Chapter 4

The LANDFIRE Prototype Project Reference Database

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Introduction

This chapter describes the data compilation process for the Landscape Fire and Resource Management Planning Tools Prototype Project (LANDFIRE Prototype Project) reference database (LFRDB) and explains the reference data applications for LANDFIRE Prototype maps and models. The reference database formed the foundation for all LANDFIRE tasks. All products generated by the LANDFIRE Prototype Project were developed from field-referenced data collected by resource professionals and screened for quality and consistency by the LFRDB team (Keane and Rollins, Chapter 3), ensuring that each LANDFIRE data layer could be recreated and improved upon with the availability of new data. Field-referenced data provided a means of assessing the accuracy of many LANDFIRE Prototype products. The LFRDB integrated field-referenced data collected for many separate projects that used different sampling methods and had varying sampling intensities. See appendix 2-A in Rollins and others, Ch. 2 for a table outlining, in part, the procedure used to build the LFRDB.

Field-referenced data play a critical role in any mapping project involving remotely sensed data (Congalton and Biging 1992). Field-referenced data are used to generate, test, and validate maps and models. Field-referenced data provide important field-referenced information that accurately describes that which is being remotely sensed or mapped, and field-referenced data points function as training sites in satellite imagery classifications (Jensen 1998; Verbyla 1995). In the LANDFIRE Prototype Project, we used field-referenced data coupled with Landsat imagery to model and map cover types (CT), canopy closure, and height (Zhu and others, Ch. 8). Field-referenced data were also used to model and map biophysical settings and wildland fuel (Frescino and Rollins, Ch. 7; Keane and others, Ch. 12).

In addition, field-referenced data serve another important purpose in the development of vegetation and fuel classifications. The distribution and occurrence frequency of cover types across landscapes – both summarized in the LFRDB – were used in the LANDFIRE Prototype Project to refine the CT classification (Long and others, Ch. 6). The PVT classification was also refined based upon field-referenced data and the relationship between vegetation occurrence and biophysical settings (Long and others, Ch. 6). Furthermore, reference data were used to develop database tables relating PVT, CT, and SS to attributes relevant to wildland fire management, such as fire behavior fuel models, fire effects fuel models, and canopy fuel characteristics (Keane and others, Ch. 12). Reference data were also integral in the development of succession pathway models (Long and others, Ch. 9), which ultimately served as the foundation for creating maps of simulated historical fire regimes and fire regime condition class (Pratt and others, Ch. 10; Holsinger and others, Ch. 11).

Finally, field-referenced data aid in both the quantitative and qualitative interpretation of maps and mapping classifications and in identifying and explaining the associated inaccuracies or inconsistencies. A common way to assess

In: Rollins, M.G.; Frame, C.K., tech. eds. 2006. The LANDFIRE Prototype Project: nationally consistent and locally relevant geospatial data for wildland fire management. Gen. Tech. Rep. RMRS-GTR-175. Fort Collins: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

the accuracy of classified images and maps is to employ the reference data as a measure by which to assess the amount of the area that was classified correctly (Story and Congalton 1986). Reference data provided three measures of accuracy for most LANDFIRE data layers: 1) locational accuracy (the probability of a pixel being mapped correctly), 2) landscape accuracy (the accuracy of pixel summaries across large areas), and 3) model accuracy (the accuracy of statistical models used to build the maps) (Keane and Rollins, Ch. 3; Vogelmann, Ch. 13).

Reference Data Requirements

All field data were georeferenced within reasonable locational accuracy, preferably 30 meters or less. To be useful in the LANDFIRE Prototype, reference data were required to have a minimum set of fields applicable to at least one of the various LANDFIRE mapping tasks. Field-referenced data suitable for the LANDFIRE Prototype could, for example, include species composition data needed to map cover type and structure, have fuel attributes for developing fuel models, or contain tree data needed to map canopy fuel. Table 1 lists some of the variables required for the LFRDB.

A critical element in acquiring LANDFIRE data was obtaining these from field plots that were sufficiently representative of all land ownerships and ecosystems.

Table 1—Examples of variables included in the LANDFIRE reference database.

Data type	Attributes
Plot	Georeferenced plot location
	Sampling date
	Digital plot photos
	Metadata
Vegetation	Species list
	Cover by species
	Cover by life form (tree, shrub, herb)
	Height by species
	Heights of individual trees
	Crown ratios (individual trees)
	Crown classes (individual trees)
	Diameters (individual trees)
	Tree density
Fuel	Fine (1-, 10-, and 100-hour)
	Coarse (1000-hour)
	Cover of live and dead shrubs
	Cover of live and dead herbs
	Base height of canopy fuel
	Height of shrubs
	Height of herbaceous vegetation

We acquired the data through three separate yet coordinated efforts. First, with cooperation and support from the Forest Inventory and Analysis (FIA) program, we obtained forest vegetation data collected on permanent FIA inventory plots (Gillespie 1999). We selected only FIA plots which occurred within one condition and used all subplot data (Interior West Forest Inventory and Analysis 2004). FIA plot variables used by the LFRDB included tree species, diameter at breast height (DBH), tree height, crown ratio, height to live crown base, and crown class. FIA data were stored in the database without geographic coordinates to preserve the confidentiality of the plot locations (Interior West Forest Inventory and Analysis 2004). Analyses requiring coordinates were conducted by FIA personnel stationed at the Missoula Fire Sciences Laboratory (Missoula, MT).

A second data acquisition effort involved the circulation of a formal request letter to federal agencies, soliciting additional reference data from the LANDFIRE Prototype mapping zones. In conjunction, the LFRDB team conducted an exhaustive search for existing field-referenced data relevant to LANDFIRE, relying heavily on cooperation from federal, state, and non-governmental organizations. Due to the diverse nature of field sampling methods and data storage procedures, the reference database team spent much time and effort converting these data into a common database structure.

Third, even after obtaining FIA data and other existing field-referenced data, large areas of the prototype mapping zones were under-represented, particularly those in the shrublands and grasslands. In response, the LFRDB team collaborated with the Southwest Regional Gap Analysis Project (Southwest ReGAP) (Utah State University 2004) to collect additional field-referenced data in under sampled areas of the prototype mapping zones.

Methods

The LANDFIRE Prototype Project involved many sequential steps, intermediate products, and interdependent processes. Please see appendix 2-A in Rollins and others, Ch. 2 for a detailed outline of the procedures followed to create the entire suite of LANDFIRE Prototype products. This chapter focuses specifically on the procedures followed to compile the LFRDB, which formed the foundation for nearly all modeling and mapping tasks in the LANDFIRE Prototype Project.

Data Acquisition

Zone 16—The three data sources for Zone 16 were FIA, Southwest ReGAP for the state of Utah, and the

Southern Utah Fuels Management Demonstration Project (Southern Utah Project). Utah field-referenced data from Southwest ReGAP included both plant species cover estimates and height measurements for each plot. The Southern Utah Project data included plant species cover estimates, height measurements, downed woody fuel transects, and individual tree measurements for each plot. .FIA data included individual tree measurements for each plot and were acquired from the national FIA Database (Miles and others 2001) and the Interior West FIA program (Interior West Forest Inventory and Analysis 2004).

Once all existing field-referenced data were acquired, we displayed the non-FIA plot locations for Zone 16 to identify obvious gaps in the reference data acquisition. Substantial portions of the central and northern areas of Zone 16 contained little or no reference data (fig. 1A). We contracted with Utah State field crews who, using the Southwest ReGAP field data collection protocols, collected additional field-referenced data in these areas (Utah State University 2004). These efforts helped fill gaps in data coverage, especially in non-forest vegetation types.

Zone 19—We drew from several sources for Zone 19 data acquisition. These data sets included information from the FIA Database; United States Department of Agriculture (USDA) Forest Service Northern Region ecosystem inventory database (ECODATA) (Jensen and others 1993); Bureau of Land Management (BLM) Fuels database from the Salmon and Challis, Idaho field offices (Gollnick-Waid 2001); United States Geological Survey (USGS) ECODATA database from Glacier National Park; and the USDA Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory, Missoula, Montana (MFSL) ECODATA database. All ECODATA plot databases included plant species cover estimates and height measurements, downed woody fuel transects, and individual tree measurements for each plot. The BLM Fuels Survey data included information on dominant and codominant plant species by life form, life form cover, fuel loading, and fire hazard.

Once all existing field-referenced data were acquired, we displayed the non-FIA plot locations within Zone 19 to determine deficiencies in the reference data acquisition for non-forested areas. Areas in the southern, eastern, and west-central portions of Zone 19 contained little or

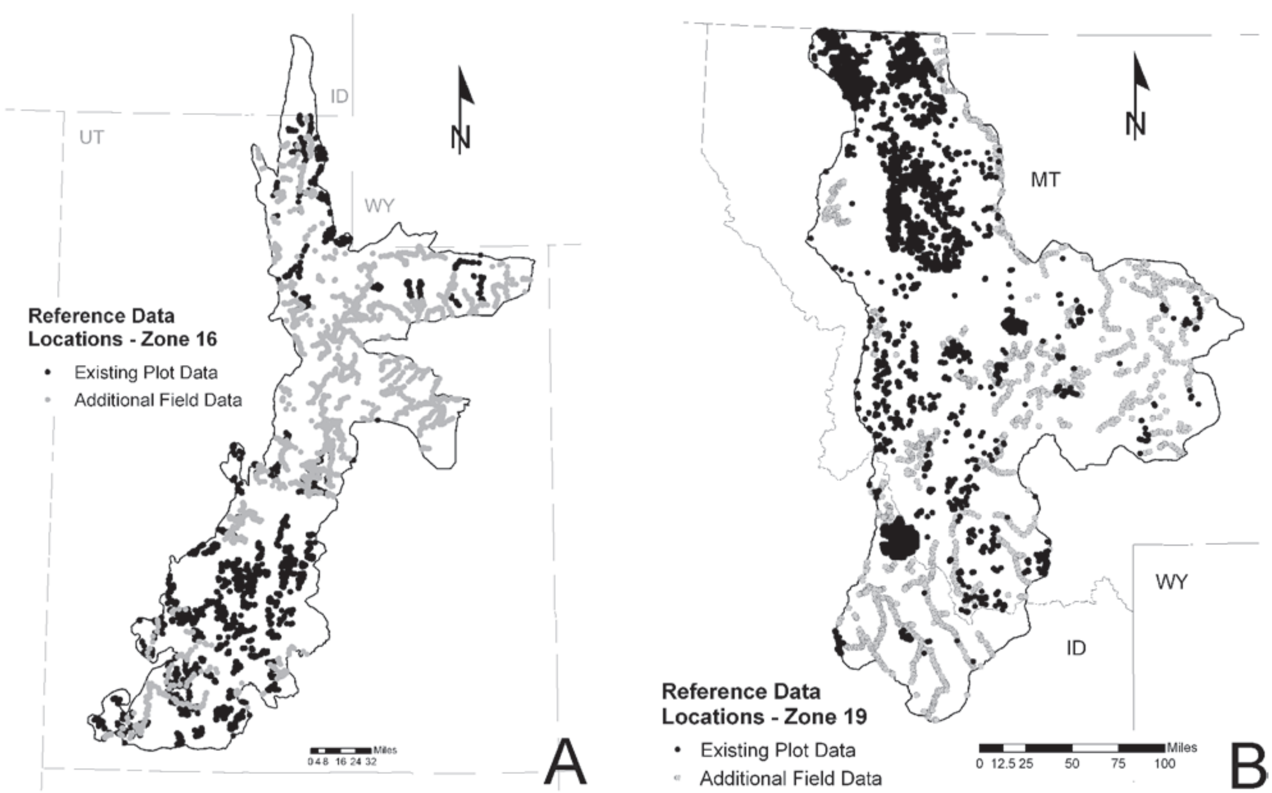


Figure 1—Field plot locations for non-FIA reference data within zones 16 (A) and 19 (B).

no reference data (fig. 1B). Again, we contracted with Utah State University field crews who, using the Southwest ReGAP field data collection protocols, collected additional field-referenced data in these areas (Utah State University 2004). As with Zone 16, these additional plot data filled in the data gaps, especially for non-forest vegetation types.

LANDFIRE Reference Database Structure

The LFRDB was composed of three levels (fig. 2), each containing data processed at the preceding level. Each data set was stored in a separate directory in its original data format (Level 3). Each directory contained the original data, metadata documentation, and any existing data-conversion queries or programs. We designed the data directory structure to follow the Fire Effects Monitoring and Inventory Protocol (FIREMON) plot identifier structure (Lutes and others, 2006; table 2). This enabled us to track summary data in the LANDFIRE attribute tables back to the original data and identify problems in the data-conversion process.

