs after planting (p-values for ages 7 -15 years are all < .001). R2adj values increased over time such that by age 15, R2adj for the height equation was 0.86, for diameter 0.95, and crown width 0.93. By 15 yrs, trees at wide spacings (14-20 ft) were showing 53%-84% wider diameter at breast height and 23%-64% greater total height than trees at one half each respective wider spacing. Results indicate that for close initial planting densities (7 to 10' spacings which is equivalent to 1026 to 505 trees per acre), early precommercial thinning (before 7 yrs after planting) may be required to avoid significant intertree competition.

After the fifteenth growing season (2004), average annual height and diameter growth are still increasing (comparing the periods between ages seven and ten with ages 10 to fifteen) for all spacings. Wide spacings averaged 4.3 feet and close spacings 2.2 feet in annual height growth over the past five years. Wide spacings averaged 0.75 inches and close spacings 0.42 inches in annual breast height diameter growth over the past five years. The differences between wide and close spacings continue to expand.

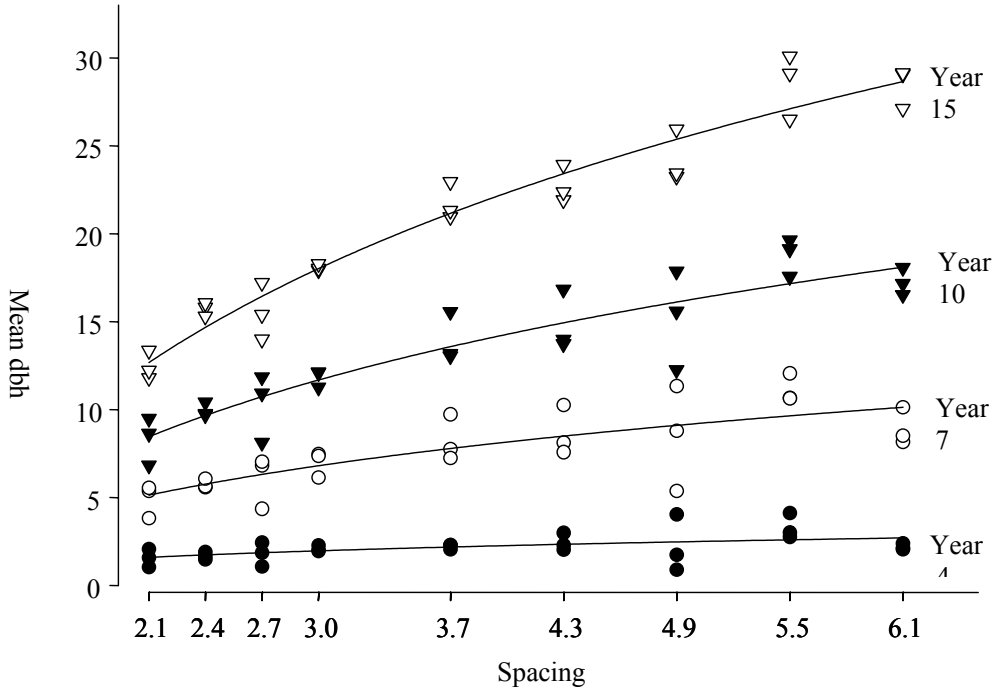
By age fifteen, average stem volume per tree ranged from 0.9 cubic feet at seven foot spacing to 8.8 cubic feet at eighteen foot spacing. Volume per acre at age fifteen ranged from a low of 937 to a high of 1418 cubic feet per acre. Both the widest (20 feet spacing due to few trees per acre) and closest (seven feet spacing due to small trees) spacings had relatively low volumes per acre. Average stem volume growth per year for eight to eighteen foot spacings over the period from age ten to age fifteen ranged from 148 to 208 cubic feet per acre with no clear relationship to spacing.

Fig. 1. Effect of spacing on height



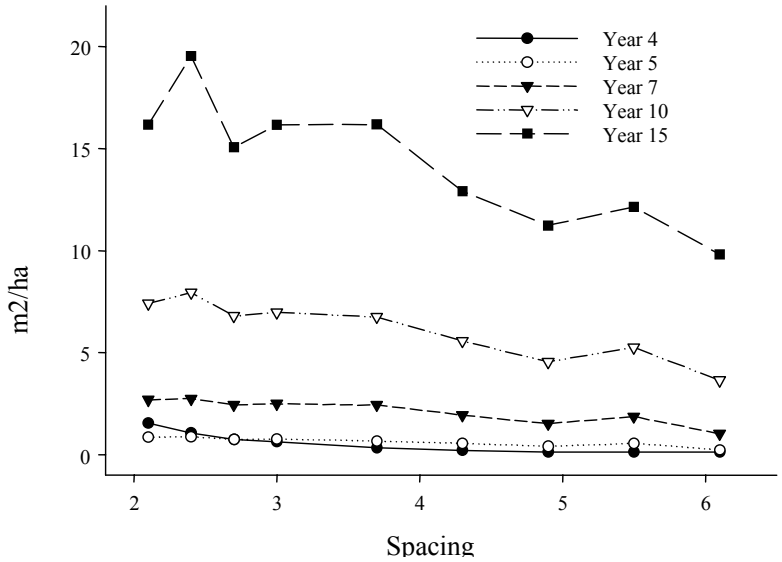
Year	N	R2adj	F-ratio	P > F
3	27	0.03	0.73	0.40
4	27	0.21	6.67	0.02
5	27	0.33	12.22	0.002
7	27	0.52	27.6	<0.001
10	27	0.73	68.03	< 0.001
15	27	0.86	151.82	<0.001

Fig. 2. Effect of spacing on diameter



Year	N	R2adj	F-ratio	P > F
3				
4	27	0.25	8.55	0.007
5	27	0.39	15.98	<0.001
7	27	0.61	38.58	<0.001
10	27	0.84	128.93	< 0.001
15	27	0.95	439.55	<0.001

