Photo Series for Major Natural Fuel Types of the United States – Phase II

Project: JFSP 98-1-1-05

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Joint Fire Science Program Project: JFSP 98-1-1-05

Final Report to the Joint Fire Science Program

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ABSTRACT

The natural fuels stereo photo series is a collection of georeferenced data and photographs that display a range of natural conditions, fuel loadings, and other fuelbed characteristics in a wide variety of forest-, woodland-, shrub-, and grass-dominated ecosystem types. The photo series are useful tools for quickly and inexpensively evaluating vegetation and fuel conditions in the field. The objectives of this project were to: (1) complete an assessment of the literature and the needs of land managers to define a maximum of 10 fuelbed types and their associated fuel elements for further development of the Natural Fuels Photo Series; (2) locate, photograph, and inventory a maximum of 20 sites within a fuelbed type that cover a range of fuel and vegetation conditions and (3) produce a printer-ready manuscript, and assist with the printing process.

Older photo series were reviewed and a needs assessment was conducted among managers and scientists to determine the fuelbed types and elements for inclusion in this project. A total of 9 fuelbed types were selected resulting in four photo series volumes: 1) Volume IIa: Hardwoods with spruce types in Alaska (Ottmar and Vihnanek 2002); 2) Volume Va: Jack pine in the Lake States (Ottmar et al. 2002); 3) Grassland, shrubland, woodland, and forest types in Hawaii (Wright et al. 2002); and 4) Volume VII: Oregon white oak, California deciduous oak, and mixed conifer with shrubs in the western United States (Ottmar et al. 2004). Volumes IIa, Va, and VII can be purchased from the National Interagency Fire Center, publication Management System for a small charge. The Hawaii photo series (PNW-GTR-545) is available free of charge from the Pacific Northwest Research Station. Data collected for this photo series effort allowed the Fuel Characteristic Classification System (JFSP 98-1-1-06) to be more robust and include more fuelbed types in historically data-poor fuel types across the United States.

INTRODUCTION

Controlling wildfires, safely using prescribed fires, conducting management actions to enhance ecosystem health, and prioritizing treatment of hazardous fuels all require accurate quantitative information about fuelbeds. Most managers have fuels data of insufficient extent, detail, or resolution necessary for fire behavior and fire effects prediction, or for fuel treatment planning. Photo series provide a quick, easy, inexpensive means for quantifying and describing existing fuel properties for selected areas within a landscape. Federal, state, and private fuel and fire managers use the Natural Fuels Photo Series to help them quantify and assess fire severity and hazard, air pollutant emissions, and other effects of fire. Photo series can reduce average field and fuel inventory time from 21 to 3 person-hours – a saving of $1,500 in inventory costs per unit sampled.

Although there are many published photo series (e.g., Maxwell and Ward 1976, 1980; Fischer 1981; Blonski and Schramel 1981) they are often limited in scope, contain single photographs, and generally do not fully characterize the entire fuelbed complex. Older photo series also lack the detail needed for validating remotely sensed data, developing Fuel Characteristic Class fuelbeds, and are often restricted to activity fuels in forested biomes. With the increase in prescribed burning in natural fuel types and in non-forested ecosystems, a study was commissioned by the Department of the Interior in January 1995 to develop a photo series for natural fuels that would improve the photo series coverage of several major fuel types common to Federally managed lands in the United States. Some critical fuel types were not covered within the scope of the original project because of funding and time limitations. Several of these critical fuel types were completed for this Joint Fire Science Program project.

OBJECTIVES

The objectives of this project were to:

(1) complete an assessment of the literature and the needs of land managers to identify a maximum of 10 fuelbed types and their associated fuel elements for further development of the Natural Fuels Photo Series.
(2) locate, photograph and field inventory a maximum of 20 sites within a fuelbed type that represents a range of fuel and vegetation conditions.
(3) produce a printer-ready manuscript, and assist with the printing process.

METHODS

ASSESSMENT OF LITERATURE AND FUEL TYPE SELECTION

The principal investigators attended five local and regional fuels meetings, organized and participated in six reconnaissance trips and planning meetings in Alaska, the Pacific Northwest, the Pacific Southwest, the Southeast, and Hawaii, and teleconferenced with nearly 100 land managers representing most Federal and many State land management agencies. This informal needs assessment resulted in selection of nine fuelbed types for this JFSP-sponsored Natural Fuels Photo Series development project (phase II; table 1). The fuelbed types included: (1) hardwoods with spruce (Alaska); (2) jack pine (Minnesota, Wisconsin, Michigan); (3) grasslands (Hawaii); (4) shrublands (Hawaii); (5) woodlands (Hawaii); (6) forests (Hawaii); (7) Oregon white oak (Oregon, Washington); (8) California deciduous oak (California); and (9) Mixed-conifer with shrub (Oregon).