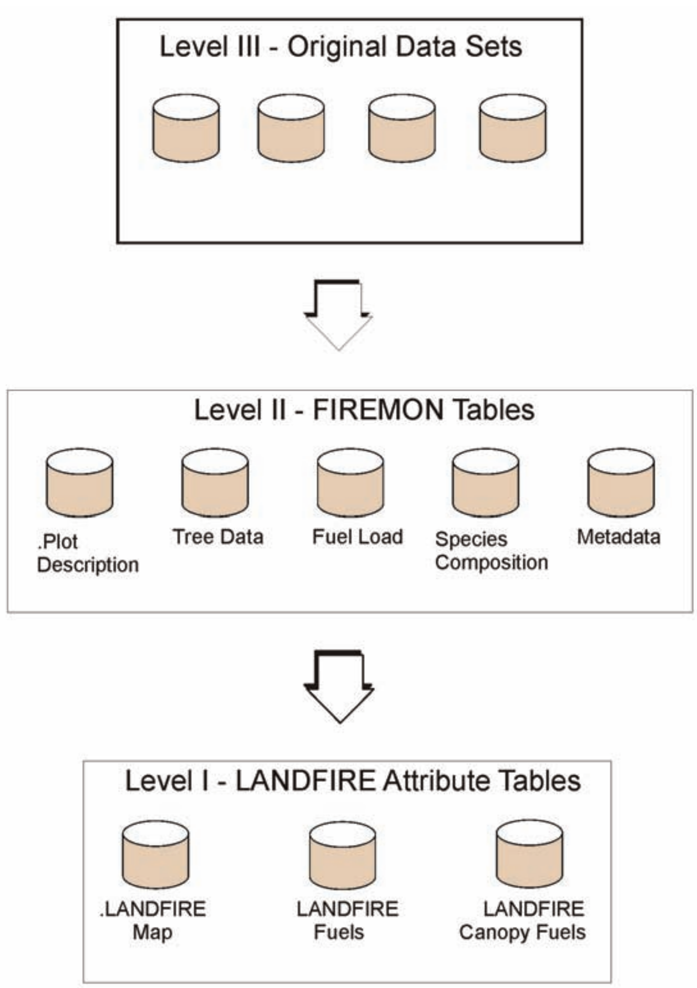


Figure 2—LANDFIRE reference database structure.

Table 2—LANDFIRE reference database data directory structure.

Directory name	Contents
FIREMON Registration ID	Subdirectories of data by major categories (such as agency)
FIREMON Project ID	Original data tables, FIREMON and LANDFIRE attribute tables
Metadata	Data conversion documents and sampling protocol documents

We then developed data-conversion routines for each data set that transformed all Level 3 data into a common database structure (Level 2) using the FIREMON database. FIREMON is a complete fire effects monitoring and inventory package that includes many field sampling methods designed to measure and describe vegetation and fuel. Most FIREMON field sampling methods are well-suited to conducting ecological inventory as well as monitoring fire effects. The FIREMON database contains a suite of tables that store collected plot data using a variety of standard vegetation and fuel sampling protocols. We used the database tables associated with the subset of FIREMON sampling methods relevant to LANDFIRE to store the LANDFIRE reference data (table 3). See appendix 4-A for a complete list of FIREMON tables and field descriptions used in the LFRDB.

We then populated the LANDFIRE attribute tables (Level 1) with data from the FIREMON database using a set of database queries (fig. 2). The LANDFIRE attribute tables were linked to the FIREMON tables and stored plot data and summary data used to develop, test, model, and map many of the LANDFIRE data layers. Level 1 attribute data included the LANDFIRE map table, the LANDFIRE fuel table, and the LANDFIRE canopy fuel table (table 4). We used the LANDFIRE map table data to model and map cover type, potential vegetation type, and structural stage; we used the LANDFIRE fuel table data to model and map fuel; and we used the LANDFIRE canopy fuel table data as input to the FUELCALC program (Keane and others, Ch. 12; Reinhardt and Crookston 2003). FUELCALC uses tree measurements and biomass equations to compute the vertical distribution of canopy biomass and uses an algorithm to calculate canopy base height (Reinhardt and Crookston 2003). FUELCALC output was used to

Table 3—FIREMON sampling methods used in the LANDFIRE reference database.

FIREMON sampling method	Type of data
Plot description (PD)	Geographic coordinates
	Life form canopy cover (tree, shrub, herbaceous)
	Hyperlinked digital plot photos
	Plant species codes (NRCS plants)
Species composition (SC)	Plant species cover
	Plant species height
	Individual tree height
	Individual tree DBH
Tree data (TD)	Individual tree live crown percent
	Individual tree crown class
	1-hr fuel
	10-hr fuel
	100-hr fuel
Fuel load (FL)	1000-hr fuel
	Live/dead shrub cover and height
	Live/dead herbaceous cover and height
Metadata (MD)	Metadata and comments
	Hyperlinked metadata documents

Table 4—LANDFIRE attribute tables.

Attribute table name	Contents
LANDFIRE map	Potential vegetation type, cover type, and structure
LANDFIRE fuel	Fuel loading
LANDFIRE canopy fuel	Canopy bulk density and canopy base height

model and map canopy bulk density and canopy base height. See appendix 4-B for a complete list of LANDFIRE map attribute tables and field descriptions.

Data-Conversion Process

We compiled data collected from many different sampling methods into a common database structure so that vegetation and fuel data could be queried in a consistent manner. We acquired plant species data that had estimates of either relative or absolute cover. Some plant species data contained entire species lists, with cover and height values for each species, whereas other data recorded cover estimates for two to four dominant species by life form. We obtained tree data sampled on variable radius and fixed radius plots. Some tree data contained data only for mature trees, whereas other data included seedling and sapling measurements. All of the surface fuel data we acquired were sampled using variations of the planar intersect method (Brown 1974). Although different sampling protocols were used for each data set, we distilled this information into basic vegetation and fuel data within a common database structure.

The data-conversion process involved converting data from their original format into the formats of the FIREMON database tables and LANDFIRE attribute tables. This process involved four steps: 1) storing the original data sets in the LFRDB Level 3 directory structure; 2) populating a Microsoft Access database containing the original data tables plus the FIREMON and LANDFIRE attribute tables; 3) building a set of crosswalk tables, data format queries, and data append queries to convert the data and populate the FIREMON and LANDFIRE attribute tables; and 4) documenting the data-conversion process and populating the FIREMON metadata tables.

Data directories—We created a directory for each data set to store the original data, any existing documentation and metadata, the FIREMON data-conversion queries and tables, and the populated FIREMON tables. The naming convention for the directories and subdirectories followed the naming convention for the FIREMON plot identification key. The FIREMON plot identification key consists of four fields: Registration ID, Project ID, Plot ID, and Date. The Registration ID and Project ID fields are used to define a directory and subdirectory for each data set. For example, the directory "mfsl" contains all data acquired from the Missoula Fire Sciences Laboratory. The subdirectories "sutah00" and "sutah01" contain field-referenced data collected for the Southern Utah Fuels Demonstration Project during the 2000 and 2001 field seasons.

Original data tables—If the original data were not delivered in an Access database, we opened an empty Access database and imported the data tables, spreadsheets, or ASCII files. We then joined the tables within Access to maintain any relationships that existed between the data in their original format.

We then imported empty FIREMON and LANDFIRE attribute tables into the Access database containing the original data set. All FIREMON tables were prefixed with "_FM_" to distinguish them from the original data tables and to organize them for easier data management (fig. 3). LANDFIRE attribute table names were prefixed with a "_" for the same reasons (fig. 3). Only FIREMON tables compatible with the sampling methods used in the original data set were added to the Access database. The imported tables retained their relationships and maintained the referential integrity of the FIREMON database. This allowed for the identification of errors associated with invalid or duplicate plot keys and allowed for cascading deletions from and updates to the FIREMON and LANDFIRE attribute tables. These tables were then populated via data-conversion queries and subsequently used to error-check the data-conversion

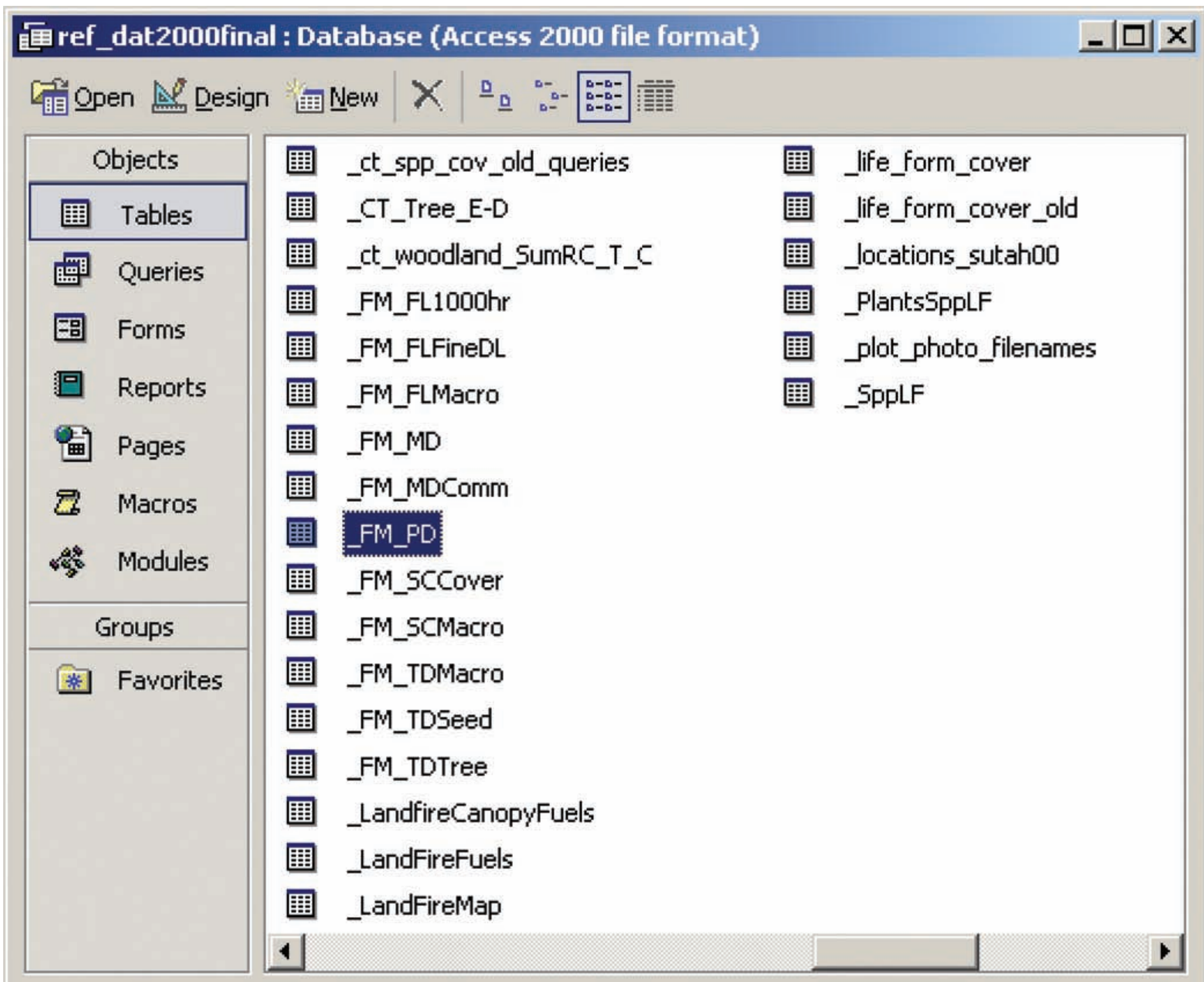


Figure 3—FIREMON tables within the Access database containing the Southern Utah Project year 2000 field data.