Fig. 3. Two ways of displaying effect of spacing on basal area/ha



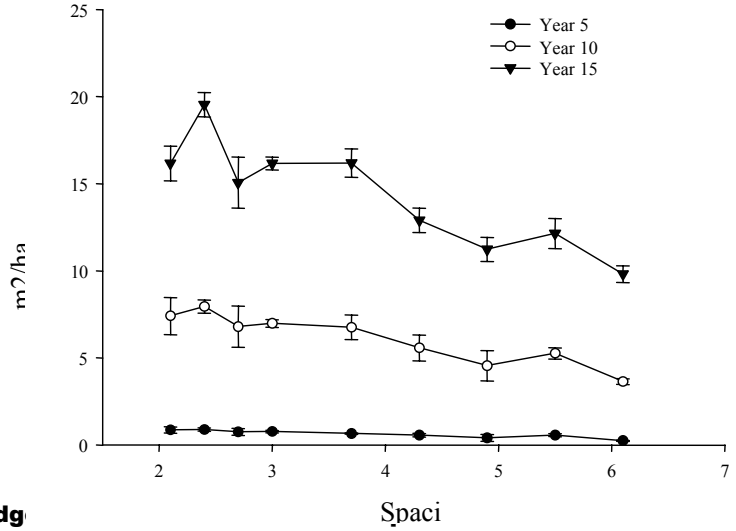


Fig. 4. Effect of spacing on crown radius

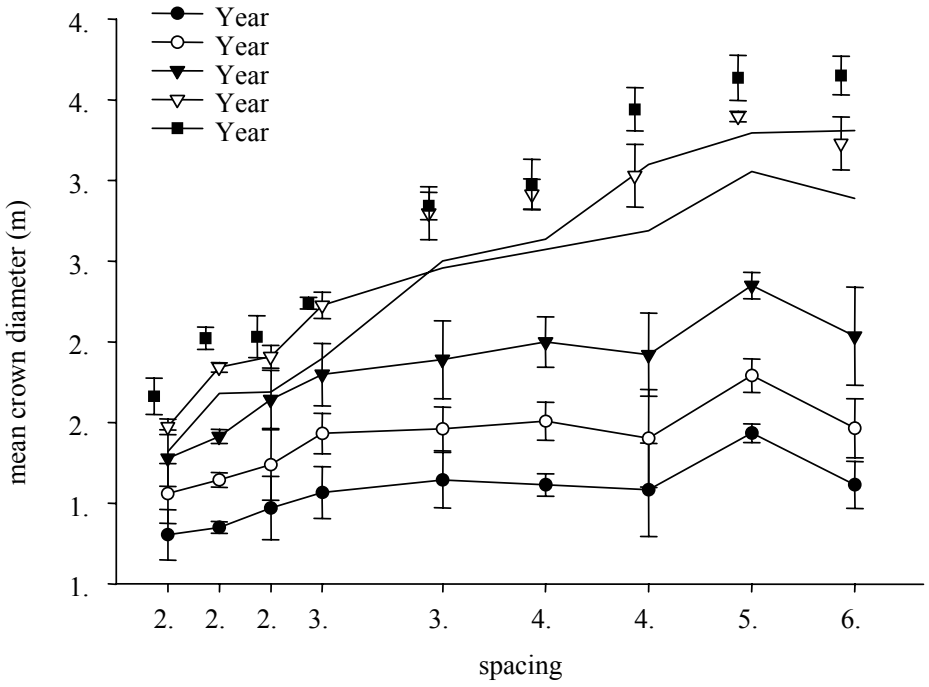
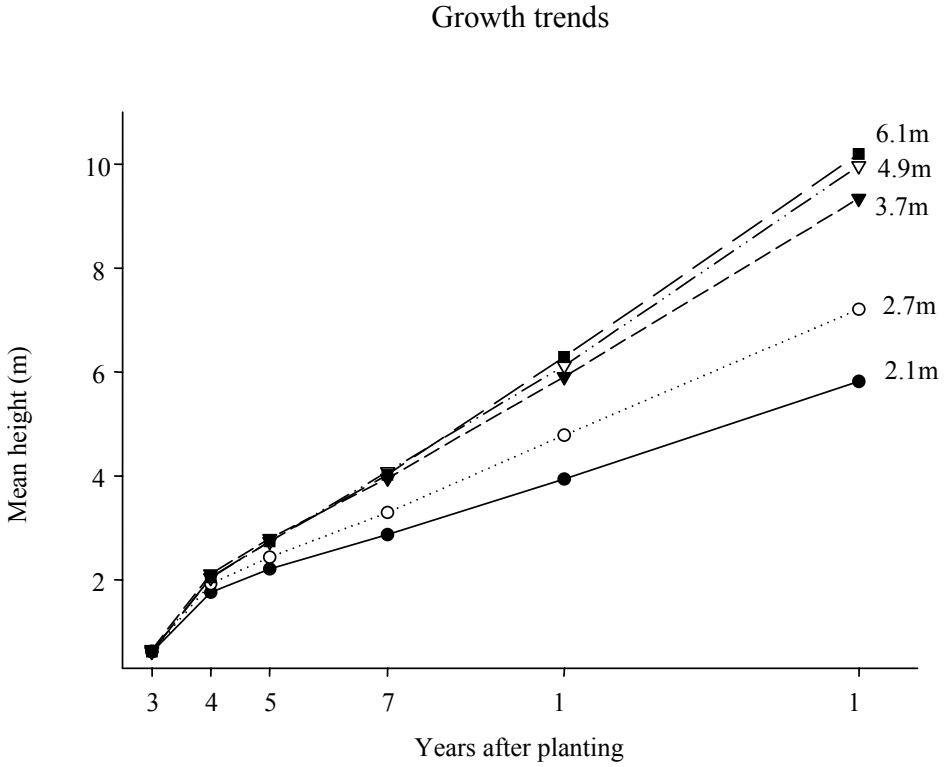


Fig. 5. Growth trends between spacings



Seasonal variation of biogenic VOCs and oxidation products over a pine forest in California

Authors: **R. Holzinger[1]; A. Lee[1]; Megan McKay[1]; and A.H. Goldstein[1]**

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ABSTRACT:

Vertical gradients of volatile organic compounds, using PTR-MS,, and water and CO_2, using a LICOR 6262, were measured in a Ponderosa pine forest in the Sierra Nevada, California (38.90º N, 120.63º W, 1315m) continuously for 11 months in 2003 and 2004. We have selected two periods representing typical summer (Jun 26 – Sept 23, 2003) and winter (Nov 21, 2003 – Jan 10, 2004) conditions at the site. Median daytime temperatures were 6 ^{o}C and 26 ^{o}C in winter and summer, respectively. Vertical fluxes and gradients of water and CO_2 revealed significant photosynthetic activity in winter. Concentrations of biogenically emitted 2-methyl-3-buten-2-ol (MBO) and isoprene were a factor of 10-20 lower in winter than in summer. The isoprene oxidation products methyl-vinyl-ketone and methacrolein were 30 times lower showing that their production was slower, consistent with oxidation capacity of the atmosphere being lower in winter. Monoterpene concentrations were only 2-3 times lower in winter. This may reflect either a longer lifetime or a relatively higher emission (compared to MBO or isoprene) of these reactive compounds in winter. The seasonal variation of local emissions, chemistry, and transport will be discussed.

BLODGETT RESEARCH

A Vertical Integration of the Forest Canopy to Assess the Atmospheric Impacts of Terpenes

Authors: **Anita Lee, Rupert Holzinger, Gunnar Schade, Max Henkle and Allen H. Goldstein**

Department of Environmental Sciences, Policy, and Management
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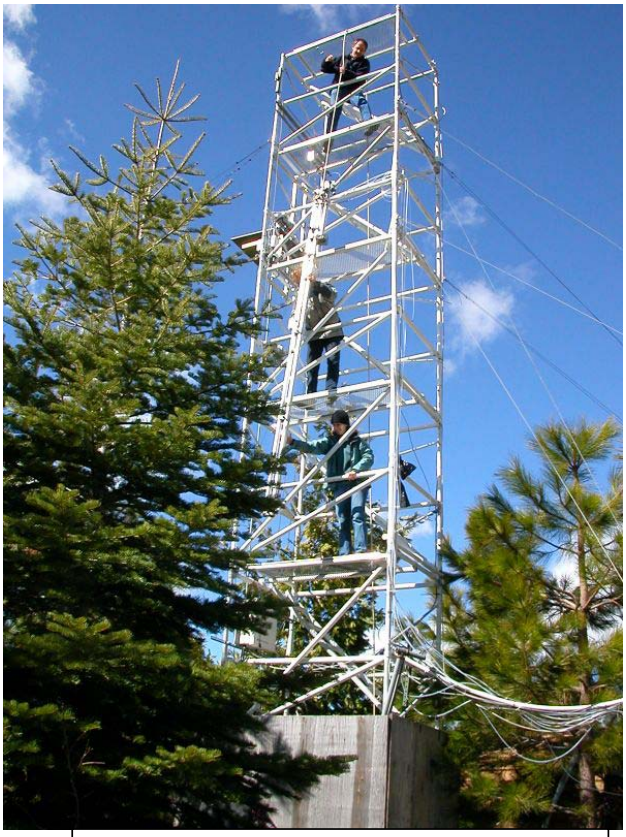
ABSTRACT:

