

TITLE: Intensified Ozone Monitoring and Assessment of Ozone Impacts on Conifers in Southern California

LOCATION: Southern California National Forests.

DURATION: 2 year project **FUNDING SOURCE:** Base

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PROJECT OBJECTIVES: The overall objective of this project is to quantify ambient ozone concentrations and tree conditions that constitute a risk to forest health in southern California national forests. Specific objectives include:

- 1) Installation of and collection of data from passive ozone monitors at 25 sites in southern California.
- 2) Evaluation of 30-50 ponderosa and/or Jeffrey pine at each site for ozone injury, mortality, and damage by other agents such as insects or diseases.
- 3) Co-location of 4 of the 25 passive monitors with existing active continuous monitors.
- 4) Analysis of ozone data and tree health data to characterize ozone distribution at landscape or forest stand scales, identify ozone hot-spots, and correlate ozone measurements among active, passive, and biological systems to tree injury and mortality.

JUSTIFICATION:

- a) *Linkage to FHM survey and plot data.* The FHM/FIA program monitors ozone on an extensive grid consisting of one ozone biosite per 250,000 to 1,000,000 acres of forested land. In southern California, there are only 8 FHM/FIA ozone biosites in or near the 4 national forests in southern California (San Bernardino, Angeles, Los Padres, and Cleveland); ozone injury has been detected on 5 of these (63%). The low density of FHM/FIA biosites in southern California (8 sites over 1.75 million acres of forest) creates obvious gaps in the ozone detection network for certain forest types or ecoregions. Passive ozone samplers provide an opportunity to fill the holes in the FHM/FIA biomonitoring grid.
- b) *Significance in terms of the geographic scale, biological impact and/or political importance of the issue.* In California, O₃ is the main phytotoxic air pollutant for plants at ambient levels. Classic examples of phytotoxic O₃ effects on forests dominated by ponderosa and Jeffrey pines have occurred for more than forty years in the San Bernardino Mountains. For the last thirty years such effects have also been seen on pines on the western slopes of the Sierra Nevada. Southern California forests are exposed to some of the highest ambient ozone levels in the United States. In recent years, extremely high tree mortality has occurred in these forests; it is thought that the combination of drought, stand densification, ozone stress, and bark beetles are responsible.
- c) *Feasibility or probability that the project will be successfully completed.* There is a high probability that this project will be completed successfully. PI's have 35 cumulative

years experience in air pollution and air pollution effects research. They are national and international experts on ozone air pollution effects on natural ecosystems. Dr. Bytnerowicz is one of the leading authorities on passive monitor use in mountain environments. Dr. Arbaugh has helped to develop current ozone evaluation methods for pines, and has extensive experience relating ozone injury to tree growth, mortality and stand composition changes.

DESCRIPTION:

a. Background: Tropospheric ozone is a phytotoxic gaseous air pollutant formed by photolysis from air pollution generated by large metropolitan areas, during transport over long distances to rural areas. Ozone, together with drought and bark beetles, is one of the key stressors affecting forest trees adjacent to urban areas. Species that show a visible foliar response to ozone pollution at ambient levels are used to detect the presence of ozone stress in the forest environment. In western forests, ozone-induced chlorotic mottle on sensitive pine species provides a reliable indication of ozone exposures that have the potential for adverse effects on tree health and growth. The FHM/FIA ozone monitoring protocol is based on utilizing ozone-sensitive species such as pine to detect the presence of ozone at damaging levels (USDA Forest Service, 2004).

Ozone passive samplers monitor levels of atmospheric ozone rather than injury; they allow O₃ distribution to be characterized at landscape or forest stand scales. Because they are inexpensive, easy to use and do not require electricity to operate, passive samplers are especially suited to remote areas. Large-scale evaluations have already been performed for the entire range of Sierra Nevada. Some passive monitors have been placed at locations in San Bernardino, Angeles and Los Padre National Forests, but not the coordinated placement needed to relate ambient ozone with ozone injury to pines. They have been used successfully to fill gaps in traditional EPA-approved sampling networks that surround population centers and they could be equally useful for the forest based FHM/FIA network, providing detection-level air quality information in areas that would otherwise remain blank.