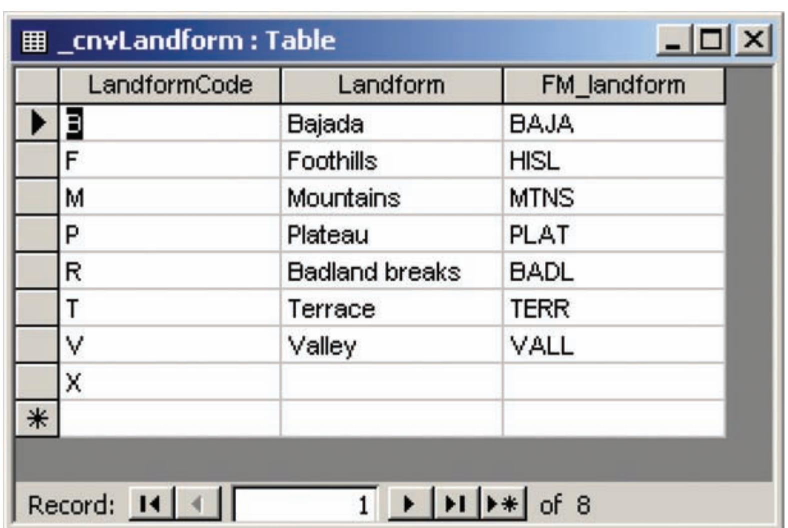
process. If errors were discovered, we emptied the FIREMON and/or LANDFIRE attribute tables, corrected the data-conversion queries, and repopulated the tables. Once the FIREMON and LANDFIRE attribute tables were loaded correctly, the data were added to the main LFRDB containing data from all data sets for that specific mapping zone.

Data-conversion queries—We created crosswalk tables to convert local codes in the original data set to standard FIREMON codes. We generated these tables by querying each applicable field in the original tables for all unique codes, creating a table from the results, and then adding a column for the FIREMON code. We populated FIREMON codes in each data-conversion table through queries or data entry. We then linked these data-conversion tables with database queries to format data for each FIREMON table. All conversion tables were prefixed with "_cnv" for easy identification in the Access database. Figure 4 illustrates a landform data-conversion table that converts the landform codes in the Southern Utah Project year 2000 data to the FIREMON landform codes. The field names containing FIREMON codes were prefixed with "FM" to distinguish these field names from field names in the original data tables (fig. 4).

Next we designed data format queries to format the original data for each FIREMON table. Each data format query was prefixed with "_format" to easily locate and identify these queries in the Access database. All necessary tables from the original data were joined with the appropriate data crosswalk tables so that the query results contained the standard FIREMON codes (fig. 5). Any numerical computations within fields, such as converting units or calculating new values, were incorporated as equations in the data format queries. Each data format query generated the FIREMON plot identifier fields plus any other relevant fields needed to populate the corresponding FIREMON table. The data format query results were then used to populate the corresponding FIREMON table (fig. 6).

FIREMON and LANDFIRE attribute tables—We developed a set of append queries to add data from the data format queries into the appropriate FIREMON tables. We prefixed these query names with "_insert" to facilitate identification in the Access database. These queries used the Access Structured Query Language (SQL) INSERT INTO statement to append data from the data format query into the corresponding FIREMON table.

Specifically, within each Access database, we designed a form with two command buttons. This form facilitated the deletion and addition of records from and to the FIREMON tables when changes were made to the data format queries and the FIREMON tables had to be updated. One button deleted all of the records in the FIREMON tables and one button added all of the



LandformCode	Landform	FM_landform
B	Bajada	BAJA
F	Foothills	HISL
M	Mountains	MTNS
P	Plateau	PLAT
R	Badland breaks	BADL
T	Terrace	TERR
V	Valley	VALL
X		

Figure 4—Data conversion table for landform codes in the Southern Utah Project year 2000 database.

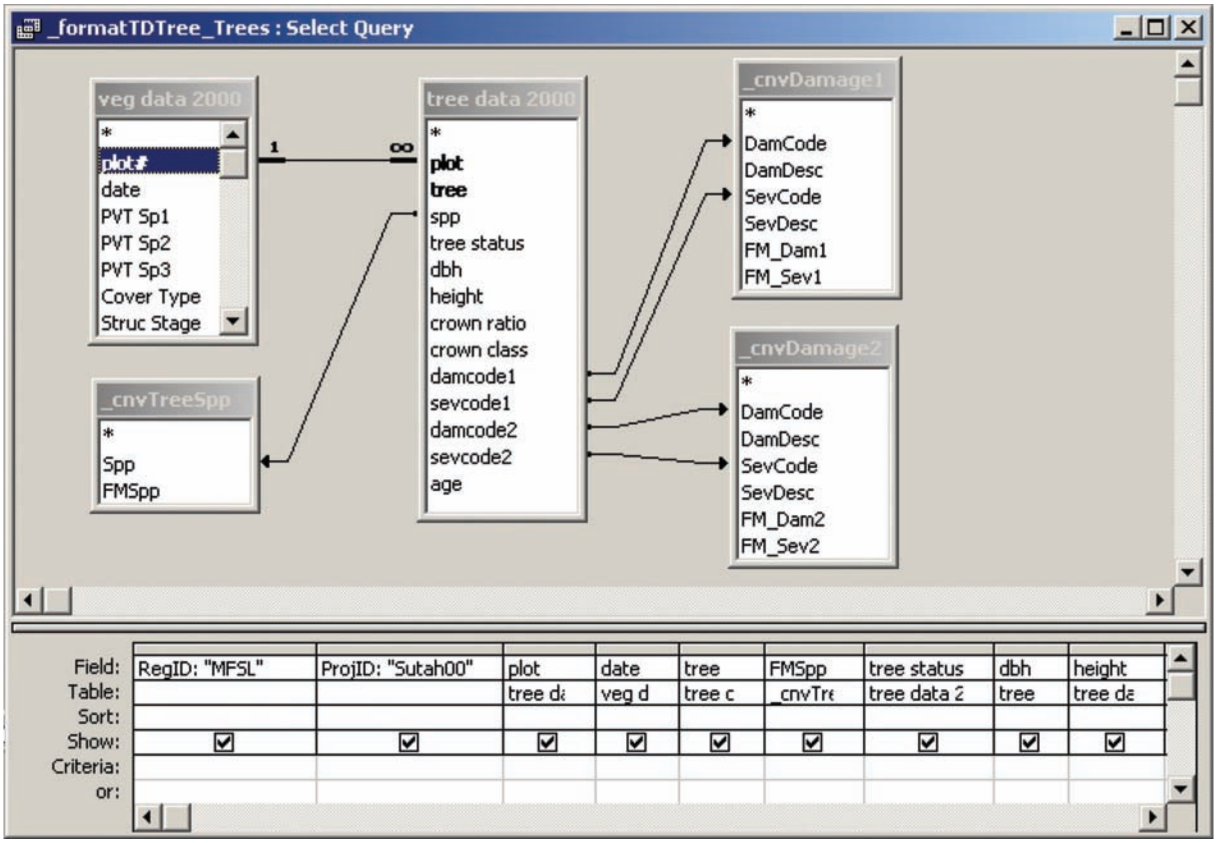
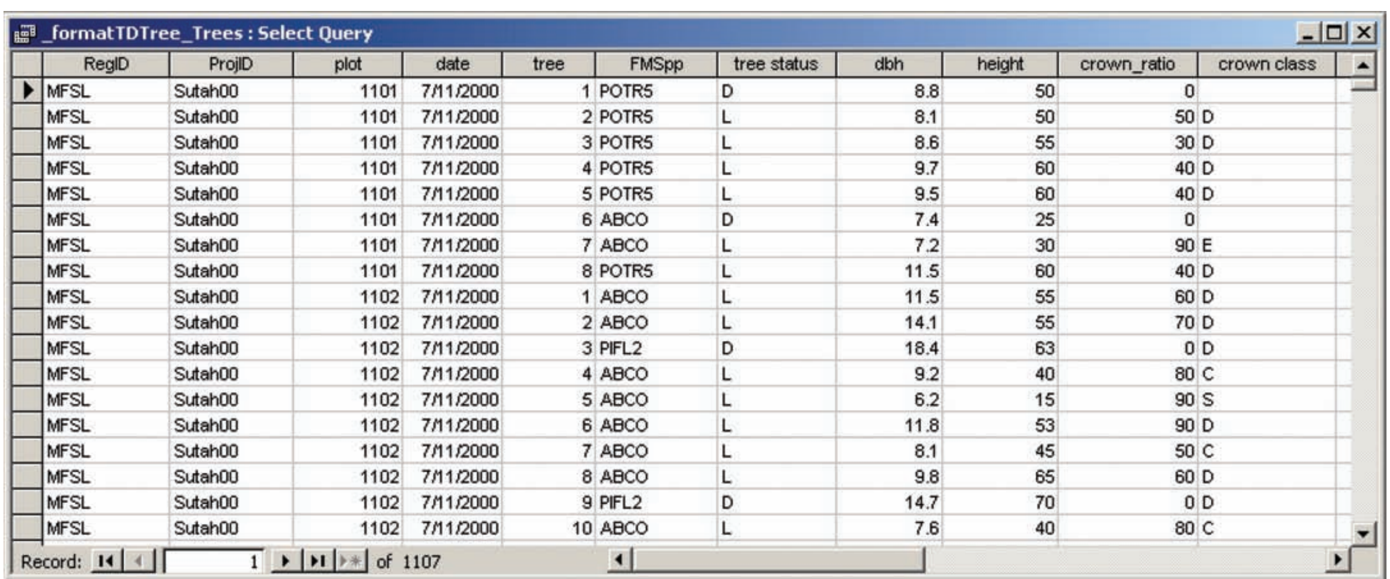


Figure 5—Data format query used to populate the FIREMON tree data (TDTree) table in the Southern Utah Project year 2000 database.



RegID	ProjID	plot	date	tree	FMSpp	tree status	dbh	height	crown_ratio	crown class
MFSL	Sutah00	1101	7/11/2000	1	POTR5	D	8.8	50	0	
MFSL	Sutah00	1101	7/11/2000	2	POTR5	L	8.1	50	50	D
MFSL	Sutah00	1101	7/11/2000	3	POTR5	L	8.6	55	30	D
MFSL	Sutah00	1101	7/11/2000	4	POTR5	L	9.7	60	40	D
MFSL	Sutah00	1101	7/11/2000	5	POTR5	L	9.5	60	40	D
MFSL	Sutah00	1101	7/11/2000	6	ABCO	D	7.4	25	0	
MFSL	Sutah00	1101	7/11/2000	7	ABCO	L	7.2	30	90	E
MFSL	Sutah00	1101	7/11/2000	8	POTR5	L	11.5	60	40	D
MFSL	Sutah00	1102	7/11/2000	1	ABCO	L	11.5	55	60	D
MFSL	Sutah00	1102	7/11/2000	2	ABCO	L	14.1	55	70	D
MFSL	Sutah00	1102	7/11/2000	3	PIFL2	D	18.4	63	0	D
MFSL	Sutah00	1102	7/11/2000	4	ABCO	L	9.2	40	80	C
MFSL	Sutah00	1102	7/11/2000	5	ABCO	L	6.2	15	90	S
MFSL	Sutah00	1102	7/11/2000	6	ABCO	L	11.8	53	90	D
MFSL	Sutah00	1102	7/11/2000	7	ABCO	L	8.1	45	50	C
MFSL	Sutah00	1102	7/11/2000	8	ABCO	L	9.8	65	60	D
MFSL	Sutah00	1102	7/11/2000	9	PIFL2	D	14.7	70	0	D
MFSL	Sutah00	1102	7/11/2000	10	ABCO	L	7.6	40	80	C

Figure 6—Query results for the data format query used to populate the TDTree table in the Southern Utah Project year 2000 database.

records to all of the FIREMON tables. The *Delete Records* button deleted all records from the FIREMON PD table, which then deleted all FIREMON records through cascading deletes. The *Add Records* button executed all the append queries in a sequence compatible with the referential integrity of the FIREMON tables.

Documentation and Metadata

We documented the data-conversion process for each data set using a table that mapped all the applicable FIREMON table names and field names to the original table names and field names. This data mapping table keeps a permanent record of the data-conversion process and facilitates the writing of data format queries for the FIREMON database structure. This table contains columns for the FIREMON table and field names, the original data table and field names, and any data-conversion algorithm or constant values applied to the field. Appendix 4-C contains the data mapping table for the Southern Utah Project year 2000 data set. Instances in which data-conversion algorithms or constants were applied to this data set include times at which we added MFSL and SUtah00 to the FIREMON Registration ID and Project ID fields, converting log diameters and decay classes from a row format to a column format, using a data-conversion table to convert local plant species codes to the Natural Resources Conservation Service (NRCS) plant codes (NRCS PLANTS Database 2005), and calculating absolute canopy cover from relative canopy cover.