Models predicting secondary organic aerosol production require input from measurements of the total terpenes emitted by an ecosystem, not just measurements of the few species typically obtained by above-canopy flux measurements. While these above-canopy fluxes are a useful measure of the terpenes that escape the forest canopy, they provide no information on the terpenes that react within the canopy. The different lifetimes of "reacted" and "escaped" terpenes result in different scales of impact (local versus regional) on the chemistry of the atmosphere. To improve our understanding of the atmospheric impacts of terpenes, we conducted measurements that vertically integrate over the forest canopy, using branch enclosure techniques, vertical gradient measurements, and above-canopy flux measurements using both PTR-MS and GC-FID. Measurements were conducted in a Ponderosa pine plantation on the western slope of the Sierra Nevada, California, in the summer of 2003. This presentation will focus on changes in the monoterpene species composition as we ascend the canopy, comparing the branch-level fluxes with the vertical concentration gradients a



Above: The Goldstein Group's instrument tower.

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Influence of canopy photosynthesis and summer rain pulses on root dynamics and soil respiration in a young ponderosa pine forest.

Authors: **Laurent Misson, Alexander Gershenson, Jianwu Tang, Ralph Boniello, Megan McKay, Weixin Cheng, Allen Goldstein.**

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ABSTRACT:

Soil respiration has been estimated to be about 68-80 PgC y-1, the largest component of carbon fluxes from ecosystems to the atmosphere. Despite its importance our understanding of soil respiration is still limited because of its high complexity and variability controlled by many biotic and abiotic factors. The fine root system play an important role in soil carbon cycling because it is a major part of the carbon input belowground annually. The first objective of this paper is to make the link between the seasonality of fine root dynamics (initiation, growth and mortality) and the carbon balance of the ecosystem. The second objective of this paper is to improve our understanding of how canopy photosynthesis influence fine root initiation, growth and mortality. In order to reach these obectives, we combined CO2 flux measurements (at ecosystem, soil, and leaf level) with aboveground (shoot, needle, stem) and belowground (fine root) growth dynamics. This research was conducted in a young Ponderosa pine plantation at the Blodgett Forest Ameriflux site located at 1315 m above sea level in the Sierra Nevada Mountains of California. One of our hypotheses was that fine root development at our site is a high priority and is tightly coupled to canopy photosynthesis and available soil water. This hypothesis is partially confirmed and mainly holds for the first part of the vegetation period when a tight coupling between photosynthesis and root growth was observed. We found that the window period for optimal root growth is extremely reduced at our site, for one part due to low soil


Goldstein group Tower

temperature during the winter and for another part due to soil water stress during summer. However, large rates of photosynthesis were observed following summer rains during the second part of the vegetation period while temperature was optimal, but root growth did not resume and mortality rates did not decrease. It is likely that fine root dynamics is controlled by both environmental variables (mainly soil temperature and water content) and endogenous factors (mainly carbohydrate supplies and phenological signal). The second hypothesis was that fine roots exert a major control over the seasonal patterns of the soil respiration; and that such control is most apparent when roots are actively growing. This hypothesis is also partially confirmed because increases in soil and ecosystem respiration corrected for temperature variations were observed during the actively growing period. This provides evidence for a direct link between canopy photosynthesis and ecosystem and soil respiration. However, increase in respiration during root growth was limited in magnitude. The largest variation in soil respiration at our site occurred due to an increase in heterotrophic respiration during unusual rain pulse events in the second part of the vegetation period. However, the activity of these heterotrophs was highly dependent on the earlier input of fresh soil labile carbon by the roots. This provides evidence for an indirect link between canopy photosynthesis, root growth and soil respiration.

Population genetic and genet structure of the forest pathogen *Leptographium wageneri*

AUTHOR: **Kabir G. Peay**

UC Berkeley, Dept of Environmental Science, Policy & Management

ABSTRACT:

Leptographium wageneri (Kendrick) MJ Wingfield is a forest pathogen native to the western United States. Its known distribution ranges North-South from New Mexico to British Columbia and East-West from Colorado to California. The pathogen infects coniferous trees causing symptomatic black staining of colonized portions of the roots and bole, commonly referred to as Black Stain Root Disease. Infection spreads to nearby trees and creates distinct mortality centers, which can become quite large. The first phase of my research will examine the population structure of *L. wageneri* using genetic markers. At the stand level this will allow me to judge the relative importance of long-distance vectoring by beetles within an infection center versus clonal spread through root-to-root infection. At the regional level this will allow me to differentiate populations of the pathogen and identify geographic barriers to dispersal. Finally, because *L. wageneri* is asexual, I will be able to identify evolutionary patterns created in the absence of recombination.

Twenty-year growth response in Nelder plot trials for giant Sequoia, ponderosa pine and Douglas-fir

Authors: **Galen Peracca, and Kevin O'Hara**

ABSTRACT:

In 1962, J.A. Nelder introduced an innovative systematic circular plot design for studying the effects of spacing upon growth characteristics in plants. Foresters soon discovered that Nelder plot arrangements offer a compact, efficient means of studying growth and yield responses to changes in growing space. Nelder plots were established on Blodgett Forest Research Station in 1985 for five different mixed-conifer species.

Five Year old Sequoias planted in Nelder plots

Three of the five existing Nelder plots were examined in 2004 to determine the effects of initial planting spacing (varying from 10649 TPA to 106 TPA) on height,

diameter and live crown in ponderosa pine, Douglas-fir and giant Sequoia monocultures. Growing space was represented as the area of the Thiessen polygon surrounding each individual tree and assuming an ideal Nelder Design 1a plot layout. In Design 1a the growing space per tree increases from the center to the edge of the plot, while the rectangularity (length-to-width ratio of the growing space per tree) remains constant. We expect height was not significantly affected by growing space while live crown and DBH were directly affected. We plan to develop relationships linking growing space availability to height and crown length at age 20. We also anticipate that these results will contribute to the scant research published on giant Sequoia growth patterns. We plan to complete the analysis and report on our findings by summer, 2005.

BLODGETT RESEARCH

The Center for Forestry in Transition

Author: **Frieder Schurr**

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4501 Blodgett Forest Road
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ABSTRACT:

The Center for Forestry and its properties (Blodgett Forest, Whitaker Forest, and Baker Forest/Summer Camp) are at the beginning of a new management era. Starting in January 2005 a reorganization of personnel, job responsibilities, and management structure began. Rick Standiford left the Center in January to pursue new opportunities as Associate Vice President for DANR at the Office of the President. And after more than 25 years as Blodgett Forest Manager and 6 as co-Director in charge of properties for the Center, Bob Heald plans to retire on June 30th to pursue other personal goals.

