



LANDFIRE 2001 and 2008 Refresh

Geographic Area Report

South Central

December 2011



Executive Summary

The LANDFIRE National project (LF_1.0.0) was successfully completed in 2009. The goal of LANDFIRE National was to generate consistent 2001 vintage 30 meter spatial data sets for all 50 States for fire and other natural resource applications. This report highlights results from the continuation of LANDFIRE as a program to update the spatial data layers through 2008. The focus of this phase of the program was to improve the data products and account for vegetation change across the landscape caused by wildland fire, fuel and vegetation treatments, and management. In addition, changes caused by insects and disease, storms, invasive plants, and other natural or anthropogenic events were incorporated when data were available. This report describes the LANDFIRE 2001/2008 Refresh effort to update existing map layers to reflect more current conditions, focusing primarily on vegetation changes. The effort incorporated user feedback and new data, producing two comprehensive Refresh data product sets:

1. LANDFIRE 2001 Refresh (LF_1.0.5) enhanced LANDFIRE map layers by incorporating user feedback and additional data to provide a foundation to update data to 2008. It was also designed to provide users with a data set to help facilitate comparisons between 2001 and 2008 (i.e. Refresh LF_1.1.0) data sets.
2. LANDFIRE 2008 Refresh (LF_1.1.0) updated map layers to reflect vegetation changes and disturbances that occurred between 1999 and 2008.

In this report, we (1) address the background and provide details pertaining to why there are two Refresh data sets, (2) explain the requirements, planning, and procedures behind the completion and delivery of the updated products for each of the data product sets, (3) show and describe results, and (4) provide case studies illustrating the performance of LANDFIRE National, LANDFIRE 2001 Refresh and LANDFIRE 2008 Refresh (LF_1.1.0) data products on some example wildland fires.



Table of Contents

Executive Summary	ii
Table of Contents	ii
1.0 Introduction	1
1.1 LANDFIRE Program.....	1
1.2 LANDFIRE Versions.....	1
1.3 LANDFIRE 2001/2008.....	3
1.4 LANDFIRE 2001/2008 Statement of Work and Work Breakdown Structure	4
1.5 LANDFIRE 2001/2008 Spatial Products.....	6
2.0 LANDFIRE 2001 and 2008 Methods and Results.....	8
2.1 Geographic Area Description	8
2.2 LANDFIRE Reference Database	10
2.3 Biophysical Settings	13
2.4 Disturbance Mapping.....	17
2.5 Existing Vegetation.....	22
2.6 Fire Behavior.....	41
2.7 Fire Effects.....	47
2.8 Fire Regime Products	55
3.0 FARSITE Comparison of LANDFIRE Fuel	62
3.1 Rock House Fire, 2011	62
4.0 LF 2001/2008 Organization	70
5.0 Disclaimers	71
6.0 Additional Information	72
6.1 Landsat.....	72
6.2 Forest Inventory Analysis	72
6.3 National Agricultural Statistics Service.....	73
6.4 Multi-Resolution Land Characteristics Consortium National Land Cover Database	73
6.5 Writers, Contributors and Technical Editors.....	74
7.0 Glossary	75
8.0 Acronyms.....	76
8.1 Acronyms for Agencies and Organizations.....	76
8.2 Acronyms for Terms, Information, and Systems.....	76
9.0 References.....	79

1.0 Introduction

1.1 LANDFIRE Program

LANDFIRE (LF), also known as Landscape Fire and Resource Management Planning Tools, is a joint program between the wildland fire management programs of the United States Department of Agriculture (USDA) Forest Service (USFS) and the United States Department of the Interior (DOI), including the following bureaus: the United States Geological Survey (USGS), the Bureau of Indian Affairs (BIA), the Bureau of Land Management (BLM), the Fish and Wildlife Service (FWS), and the National Park Service (NPS). The Nature Conservancy (TNC) serves as a cooperating partner. LF applies consistent methodologies and processes to create comprehensive spatial data and models describing vegetation and wildland fire/fuel characteristics across the United States. Mapped data products are based on Landsat satellite imagery and an extensive database of field-reference data (including USFS Forest Inventory Analysis (FIA) data).