SITE SELECTION, DATA COLLECTION AND PHOTOGRAPHY

Sites photographed for a fuelbed type are selected to show a range of conditions of various site attributes depending on the ecosystem type. For example, the hardwood with spruce sites in Alaska (Volume IIa) were selected to represent a range of conditions in Alaska hardwood ecosystems undergoing succession to spruce, while sites in the jack pine series (Volume Va) were selected to show ranges of down and dead woody material loading, understory composition, and overstory development. Photographs were taken and fuel loading, stand structure, and composition data were collected by using the procedures of Maxwell and Ward (1980) as a guide (fig. 1).

Table 1. Fuelbed types, location, number of sites, and photo series published for this project.

Fuelbed Type	Location	Sites	Photo Series Title
Hardwoods with spruce	Alaska	15	Stereo Photo Series for Quantifying Natural Fuels. Volume IIa: Hardwoods with Spruce in Alaska – October 2002, PMS 836/NFES 2668
Jack pine	Minnesota Wisconsin Michigan	19	Stereo Photo Series for Quantifying Natural Fuels. Volume Va: Jack Pine in the Lake States – October 2002, PMS 837/NFES 2669
Grassland	Hawaii	13	Stereo Photo Series for Quantifying Natural Fuels: Grassland, Shrubland, Woodland, and Forest Types in Hawaii – March 2002, PNW-GTR-545
Shrubland	Hawaii	7	
Woodland	Hawaii	7	
Forest	Hawaii	9	
Oregon white oak	Oregon Washington	10	Stereo Photo Series for Quantifying Natural Fuels. Volume VII: Oregon White Oak, California Deciduous Oak, and Mixed-Conifer with Shrub Types in the Western United States – May 2004, PMS 839/NFES 2719
California deciduous oak	California	9	
Mixed-conifer with shrub	Oregon	11	
Total		100	

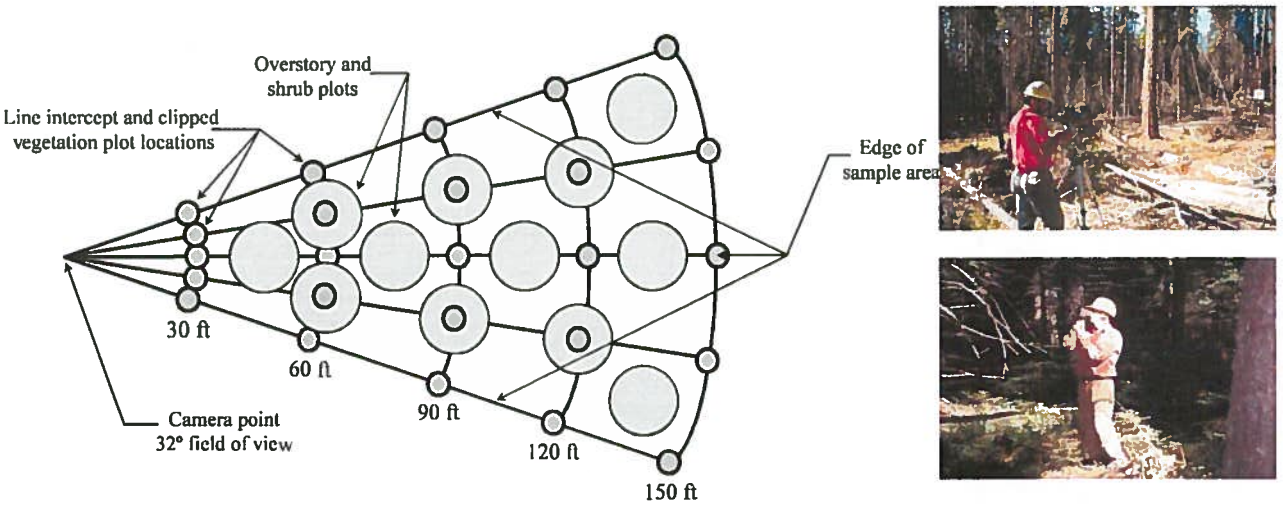

Figure 1. Photo series sampling layout. Forty random azimuth line transects (one at each point on the 30- and 150-foot arcs, and two at each point on the 60-, 90-, and 120-foot arcs) and 12 clipped vegetation plots (two to three per arc) were located within the sample area. Trees, shrubs, and seedlings were inventoried on 12 systematically located sample plots.