However, Bob has graciously agreed to work up to 50% time during the next 2 years to aid in the transition. He will continue in his role as co-Director in charge of properties. Starting January 2005 he will relinquish his role as field manager for the properties and will concentrate his efforts on completing the major infrastructure projects that are currently ongoing at the properties.

Day to day management at the properties is now the responsibility of Frieder Schurr (Blodgett Forest) and Rob York (Whitaker Forest and Baker Forest). Operations at the properties are not expected to go through any drastic changes due to the transition. Any requests for aid in locating research sites or requests for assistance for approved research projects and other matters at the properties should be made directly to Rob or Frieder.

New research proposals and modifications to existing research proposals (including extensions) will continue to go through the same channels as always. Proposals must be submitted to the Directors (Bob Heald and John Battles) who will guide them through the review process. Approvals will come from Bob and/or John directly. Please keep your project status up to date. Expired projects are subject to cancellation and will not have any priority or protection with respect to forest management activities.

The only major change in research project considerations at the properties will be in how they impact required management activities that must continue at the properties. The forests (especially Blodgett) are working forests that are dependent on timely activities including timber harvests and cultural activities to maintain their wide range of stand conditions and research opportunities. New or extended projects in management compartments will only be approved if they do not significantly alter these activities. Projects that will significantly increase management costs due to altered or delayed management activities will only be approved if the project includes funds to offset these additional costs. Higher management costs directly impact the level of services available at the forests including staffing, housing, and in field assistance.

Left:
Marking Inventory Plots Centers

Right:
Beginning Planting Operations

Ecology of the Spotted Owl in the North-Central Sierra Nevada

Authors: **Mark Seamans, Michelle Crozier, and R. J. Gutiérrez**

University of Minnesota
Department of Fisheries, Wildlife, and Conservation Biology
St Paul, MN 55108

ABSTRACT:

We used a capture/recapture study design to study population ecology of the California spotted owl (*Strix occidentalis occidentalis*). Our 925 km^2 study area was between Georgetown, CA, and the western shore of Lake Tahoe. Since 1986, we have conducted over 14,000 surveys and captured and uniquely marked 262 territorial and 282 juvenile California spotted owls. From this data we are able to estimate annual rates of survival, fecundity, and population change. Estimates of vital rates for territorial owls varied by age-class: annual survival = 0.53 [SE = 0.10] for 1 and 2-year-olds, and 0.84 [SE = 0.02] for owls $\geq$3 years-old; annual number of young fledged = 0.62 [SE = 0.14] for 1 and 2-year-olds, and 0.80 [SE= 0.13] for owls $\geq$3 years-old. Fecundity varied extensively over time (coefficient of temporal process variation [CV] = 70%) relative to survival (CV < 5%). Annual rate of population change followed a quadratic patter, with a peak around 1995. Average annual rate of population change was 1.025 (SE=0.020).

We have implemented ancillary research on spotted owl food habits, competitors, predators, physiology, habitat requirements, genetics, disease, and disturbance, to provide insight into why this population varies over space and time. This information is used by individuals and agencies for better management of California spotted owls. For example, we initiated a West Nile Virus pilot study in 2004, testing owls and their prey for presence of this virus. We have also initiated population and behavioral studies on great horned and barred owls, two main competitors and potential predators of the spotted owl. In addition, we continue to follow habitat changes in space and time, and their effects on spotted owls.

Refining the Aggregation Pheromone and Testing Interruption of the Flight Behavior of the California Fivespined Ips, *Ips paraconfusus*

Authors: **Steven J. Seybold[1], Jana C. Lee[1,2], Shakeeb M. Hamud[1], Dezene P.W. Huber[1,2], and David L. Wood[3]**

[1]*Chemical Ecology of Forest Insects, Pacific Southwest Research Station, USDA Forest Service, Davis, CA 95616*
[2]*Department of Entomology, University of California, Davis, CA 95616*
[3]*Division of Insect Biology, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720*

ABSTRACT:

The California fivespined ips, *Ips paraconfusus* Lanier, is an economically-important bark beetle in California forests. At Blodgett Forest Research Station it occurs in ponderosa pine, *Pinus ponderosa*, and sugar pine, *Pinus lambertiana*. *Ips paraconfusus* is the first beetle for which any pheromone was isolated. During the 1960's, Blodgett Forest populations were used in the initial pheromone isolation and field studies. The male-produced pheromone is a synergistic blend of three monoterpene alcohols, ipsenol, ipsdienol, and *cis*-verbenol (Silverstein et al., 1966). The alcohols occur as pairs of optical isomers called enantiomers and the naturally occurring compounds isolated from males were (4*S*)-(−)-ipsenol, (4*S*)-(+)-ipsdienol, and (1*S*,2*S*)-(+)-*cis*-verbenol. The current commercially available pheromone for *I. paraconfusus* is an equal (racemic) mixture of the optical isomers of ipsenol and ipsdienol, and ~80%-(1*R*,2*R*)-(−)-*cis*-verbenol (Table 1). Thus, the commercially available pheromone does not match the naturally occurring compounds.

In August and September 2004 we used multiple funnel traps and commercially available pheromones in modern release devices to test the preference of *I. paraconfusus* for the enantiomers of ipsdienol in combination with racemic ipsenol and 80%-(1*R*,2*R*)-(−)-*cis*-verbenol (Table 2). The experiment also included another behavioral chemical (semiochemical) called conophthorin, which is known to interrupt the flight response of other species of *Ips*. Conophthorin has been isolated from a wide range of natural sources, including cone beetles, twig beetles, wasps, and angiosperm tree bark. Our experiment was organized in a randomized complete block design

consisting of four blocks of seven treatments (two blocks each in Compartments 270 and 611) with the treatments re-randomized nine times during the study period. We found that *I. paraconfusus* had a strong preference for the bait containing (+)-ipsdienol. Very few beetles were attracted to the mixture containing (–)-ipsdienol. A doubled release rate of racemic ipsdienol attracted fewer *I. paraconfusus* than the single release rate of (+)-ipsdienol; this indicates that the (–)-enantiomer of ipsdienol interrupts the attractive response, confirming previous work in Siskyou Co. (Light and Birch, 1979) and San Diego Co. (Paine and Hanlon, 1991). Conophthorin interrupted the response of *I. paraconfusus* to the attractant containing (+)-ipsdienol. Thus, among the treatments tested, the most effective attractant for *I. paraconfusus* was racemic ipsenol, (+)-ipsdienol, and (–)-*cis*-verbenol. Both (–)-ipsdienol and conophthorin could be used to interrupt the aggregation response of *I. paraconfusus*. Future work at BFRS might investigate the combined effect of (–)-ipsdienol, conophthorin, and another widely used bark beetle semiochemical, verbenone, on the interruption of *I. paraconfusus*.

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SILVERSTEIN, R. M., RODIN, J. O., and WOOD, D. L. 1966. Sex attractants in frass produced by male *Ips confusus* in ponderosa pine. *Science* 154: 509-510.