LF provides the first implementation of methodologies and processes to develop and combine intermediate scale (30 m) spatial vegetation and fire information consistently across the entire United States. Such a suite of integrated vegetation, fuel, and fire regime data sets has not previously been created by the public or private sectors. LF data products facilitate national and regional (large landscape level) fire planning activities and the reporting of wildland fire management activities. LF products provide managers with the data needed for collaborative, landscape-scale, cross-boundary, interagency planning and implementation. LF data support land management to 1) identify fuel where fire hazards and fire risks to local communities may be located, 2) identify vegetation and fuel conditions where rehabilitation may benefit fire-dependent landscapes, 3) prioritize resources for national budget formulation and allocation, and 4) enhance management knowledge of fire behavior to improve firefighting safety. Programs within the wildland fire community that use LF data include the National Cohesive Wildland Fire Management Strategy, the Wildland Fire Decision Support System, Fire Program Analysis, and the Hazardous Fuel Prioritization and Allocation System.

While LF has proven highly valuable for the wildland fire community, it also provides value for other land management disciplines. LF data products provide an informational foundation that supports many diverse applications, including land management planning, environmental analyses, biological evaluations, monitoring, and resource assessments. Moreover, LF data are being considered as a key information input to a range of Federal interagency carbon sequestration and climate research initiatives. LF products are used in the land and resource management domains for setting strategic direction, supporting resource and staffing determinations, designing conservation management activities, and assessing risks to the environment and communities.

1.2 LANDFIRE Versions

In an effort to address user feedback and leadership direction, the LF team started from the base collection of data products developed during the LF National Project (circa 2001) to provide an updated collection of LF products. As such, different versions of LF data products were developed, requiring the creation of a data versioning specification. The data versioning table, available on the LF website

Introduction

(http://www.landfire.gov/version_comparison.php), assists users in understanding the differences among the various versions of LF data available on the LF Data Distribution Site (DDS). When LF data products are updated in the future, most of the versions currently available will be removed from the DDS and archived. Previous versions will be made available upon request. At any given point in time, there will be at most three versions of the data products available from the DDS. These will remain available for download on the DDS until the next product update has been completed.

1.2.1 LANDFIRE National (LF 1.0.0) circa 2001

LF National (LF_1.0.0) constitutes the first complete LF mapping of all geospatial data products for the nation. LF National was a five-year project that incorporated Landsat imagery from 1999 through 2003 (circa 2001) and delivered data on vegetation characteristics and condition, fire behavior and effects, fuel models, historical fire regimes, and fire regime conditions class for the United States in 2009. In this report, we refer to this data set simply as “LANDFIRE National” or “LF National.” The final deliverables for LF National included all of the layers required to run fire behavior models, such as the Fire Area Simulator (FARSITE; Finney, 2004). Methods used were consistent and repeatable across all ownerships nationwide. The consistent and comprehensive nature of LF National methods ensured that data were nationally relevant, while the 30-meter grid resolution assured that data had local application. A modified suite of the LF National data products was delivered for Alaska and Hawaii.

1.2.2 LANDFIRE 2001 (LF 1.0.5) and 2008 (LF 1.1.0) Refresh

The LF 2001/2008 Refresh represents the initial effort to enhance and update LF layers to maintain the currency of the data sets across all 50 States. These versions were produced in tandem, starting in fall 2009 with the LF 2001 Refresh (LF_1.0.5), and finishing in calendar year 2011 with the LF 2008 Refresh (LF_1.1.0). LF 2001/2008 enhancements and updates were developed to facilitate comparative analyses, evaluate trends, and potentially monitor changes over time. In this report, we use the following simplified terminology.

When the enhancement and update segments are referred to individually, we use:

- (enhancements) “LANDFIRE 2001” or “LF 2001” for LANDFIRE 2001 Refresh (LF_1.0.5)
- (updates) “LANDFIRE 2008” or “LF 2008” for LANDFIRE 2008 Refresh (LF_1.1.0)

When we refer to both of these segments together in a generic fashion, we use:

- “LANDFIRE 2001 and 2008” or “LANDFIRE 2001/2008”
- “LF 2001 and LF 2008” or “LF 2001/2008”

The LF 2001 version was implemented to enhance the LF National data set and provide a foundation upon which to build the updated geospatial data set.