Single and stereo-pair photographs were included in each guide. The three-dimensional image obtained by viewing the photographs with a stereoscope will improve the ability of the land manager to appraise natural fuel, vegetation, and stand structure conditions. A larger, wide-angle photograph was included for additional comparisons. Two wide angle photographs, showing leaf-on and leaf-off views, are included for sites with a deciduous component. The summary data for each site relate to the field of view of the stereo-pair photographs.

Photograph and Information Arrangement

The photographs and accompanying data summaries are presented as single sites organized into

series. Each site is arranged to occupy two facing pages. The upper page contains a wide-angle (50mm) photograph (or photographs) and general site, stand, and forest floor or understory information. The lower page includes the stereo-pair photographs and summaries of overstory structure and composition, understory vegetation structure and composition, or forest floor depth loading and constancy, and dead and down woody material loading and density by size class.

Site Information

The camera point of each site was located with a global positioning system (GPS) receiver using the WGS-84 datum. Aspect and slope were measured with a compass and clinometer, respectively. Community types, plant associations, and alliances were based on vegetation structure, composition, and successional status. Society of American Foresters (SAF) cover type (current vegetation composition) was assigned for each site based on descriptions in Eyre (1980).

Stand Information

Tree and understory species (shrub, forb, and graminoid species) present at a site are listed in order of abundance. Understory species coverage was estimated using line intercept transects (Canfield 1941). Crown closure was measured either with a forest densitometer at 95 systematically located points in the sample area or, for forests with low tree cover or small stature, was estimated by using line intercept transects. Live seedling composition, density, and coverage were estimated by using twelve 0.005-acre circular plots representing 43 percent of the sample area; all trees less than 4.5 feet tall were considered seedlings.

Saplings and Trees

Overstory trees and saplings (i.e., trees $\geq$4.5 feet tall) were sampled in twelve 0.005-acre circular plots located systematically throughout the sample area or within the entire sample area for sites with low tree density (fig. 1). Tree measurement data were summarized by diameter at breast height (d.b.h.) size class and by tree status (all, live, or dead). Height to crown base (defined as the height of the lowest, continuous live or dead branch material of the tree canopy), and height to live crown (defined as the height of the lowest continuous live branches of the tree canopy) were also measured. Live crown mass values, where reported, (i.e., live branches and foliage) were calculated from species and size-specific allometric equations.

Understory Vegetation

Understory species coverage was estimated by using line intercept transects (Canfield 1941). Understory vegetation heights were measured at 25 points located systematically throughout the sample area. Typically, understory vegetation biomass was determined by sampling twelve square, clipped vegetation plots (10.76 square feet each) also located systematically throughout the sample area (fig. 1). All live and dead understory vegetation (regardless of size) within each square plot was clipped at ground level, separated, and returned to the laboratory for oven drying. Understory vegetation and other collected material were ovendried at a minimum of 158°F for at least 48 hours before weighing and determination of area loading.

Woody Material

Measurement techniques used for inventorying dead and down woody material were patterned after the planar intersect method outlined by Brown (1974) and described by Maxwell and Ward (1980). Forty transects of random azimuth starting at 25 systematically located points within the sample area were used to determine woody material loading and density (fig. 1). Woody material data are reported by size classes that correspond to timelag fuel classes used in fire behavior modeling (see, for example, Burgan and Rothermel 1984). Woody material in 10-hour, and 100-hour and larger size classes was tallied on transects that were 10 feet and 30 feet long,

respectively. Woody material loading in the 1-hour size class (and the 10-hour and 100-hour size classes for several of the sites) was determined by collecting, oven drying, and weighing all pieces in twelve 10.76-square-foot sample plots. The decay class and the actual diameter at the point of intersection was measured for all pieces >3 inches in diameter. Woody material loading and woody material density were calculated from relationships that use number of pieces intersected and transect length (and wood specific gravity for loading), respectively, developed by Brown (1974) and Safranyik and Linton (1987).