TABLE 1. RELEASE RATES AND CHEMICAL PURITIES OF SYNTHETIC SEMIOCHEMICALS USED IN IPS PARACONFUSUS *TRAPPING STUDIES,*

BLODGETT FOREST RESEARCH STATION, 27 AUG.-22 SEPT., 2004

Semiochemical[a]	*Enantiomeric composition*	*Load (mg)*[b]	*Release rate (mg/day)*[c]	*Chemical Purity*
Ipsenol	**Racemic**	**40**	**0.4**	**> 98%**
Ipsdienol	**Racemic**	**40**	**0.2**	**> 97%**
***R*-Ipsdienol**	**96.5%-(–)**	**40**	**0.2**	**95%**
***S*-Ipsdienol**	**96%-(+)**	**40**	**0.2**	**95%**
***cis*-Verbenol**	**83%-(–)**	**75**	**0.3-0.6**	**> 98%**
(*E*)-conophthorin	**Racemic**	**70**	**3.0**	**~90%**

[a]Phero Tech International Product Numbers L1-2240/250 (ipsenol), L1-2140/250 (racemic ipsdienol), L1-2140/203 [(–)-ipsdienol], L1-2140/297 [(+)-ipsdienol], A2-3011/000 (*cis*-verbenol), and RD-0377/000 (conophthorin).

[b]Polyethylene centrifuge tube release device (400 µl) for conophthorin; all other semiochemicals used a polyvinyl chloride bubble cap release device.
[c]Release rates determined at 25^0 C using a volatile trapping system (Phero Tech Inc.).

TABLE 2. SEMIOCHEMICAL TREATMENTS USED IN *IPS PARACONFUSUS* TRAPPING STUDY, BLODGETT FOREST RESEARCH STATION, 27 AUG.-22 SEPT., 2004

Semiochemical Treatments
Unbaited trap
Racemic ipsenol, racemic ipsdienol (1X), 83%-(–)-*cis*-verbenol
Racemic ipsenol, racemic ipsdienol (2X), 83%-(–)-*cis*-verbenol
Racemic ipsenol, (*S*)-(+)-ipsdienol (1X), 83%-(–)-*cis*-verbenol
Racemic ipsenol, (*R*)-(–)-ipsdienol (1X), 83%-(–)-*cis*-verbenol
Racemic ipsenol, (*S*)-(+)-ipsdienol (1X), 83%-(–)-*cis*-verbenol, racemic conophthorin
Racemic conophthorin

Experimental Fuel Treatment Impacts on Forest Structure, Potential Fire Behavior, and Predicted Tree Mortality in a Mixed Conifer Forest

Authors: **Scott L. Stephens and Jason J. Moghaddas**

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ABSTRACT:

Fuel treatments have been suggested as a means to limit the size and intensity of wildfires but few experiments are available to analyze the effectiveness of different treatments. This paper presents information from a replicated, stand level experiment from mixed conifer forests in the north-central Sierra Nevada that investigated how control, mechanical (thinning from below followed by rotary mastication), prescribed fire, and mechanical followed by prescribed fire treatments affected fuels, forest structure, potential fire behavior, and modeled tree mortality at 80th, 90th, and 97.5th percentile fire weather conditions. Fuels Management Analyst was used to model fire behavior and tree mortality. Commercial thinning and mastication each reduced crown bulk density by approximately 19% in mechanical only and mechanical plus fire treatments. Prescribed burning significantly reduced the total combined fuel load of litter, duff, 1, 10, 100, and 1,000-hour fuels by as much as 80%. This reduction significantly altered modeled fire behavior in both mechanical plus fire and fire only treatments in terms of fireline intensity and predicted mortality. The prescribed fire only and mechanical followed by prescribed fire treatments resulted in the lowest average fireline intensities, rate of spread, and predicted mortality. The control treatment resulted in the most severe modeled fire behavior and tree mortality. Mechanical only treatments were an improvement over controls but still resulted in tree mortality at severe fire weather when compared with the treatments that included prescribed fire. Restoration of mixed conifer ecosystems must include an examination of how proposed treatments affect fire behavior and effects. Variation in existing stand structures will require solutions that are site specific but the principals outlined in this work should help managers make better decisions.

Setting a control burn

Fire and Fire Surrogate Study

Compartment 380 post burn

Inventory pole post burn 2000, Compartment 60

Fuel Treatment Impacts on Terrestrial Coarse Woody Debris and Snags in a Sierra Nevada Mixed Conifer Forest

Authors: **Scott L. Stephens and Jason J. Moghaddas**

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ABSTRACT:

Coarse woody debris (CWD) and snags are important elements of the structure and function of mixed conifer forests in the Sierra Nevada. In this paper, we report on the impacts of several replicated fuel treatments including, prescribed fire, mechanical alone, mechanical followed by prescribed fire, and control, on CWD and snag quantity and structure. Post treatment, the density of snags greater than 15 cm DBH in decay class 1 significantly increased in fire only and mechanical plus fire treatments compared with mechanical only and control treatments. Snag volumes (m^3ha^{-1}) were not significantly different between treatments for all decay classes. CWD (density, percent cover, volume) in decay classes 1 and 2 was not significantly altered by any treatment when aggregated across all diameter classes. Volume of CWD in decay class 3 was significantly reduced in the fire only treatment when compared to controls. Density and volume of CWD in class 4 was significantly reduced in mechanical plus fire and fire only treatments when compared with the controls and mechanical only treatments. Retention of large CWD levels may benefit some wildlife species short-term but increases in fire hazards and increased difficulties in fire control are the negative consequence. High overall fuel loads also increase the probability of CWD and snag consumption when an area inevitably burns. The influences of altering CWD and snag characteristics should be analyzed in the context of long-term forest management goals, including the reintroduction of fire as an ecosystem process and production of forests that can incorporate wildfire without tree mortality outside a desired range.

Silvicultural System Impacts on Potential Fire Behavior and Forest Conservation: 25 Years of Experience from the Sierra Nevada, California

Authors: **Scott L. Stephens and Jason J. Moghaddas**

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ABSTRACT:

Most agency administrators and ecologists agree that reducing the levels of hazardous fuels on forests is essential to protect adjacent human communities and to restore healthy watersheds. The current debate over the appropriateness, technique, and timing of treatments utilized to restore vegetation structure and composition, fuel loads, and fire behavior is currently on-going at local, state, and national levels. To provide information for these forums, the efficacy of nine traditional silvicultural systems used in the Sierra Nevada and elsewhere is evaluated in terms of vegetation structure, fuel bed characteristics, modeled fire behavior, and potential wildfire related mortality. The nine silvicultural systems include old growth reserve, young growth reserve, thinning from below, individual tree selection, overstory removal, and four types of plantations. These are the most commonly used silvicultural systems on federal, state, and private lands in the western United States. Each silvicultural system had three replicates and varied in size from 15-25 ha; a systematic design of plots was used to collect tree and fuel information. The reserves and thinning from below treatments preformed better than all other silvicultural systems but they also have moderate vulnerability to being damaged by wildfire during severe conditions. A new group of silvicultural treatments is needed to begin the restoration of western Untied States forests that have been impacted by past management decisions such as fire suppression and harvesting. The use of prescribed fire alone or in combination with other silvicultural treatments can be very effective in reducing potential fire behavior and effects in many western forests. Prescribed fire has the advantage of reducing fuel hazards in conjunction with the reintroduction of a fundamental ecosystem process, a combination that begins to meet the requirements of ecological restoration.