The LF 2008 version was implemented to update the LF National data set to reflect changes from recent (1999-2008) natural disturbances (such as wildland fires) and management activities using Landsat imagery.

1.3 LANDFIRE 2001/2008

The LF 2001 and LF 2008 components of the LF Program sustain and extend the investment value of the original LF National data products with enhancements and updates to the LF spatial data suite. LF 2001 addressed vegetation discrepancies and areas of concern detected after the initial mapping effort. Problems with LF National products identified by users included discrepancies in vegetated versus non-vegetated lands, vegetation/land use categories, vegetation structure, and water/riparian attribution. Enhancements to address these discrepancies were requested by stakeholders that use LF data. The map layers were enhanced in LF 2001 by leveraging additional data sources, such as Soil Survey Geographic (SSURGO) data.

LF 2008 focused on updates to the suite of LF data products to reflect 2008 conditions. This focus was on updating landscape-level vegetation changes, such as those resulting from wildland fire, fuel and vegetation / silvicultural treatments, mortality from insects and disease, storm damage, invasive plants, and other natural or anthropogenic events where relevant data were available that occurred in the years from 1999 - 2008. To create LF 2008 products, Landsat imagery was used to detect vegetation change and landscape disturbance. A collection of recent natural disturbance and land management activities was compiled and stored in a spatial database. These products were combined along with other data sets to update existing vegetation and fuel layers. These updated vegetation and fuels layers were then used to update other LF data products. LF 2008 did not use new imagery to remap the entire landscape only to identify vegetation change or disturbance. To update products, LF 2001/2008 leveraged information and comments received through various sources, such as the LF help desk (<http://www.landfire.gov/contactus.php>), after action reviews, fuel calibration workshops, and lessons learned examples. LF 2001/2008 products have been used as inputs to strategic wildland fire management decision support systems and are expected to improve the relevance and reliability of the outcomes generated by these systems.

Nine geographic areas (GeoAreas; Figure 1) were defined to include all of the original mapping zones used from the National Land Cover Database (NLCD; based loosely on Omernik, 1987) for use in the LF National effort. The application of mapping zones as a pre-classification stratification method has been used in many mapping approaches (Homer et al. 1997; Homer et al. 2004). Research has shown that carefully defined mapping zones maximize spectral differentiation, provide a means to facilitate partitioning the workload into logical units, simplify post-classification modeling and improve classification accuracy (Homer et al. 2004). The GeoAreas were not intended to represent standardized analysis units or reporting extents. The primary purpose of the GeoAreas and mapping zones was to define ecologically relevant divisions for data acquisition and production planning.

