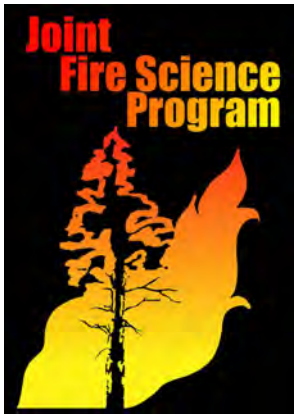
DIGITAL PHOTO SERIES



Final Report to the Joint Fire Science Program

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PROJECT SUMMARY:
The Digital Photo Series (DPS) is a web-based application that provides access to the Natural Fuels Photo Series database and photographs. The DPS works through a user's internet browser, but has also been designed to work as a stand-alone application when the computer is disconnected from the internet. A user-friendly interface allows users to browse, query, and download photo series data and high-quality photographs. The Digital Photo Series is intended to complement, not replace, the printed photo series volumes.

BACKGROUND:

Photo series provide quick and easy ways for managers to quantify and describe existing fuel and vegetation properties, such as loading of dead and down woody material, tree density, or height of understory vegetation. This information is critical for making fuel management decisions and for predicting fire behavior and fire effects. The Digital Photo Series is a user-friendly, web-based project that provides the Natural Fuels Photo Series data and images in electronic form. It includes data from all 14 volumes published to date, with 37 photo series containing a total of 398 sites in database form. System architecture enables searching, downloading, customized site generation, and side-by-side comparisons. The DPS builds on the published volumes both in content and presentation. In many cases, more information has been added than was originally published (e.g., land owner and Bailey's ecoregion), in others, data have been rearranged and terminology (e.g., field names, table headings) altered to standardize among the sites. Photo series sites can be navigated using 1) the site search page, where a user can specify geographic and ecological criteria to locate sites of interest; 2) the site

browser page, where a user can browse the photo series using an expandable navigation tree with all 398 sites organized by volume; and 3) the custom site builder page, where a user can combine data tables to create their own sites. The DPS provides added functionality for fire and fuels planners and scientists by enabling querying, report generation, and output formatted for use with other fire management tools and software. The DPS enables easier and more effective use of the comprehensive fuels data sets available for numerous ecosystems (which in the future could potentially include older, more difficult-to-find, and out-of-print-photo series) for strategic planning and analysis, and for improved implementation of field projects. The DPS has the ability to grow to include new photo series, fuels data accompanied by photographic documentation, as well as older, more difficult-to-find, and out-of-print photo series, and to evolve as the priorities and needs of fire and fuels managers change.

The Natural Fuels Photo Series

Accurate, complete fuels data are critical for all fire management planning and implementation. Fuels data are often lacking or difficult to obtain for many areas or ecosystems. With assistance from the Joint Fire Science Program (JFSP) and others, the Fire and Environmental Research Applications (FERA) team, located at the Pacific Wildland Fire Sciences Laboratory, in Seattle, Washington, developed the Natural Fuels Photo Series to address this critical need for high quality fuels information. Photo series are useful tools for quickly and inexpensively evaluating vegetation and fuel conditions in the field. The Natural Fuels Photo Series is a collection of geo-referenced data and photographs that collectively display a range of natural conditions and fuel loadings in a wide variety of forest-, shrub-, and grass-dominated ecosystem types.