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

Authors: **Margaret S. Torn[1], Todd Dawson, Julia Gaudinski, Jeffrey Bird, and Stefania Mambelli[2]**

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ABSTRACT:

Sequestering carbon (C) in terrestrial ecosystems is a potential approach to reducing the buildup of atmospheric CO_2. Soil is the most effective sequestration reservoir for C in many ecosystems because of the long turnover time of soil organic matter (SOM) compared to most plant tissues, and because of less inter-annual variability or disturbance-driven losses. Beginning in 2001, we have been conducting a multi-investigator project—centered at Blodgett but also using other temperature forests--to fill critical gaps in belowground plant-soil carbon cycling. Our objectives at Blodgett we include: (1) quantifying the stocks and lifetime of fine roots and determining the lower bound of NPP "pumped" into soil carbon through fine roots; (2) comparing the sequestration efficiency of leaf and fine-root inputs, including litter decay, humification, and SOM products; (3) characterizing the turnover times of SOM pools. We are using a variety of isotopic techniques, such as ^{14}C analysis of roots and SOM and dual-label ($^{13}C/^{15}N$) litter traced into the microbial community, and SOM fractions, and CO_2.

Preliminary results include: (1) Fine roots must be considered as (at least) two populations, short-lived (< 1 yr) and longer lived (2-18 yr). Sampling via size-class may not be the best strategy, as fine roots with same size class can have very different lifetimes, form, and potential function. (2) C allocation to fine roots versus leaves enhances sequestration in the short term because fine roots live longer and decompose more slowly than leaves (regardless of soil depth). (3) Longer-term implications of plant allocation are unclear because differences in initial litter decomposition between roots and leaves may not portend the trend in humification and storage as SOM. Moreover, altering plant allocation patterns or locking up nutrients in sequestered OM may influence the plant's ability to acquire belowground and aboveground resources, which may in turn feedback to alter productivity and long-term C sequestration.

Effects Of Fire And Fire Surrogate Treatments On Fisher Habitat

Authors: Richard L. Truex, William J. Zielinski, and Frederick V. Schlexer.

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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 is the risk of catastrophic fire. Land management activities designed to reduce fuel loads and reintroduce fire as an ecological process may ultimately benefit the fisher population by reducing the likelihood of large fires, though there are short-term risks associated with these activities (e.g., loss of large snags and logs). During 2001 we initiated research at the Blodgett Forest Research Station (BFRS) and Sequoia-Kings Canyon (SEKI) in conjunction with the Fire and Fire Surrogate (FSS) Treatment Study to examine the short-term effects of several management activities on fisher habitat quality. At each FFS site, 10 plots within each treatment unit were sampled before and 1 year after treatment. Changes in fisher habitat suitability are being assessed using a Resource Selection Function developed for fisher in California. Field data collection was completed at both FFS sites during 2004, and data analysis is ongoing. Efforts will be made to resample all plots 5 years after treatment implementation to better understand the delayed effects of treatments on fisher habitat suitability. Project completion is expected during 2005.

Stand structural response to decline of sugar pine in California's mixed-conifer forests.

Author: **Kristen M. Waring and Kevin L. O'Hara**

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ABSTRACT:

Research in the Sierra Nevada mixed-conifer forests investigating the response of individual trees to the decline of sugar pine is lacking, as are detailed views of stand dynamics based upon stand reconstruction studies. Sugar pine decline began approximately 80 years ago, as a result of an introduced tree disease, white pine blister rust. This project is investigating which tree species' show quantitative responses to sugar pine decline, and how quickly the response occurs. Temporary circular plots were located throughout the Sierra Nevada Mountains including Blodgett Forest, ranging in size from 1/10 ha to 1/25 ha. On each plot, several trees were chosen for more intensive sampling, including destructive sampling where possible. Data collection included diameter, total height, crown radii, tree vigor measurements, sapwood area, age, and growth. On destructively sampled trees, cross sections were removed at various points along the tree bole for detailed ring measurement analysis. On other sample trees, cores were taken at the base, breast height (1.37m), and three meters. Expected results include detailed descriptions of stand dynamics, individual tree responses (quantified via growth and vigor analysis), and guidelines for management of affected mixed-conifer stands. Completion of data analysis and write-up is expected by mid-2005.

Radiata pine tree growth as affected by western gall rust: results from a genetics trial.

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ABSTRACT:

Radiata pine (*Pinus radiata*), planted worldwide as an important timber species, is native to the central California coast and two islands off the coast of southern California. Within its native range, radiata pine succumbs to branch and stem deformities resulting from galls formed following infection by western gall rust (caused by *Endocronartium harnessii*). In locations with large radiata pine plantations, introduction of western gall rust could have negative impacts on the local timber economy. Previous research into the radiata pine – western gall rust pathosystem found a relationship between genetic origin and number of galls present. Ramets from that research were then selected for a common garden experiment that began in 1988. Twenty-eight clones from a range of genetic origin and exhibiting a range of western gall rust susceptibility were chosen and planted in four blocks at Russell Research Station in Lafayette, California. Tree measurements, including western gall rust infection data, diameter at breast height, tree height, and stem form were collected periodically between 1988 and 2001. Analysis included both parametric and nonparametric tests due to non-normality in gall count data. In general, trees with more galls had less volume and better stem form. Nonparametric comparisons of gall counts between genetic origin group showed that trees from the island populations had significantly fewer branch and stem galls than other groups but also had lower volume growth. Trees from the mainland populations had more galls than all other genetic origin groups. These results may be useful in quantifying the risk present from accidental introduction of western gall rust into new locations such as New Zealand, where radiata pine is an important component of the timber economy.

Effect of burn residue proximity on growth of 5 planted mixed conifer species after 6 years

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ABSTRACT:

Burned areas represent a significant amount of the forest landscape that can potentially be planted following site preparation techniques that use burning of logging residue. However, managers implementing post-harvest or post-wildfire regeneration efforts face uncertainty in performance of seedlings planted in or around post-burn residues (i.e. ash substrate) given expected changes in soil moisture and nutrient availability. To address this uncertainty, five species were planted following site preparation beneath a shelterwood overstory in a Sierra Nevada mixed conifer forest. We planted seedlings within, on the edge, and outside of ash substrates following experimental burning of

uniform debris piles. After six years, height and radial growth was evaluated with respect to burn pile proximity. For Douglas-fir, sugar pine, ponderosa pine, and giant sequoia, relative and absolute height and radial growth were influenced by burn pile proximity. In general, seedlings planted within burn piles grew better than seedlings planted on the edges and outside of burn piles. Incense cedar growth was not influenced by burn pile proximity. Shrub competition also varied by burn pile proximity, but was only important in explaining Douglas-fir height growth. Mortality for all species was low regardless of burn pile proximity. Further opportunities exist for this study exploring the effects of fire-caused soil nutrient changes on seedling growth over time.