Documents describing the field sampling protocols and the database structure for each data set were compiled as metadata for the LFRDB. We stored these documents in a metadata subdirectory for each data set. We also recorded any metadata pertaining to the data-conversion process in the FIREMON metadata tables (table 3). Metadata documents that were supplied with each data set were also stored in a documents directory associated with the main LFRDB

Quality Assurance and Quality Control (QA/QC)

Inaccurate reference data may introduce systematic or random bias into any type of mapping effort (Congalton 1992). We therefore implemented a set of systematic quality control measures to assure a high confidence level in the maintenance of data quality and accuracy standards. We developed QA/QC procedures to test for potential errors inherent within the reference data and to assess the quality of the reference data. We targeted three specific categories of QA/QC: 1) geospatial, 2) information content, and 3) land cover change detection.

Geospatial—We recognized that many incorrect plot coordinates result from human data entry errors and from samplers, who, in order to save time, record geographic coordinates along a road instead of from the actual plot center. Such locational inaccuracies were identified and corrected before the field-referenced data were used. We displayed data points using ArcGIS to visually inspect the distribution of plot locations for obvious problems resulting from coordinate errors, such as points occurring well outside the known perimeter of a particular data set. Data points were displayed with road network and hydrology coverages to identify problems such as sample points recorded on roads and in bodies of water. We also calculated the distance of field plots from the nearest road and noted plots positioned within 90 meters of a road.

Information content—We also identified errors related to the information collected at each sample point as numerous errors occur within the plot data, such as fields left empty and data recorded incorrectly. We sorted data records and scanned fields for null values in required fields to ensure that all plot identifiers and plot locations were unique. In addition, we assessed the quality of plant species data and determined the level of information provided, such as whether the data contained full or partial plant species lists. We also noted whether heights were provided for each species, flagging plots with species heights exceeding the normal range.

Land cover change detection—Plot data used for LANDFIRE Prototype Project were collected over a variety of dates ranging back to the late 1980s. Over time, land cover changes rendered some plot information obsolete. We therefore evaluated older data sets for land cover changes resulting from either natural or human causes. We used Landsat imagery from the Multi-Resolution Land Characteristics (MRLC) 1992 and 2001 projects and the 1992 National Land Cover Data Set (NLCD) (Vogelmann and others 2001) in this evaluation.

MRLC 1992 and MRLC 2001 data consist of a collection of terrain-corrected Landsat imagery covering all of the United States. The 1992 NLCD is a classified Landsat product delineating land cover types across the conterminous United States. MRLC 2001 Landsat imagery and NLCD 1992 land cover data were used for the LANDFIRE vegetation classification, providing a means to visually evaluate field-referenced data for errors. Each reference point was selected by life form (for example, forest, shrub, or herbaceous), overlaid onto both the 2001 Landsat imagery and the 1992 NLCD land cover data, and then visually interpreted for validity. This subjective point evaluation was adequate for identifying obvious plot errors, such as lodgepole pine-dominated plots situated in the middle of a large, homogeneous herbaceous area.

To detect reference data errors due to land cover change, we compared the difference between the Normalized Difference Vegetation Index (NDVI) of the MRLC 1992 and the MRLC 2001 image data sets. NDVI is a widely used vegetation index calculated as a ratio between the measured reflectance in the red and near infrared spectral bands of the Landsat imagery. This index has been shown to be highly effective in providing reliable quantification of vegetation cover (Goward and others 1991). The differencing of these NDVI data over time provides an excellent spatial representation of vegetation change. We extracted data values from the resultant images of the NDVI of MRLC 2001 Landsat data minus the NDVI of MRLC 1992 Landsat imagery. Changed areas within the differenced images assume strongly positive or negative values, especially when the changes are great (for example, the clear-cutting of a forest, mortality caused by insect defoliation, or forest regeneration). The differenced images were evaluated to determine the appropriate threshold values that depicted major change. The differenced NDVI values were extracted for each reference data point, and those points with values above the defined thresholds were flagged as areas of possible change. These points were then examined in greater detail by overlaying on the MRLC 2001 imagery, and a decision was made as to whether these points should be used in LANDFIRE analyses.

LANDFIRE Reference Database Content

The LFRDB included a subset of tables from the FIREMON database plus the LANDFIRE attribute tables. The plot description (PD), tree data (TD), fuel load (FL), species composition (SC) and metadata (MD) tables comprise the FIREMON subset in the LFRDB (table 3). Figure 7 shows the relationships between the FIREMON tables and the LANDFIRE attribute tables.

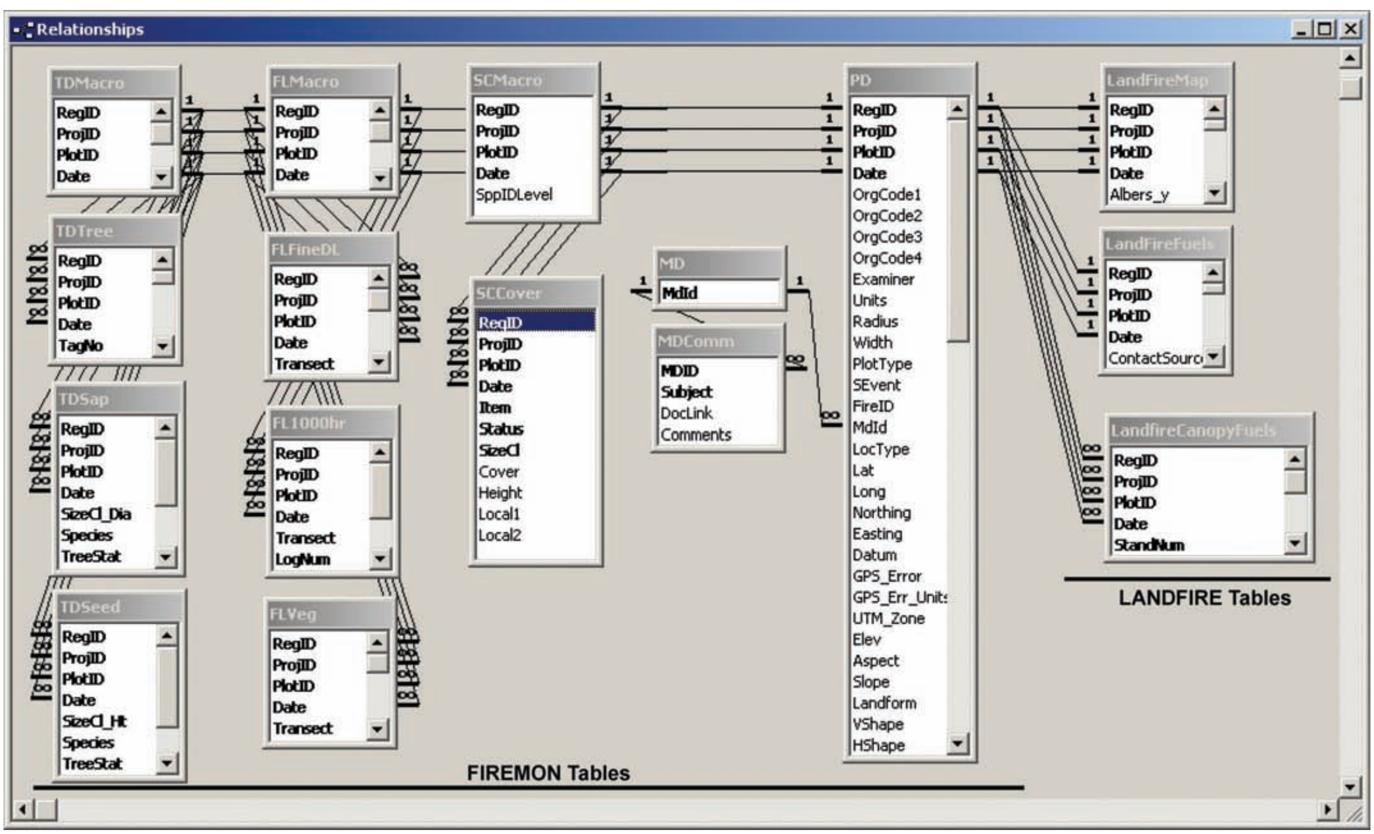


Figure 7—LANDFIRE reference database relationships view showing FIREMON tables and LANDFIRE attribute tables.

We linked FIREMON tables from each data set separately to the LFRDB. We then developed a set of append and update queries for data management purposes. Append queries insert the data from each linked FIREMON table into the appropriate LFRDB table. Each append query is prefixed with "_insert" followed by the table name to which it adds data. Update queries modify the LANDFIRE map table by assigning a PVT, CT, and SS to each plot. All update queries are prefixed with "_update" followed by the table and field in which they update. These queries are run only after the cover type program and PVT queries are executed (see below sections on cover type and potential vegetation type). Linked tables were deleted after all required append queries were run and the data were successfully appended to the reference database tables. This procedure was repeated for each data set within a mapping zone until all plot data for the mapping zone were added.

Cover Type

We assigned a cover type (for example, Ponderosa Pine, Douglas-fir, etc.) to each plot in the reference database using differing methods for FIA and non-FIA data. Plot data including plant species cover and height information were processed with a computer program to assign a LANDFIRE cover type based on the dominant overstory plant species. FIA plots were assigned a cover type based on the dominant tree species by basal area.

Plant species cover and height data—A LANDFIRE cover type classification program was developed to assign a LANDFIRE cover type to each plot having plant species cover and height data. This program consists of a Windows graphical user interface (GUI) front-end (fig. 8) called *covertypewin.exe* and a console application called *covertype.exe*. These two programs are .NET

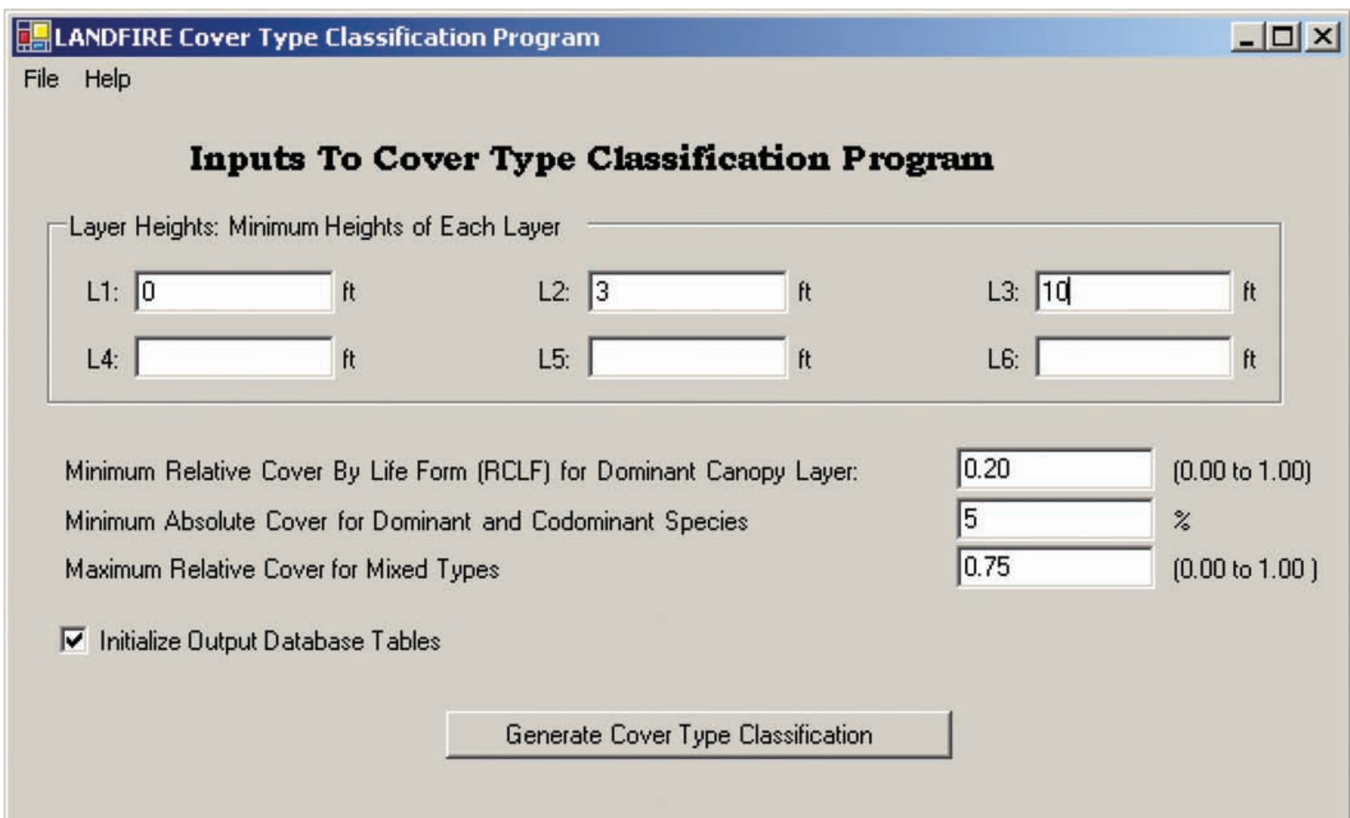


Figure 8—Cover type classification program graphical user interface (GUI) – front end.

executables and run under the Microsoft .NET Framework version 1.0 (Microsoft .NET 2005). Covertypewin.exe is the GUI portion of the package and invokes the console application covertype.exe, which then determines the cover type assignment for each plot.

