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

Project: JFSP 98-1-1-05

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Photo Series – Phase II Final Report 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.
null
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.

<table>
<thead>
<tr>
<th>Fuelbed Type</th>
<th>Location</th>
<th>Sites</th>
<th>Photo Series Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jack pine</td>
<td>Minnesota</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Michigan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grassland</td>
<td>Hawaii</td>
<td>13</td>
<td>Stereo Photo Series for Quantifying Natural Fuels: Grassland, Shrubland, Woodland, and Forest Types in Hawaii – March 2002, PNW-GTR-545</td>
</tr>
<tr>
<td>Shrubland</td>
<td>Hawaii</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Woodland</td>
<td>Hawaii</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>Hawaii</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Oregon white oak</td>
<td>Oregon</td>
<td>10</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Washington</td>
<td></td>
<td></td>
</tr>
<tr>
<td>California deciduous oak</td>
<td>California</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Mixed-conifer with shrub</td>
<td>Oregon</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

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 ≥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 oven-dried 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,
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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.

DEVELOPABLE

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.

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


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


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


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