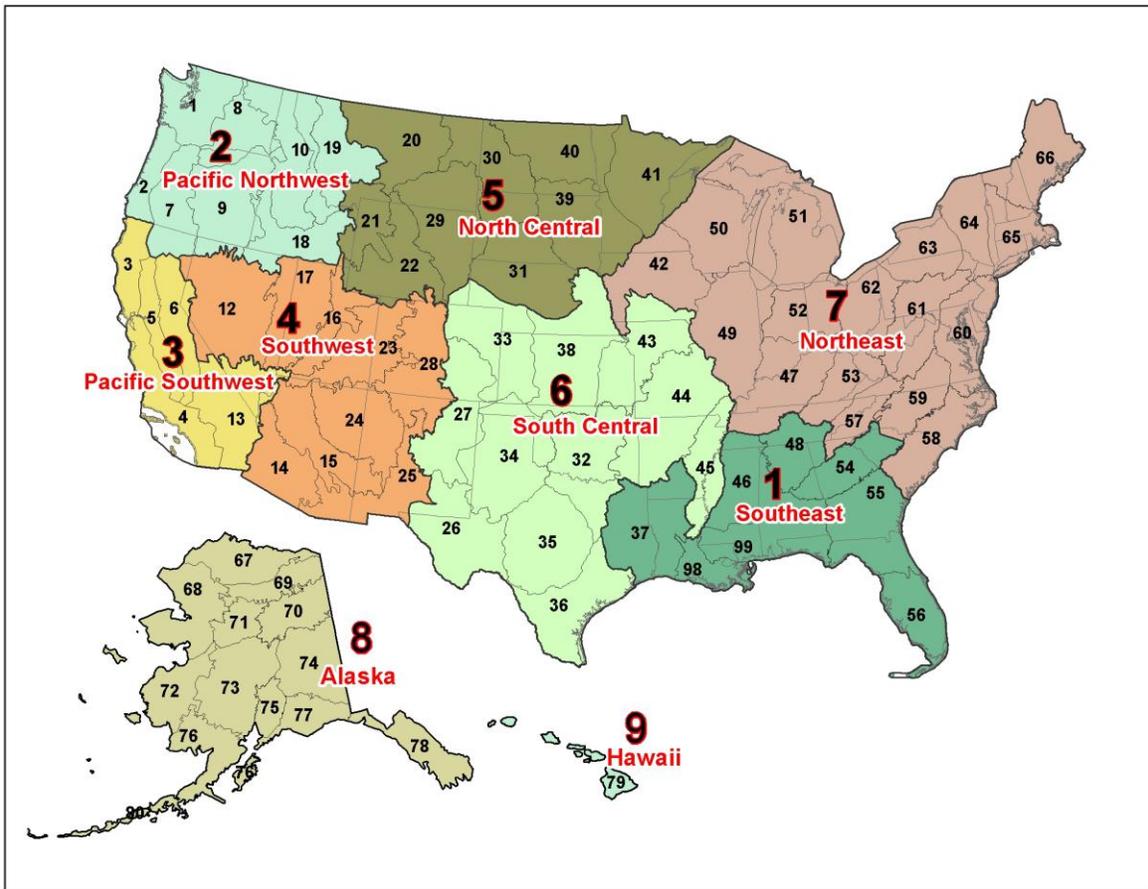


Figure 1 – Map of LF 2001/2008 GeoAreas according to the schedule. This image shows the nine GeoArea boundaries, which are comprised of National Land Cover Database 2001 mapping zones (numbered units), State boundaries are included for reference. GeoArea numbers and corresponding colors relate to the schedule in Table 1 below.

1.4 LANDFIRE 2001/2008 Statement of Work and Work Breakdown Structure

LF 2001/2008 used conventional best practices in project and program management to address the organizational structure, scheduling, and implementation procedures. The effort was faced with uncertainties common to many initiatives in the public and private sectors with regard to funding availability for elements within and outside of the scope of the program, contract acquisition, and prioritization of requirements that would shape the final suite of deliverables.

A statement of work (SOW) approach was used to define the scope of LF 2001/2008 and the data products to be delivered. In essence, the SOW included the development of comprehensive documentation describing the general methodological approach required to develop the suite of LF 2001/2008 intermediate and final products (deliverables). The SOW also included guidelines for quality assurance and quality control procedures, program management and program performance standards, estimates of overall duration, and an independent estimate of cost to the government for the defined scope of work.

Introduction

A primary element of the SOW was a structured index and definition of work segments and deliverable-scheduled milestones. This structure is referred to as a Work Breakdown Structure (WBS) – also a standard best practice in program planning and management – and is used for effective organization and management of work activities. The SOW document and WBS organization drew upon lessons learned and program management artifacts developed during the completion of the LF National project and the LF 2007 Rapid Refresh project. A summary display of the actual project results in terms of scheduled initiation and completion of project milestones is provided in Figure 2 below. A description of the project milestones (such as GeoAreas and Group A and Group B product segments as outlined in Table 2) is provided in detail in section 1.5 of this report.