There are several user inputs to this program (fig. 8). *Layer heights* are used to specify the lower height of up to six vegetation strata (for example, <1 m, 1 to 3 m, etc.). *Minimum relative cover by life form (RCLF) for dominant canopy layer* specifies the minimum RCLF value, determining which stratum or combination of strata occupies the dominant canopy. For example, if this parameter is set to .20 (20 percent) and tree species in the upper stratum (>3 m) occupy only 10 percent RCLF, the next lower stratum is added to the dominant canopy layer. If tree species in these two strata occupy at least 20 percent RCLF, then these strata are considered to occupy the dominant canopy (in other words, >1 m). This parameter is used primarily to determine the dominant canopy layer on forested plots where overstory and understory species coexist. *Minimum absolute cover for dominant and codominant species* specifies the cover threshold for determining dominant and codominant species. *Maximum relative cover for mixed types* specifies the relative cover value used to determine whether a plot falls in a mixed cover type (such as Pinyon – Juniper) or a single species cover type (such as Juniper). The *Initialize output database tables checkbox* indicates whether the program will delete the current contents of the output table before program execution.

This program requires one configuration file, three lookup tables, two input data tables, and generates one output table. Two of the three lookup tables associate dominant and codominant plant species with a LANDFIRE cover type. The other lookup table determines "tie-breakers," based on successional development, when two or more cover types have equal cover. For example, a tie between Douglas-fir and Ponderosa Pine cover types went to the later successional cover type of Douglas-fir. The input data tables contain plot life form cover values (tree, shrub, and herbaceous) and individual plant species' canopy cover and height values. The output table, *cover type classification,* is populated with the LANDFIRE cover type, dominant and codominant plant species, and their associated cover values. The configuration file sets the database paths for the input and output data tables.

The LANDFIRE cover type classification program first determined the dominant life form on the plot based on the cover type classification rule set (Long and others, Ch. 6). Next, the program determined the dominant canopy layer. We stratified canopy layers using the FIREMON defaults of 0 to 1 m, 1 to 3 m, and greater than 3 m. Relative cover for each species in the dominant life form was totaled for each canopy layer until a minimum value was reached. We set this minimum value at 20 percent. The cover type was determined by totaling the canopy cover values for each species in the dominant layer by cover type and selecting the cover type that has the greatest canopy cover. Plots having cover types with equal cover in the dominant canopy layer were assigned the later successional cover type.

For cover types based on codominance, such as Pinyon – Juniper, the program calculated the relative cover of each codominant species to determine if both were greater than or equal to 25 percent. For example, in Zone 16, the Pinyon – Juniper cover type was distinguished from the Juniper cover type based on each species having at least 25 percent cover.

This program also determined the dominant and codominant plant species on a plot. These plant species were within the dominant life form, typically within the assigned cover type and dominant canopy layer, and had the greatest absolute cover values. If there was only one species on the plot in the assigned cover type, the codominant species was determined as the species with the next greatest canopy cover within the dominant life form. Ties went to the later successional species. We set the minimum cover value at zero and reported a dominant and codominant plant species, when possible, and their associated cover values.

FIA tree data—FIA tree data include tree species codes, DBH, and trees per acre. We developed Access queries to calculate the basal area for each species on a plot, calculated the basal area by LANDFIRE cover type, and assigned the cover type having the greatest basal area. Plots having cover types with equal basal area were assigned the later successional cover type.

For cover types based on codominance, such as Pinyon-Juniper, we calculated the relative basal area of the codominant species to determine if it is greater than or equal to 25 percent. For example, in Zone 16, mixed pinyon-juniper plots were distinguished from juniper-dominated plots. The criterion for distinguishing the Pinyon – Juniper cover type from the Juniper cover type was that pinyon and juniper must each have at least 25 percent relative cover.

We then identified the dominant and codominant tree species as those having the greatest basal area within the LANDFIRE cover type. If there was only one species on the plot in the assigned cover type, the codominant species was selected as the species with the next greatest basal area. Ties went to the later successional species for reasons described above.

Potential Vegetation Type

The LANDFIRE potential vegetation type (PVT) classifications (Long and others, Ch. 6) were based on two levels of indicator species, one associating plant species with each Level 2 PVT and one associating plant species with each Level 3 PVT. The indicator species were ordered in these tables by shade tolerance (more to less) within forest PVTs or by a moisture gradient (xeric to mesic) within shrubland or herbaceous PVTs (Long and others, Ch. 6). We developed a set of database queries for assigning LANDFIRE PVTs to plots based on the presence of these indicator species.

The first set of database queries assigned a Level 2 PVT sequence number to each plot based on the PVT Level 2 indicator species list (Long and others, Ch. 6). First, each plant species that was in the PVT classification and present on a plot was assigned a Level 2 PVT sequence number. Then, the lowest sequence number on the plot determined the Level 2 PVT for the plot. A minimum cover percentage level for shrub indicator species (greater than or equal to 10 percent) was used to prevent plots with an herbaceous cover type from being assigned a shrubland PVT, such as in plots having shrub species present yet a total shrub cover of less than 10 percent.

The second set of database queries assigned a Level 3 PVT sequence number to each plot based on the PVT Level 3 indicator species list (Long and others, Ch. 6). Again, each plant species that was in the PVT classification and present on a plot was first assigned a Level 3 PVT sequence number. Then the lowest sequence number on the plot determined the Level 3 PVT for the plot. We then concatenated the Level 2 and Level 3 PVT labels to generate the proper PVT label.

Data Management and Summary Queries

Data management queries involved appending data to the reference database tables and updating the LANDFIRE map table with PVT, CT, and SS assignments for all plots. We created data summary queries to assist in the development of the potential vegetation classification, the cover type classification, succession pathway models, and fuel model classifications. These data summary queries included plot counts by CT, PVT / CT, and PVT / CT / SS; constancy cover tables by CT, PVT / CT, and PVT / CT / SS; and fuel loading by CT, PVT / CT, and PVT / CT / SS. We built a form within the LFRDB to automate the data management and data summary tasks (fig. 9). Automating these tasks facilitated database plot record updates as modifications were made to the PVT, CT or SS classifications.

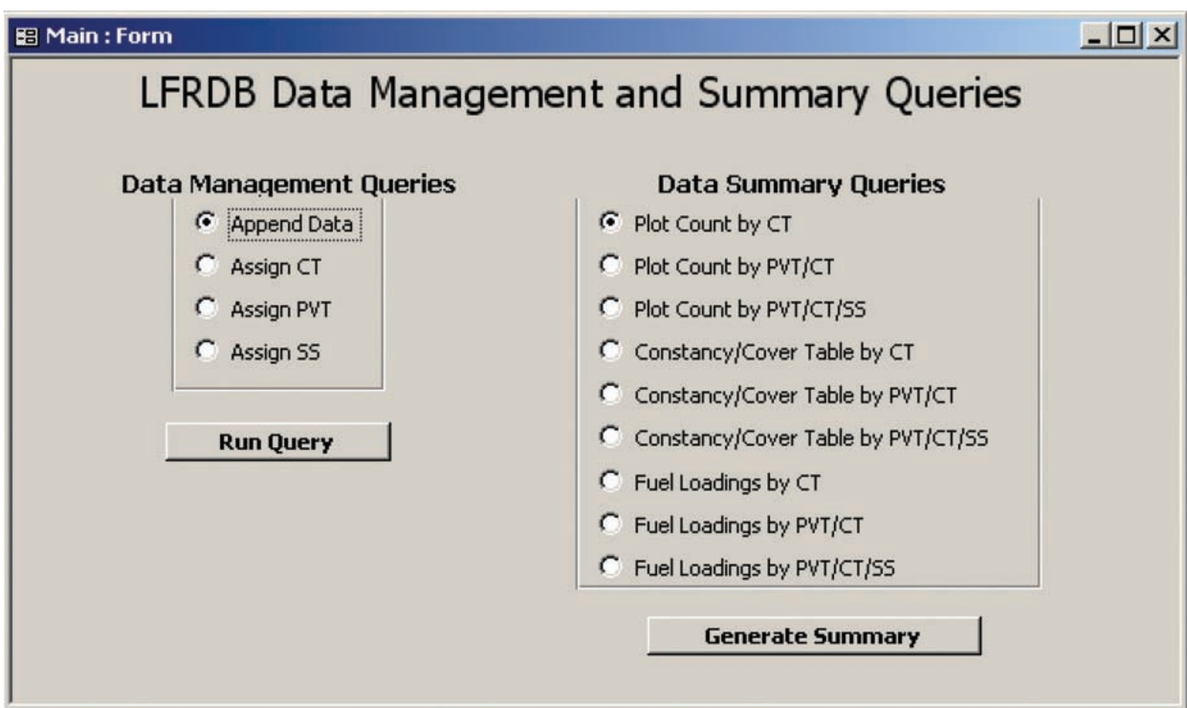


Figure 9—Form for automating data management and data summary tasks.

FIREMON Database Application

The FIREMON database application has two features that were applicable to the LFRDB: plot photo and metadata document hyperlinks. The FIREMON database application was connected to the LFRDB using the *Configuration and Settings* menu. This menu also set the directory path for the FIREMON documents and photos directories. The FIREMON plot description (PD) data entry form allowed the LANDFIRE team to view hyperlinked photos (fig. 10). For each mapping zone, we placed all acquired digital plot photos into a photo directory. The digital image (photo) file names were added to the FIREMON PD photo fields during the data-conversion process. These photos could then be viewed via the plot photo hyperlink on the PD form. The FIREMON MD data entry form allowed the team to view hyperlinked documents (fig. 11). For each mapping zone, we placed all associated metadata documents into a documents directory. The document file names were added to the MD table document link field in the LFRDB for each mapping zone. These documents could then be viewed via the document hyperlink.