The Natural Fuels Photo Series builds on a well-established tradition and methodology (e.g., Blank 1982; Blonski and Shramel 1981; Koski and Fisher 1979; Fisher 1981; Maxwell and Ward 1979, 1980a, 1980b; Ottmar and Hardy 1989a, 1989b; Reeves 1988, etc.). It is a popular and valuable tool with a large, diverse user base. Photo series are currently available for a wide range of ecosystem types nationwide. While primarily intended as a fuel inventory resource for fire managers and practitioners, the photo series can also be used to ecologically assess landscapes through appraisal of living and dead woody material and vegetation biomass and stand characteristics. Once an inventory has been completed, stand treatment options such as prescribed fire or harvesting can be planned and implemented to better achieve desired effects while minimizing negative impacts on other resources. The Natural Fuels Photo Series is useful in several branches of natural resource science and management: inventory data such as these can be used as inputs for evaluating animal and insect habitat, nutrient cycling, and microclimate. Fire managers can use these data for predicting fuel consumption, smoke production, fire behavior, and fire effects during wildfires and prescribed fires. Additionally, the photo series can be used to estimate carbon sequestration, an important factor in predictions of future climate, and to link remotely sensed imagery to live and dead fuels on the ground. The Natural Fuels Photo Series continues to evolve and grow as land managers, researchers, and policy-makers identify ecosystems for which vegetation and fuel inventory data are needed.

At present, 14 Natural Fuels Photo Series volumes have been published (Table 1); an additional volume to estimate post-hurricane fuels in southeastern US forest types is under development. Each volume documents a range of fuel conditions in 1-4 ecosystems, with detailed summary data and high-resolution photographs (stereo, wide-angle, and standard view). Each site includes inventory data summarizing vegetation composition, structure, and loading; woody material loading; density by size class, forest floor depth, and loading; and various site characteristics. The FERA team is the custodian of the raw and processed data, manuscript proofs, and photographic media that have been used to produce the Natural Fuels Photo Series books. Close familiarity allowed FERA to extract the maximum benefit from these data sets and materials during the development of the Digital Photo Series, the electronic complement to the Natural Fuels Photo Series books.

Table 1. Natural Fuels Photo Series developed by FERA (see References section for full citations).

Volume	Region	Ecosystem Types
I	Pacific Northwest	Mixed-conifer, western juniper, sagebrush, grass
II	Alaska	Black and white spruce
IIa	Alaska	Hardwoods with spruce
III	Rocky Mountains	Lodgepole pine, quaking aspen, Gambel oak
IV	Southwest	Pinyon-juniper, sagebrush, chaparral
V	Central & Lake States	Red & white pine, northern tallgrass prairie, mixed oak
Va	Lake States	Jack pine
VI	Southeast	Longleaf pine, pocosin, marshgrass
VIa	Southeast	Sand hill, sand pine scrub, hardwood with white pine
VII	West Coast	White oak, deciduous oak, mixed-conifer with shrubs
VIII	Northeast	Hardwoods, pitch pine, red spruce/balsam fir
IX	Southwest	Oak-juniper woodlands and savannahs
X	Montana	Sagebrush with grass, ponderosa pine-juniper
Hawaii	Hawaii	Grassland, shrubland, woodland, forest

The Digital Photo Series

The Natural Fuels Photo Series was originally designed as a field-based inventory tool in book form. At the time of its inception (mid-1990's), conventional printing was the most effective way to present the images and data of the Natural Fuels Photo Series in a concise, economical, user-friendly package. Changes in software, hardware and network technology, and development of new fire- and natural resource-based software applications that require fuel and stand information as inputs, highlighted the need to enhance the data and utility of the Natural Fuels Photo Series by making it available in an electronic format. Furthermore, fire and fuels management require more and better fuel and vegetation data, like those included in the Natural Fuels Photo Series, to effectively plan treatments, including prescribed fire and mechanical fuels treatment.

The objective of the Digital Photo Series (DPS) project was to develop both an online and stand-alone software application that would access a geo-referenced database containing the images and data published in the Natural Fuels Photo Series, as well as additional data that were collected but not included in the space-constrained book versions. Making the Natural Fuels Photo Series data available in digital form provides added functionalities such as the ability to query and browse data and images across series and volumes, the ability to compare the fuels on sites side-by-side, and the ability to build and save custom fuelbeds. Data from the DPS also has the potential to interface with existing and future fire and fuel-management software packages (e.g., Fuel Characteristic Classification System, Behave, FOFEM, Consume 3.0, etc.). Additionally, providing the Natural Fuels Photo Series data through an online database allows the flexibility to update the database as new data become available (i.e., as new photo series are developed). Development of the DPS was intended to complement, not replace, the paper and ink versions available now and in the future; its primary goal was to be a tool to more easily and effectively use the comprehensive data sets available for numerous ecosystems for strategic planning and analysis, and for implementation of field projects.