In the late 1960's and early 1970's, ozone injury monitoring sites were established in southern California National Forests. Some sites were maintained by research, such as the San Bernardino Mountain sites, and a few were maintained by R-5 Air Quality Management program in the Angeles and Los Padres NF. As funding allowed, sites were evaluated for ozone, insect, and drought damage but no comprehensive evaluation has been conducted since the early 1970's. As a result we have little information on regional changes in ozone injury and the relationship of ozone injury to tree mortality. Additionally, the FHM/FIA biosites were only established over the last 5 years, with many installed as recently as 2004, so that long-term change data is not available from them either. Analyzing the condition of long-term sample trees with historical and present ozone injury will help clarify the role of air pollution and mortality rates, and provide insight into future stand mortality locations and rates.

b. Methods: All previously established ozone pine injury plots in which Cleveland, San Bernardino, Angeles and Los Padre National Forests will be revisited and Ogawa passive samplers installed nearby to each site. Thirty to fifty ponderosa/Jeffrey pine trees will be evaluated at each site using the established FPM ozone injury protocols (Miller et al. 1990). These protocols include standard silvicultural measurements (such as tree height, live crown height and dbh) as well mortality and observations of diseases and insect damage that the tree maybe experiencing. Passive ozone monitor information will be used to calculate ozone exposure index (SUMO), which has been shown to be useful for estimating ozone injury in the

Sierra Nevada and San Bernardino Mountains (Arbaugh et al. 1998). These indices will be correlated with measured ozone injury to determine if SUMO is useful to describe patterns of ozone injury for all of Southern California.

c. Products: A final report and scientific publication will be prepared that describes the relationship between ozone concentrations, ozone injury and mortality of conifers in Southern California. Both will include tables, graphs and maps of ozone concentrations for southern California and correlation with long-term tree-specific ozone injury history. A poster will be prepared at the end of each year for the national FHM meeting outlining interim or final results of the project.

d. Schedule of Activities: Ozone monitoring will be performed between May and October, 2005 and 2006 at least 25 locations in California. In 2005 we used matching funds to increase this number to 37 sites. Foliar injury surveys will be conducted between August 15 and September 30, in 2005 and in 2006.

e. Progress/Accomplishments: This is a 2-year study. Thirty seven sites of passive ozone samplers (12 more than expected) were installed in southern California and central coast locations using funds from this study, National Fire Plan, research appropriations and National Science Foundation Grants. Samplers are being exchanged every two weeks between May 2005 and October 2005. Continuous 2B Technology ozone monitors have been collocated at 5 passive sampler locations. Preliminary analyses of passive samplers at 26 sites for three sampling periods indicate that spring ambient ozone was high at many sites in the four southern California Forests. Spatial maps will be constructed when all periods and locations have been analyzed.

Foliar sampling is presently being conducted. Sites are being evaluated using Forest Pest Management (FPM) protocols. Unusual patterns of needle abscission have been observed in the eastern San Bernardino Mountains. Multiple age cohorts of needles have abscised about a month earlier than normal. Thus trees with 5 age groups in July, now appear to have only 2 or 3 age groups of needles. This has only occurred on Jeffrey pines, and may be due to early cool weather and/or effects of the past drought. Due to this unexpected occurrence, fewer sites will be evaluated for foliar injury than originally planned for FY05. Sites missed in FY05 will be evaluated in FY06.

Most data for foliar injury is not yet available, but early results indicate that ozone injury is lower in southern California than in previous surveys. Summary data for passive samplers and foliar evaluations will be presented at the annual FHM working group meeting in Feb. 2006.

COSTS:

We are requesting \$24,000 total support in Year 2.

	Item	Requested FHM EM Funding	Other-Source Funding	Source
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YEAR 2				
Administration	Salary	20,000	30,000	Research Appropriation, National Fire Plan, NSF
	Overhead	0		
	Travel	1,000	2,000	Research Appropriation
Procurements	Contracting	0		
	Equipment	0	1,000	
	Supplies	1,000		
	Analysis	2,000		
	Total	24,000	33,000	

References:

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