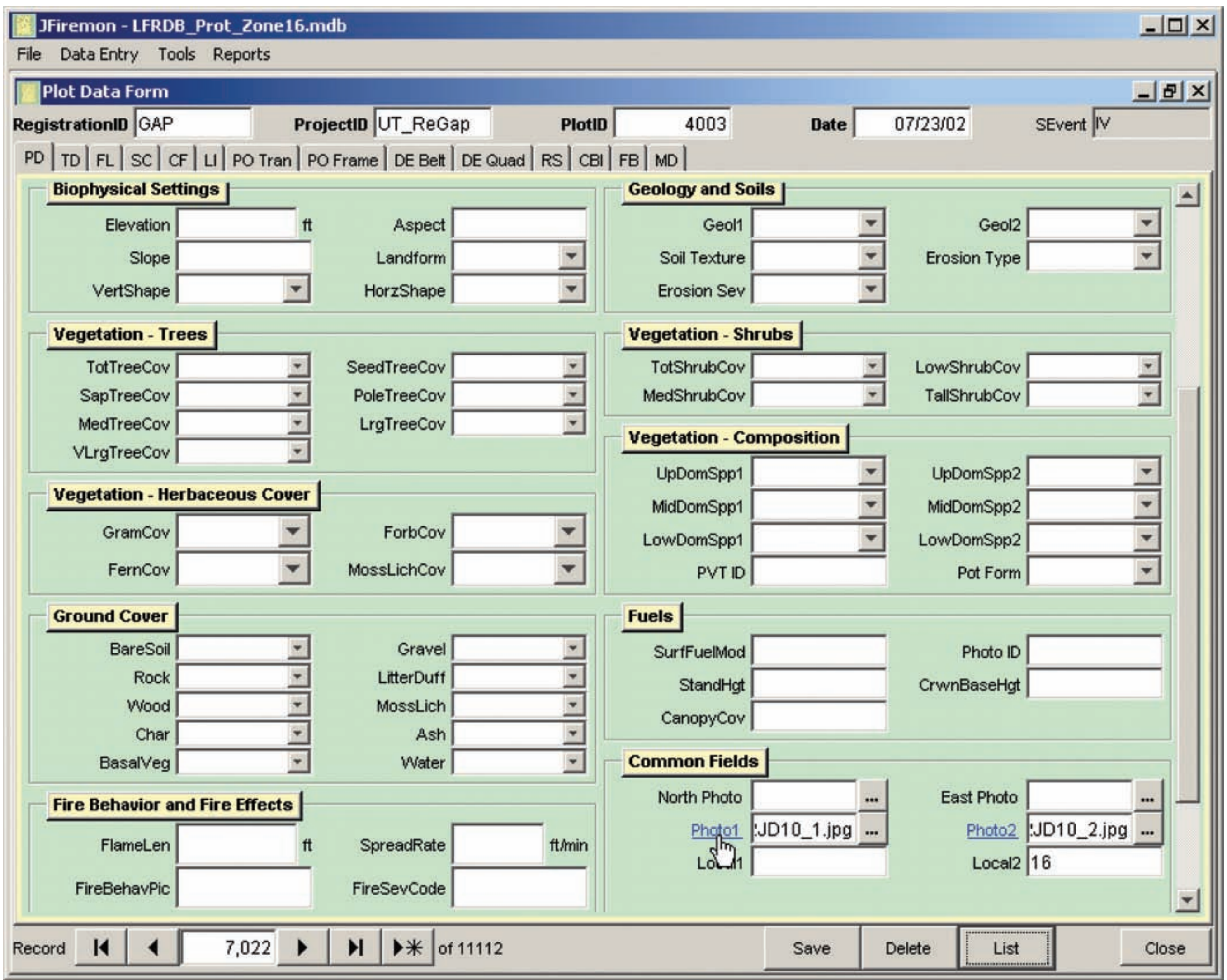


Figure 10—FIREMON plot description form illustrating the plot photo hyperlink.

Results and Discussion

Reference Database Implementation

The FIREMON database was designed to be flexible, and it proved to be fully capable of storing the primary data elements required for the LFRDB. One accommodating feature of FIREMON is that many of the fire monitoring and ecosystem inventory sampling methods employ standard field sampling techniques The flexibility of the FIREMON database allowed customization of the core data tables to store data from a diverse set of field-referenced databases. For example, the FIA, ECODATA, and Southern Utah Project tree data were easily added to the FIREMON TD tables; The ECODATA, Utah field-referenced data from Southwest ReGAP, and Southern Utah Project plant species composition and cover data were easily added to the FIREMON SC tables; The FIREMON PD table accommodated all locational information and site data; and the FIREMON MD tables stored all metadata on field sampling protocols and the data-conversion process.

Additional LANDFIRE attribute tables were easily integrated into the FIREMON database and linked to the FIREMON PD table. These tables were developed specifically for LANDFIRE modeling and mapping tasks and facilitated reference data dissemination to specific LANDFIRE teams. For example, data from the LANDFIRE map attribute table were used to model and map cover type and vegetation structure (Zhu and others, Ch. 8) and to model and map potential vegetation (Frescino and Rollins, Ch. 7). In addition, these data

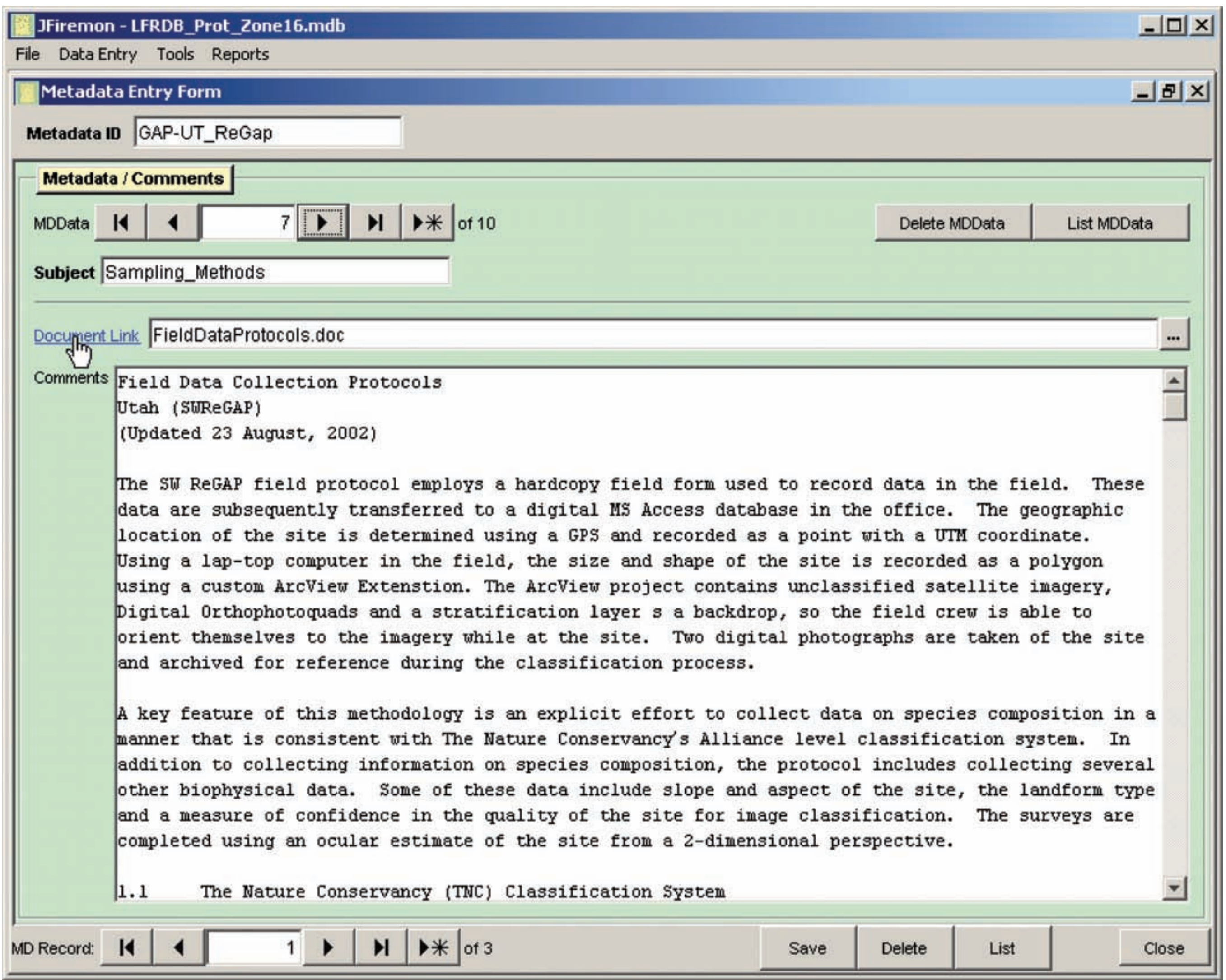


Figure 11—FIREMON metadata form illustrating the document hyperlink.

were used to refine the existing and potential vegetation classifications (Long and others, Ch. 6). Data in the LANDFIRE map attribute and fuel attribute tables were used to map fire behavior fuel models (Anderson 1982; Scott and Burgan 2005), fire effects fuel models (Keane and Rollins, Ch. 3; Keane and others, Ch 12; Lutes and others, in preparation; Sandberg and others 2004), and canopy fuel. These tables were used to map fire behavior and effects fuel models based on spatially explicit layers of PVT, CT, and SS. (Keane and others, Chapter 12). The LANDFIRE canopy fuel attribute table was also used as input to the FUELCALC program, and FUELCALC output was used to model and map canopy bulk density and canopy base height (Keane and others, Chapter 12).

In addition to using the FIREMON database to store field-referenced data, we developed a simple and efficient data-conversion process. The *Access Query Design Window* provided a relatively easy way for reference database team members to build the SQL statements required for the data-conversion process. This process was easy to teach resource personnel with limited database skills and was effective as a data migration and data cleaning tool. Our method proved adaptable enough to convert a wide range of data into a common database structure. In addition, our process provided an easy way to track plot records from the LANDFIRE attribute tables back to the original data stored in the data directories for each data set.

Reference Data Acquisition and Applications

Zone 16—Approximately 11,000 plots were compiled in the LFRDB for Zone 16. The initial acquisition of existing data sets for Zone 16 produced only three viable data sets: FIA tree data, Southern Utah Project data, and Utah field-referenced data from Southwest ReGAP. Since FIA data is fairly extensive in forested areas, the limiting factor was the acquisition of non-forest vegetation data. The Southern Utah Project data adequately covered the southern portion of Zone 16. The initial Utah data acquired from Southwest ReGAP contained very little reference data for the northern and central portions of Zone 16. A strategic partnership between the Southwest ReGAP project and the LANDFIRE Prototype Project was crucial in obtaining additional field-referenced data for Zone 16.

Concerning applications, all data sets acquired for Zone 16 included vegetation data used to model and map potential vegetation, cover type, and structure. In addition to use in mapping vegetation cover and structure, all FIA tree data were used for modeling and mapping canopy fuel (canopy bulk density and canopy base height). A limited number of plots in the Southern Utah Project data set had tree data used for modeling and mapping canopy fuel and downed woody fuel transect data used for mapping fire behavior and effects fuel models.

Zone 19—Approximately 12,500 plots were compiled in the reference database for Zone 19. The initial data acquisition for Zone 19 produced several viable data sets in addition to the FIA tree data, due in part to existing ECODATA plots from the USDA Forest Service Northern Region ecology program and USGS and MFSL research in and around Glacier National Park. We acquired data for thousands of BLM fuel inventory plots, as well; however, these were heavily concentrated around Salmon and Challis, Idaho. Moreover, many of the ECODATA plots were concentrated around the Flathead National Forest and Glacier National Park. We lacked field-referenced data for many non-forested areas in the southern and eastern portions of Zone 19. Therefore, it was crucial to contract with the Utah field crews from Southwest ReGAP for additional field-referenced data collection.

All data sets for Zone 19 included vegetation data used to model and map potential vegetation, cover type, and structure. In addition to use in mapping vegetation and structure, all FIA tree data were used for modeling and mapping canopy fuel. All ECODATA data sets had tree data for modeling and mapping canopy fuel and downed woody fuel transect data for mapping fire behavior and effects fuel models.

Limitations of Acquired Data

Some of the existing data sets obtained for the LANDFIRE Prototype proved limited in utility. For example, the data sets acquired from research projects -- MFSL and USGS ECODATA plots for Glacier National Park -- provided the most accurate data for mapping existing and potential vegetation and fuel models, yet these data were geographically limited. Second, FIA tree data provided valuable plot data for forest ecosystems, including individual tree measurements used for modeling and mapping potential vegetation, cover type, canopy height, canopy cover, and canopy fuel. In order to maintain nationally consistent FIA data, however, we used only the FIADB data tables that are available nationally; we did not use FIADB seedling and understory vegetation data as these are not collected across the country. Third, the Utah data collected for Southwest ReGAP and for additional Zone 19 reference plots were useful for modeling and mapping potential vegetation, cover type and structure. However, because height data were not always collected for every plant species recorded, only a subset of data collected using the Southwest ReGAP sampling protocols could be used to model and map structure. Lastly, although there were approximately 4,000 data points in the BLM dominant and co-dominant species data sets, most of the data were tightly clustered geographically, limiting their utility for mapping vegetation and fuel across the entire extent of Zone 19.

Recommendations for National Implementation

Cooperation with Outside Agencies

Projects requiring extensive field-referenced data, such as LANDFIRE, must rely heavily on existing data sources since there is not enough time or money to collect new reference data. We initially solicited data via a formal data request letter sent to agency personnel, but this effort yielded only a few small and limited data sets. Nonetheless, a formal data request letter will be necessary for the national implementation of LANDFIRE and will likely generate some high-quality data sets. We do, however, caution against relying primarily on such a letter to generate the quantity and quality of data required for a project the size and scope of LANDFIRE. We discovered that the most efficient and effective way to obtain high-quality, well-distributed data is through cooperation with agencies that have already collected similar reference data. All major field-referenced data contributions for the LANDFIRE Prototype Project were obtained through new or existing relationships with outside agencies and research projects.