MATERIALS AND METHODS:

Development of the DPS occurred in four overlapping phases. Phase 1 included system design and engineering. Phase 2 included data entry and compilation, as well as photo compilation and scanning. Phase 3 included software programming and initial testing. Phase 4 is still in progress, and includes application testing, distribution and technology transfer.

Phase 1 – system design and engineering

Users of the book-form Natural Fuels Photo Series were surveyed to determine what additional features they were interested in seeing in the DPS. Input from the wider user community was also solicited to insure that the interface design and output specifications met the preferences and technology requirements of fire and fuels managers and planners, particularly those employed by federal land management agencies. This process was carried out through the distribution of a questionnaire (see Appendices 1 and 2) and informal discussions with interested parties. Discussions with in-house, contract, and national-level Forest Service software programmers and web developers informed decisions regarding system architecture and application functionality.

Phase 2 – data entry and compilation

Natural Fuels Photo Series data were stored in various electronic formats in the FERA archive. Some of these data required re-coding and analysis to extract their full value for the DPS. Data collected from 398 sites were standardized and consolidated into a relational database. Film images (positive and negative transparencies) for the wide-angle photos were scanned into digital format. Small- and medium-sized thumbnails (15-30 KB each) and high resolution (250-500 KB each) digital images are available online; very high resolution (25-30 MB each) digital images are available upon request. Refinements of this database will continue, and additional data elements not included in print are being added. Several projects, including LANDFIRE, FFE-FVS, and FIRETEC, have requested and been supplied this database.

Phase 3 – software programming and initial testing

The DPS application consists of a user-friendly web interface that can be accessed using a web browser (such as Internet Explorer or Mozilla Firefox), either through the internet (http://depts.washington.edu/nwfire/dps/) or from an individual computer's hard drive. A series of web pages provide access to the database, which is currently located on a University of Washington web server. The web pages were developed using a combination of HTML, JavaScript, CSS, and PHP with help from the Smarty® template engine and require a web browser connected to a server that can resolve PHP scripts. The DPS application was tested on both Windows and Macintosh computers and on both Mozilla® Firefox 1.0 and 2.0 and Microsoft® Internet Explorer 6.0 and 7.0.

In the absence of a web connection, a stand-alone version of the DPS (utilizing the portable MicroWeb® web server) can be used to run the site from a local computer hard drive. At present, an approximately 300 MB self-executing zip file can be sent to users upon request, and soon the file will be downloadable from the FERA website. After installing the stand-alone version of the DPS, the user can start the application and open the DPS home page with their default web browser. The stand-alone version functions identically to the web-based version by utilizing the user's web browser and micro server software (MicroWeb®) to mimic an internet connection. Creating an application that functions the same whether on or off-line eliminates the need for users to learn more than one program.

The DPS interface is organized into tabbed pages, allowing a user to navigate to photo series sites in a variety of ways. A user can navigate to a site using the "Site search" page (Figure 1) by selecting specific geographic criteria (e.g., clicking on a map, or selecting state, Bailey's ecoregion, and/or land owner) and/or ecological criteria (e.g., cover type, species, and structural attributes). Alternatively, a user can navigate the photo series using an expandable