Early growth trends and stand level effects of experimental gaps

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ABSTRACT:

Gap-based silviculture has been proposed as a regeneration method with potential for use within a wider framework of management for diverse objectives. Yet uncertainty remains about details of implementation and expected growth within and surrounding both artificial gaps and in forests undergoing gap-phase succession. To address these uncertainties, experimental gaps ranging in size from 0.1 to 1.0 ha were created at Blodgett Forest Research Station, California. Six species were planted in a wagon-wheel design and repeatedly measured through the first 7 years to track relative survival and growth trends as influenced by species, within-gap position, and gap size. We took a broad perspective by also measuring the growth response of mature trees surrounding gaps along transects from gap edges into the intact matrix. After seven years, giant sequoia is the tallest species within gaps, but its projected growth is declining. Ponderosa pine (second tallest) and sugar pine (fifth) both have linear growth rates and are projected to surpass other species in terms of stature. Douglas-fir (third tallest) and incense cedar (fourth) had rapid early growth but have declining rates at year seven. White fir growth rate is steady but relatively low. Shade tolerance classifications did not predict functional responses of height growth to gap size. Instead, the models chosen (by an information-theoretic approach using Akaike Information Criteria) tended to reflect speculated gap growth strategies that may be related to gap-partitioning and eventual co-dominance in the canopy. An asymptotic fit of height growth to gap size was most commonly selected as the best model among a set of feasible a priori candidate models. As gap size increased, height gains tended to diminish between 0.3 and 0.6 ha. Likewise, gaps smaller than or equal to this same size range maximized matrix tree growth across the entire stand. For the 5 years after gap creation, trees along the gap borders benefited in terms of radial growth increment within 10 meters of gap edges. The depth of this edge influence is constant between orientations from gap center and between gap sizes, suggesting increased underground resources as the dominant cause of growth release. For balancing the growth tradeoff between regenerating and matrix

trees, gap sizes of about 0.25 ha were ideal. Life history differences between species, especially timing of growth rate changes following gap creation, influence height dominance patterns over time.

WORKING AT BLODGETT FOREST

Photo point monitoring at Blodgett Forest Research Station

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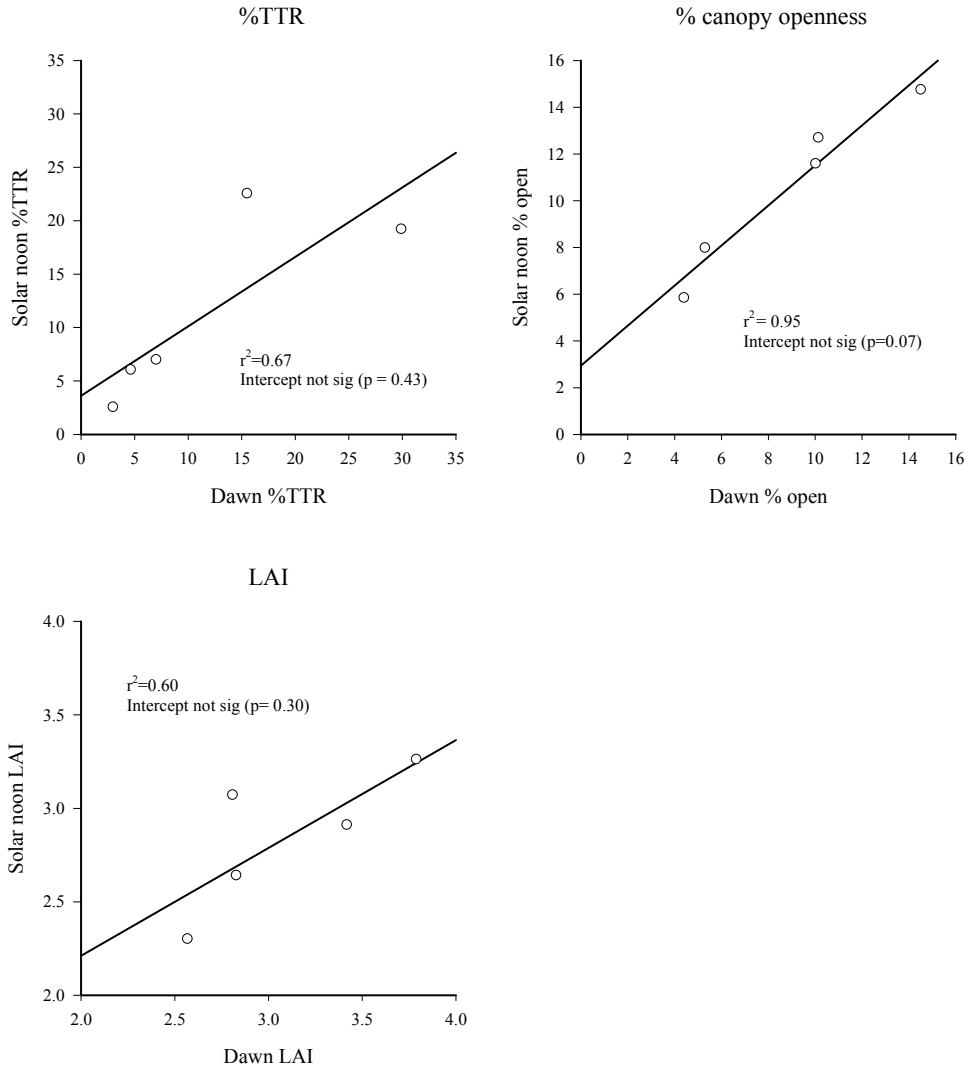
ABSTRACT

I am evaluating the potential use of repeat photography as a resource for BFRS research and management. This pilot study has two components: 1) determine the relative costs and procedures for implementing a forest-wide photo monitoring system of vegetation on permanent inventory plots; and 2) evaluate the prospect of using hemispherical photography to monitor canopy cover, light penetration, and leaf area index (LAI) for stocking control.

1. Permanent vegetation plots in compartment 100 were used for the pilot study. A standard, 2 mega-pixel 35mm lens digital camera (Canon) was used to take the photos. A meter board was placed at plot center (the photo point) for reference, and photos were taken from each cardinal direction surrounding the photo point. The most critical decision in carrying out a photo point monitoring effort is establishing the distance from the camera to the photo point. This distance must remain the same over time, and it also determines how much of the plot is captured by the photo (focal length differences from year to year can be adjusted for with post-capture formatting). Using a qualitative assessment of the images, a distance of about 12 meters effectively captures the plot area. The photos (4/plot) took an average of about 16 minutes per plot (n=7). This average includes the time it took for two people to measure out a distance of 12 meters from the photo point in each cardinal direction. Downloading and archiving images took about 1 minute per plot. Cost of digital space for data storage was not quantified. In establishing a protocol for such a monitoring program, standards for offsetting from (or skipping) large trees and for clearing away vegetation that is close to the camera lens should be developed. Permanent marking of photo locations with ground stakes should also be considered. In about half of the photos, the meter board at plot center could not be seen because of dense understory vegetation. I recommend taking at least 4 photos per plot, thus relying on simple probability for usually getting at least one clear photo per plot over time.

2. The hemispherical photos were taken at either dusk or dawn during ideal, isotropic conditions. I also took a subset of photos during mid-day to evaluate the potential to take photos during the day, thus lowering the cost (but also lowering the photo quality). I took pictures in three compartments immediately before and after three different types of regeneration methods (single-tree selection, overstory removal, and clear cut). Total costs of a long-term monitoring program (labor, analysis, and training) range from about $5 to $25/ photo (J. Battles, personal communication), depending on the required level of precision. Costs can further be reduced if monitoring is focused at the stand level, rather than the point level. The stream plots were more expensive because they are farther apart from each other and are often more remote. The increased cost for stream photos should be weighed against the high value placed on the functional role of canopy cover for stream quality. The mid-day photos show promise to correlate well with dawn/dusk photos when % canopy coverage is measured. LAI and %TTR, however, did not correlate as well. It does not appear that the reduction in cost associated with taking photos at mid-day will justify the loss of precision in LAI and %TTR *when high precision is required*. Once the post-harvest photos are analyzed, the degree of correlation between changes measured from hemispherical photography metrics with changes measured directly from the vegetation will be assessed.