It is of particular importance to have cooperation from FIA in light of the confidential nature of FIA plot locations. The Interior West FIA program provided the LANDFIRE Prototype Project with one part-time FIA employee to facilitate data acquisition and perform tasks requiring the use of FIA plot coordinates. In addition, through this partnership we were able to acquire plot data other than those available from the FIADB. Furthermore, collaboration between LANDFIRE and the Southwest ReGAP Project gained the LFRDB team access to a wealth of data for Zone 16. Once we established a relationship with the Utah State Southwest ReGAP team, we were able to obtain all existing plot data as well as contract with their Utah field crews to acquire additional field-referenced data for zones 16 and 19. Contracting with other agencies' field crews capitalizes on their resources and expertise in field sampling, thereby saving investment in additional resources and training.

Data Triage

Data triage is critical to the timely delivery of reference data. It is easy to become overwhelmed by too much data and too little time for processing. For this reason, it is essential to concentrate on large, high-quality data sets with wide geographic coverage containing data elements pertinent to the LANDFIRE mapping tasks. We do not recommend spending much time on small data sets unless they have high quality data (such as certain data sets from intensive research projects) or until after the large data sets have been processed. Next, prior to data conversion, we recommend identifying all plot locations mistakenly recorded on roads, in water, or outside the known study area. Assessing the locations of existing reference data will also highlight areas in need of additional field data collection. Identifying these areas early in the process allows ample time to contract with field crews prior to the up-coming field season.

Keep it Simple

Most of the data sets we acquired for the LANDFIRE Prototype Project contained many more variables than were necessary for our purposes. We initially converted all original data that could populate the FIREMON database fields and recommend this as the first step in data conversion since all data elements of the original data set exist in a common database for use in the prototype effort. When time is a limiting factor, however, it is practical to first convert only the fields required to populate the LANDFIRE attribute tables. If time allows, the data-conversion queries may be modified and plot records updated in the LFRDB. We did spend a substantial amount of time converting data that were never used for the LANDFIRE Prototype, yet the prototype nature of the project required that we had all data available while the LANDFIRE mapping processes were being developed.

Because of the large quantity of field-referenced data and necessary distribution across LANDFIRE mapping teams, the LANDFIRE National will require a true multi-user relational database management system capable of accommodating more data than Microsoft Access and operating efficiently under a distributed computer network. Although a database with greater flexibility than that of Access should ultimately be used for LANDFIRE National, the Access reference database used in the prototype effort proved satisfactory for our purposes. If, for LANDFIRE National, a separate LFRDB were built for each mapping zone, Access would be able to accommodate the large amount of plot data and the entire data-conversion process described in this chapter could be applied.

Conclusion

In conclusion, the use of existing databases to meet the broad-scale mapping objectives of the LANDFIRE Prototype Project worked well. Existing databases from both government and non-government sources provided excellent information for successfully completing the LANDFIRE mapped products. In this prototype effort, however, we found that field data for non-forested areas were rare relative to those of forested areas. This scarcity of data for non-forested areas may pose more of a limitation in other areas of the United States than it did in the two study areas of the LANDFIRE Prototype Project. For this reason, it may be necessary to collect additional data in non-forested areas for national implementation of the LANDFIRE methods.

For further project information, please visit the LANDFIRE website at www.landfire.gov.

The Author

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Appendix 4-A—FIREMON tables and fields in the landfire reference database

Plot description (PD)	
Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
OrgCode1	Organization code 1
OrgCode2	Organization code 2
OrgCode3	Organization code 3
OrgCode4	Organization code 4
Examiner	Name of FireMon crew boss or lead examiner
Units	Units of measurement (english or metric)
Radius	Radius/length of the macroplot in feet (meters)
Width	Width of macroplot in feet (meters)
PlotType	Type of plot: C=Control, M=Measured
SEvent	Sampling event - reason why plot is being measured at this time
FireID	Fire behavior database key-id
MdId	Metadata Key-Id
LocType	Type of Location L=Lat/Long, U=UTM
Lat	Latitude of plot center
Long	Longitude of plot center
Northing	UTM Northing of plot center
Easting	UTM Easting of plot center
Datum	GPS datum
GPS_Error	GPS error (meters or feet)
GPS_Err_Units	Units for GPS Error: ft = feet, m=meters
UTM_Zone	UTM zone
Elev	Elevation above mean sea level - feet (meters)
Aspect	Aspect of plot in azimuth - degrees
Slope	Average slope (rise/run)*100 - percent
Landform	Landform code
VShape	Shape of plot perpendicular to contour
HShape	Shape of plot parallel to contour
Geol1	Primary surficial geology code
Geol2	Secondary surficial geology code
SoilTex	Soil texture
EType	Erosion type
ESev	Erosion severity
TreeC	Total tree cover - percent
SeedC	Seedling cover - percent
SapC	Sapling cover- percent
PoleC	Pole cover - percent
MedC	Medium tree cover - percent
LTreeC	Tree cover - percent
VLTreeC	Very large tree cover - percent
ShrubC	Total shrub cover - percent
LShrubC	Low shrub cover - percent
MShrubC	Medium shrub cover - percent
TShrubC	Tall shrub cover - percent
GramC	Graminoid cover - percent
ForbC	Forb cover - percent
FernC	Fern cover - percent
MossC	Moss and lichen cover - percent
USpp1	Most dominant species in upper layer
USpp2	Second most dominant species in upper layer
MSpp1	Most dominant species in middle layer
MSpp2	Second most dominant species in middle layer

Appendix 4-A — (Continued)

LSpp1	Most dominant species in lower layer
LSpp2	Second most dominant species in lower layer
PVTId	Potential vegetation type code
PotForm	Potential life form code
BSoilGC	Bare soil ground cover - percent
GravelGC	Gravel ground cover - percent
RockGC	Rock ground cover - percent
DuffGC	Duff and litter ground cover - percent
WoodGC	Wood ground cover - percent
MossGC	Moss and lichen ground cover - percent
CharGC	Charred ground cover - percent
AshGC	Ash ground cover - percent
BVegGC	Basal vegetation ground cover - percent
WaterGC	Water ground cover - percent
FModel	Fire behavior fuel model (Anderson 1982)
PhotoID	Fuel photo series
SHT	Stand height: height of highest stratum which contains at least 10% of canopy cover - feet (meters)
CBH	Canopy fuel base height - feet (meters)
CanopyC	Percent canopy cover of forest canopy >6.5 feet - feet (meters)
FLength	Average flame length - feet (meters)
SRate	Spread rate; average speed of fire - feet/min (meters/min)
FBevPic	Picture code for fire behavior picture
FSC	Fire severity code
NorthPic	Code for plot photo taken in direction of due north
EastPic	Code for plot photo taken in direction of due east
Photo1	Code for plot photo 1
Photo2	Code for plot photo 2
Local1	Local code 1
Local2	Local code 2
Comments	Comments about plot

Species composition – macroplot (SCMacro)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
SppIDLevel	Plant species ID level; minimum cover recorded – percent
RegID	

Species composition (SCCover)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
Item	Item code
Status	Heath of species - (live or dead)
SizeCl	Size class
Cover	Canopy cover - percent
Height	Average height - feet (m)
Local1	Optional field 1
Local2	Optional field 2

Tree data – macroplot (TDMacro)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
MacroPlotSize	Macroplot size - acres (square meters)
MicroPlotSize	Microplot size - acres (square meters)
SnagPlotSize	Snagplot size - acres (suqare meters)
BreakPntDia	Break point diameter - inches (cm)

Appendix 4-A — (Continued)

Tree data – mature trees (TDTree)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
TagNo	Tree tag number
Species	Species code
TreeStat	Health of tree (live or dead)
DBH	Diameter at breast height - inches (cm)
Height	Tree Height - feet (m)
LiCrPct	Live crown percent
LiCrBHt	Live crown base height feet (m)
CrwnCl	Crown position class
Age	Tree age - years
GrwthRt	Tree growth rate (last 10 yrs radial growth) - inches (mm)
DecayCl	Decay class
Mort	Cause of mortality
DamCd1	Damage code 1
DamSev1	Severity code 1
DamCd2	Damage code 2
DamSev2	Severity code 2
CharHt	Bole char height - feet (m)
CrScPct	Crown scorch percent
Local1	Optional code 1

Tree data – saplings (TDSap)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
SizeCl_Dia	Size class
Species	Species code
TreeStat	Tree status
Count	Count number of trees by species, size class, and status
AvgHt	Average height - feet (m)
AvgLiCr	Average live crown percent
Local1	Local field 1

Tree data – seedlings (TDSeed)

Field Name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
SizeCl_Ht	Size class
Species	Species code
TreeStat	General health condition of sample tree
Count	Number of trees by species, size class, and status
Local1	Local field 1

Fuel load – macroplot (FLMacro)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
1HRTranLen	1-hr transect length - feet (m)
10HRTranLen	10-hr transect length - feet (m)
100HRTranLen	100-hr transect length - feet (m)
1000HRTranLen	1000-hr transect length - feet (m)
NumTran	Number of transects

Appendix 4-A — (Continued)

Fuel load – fine fuel, duff, and litter (FLFineDL)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
Transect	Line transect number
Slope	Slope of transect (rise/run)*100 - percent
1hr	Number of pieces 0 - 0.25 in. (0 - 0.635 cm) in diameter
10hr	Number of pieces 0.25 - 1.0 in. (0.635 - 2.54 cm) in diameter
100hr	Number of pieces 1- 3 in. (2.54 and 7.62 cm) in diameter
D/LDep1	Depth of duff/litter profile - inches (cm)
LitterPct1	Proportion of total profile depth that is litter- percent
D/LDep2	Depth of duff/litter profile - inches (cm)
LitterPct2	Proportion of total profile depth that is litter - percent
Local1	Local field 2

Fuel load – 1000-hr fuel (FL1000hr)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
Transect	Line transect number
LogNum	Log number
Dia	Diameter of log at line intersection - inches (cm)
DecayCl	Log decay class
Local1	Local field 1

Fuel load – vegetation (FLVeg)

Field name	**Description**
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
Transect	Line transect number
LiShC1	Live woody cover at point 1
DdShC1	Dead woody cover at point 1
ShHt1	Woody height at point 1
LiHeC1	Live non-woody cover at point 1
DdHeC1	Dead non- woody cover at point 1
HeHt1	Non-woody height at point 1
LiShC2	Live woody cover at point 2
DdShC2	Dead woody cover at point 2
ShHt2	Woody height at point 2
LiHeC2	Live non-woody cover at point 2
DdHeC2	Dead non- woody cover at point 2
HeHt2	Non-woody height at point 2

Metadata ID (MDID)

Field name	**Description**
MdId	Metadata ID

Metadata (MDComm)

MDID	Metadata ID
Subject	Metadata subject
DocLink	Hyperlink for metadata documen

Appendix 4-B—LANDFIRE attribute tables

LANDFIRE map

Field name	Description
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
Albers_y	Albers Northing of plot center
Albers_x	Albers Easting of plot center
Datum	Datum of coordinate system
LF_Zone	LANDFIRE zone - MRLC zone in which plot is located
Orig_CoverType	Cover type assigned in original data set
LF_CoverType	LANDFIRE cover type
LF_CoverTypeCode	LANDFIRE cover type code
DomSpp	Dominant plant species
DomSppC	Dominant plant species cover - percent
CoDomSpp	Codominant plant species
CoDomSppC	Codominant plant species cover - percent
TreeC	Tree cover - percent
ShrubC	Shrub cover - percent
HerbC	Herbaceous cover - percent
TreeHt	Average tree height weighted by canopy cover (ft.)
ShrubHt	Average shrub height weighted by canopy cover (ft.)
HerbHt	Average herbaceous height weighted by canopy cover (ft.)
Orig_StrucStage	Structural stage assigned in original data set
LF_StrucStage	LANDFIRE structural stage
LF_StrucStageCode	LANDFIRE structural stage code
Orig_PVT	Potential vegetation type assigned in original data set
LF_PVT	LANDFIRE potential vegetation type
LF_PVTCode	LANDFIRE potential vegetation type code
SoilTex	Soil texture
PhotoID	Plot photo filename identifier
Reference	Data reference
Loc_Meth	Method for determining plot location
Loc_Acc	Plot location accuracy (meters)
DistToRoad	Distance to nearest road (meters)
NLCD_Code	NLCD code
NLCD_Desc	NLCD description
LifeFormCover_QAQC	Codes for life form cover QA/QC
SppCover_QAQC	Codes for plant species data QA/QC
SppHeight_QAQC	Codes for plant species height QA/QC