Surface Litter and Duff Depth Information

Surface material and duff depth were measured every five feet between the 30- and 150-foot arcs of the three center transects for a total of 75 measurements (fig. 1). Litter and duff loading were calculated from bulk density values derived from field measurements or through collection of material in twelve 10.76 square foot plots.

Deliverables

The primary deliverable products for the project were four new volumes of the Natural Fuels Photo Series, three progress reports, and a webpage. Additional products and technology transfer has been completed that were beyond the scope of the project (table 2). The Fire Behavior Project at the Missoula Fire Lab used the photo series to develop 42 new fire behavior fuel models. Photographs and data from several of the photo series from this project were used to describe and represent some of these new fuel models. Data collected for this photo series effort allowed the Fuel Characteristic Classification System (JFSP 98-1-1-06) to be more robust and include more fuelbeds in types that were historically data-poor.

Table 2. Comparison of proposed and actual deliverables.

Proposed	Delivered
1 printer-ready manuscript and CD with a maximum of 10 fuelbeds with a maximum of 20 sites each.	Four printed photo series volumes containing nine fuelbed types with 100 sites. NWCG advised against development of a CD.
2 publications describing inventory and photographic methodologies	None. The inventory and photographic methodologies are presented in each photo series publication.
3 progress reports	Four progress reports were completed for the JFSP.
Web Page	A website link to the photo series project was established at www.fs.fed.us/pnw/fera/photoseries.html.
Not proposed	Presentation to JFSP Review Board (2002)
	RX-410 Photo Series Training Package
	Fact sheet and images posted on FireHouse for Vol. VII
	Eleven poster presentations and published abstracts.
	Seven presentations at various conferences and seminars.
	35 photo series presentation and exercises at RX 410 (Smoke management), RX 300, (Burn Boss), and RX 310 (Fire Effects) national and regional training sessions.
	Provided photo series photo scans and fuelbed data to the Missoula Fire Lab Fire Behavior project for building new fire behavior fuel models.

Photo Series Publications

Four Natural Fuel Photo Series publications have been printed and distributed through the National Interagency Fire Center Publication Management System (Volumes IIa, Va, and VII) and the Pacific Northwest Research Station (Hawaii):

Ottmar, Roger D.; Vihnanek, Robert E. 2002. Stereo photo series for quantifying natural fuels. Volume IIa: hardwoods with spruce in Alaska. PMS 836. Boise, ID: National Wildfire Coordinating Group, National Interagency Fire Center. 41 p.

Ottmar, Roger D.; Vihnanek, Robert E.; Wright, Clinton S. 2002. Stereo photo series for quantifying natural fuels. Volume Va: jack pine in the Lake States. PMS 837. Boise, ID: National Wildfire Coordinating Group, National Interagency Fire Center. 49 p.

Wright, Clinton S.; Ottmar, Roger D.; Vihnanek, Robert E.; Weise, David R. 2002. Stereo photo series for quantifying natural fuels. Grassland, shrubland, woodland, and forest types in Hawaii. Gen. Tech. Rep. PNW-GTR-545. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 91 p.

Ottmar, Roger D.; Vihnanek, Robert E.; Wright, Clinton S.; Olson, Diana. 2004. Stereo photo series for quantifying natural fuels. Volume VII: Oregon white oak, California deciduous oak, and mixed-conifer with shrub types in the western United States. National Wildfire Coordinating Group, National Interagency Fire Center. 76 p.

Other Publications

One proceedings paper was published about the Brazil photo series that included discussion of the JFSP-funded photo series project.

Ottmar, R.D., R.E. Vihnanek, H.S. Miranda, M.N. Sato and S.M.A. Andrade. 2004. Stereo photo series for quantifying biomass for the cerrado vegetation in central Brazil. Floresta 34(2): 109-112.

Web Page

A web page including project progress, citation and ordering information was established at www.fs.fed.us/pnw/fera/photoseries.html.

Posters, Abstracts, and Presentations

Ottmar, R.D. 2000. Stereo photo series for quantifying natural fuels in Hawaii. California-Nevada-Hawaii Fire Council. Presentation. April 2000, Kaanapali, Hawaii.

Ottmar, R.D., R.E. Vihnanek and C.S. Wright. 2000. Stereo photo series for quantifying natural fuels. Poster and abstract. Fire Conference 2000: The First National Congress on Fire Ecology, Prevention, and Management, November 27-December 1, 2000, San Diego, California.