Figure. Hemispherical photo results: Best conditions (dawn) v. worst conditions (solar noon). Data from a pilot study at Blodgett Forest Research Station, CA.



Effort of pruning and its influence on growth of mixed-species plantations at Blodgett Forest, CA

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ABSTRACT:

The potential economic benefits of pruning planted trees has driven some plantation managers to invest in pruning as a way to increase the value of future harvests through the added value of clear-grain wood. Other benefits of pruning such as reductions of ladder fuels, aesthetics, and understory development of desired herb and forb species also add to the potential value of pruning. Costs of pruning, however, are carefully considered in the context of these potential benefits. Along with a pruning treatment's associated costs of labor and equipment, the potential cost of decreased growth and yield is also of concern where trees are scheduled to be harvested or gains in carbon stocks are desired. While it is known that leaf area generally influences stem growth, some physiological studies have demonstrated that shaded portions of live crowns do not contribute positively to carbon balance for some species. It is therefore reasonable to expect that below a threshold level of leaf area reduction, pruning would not have an effect on plantation growth (i.e. no growth "cost" of pruning). To test this expectation, we tracked the growth of ponderosa pine, giant sequoia, and Douglas-fir plantations treated with four different crown removal intensities. Plots within a 10-year old mixed-species plantation were pruned to either 7 ft (3% of crown removed), 12 ft (16% removed), 18ft (38% removed), or left as a control (0% removed). Crown and stem form parameters were measured before and 6 or 7 years after the treatments in both impacted and control plots. Here, we present a small portion of the results, focusing on pruning effort between species and the effects of pruning on height and radial growth. Differences in pruning effort were quantified in terms of the number and size of branches removed. Douglas-fir branches were both small and few compared to giant sequoia which had many, small branches and ponderosa pine which had few, large branches. No differences in height or radial growth between treatments were detected, implying a zero-sum growth cost of pruning as much as 38% of the crown on fast-growing, young trees at Blodgett Forest Research Station. Studies with treatments that remove more of

the crown area are needed to detect relationships of crown removal and growth at higher pruning intensities. More plots and incorporation of timing differences in pruning might be able to detect an *increase* in growth efficiency as a result of pruning. Other variables such as epicormic branching, branch stub occlusion, and taper rate were measured but have not been analyzed.

Release potential of giant sequoia following heavy suppression

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ABSTRACT:

Giant sequoia (*Sequoiadendron giganteum)* has proven potential as a fast-growing species for use in intensively managed plantations both within and outside of its native range. Despite the best of intentions of managers, these plantations are sometimes overtaken by competing vegetation. Additionally, where the use of herbicides is not an option, competing vegetation may be too burdensome to control frequently enough to maintain open growing conditions for planted seedlings. Giant sequoia is especially susceptible to shrub competition as reductions in light and water availability tend to suppress its growth severely. Giant sequoia does, however, have a high survival rate when suppressed. Hence managers are sometimes faced with plantations of giant sequoia that are severely suppressed, even surviving below a shrub canopy. To assist managers when facing this situation and to gain insight into giant sequoia physiology, we set up an experiment at Blodgett Forest Research Station to answer the following questions:

1. Do giant sequoia effectively release from heavy shrub competition?
2. What characteristics of suppressed giant sequoia individuals are indicative of release potential?
3. How do released individuals via brush removal compare with the clear-and-plant method (i.e. “starting over”)?

To answer these questions we did a paired experiment: One location that had suppressed giant sequoia had a shrub removal treatment and another area had a clear-and-plant treatment. In both study areas, competing shrub was controlled over time and repeated measures were performed. Giant sequoia responded quickly to the removal of competing shrubs, growing at a linear height rate for the 20 years following treatment. Height to live crown ratio, foliage quality, and stature relative to shrub height (level of suppression) were all important factors in explaining final height 20 years following treatment. However, variability in relative growth (i.e. controlling for differences in initial height) was not affected by level of suppression. Individuals that started beneath the shrub canopy released as well as those above the canopy. Seedlings with higher live crown ratios grew taller through 20 years after release (both in absolute and relative terms). When compared to a nearby stand which was cleared and planted the year following the shrub removal treatment, the released trees did not grow as well as trees that were planted. Planted seedlings grew taller by 27% and radially by 37%. Giant sequoia growth responds relatively well to release, but in this case, released trees did not grow as well as planted seedlings. When choosing individuals for release, live crown ratio and height were predictors of eventual tree size 20 years following release.

Species adjacency study: Potential growth responses to inter-tree signaling

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ABSTRACT:

The finding that individual trees in controlled environments modify their morphological growth allocation according to light signaling received by adjacent neighbor individuals (Ballare et al. 1990 *Science. 247*; Gilbert et al. 2001 *Nature. 411*) is a phenomenon having implications in evolutionary ecology, tree physiology, and potentially forest management. Some studies in field settings have attributed observed differences in seedling growth to signaling caused by species adjacency, but results from direct experimentation of species adjacency have not been reported (though at least one study is underway in Douglas-fir/hemlock forests). This study at BFRS was initiated to test the hypothesis that detectable differences in survival and growth could be attributed to a seedling's surrounding neighbor species composition. It experimentally explores the potential manipulation of individual seedling growth by controlling the composition of the neighboring tree environment with common regeneration practices. The over-arching hypothesis is that, all other factors being equal, individuals grow differently while surrounded by conspecific individuals than when surrounded by individuals of a different species. Specifically, individuals surrounded by different species are expected to grow more competitively with respect to capturing light and avoiding shading from neighbor trees. Tall, narrow crowns and a relatively greater allocation to shoot growth compared to root growth would reflect this competitive response. Species that are more shade-intolerant are expected to respond with more sensitivity to conspecific neighbors; more shade-tolerant species are expected to elicit more response from focal trees than shade intolerants. These expectations are derived from other studies that have aligned both adjacency signaling and reception capacities along successional (or tolerance) rankings. In the mixed-conifer forest of the Sierra Nevada, where five conifer species share dominance in mature canopies, this possible trade-off between shade tolerators and shade avoiders in life history strategy may contribute (among other factors) to explaining the maintenance of species diversity. On a more

practical level, information on growth patterns according to species adjacency can help in the design of planting arrangements in cleared forests, where high survival and growth is the objective.

At three locations (Compartments 91, 152, and 320), 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. Focal seedlings were double planted to increase the chance of survival of at least one tree at the focal location. The design was meant to create 5 focal trees per plot, each with surrounding neighbor trees. The replication within a plot increased the plot-level precision for short-term measurements (within ~ 5 years). Beyond 5 years, inter-tree competition due to shading and underground water use can be expected to confound the adjacency factor (if any). The planting design allows for extending the project into the future by allowing the thinning of neighbor trees and 4 of the 5 focal trees, while keeping the neighbor environment of 1 focal tree intact.

Because of problems with plot maintenance thus far (5 years after planting), results from this experiment will be limited. However, the potential application to forest management and the potential contribution to scientific disciplines that may come from studies like this one justify an effort to salvage information that may result from future measurements. In compartments 152 and 91, plots will be thinned to one focal tree per plot. A measurement of focal trees should correspond with the thinning in order to measure relative growth in the future. Survival surveys of all focal trees within plots will be done to explore any detectable differences in mortality as a result of species adjacency. Annual vegetation control (herbicide application or hand-weeding) within the plots is essential.