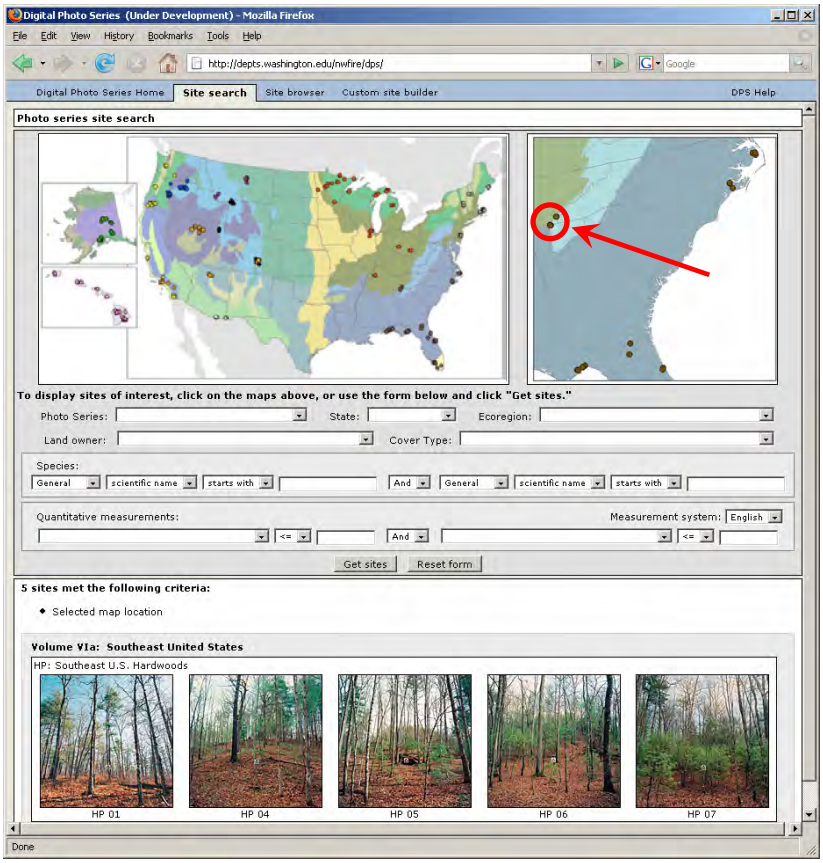

Figure 1. Site search interface for the DPS. In this example, search results generated by clicking the circled cluster of points are shown below the search form. Users can also search by specific geographic (e.g., state, Bailey's ecoregion, and land owner) and/or ecological criteria (e.g., cover type, species, and structural attributes).