LANDFIRE fuel

Field name	Description
RegID	Unique 4 character code for each FIREMON user
ProjID	Unique 8 character code for each project
PlotID	Unique number for each plot
Date	Sampling date
ContactSource	Contact person for data
DataSource	Source of data
DataSourceInfo	Information about source of data
DataComments	Data comments
ID1	Organization code 1
ID2	Organization code 2
ID3	Organization code 3
ID4	Organization code 4
Units	Measurement units (E or M)
Albers_y	Albers Northing of plot center
Albers_x	Albers Easting of plot center
Datum	Datum of coordinate system

Appendix 4-B — (Continued)

LF_Zone	LANDFIRE zone - MRLC zone in which plot is located
Slope	Elevation above mean sea level - feet (meters)
Aspect	Aspect of plot in azimuth - degrees
Elevation	Average slope (rise/run)*100 - percent
LocationComments	Comments on plot location
LandfirePVT	LANDFIRE potential vegetation type
CurrentLifeForm	Current life form on plot
PotLifeForm	Potential life form on plot
CoverType	Land cover type
HabitatType	Habitat type
BaileyProvince	Bailey Province
ICRBStructure	ICRB stand structure
VegDataFile	Vegetation data file
OverSpecies1	Dominant overstory species
OverSpecies2	Codominant overstory species
UnderSpecies1	Dominant understory species
UnderSpecies2	Codominant understory species
Graminoid1	Dominant graminoid species
Graminoid2	Codominant graminoid species
Shrub1	Dominant shrub species
Shrub2	Codominant shrub species
Forb1	Dominant forb species
Forb2	Codominant forb species
FuelbedDepth	Fuelbed depth
Carrier1	Primary fire carrier
Carrier2	Secondary fire carrier
VegComments	Vegetation comments
Event	Fire event
Pre/post	Pre/post fire effects
ActivityFuel	Activity fuel
EventComments	Event comments
1-hrBiomass	1-hr fuel biomass
10-hrBiomass	10-hr fuel biomass
100-hrBiomass	100-hr fuel biomass
3”<TotalBiomass	1-100-hr total fuel biomass
3”>TotalBiomass	1000-hr total fuel biomass
3”>SndBiomass	1000-hr sound fuel biomass
3”>RotBiomass	1000-hr rotten fuel biomass
3”-9”SndBiomass	3”-9” sound fuel biomass
3”-9”RotBiomass	3”-9” rotten fuel biomass
9”-20”SndBiomass	9”-20” sound fuel biomass
9”-20”RotBiomass	9”-20” rotten fuel biomass
20”+SndBiomass	20” and larger sound fuel biomass
20”+RotBiomass	20” and larger rotten fuel biomass
DWMethod	Downed woody sampling method
DWSource	Downed woody sampling method source
DWComments	Downed woody comments
DuffBiomass	Duff biomass
DuffBulkDen	Duff bulk density
DuffMethod	Duff method
DuffSource	Duff source
DuffComments	Duff comments
LitterBiomass	Litter biomass
LitterBulkDen	Litter bulk density
LitterMethod	Litter method
LitterSource	Litter source
LitterComments	Litter comments
LiveHerbBiomass	Live herbaceous biomass
DeadHerbBiomass	Dead herbaceous biomass

Appendix 4-B — (Continued)

HerbMethod	Herbaceous sampling method
HerbSource	Herbaceous sampling method source
HerbComments	Herbaceous comments
LiveShrubBiomass	Live shrub biomass
DeadShrubBiomass	Dead shrub biomass
ShrubMethod	Shrub sampling method
ShrubSource	Shrub sampling method source
ShrubComments	Shrub comments
OtherBiomass	Other biomass
OtherMethod	Other biomass sampling method
OtherSource	Other biomass sampling method source
OtherComments	Other comments
#ofTrans	Number of transects
1-hrLen	1-hr transect length
10-hrLen	10-hr transect length
100-hrLen	100-hr transect length
1000-hrLen	1000-hr transect length
1-hrQMD	1-hr fuel quadratic mean diameter
10-hrQMD	10-hr fuel quadratic mean diameter
100-hrQMD	100-hr fuel quadratic mean diameter
TransectComments	Transect comments
DecayCl1Den	Decay class 1 density
DecayCl2Den	Decay class 2 density
DecayCl3Den	Decay class 3 density
DecayCl4Den	Decay class 4 density
DecayCl5Den	Decay class 5 density
DecayClassComments	Decay class comments

LANDFIRE canopy fuel

Field name	**Description**
RegID	Unique code for each FIREMON user (up to 4 characters)
ProjID	Unique code for each project (up to 8 characters)
PlotID	Unique code for each plot
Date	Sampling date
StandNum	Stand number
Tag	Tree ID number
Spe	Tree ID - 2 character code
Dia	Diameter at breast height (inches)
Hgt	Tree height (feet)
C-HBC	Height to base of live crown (feet)
CC	Crown class (code = D, C, I, S, E, G)
TPA	Tree density (trees/acre)

Appendix 4-C—FIREMON data conversion table for Southern Utah Project year 2000 data, which shows how fields from the Sutah Access database are mapped and converted to fields in the FIREMON access database

FIREMON table	FIREMON field	Sutah00 table	Sutah00 field	Conversion
FL1000hr	RegID			MFSL
FL1000hr	ProjID			Sutah00
FL1000hr	PlotID	Down Wood 2000	Plot#	
FL1000hr	Date	Veg data 2000	Date	
FL1000hr	Transect	Down Wood 2000	Transect	
FL1000hr	LogNum	Log1-17		Horiz – vert
FL1000hr	Dia	Log1-17 dia		Horiz – vert
FL1000hr	DecayCl	Log1-17 dc		Horiz – vert
FL1000hr	Local1			
FLFineDL	RegID			MFSL
FLFineDL	ProjID			Sutah00
FLFineDL	PlotID	Down Wood 2000	Plot#	
FLFineDL	Date	Veg data 2000	Date	
FLFineDL	Transect	Down Wood 2000	Transect	
FLFineDL	Slope	Down Wood 2000	Slope	
FLFineDL	1hr	Down Wood 2000	1Hour	
FLFineDL	10hr	Down Wood 2000	10Hour	
FLFineDL	100hr	Down Wood 2000	100Hour	
FLFineDL	D/LDep1	Down Wood 2000	DuffLittDepth30	
FLFineDL	LitterPct1			
FLFineDL	D/LDep2	Down Wood 2000	DuffLittDepth60	
FLFineDL	LitterPct2			
FLFineDL				
	Local1			
FLMacro	RegID			MFSL
FLMacro	ProjID			Sutah00
FLMacro	PlotID	Down Wood 2000	Plot#	
FLMacro	Date	Veg data 2000	Date	
FLMacro	1HrTranLen			60
FLMacro	10HrTranLen			60
FLMacro	100HrTranLen			60
FLMacro	1000HrTranLen			60
FLMacro	NumTran			7
PD	RegID			MFSL
PD	ProjID			Sutah00
PD	PlotID	Site2000	Plot#	
PD	Date	Veg data 2000	Date	
PD	OrgCode1			
PD	OrgCode2			
PD	OrgCode3			
PD	OrgCode4			
PD	Examiner			
PD	Units			E
PD	Radius			37.2
PD	Width			
PD	PlotType			
PD	SEvent			
PD	FireID			
PD	MdId			
PD	LocType			
PD	Lat			
PD	Long			
PD	Northing	Location Data 2000	Northing	

Appendix 4-C — (Continued)

FIREMON table	FIREMON field	Sutah00 table	Sutah00 field	Conversion
PD	Easting	Location Data 2000	Easting	
PD	Datum			
PD	GPS_Error			
PD	GPS_Err_Units			
PD	UTM_Zone			12
PD	Elev	Location Data 2000	Elevation	
PD	Aspect	Site2000	Aspect	
PD	Slope	Site2000	Slope	
PD	Landform	Site2000	Landform	Table: _cnvLandform
PD	VShape			
PD	HShape			
PD	Geol1			
PD	Geol2			
PD	SoilTex	Site2000	Soil	
PD	EType			
PD	ESev			
PD	TreeC	Veg data 2000	Tot tree cover	
PD	SeedC			
PD	SapC			
PD	PoleC			
PD	MedC			
PD	LTreeC			
PD	VLTreeC			
PD	ShrubC	Veg data 2000	Shrub cover	
PD	LShrubC			
PD	MShrubC			
PD	TShrubC			
PD	GramC	Veg data 2000	Gramm cover	
PD	ForbC	Veg data 2000	Forb cover	
PD	FernC			
PD	MossC			
PD	USpp1			
PD	USpp2			
PD	MSpp1			
PD	MSpp2			
PD	LSpp1			
PD	LSpp2			
PD	PVTId	Veg data 2000	PVT Sp1, 2, 3	PVT Sp1 + PVT Sp2 + PVT Sp3
PD	PotForm			
PD	BSoilGC			
PD	GravelGC			
PD	RockGC			
PD	DuffGC			
PD	WoodGC			
PD	MossGC			
PD	CharGC			
PD	AshGC			
PD	BVegGC			
PD	WaterGC			
PD	FModel	Site 2000	FBFM nor	
PD	PhotoID			
PD	SHT	Site 2000	Stand ht	
PD	CBH	Site 2000	Cbh	
PD	CanopyC	Site 2000	FARSITE cc	
PD	FLength			
PD	SRate			
PD	FBevPic			

Appendix 4-C — (Continued)

FIREMON table	FIREMON field	Sutah00 table	Sutah00 field	Conversion
PD	FSC			
PD	NorthPic			
PD	EastPic			
PD	Photo1			
PD	Photo2			
PD	Local1			
PD	Local2			
PD	Comments			
SCCover	RegID			MFSL
SCCover	ProjID			Sutah00
SCCover	PlotID	Species 2000	Plot#	
SCCover	Date	Veg data 2000	date	
SCCover	Item	Species 2000	Species	Table: _cnvSpp
SCCover	SizeCl			
SCCover	Cover	Species 2000	Rc	Rc * Lifeform CC fraction
SCCover	Height	Species 2000	Ht	
SCCover	Local1			
SCCover	Local2			
SCMacro	RegID			MFSL
SCMacro	ProjID			Sutah00
SCMacro	PlotID	Species 2000	Plot#	
SCMacro	Date	Veg data 2000	Date	
SCMacro	SppIDLevel			
TDMacro	RegID			MFSL
TDMacro	ProjID			Sutah00
TDMacro	PlotID	Tree data 2000	Plot	
TDMacro	Date	Veg data 2000	Date	
TDMacro	MacroPlotSize			
TDMacro	MicroPlotSize			
TDMacro	BreakPntDia			
TDSeed	RegID			MFSL
TDSeed	ProjID			Sutah00
TDSeed	PlotID	Seedling Data 2000	Plot#	
TDSeed	Date	Veg data 2000	Date	
TDSeed	SizeCl_Ht	Seedling Data 2000	SizeClass	
TDSeed	Species	Seedling Data 2000	Species	
TDSeed	TreeStat			
TDSeed	Count	Seedling Data 2000	Number	
TDSeed	Local1			
TDTree	RegID			MFSL
TDTree	ProjID			Sutah00
TDTree	PlotID	Tree data 2000		
PJ Data 2000	Plot			
Plot No				
TDTree	Date	Veg data 2000	Date	
TDTree	TagNo	Tree data 2000		
PJ Data 2000	Tree			
PJ Number				
TDTree	Species	Tree data 2000		
PJ Data 2000	Spp			
Spp				
TDTree	TreeStat	Tree data 2000		

Appendix 4-C — (Continued)

FIREMON table	FIREMON field	Sutah00 table	Sutah00 field	Conversion
PJ Data 2000 Status	Tree status			
TDTree	DBH	Tree data 2000		
PJ Data 2000 Dbh (in)	Dbh			
TDTree	Height	Tree data 2000		
PJ Data 2000 Height (ft)	Height			
TDTree	LiCrPct	Tree data 2000		
PJ Data 2000 Crnratio	Crown ratio			
TDTree	LiCrBHt			
TDTree	CrwnCl			
TDTree	Age	Tree data 2000	Age	
TDTree	GrwthRt			
TDTree	DecayCl			
TDTree	Mort			
TDTree	DamCd1	Tree data 2000		
PJ Data 2000 Damcode1	Damcode1			
TDTree	SevCd1	Tree data 2000		
PJ Data 2000 Sevcode1	Sevcode1			
TDTree	DamCd2	Tree data 2000	Damcode2	
TDTree	SevCd2	Tree data 2000	Sevcode2	
TDTree	CharHt			
TDTree	CrScPct			
TDTree	Local1			