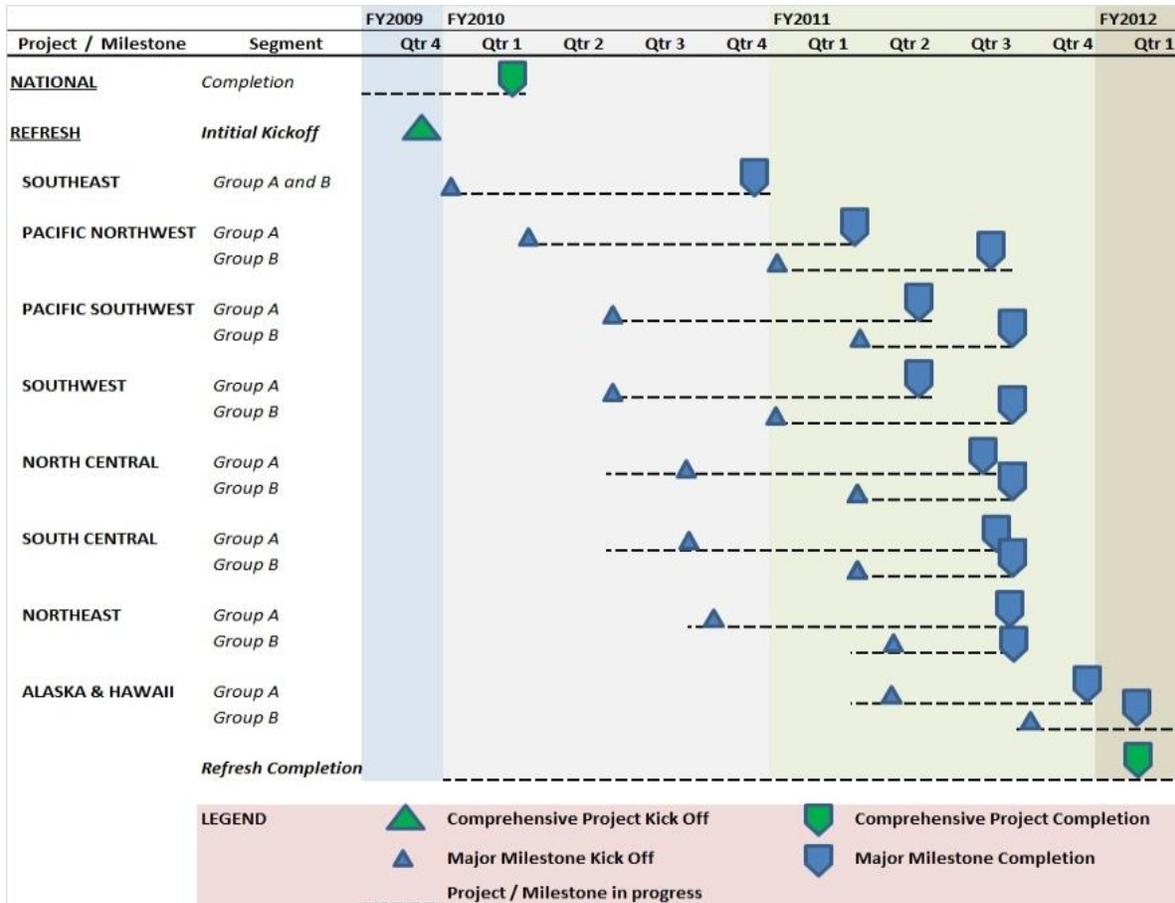


Figure 2 – LF 2001/2008 Gantt chart. This is a summary display of the actual results of the start and finish dates of the milestones and segments [such as GeoArea and Group A and Group B products]. These milestones and segments comprise the WBS discussed in Section 1.4.

The LF 2001/2008 effort was challenged by external factors such as mandatory work stoppages related to contractual reviews at the USFS and access to a range of qualified vendors through contract vehicles at both DOI component agencies and the USFS. Moreover, evolving management requirements resulted in longer periods of time required to complete processes for conducting full and open competitive bidding and finalizing vendor selection and formal work kickoff. Nonetheless, the use of comprehensive SOW documentation and WBS organization permitted the LF program to segment certain elements of development work and allocate these elements to vendor organizations that were best qualified and able to complete the LF 2001/2008 work at an optimal combination of cost, quality, and schedule performance.