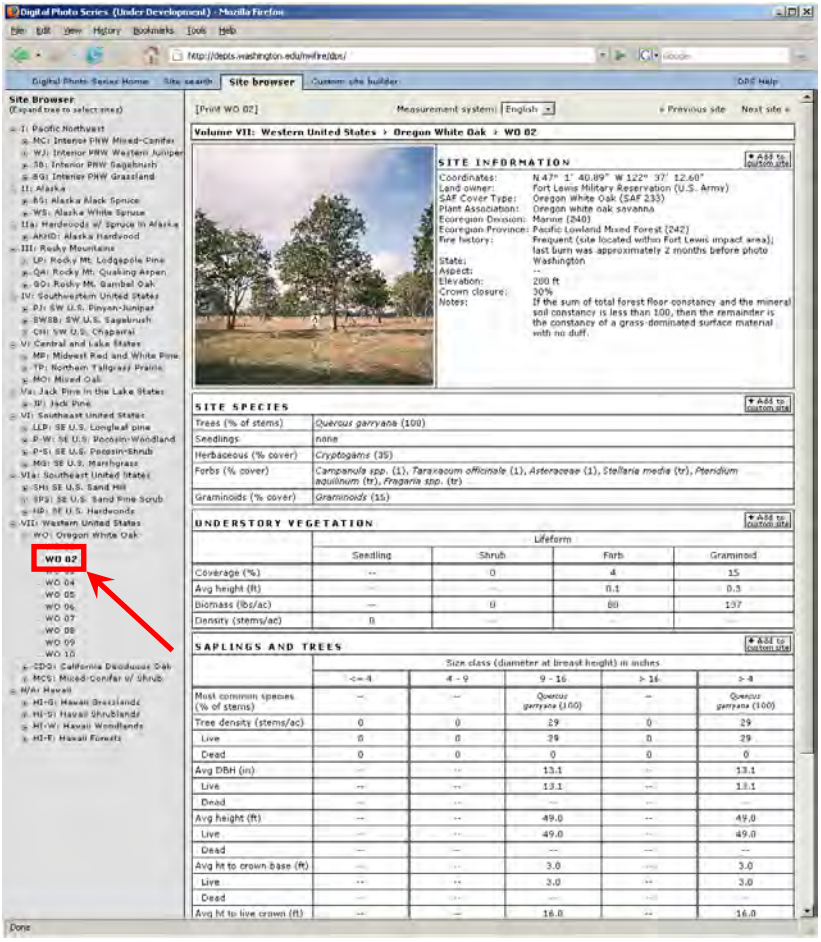

Figure 2. Site browser interface for the DPS. Selecting a site from the navigation tree, as indicated by the highlighted box, loads the data and photograph for a photo series site. All 398 sites are organized by volume in the navigation tree.

navigation tree that includes all 398 sites organized by volume using the "Site browser" page (Figure 2). Additionally, a user can create a custom site using the "Custom site builder" page (Figure 3). Data tables can be combined to create custom sites with data that are more representative of a specific land management unit, or a desired management state. Custom sites can be saved and shared between DPS users. Finally, a "DPS Help" page can be accessed by selecting the tab on the far right of the DPS screen.

The DPS diverges slightly from the published volumes both in content and presentation. In many cases more information was added than was originally published (e.g., land owner and Bailey's ecoregion), in others, data were rearranged and terminology (e.g., field names, table headings) altered to standardize among the sites. At present the DPS only offers wide-angle photos for each site; we are hopeful that technological advances in coming years will reach the mainstream and allow users to view stereoscopic images on a computer screen. The DPS also offers a choice of measurement system; it defaults to English units, however, users can toggle between English and metric units. The DPS provides added functionality for fire and fuels planners and scientists by providing downloadable data for each photo series and high resolution images for each site. Development activities are ongoing that will enable users to generate output formatted to interface with other fire management tools and software that require fuels data as inputs (e.g., FCCS, CONSUME, BehavePlus, etc.).

Phase 4 – testing, distribution and technology transfer

Testing was performed in-house by users with a range of experience both with the photo series and software development. Participants in the various workshops at which the DPS was demonstrated and taught also served as an informal testing community. Workshop

participants provided feedback in terms of application content and functionality as well as supplying a wide variety of test platforms (i.e., different computer and operating system setups).
All of the documentation included in the printed Natural Fuels Photo Series volumes is available in the DPS. In addition, documentation for the DPS application can be found on the "DPS Help" page. The "Digital Photo Series Home" page provides a brief description of the DPS. The "DPS Help" page includes a more detailed introduction and also a description of the differences between the DPS and published photo series volumes, computer system requirements, instructions for navigating the DPS (including the site search, site browser and custom site builder tabs) and using its functionality (e.g., download and interpret data files, view larger photographs, etc.), and an explanation of how to run the MicroWeb® edition of DPS.

Figure 3. Custom site builder interface for the DPS. Selecting sites from the drop down boxes loads the data and photograph for multiple photo series sites. Custom sites can be saved and shared with other users.

The primary technology transfer mechanisms for the DPS are the web-based application and the stand-alone application (see Tables 2 and 3). At present, the stand-alone application is available through the mail on CD-ROM for users that lack internet connectivity. It will be made available for download from the DPS and FERA websites; updates will be made available online. Discussions are ongoing with the Fire Research and Management Exchange (FRAMES) group at the University of Idaho to add the DPS to the FRAMES website. Other technology transfer activities include demonstrations of the DPS application at 13 workshops and 2 science delivery discussions, a posting and fact sheet on FIREHouse (June 2005), a JFSP highlight (September 2005), and distribution of the DPS database to the FIRETEC, LANDFIRE, and FFE-FVS projects. An online seminar will be offered during Fall 2007 (once the fire season has slowed); additional web seminars may be offered if interest is high. A short section addressing the DPS is already incorporated into the existing Natural Fuels Photo Series online tutorial (available for download

from: http://www.fs.fed.us/ pnw/fera/research/tutorials/photoseries.shtml); additional content will be added to address the DPS in greater detail.