Ottmar, R.D., R.E. Vihnanek and C.S. Wright. 2001. Stereo photo series for quantifying natural fuels in the Americas. Poster. Brasilian conference of ecology. November 2001, Porto Allegre, Brazil.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2002. Stereo photo series for quantifying natural fuels. Poster. National Fire Plan/WFLC Symposium. January 2002, New Orleans, Louisiana.

OTTMAR, R.D. 2002. Stereo photo series for quantifying natural fuels in Hawaii. California-Nevada-Hawaii Fire Council. Presentation. April 2002, Hilo, Hawaii.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2002. Stereo photo series for quantifying natural fuels in the Americas. Poster and abstract. 2002 Fire Conference: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States, December 2-5, 2002, San Diego, California.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Poster and extended abstract. In: Kush, John S. (ed.), Longleaf pine: a southern legacy rising from the ashes. Proceedings of the fourth longleaf alliance regional conference. November 17-20, 2002, Southern Pines, North Carolina. Longleaf Alliance Report No. 6.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Poster and extended abstract. Proceedings of the workshop: Using fire to control invasive plants: what's new, what works in the Northeast? January 24, 2003, Portsmouth, New Hampshire.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Presentation. Seminar on fire management and forest restoration. February 10, 2003, University of Guadalajara, Autlan, Jalisco, Mexico.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Poster and abstract. Society for Ecological Restoration, Northwest Chapter and the Pacific Northwest Chapter of the Society of Wetland Scientists "The Restoration Toolbox" Joint Regional Conference. March 24-28, 2003, Portland, Oregon.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Poster and extended abstract. 3rd International conference on wildland fire and international wildland fire summit. October 3-6, 2003, Sydney, Australia.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Presentation. 6th Congress of Mexican forest management. November 5-7, 2003, University of San Luis Potosi, San Luis Potosi, Mexico.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Poster. 5th Symposium on Fire and Forest Meteorology and the 2nd International Wildland Fire Ecology and Fire Management Congress. November 17-20, 2003, Orlando, Florida.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2003. Stereo photo series for quantifying natural fuels in the Americas. Presentation. 10th Symposium on research, natural resource development, and management. November 24-27, 2003, University of Guadalajara, Autlan, Jalisco, Mexico.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2004. Stereo photo series for quantifying natural fuels in the Americas. Presentation. 2nd Seminar on fire management and forest restoration. March 11, 2004, Independent Agricultural University Antonio Narro, Saltillo, Mexico.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2004. Stereo photo series for quantifying natural fuels in the Americas. Poster. First international symposium on forest fires and fire management. July 1-3, 2004, Zapopan, Mexico.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2004. Stereo photo series for quantifying natural fuels in the Americas. Poster. 16th Mexican botany congress. October 17-22, 2004, Oaxaca, Mexico.

OTTMAR, R.D., R.E. VIHNANEK AND C.S. WRIGHT. 2004. Stereo photo series for quantifying natural fuels in the Americas. Poster. The week of fire. October 19-21, 2004, Cancun, Mexico.

LESSON PLANS AND TRAINING

A "how to use the photo series" lesson plan was developed and implemented in the Smoke Management Techniques RX- 410 National Training Curriculum. The lesson has since been incorporated into several regional training curricula, including: RX 310 Fire Effects and RX 300 Prescribed Fire Burn Boss.

TRAINING

The principal Investigator has taught how to use the photo series approximately 35 times at both National and regional training sessions. In addition, photo series training was given to a group of Mexican fire management professionals at the Forestry Center in Cuidad Guzman, Mexico from February 21-March 2, 2005.

MISCELLANEOUS

Photographs and data from several of the photo series sites from this project were used to describe and represent some of the new fire behavior fuel models developed by the Fire Behavior Project at the Missoula Fire Lab.

LITERATURE CITED

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MAXWELL, W.G. AND F.R. WARD. 1980. Guidelines for developing or supplementing natural photo series. Res. Note PNW-358. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 16 p.

SAFRANYIK, L. AND D.A. LINTON. 1987. Line intersect sampling for the density and bark area of logging residue susceptible to the spruce beetle, *Dendroctonus rufipennis* (Kirby). Inf. Rep. BC-X-295. Victoria, BC: Canadian Forestry Service, Pacific Forestry Centre. 10 p.