Benefits of the Digital Photo Series:

The DPS leverages the very detailed and expansive data set developed during the course of the various phases of the Natural Fuels Photo Series (phases II and III were funded by the JFSP). As with the book version, data characterizing all of the vegetation and fuels (not just the down woody and surface fuels) in an ecosystem is viewable from the application interface, and available as printed or saved reports. In addition to the data published in the bound volumes, the DPS includes data that were collected but not printed due to publication limitations. The DPS also allows users the choice to view the data either in English or metric units (the book versions were published using English units). Users are able to draw on data and high quality images from all published volumes simultaneously. The DPS combines data from a large number of sites and ecosystems (i.e., individual photo series site data) in a single repository, allowing managers and planners to compare and query data from a variety ecosystems and locations to examine similarities and differences. The ability to query across locations and ecosystems allows users familiar with one fuel type to compare with other types with which they may be less familiar.

The DPS is intended to complement, not replace, the paper and ink versions available now and in the future. Published volumes are more appropriate for use in a field setting and can be used with a stereoscope for a three-dimensional view of photo series sites.

The Future of the Digital Photo Series:

The DPS has been designed to accept new photo series as they are developed, allowing it to grow and evolve as more data become available. Future versions may incorporate data from other published photo series or fuels inventories that are accompanied by photographic documentation. The system design and interface are robust and can readily accept new data as appropriate. The current interface allows users to browse, query and download photo series data and photographs and to generate customized sites. Additional features will be developed with input and ideas from current and future users of the DPS, as well as current users of the Natural Fuels Photo Series books and fire and fuels planners, managers and scientists.

Science Delivery and Application:

This project was funded specifically to develop a digital interface for the Natural Fuels Photo Series. The DPS web application and stand-alone software are the primary deliverable products for this project (Table 2). A short article suitable for *Fire Management Today* is also being drafted to make the existence of the DPS more widely known among the fire management community. The relational database containing the Natural Fuels Photo Series data is an intermediate product that has been shared with fire and fuel scientists. Digital Photo Series demonstrations and other science delivery activities are listed in Table 3.

Table 2. Proposed and actual project deliverables.

Proposed	Delivered	Status
DPS application	The DPS application can be accessed at the following website: http://depts.washington.edu/nwfire/dps. The DPS provides access to the Natural Fuels Photo Series data and images in electronic form and provides added functionality such as browsing, querying, report generation, and downloadable data. Access to the DPS is through a web browser and internet connection. If not in a network setting (e.g., in the field or at fire camp), a stand-alone version of the DPS is available.	Done
DPS database*	Microsoft® Access database including all data from the Natural Fuels Photo Series. Copies of the database have been distributed to: Los Alamos National Laboratory, Wildland Fire Prediction Model (FIRETEC; Dr. Rodman Linn), UDSDA Forest Service, Rocky Mountain Research Station, Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS; Ms. Stephanie Rebain and Dr. Elizabeth Reinhardt) and LANDFIRE (Ms. Karen Short).	Done
User survey	Users of the book-form Natural Fuels Photo Series were surveyed to determine what additional features they would like to see in the DPS (Appendices 1 and 2). This process was carried out through the distribution of a questionnaire and informal discussions with interested parties.	Done
DPS tutorial and lesson plan	Additional material addressing the DPS will be incorporated into the existing online tutorial and lesson plan designed to teach students how to use the Natural Fuels Photo Series.	Partially implemented
DPS quick reference sheet*	A "quick reference" sheet providing basic instruction on DPS navigation and use.	Done
DPS online seminar	In an effort to reach a broad audience, a web seminar will be scheduled for Fall 2007 (once the fire season has slowed). This seminar will use the Verizon Advanced Net Conference Live Meeting service, and will include a quick lesson on how to navigate the DPS, as well as practical examples of how the DPS can be used for fire and fuels management.	To be offered Fall 2007
Technology transfer	Technology transfer activities include demonstrations of the DPS application at 13 workshops and 2 science delivery discussions, a posting on FIREHouse, and a JFSP highlight; these activities are described in more detail in Table 3.	Done
Publication	A draft manuscript announcing the release of the DPS, describing its functionality, and detailing its development will be submitted to *Fire Management Today* in September 2007.	To be submitted Sept. 2007
JFSP final report	WRIGHT, C.S., R.E. VIHNANEK AND R.D. OTTMAR. 2007. Digital Photo Series. JFSP final report.	Done

*Deliverables in excess of proposed.

Table 3. Digital Photo Series technology transfer activity dates and descriptions.

Date	Venue	Presentation Type
June 2005	FIREHouse (the Northwest and Alaska Fire Research Clearinghouse) posting	DPS information and a link to the application
September 2005	JFSP Project Highlight	DPS highlighted in monthly JFSP highlight publication
November 2005	USDA Forest Service, Region 6, Integrated Vegetation Management Workshop, Hood River, OR	DPS demonstration
November 2005	Southern Regional Fuels Workshop*, Jones Center for Ecological Research, Ichauway, GA	DPS demonstration
February 2006	Hawaii Regional Fuels Workshop*, State of Hawaii, Department of Forestry, Hilo, HI	DPS demonstration
March 2006	1st Fire Behavior and Fuels Conference, San Diego, CA	DPS demonstration
May 2006	Pacific Northwest Regional Fuels Workshop*, USDA Forest Service, Region 6, Sunriver, OR	DPS demonstration
August 2006	Alaska Regional Fuels Workshop*, Alaska Fire Service, Fairbanks, AK	DPS demonstration
November 2006	3rd Fire Ecology and Management Conference, San Diego, CA	DPS demonstration
November 2006	Midwest Regional Fuels Workshop, Portsmouth, OH	DPS demonstration
March 2007	Southern California Regional Fuels Workshop*, Cal-Poly University, San Luis Obispo, CA	DPS demonstration
March 2007	2nd Fire Behavior and Fuels Conference, San Destin, FL	DPS demonstration
April 2007	Western Regional Fuels Workshop, University of Idaho, Moscow, ID	DPS demonstration
May 2007	Southwest Regional Fuels Workshop*, Albuquerque, NM	DPS demonstration
July 2007	PNW Fire Research Science Delivery Discussion, Seattle, WA	DPS demonstration
September 2007	Southeast Regional Fuels Workshop, Jones Center for Ecological Research, Ichauway, GA	DPS demonstration
September 2007	Carnegie Mellon University, Software Engineering Institute Modeling Session (in Seattle, WA)	DPS demonstration

*Regional Fuels Workshops funded with a grant to R.D. Ottmar by the JFSP. These 2-½ day workshops taught participants to use the Fuel Characteristic Classification System (FCCS), Consume 3.0, the Natural Fuels Photo Series, and the Digital Photo Series.

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Numerous individuals contributed to the successful completion of the Digital Photo Series: Diana Olson, Alynne Bayard, Lara Kellogg, Mike Tjoelker, Jeff Kelly, Paul Campbell, Frank Archuleta, Ann McAuley, Noah Carlson, Felicia Mehl, Zhen Zhu, and Veronica Mendoza. John Szymoniak helped us distribute our survey questionnaire to federal fire and fuels professionals. Funding for the creation of the Digital Photo Series was provided by the Joint Fire Science Program. Development of the original Natural Fuels Photo Series was funded in part by the Department of Interior fuels working group, the National Fire Plan, the Joint Fire Science Program, the State of Hawaii, the Department of the Army, the United States Air Force, and others.

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