Introduction

At the inception of the LF 2001/2008 effort, there was a tight interdependency in scheduling between LF 2001/2008 and the Monitoring Trends in Burn Severity (MTBS) project. As noted in detail throughout this GeoArea report, LF 2001/2008 used data such as the MTBS mapping products to characterize the landscape changes reflected in LF 2001/2008 data layers. Thus, the structure of LF 2001/2008 production activities as well as product releases were linked to the organization of the original MTBS production schedule, which was segmented by geographic regions across the conterminous United States (CONUS).

1.5 LANDFIRE 2001/2008 Spatial Products

LF 2001/2008 was originally estimated to span 24 months and involve over 500 unique tasks to deliver updated LF data layers. The update was highly dependent upon field data in the form of landscape change polygons and other information regarding landscape conditions. LF partitioned the delivery of the updated LF 2001/2008 products into two segments, "Group A" and "Group B," to facilitate management direction and the fulfillment of user needs. The staggered release of products by GeoArea (Table 1) and grouping of data products (Table 2) was determined to be the most practical approach with respect to scope limitations, cost considerations, and contractual circumstances.

Table 1 – LF 2001/2008 product delivery schedule listing the nine GeoAreas as represented above in and delineating delivery of "Group A" and Group "B" data sets

Table 1. LF 2001/2008 Schedule		
Geographic Area	Group A	Group B
Southeast	4 th Qtr. 2010	4 th Qtr. 2010
Pacific Northwest	1 st Qtr. 2011	3 rd Qtr. 2011
Pacific Southwest	2 nd Qtr. 2011	3 rd Qtr. 2011
Southwest	2 nd Qtr. 2011	3 rd Qtr. 2011
North Central	2 nd Qtr. 2011	3 rd Qtr. 2011
South Central	3 rd Qtr. 2011	3 rd Qtr. 2011
Northeast	3 rd Qtr. 2011	3 rd Qtr. 2011
Alaska	3 rd Qtr. 2011	4 th Qtr. 2011
Hawaii	3 rd Qtr. 2011	4 th Qtr. 2011

Introduction

Table 2 - LF 2001/2008 list of data products and how they were grouped (Group A and Group B) to facilitate management direction and user needs.

Table 2. LF 2001/2008 Products and Groupings	
Group A	Group B
Fire Behavior Fuel Model 13 (FBFM13)	Biophysical Settings (BpS)
Fire Behavior Fuel Model 40 (FBFM 40)	Vegetation Condition Class (VCC)
Canadian Forest Fire Danger Rating System (CFFDRS) (Alaska Only)	Vegetation Departure Index (VDEP)
Forest Canopy Bulk Density (CBD)	Fire Regime Groups (FRG)
Forest Canopy Base Height (CBH)	Mean Fire Return Interval (MFRI)
Forest Canopy Cover (CC)	Percent Low Severity Fire (PLS)
Forest Canopy Height (CH)	Percent Mixed Severity Fire (PMS)
Fuel Characteristic Classification System	Percent Replacement Severity Fire (PRS)
Fuelbeds (FCCS)	Fuel Loading Models (FLM)
Existing Vegetation Type (EVT)	Succession Classes (SCLASS)
Existing Vegetation Cover (EVC)	
Existing Vegetation Height (EVH)	

2.0 LANDFIRE 2001 and 2008 Methods and Results

2.1 Geographic Area Description

The South Central (SC) GeoArea consists of 11 mapping zones encompassing large portions of Arkansas, Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma and Texas as well as small portions of Iowa, Louisiana and Mississippi, approximately 420 million acres. The NLCD mapping zones within the SC GeoArea are listed in Table 3.

Table 3– SC GeoArea mapping zone numbers (see below Figure 3) and titles as labeled by the NLCD program.

Table 3. South Central GeoArea Mapping Zones	
Mapping Zone	Mapping Zone Name
26	Chihuahuan Desert
27	Great Plains Tablelands
32	Southeastern Great Plains
33	Western Great Plains
34	Southern Great Plains
35	Edwards Plateau
36	Western Gulf Plains
38	Eastern Great Plains
43	Till Plains
44	Ozark Highlands
45	Mississippi Alluvial Plains

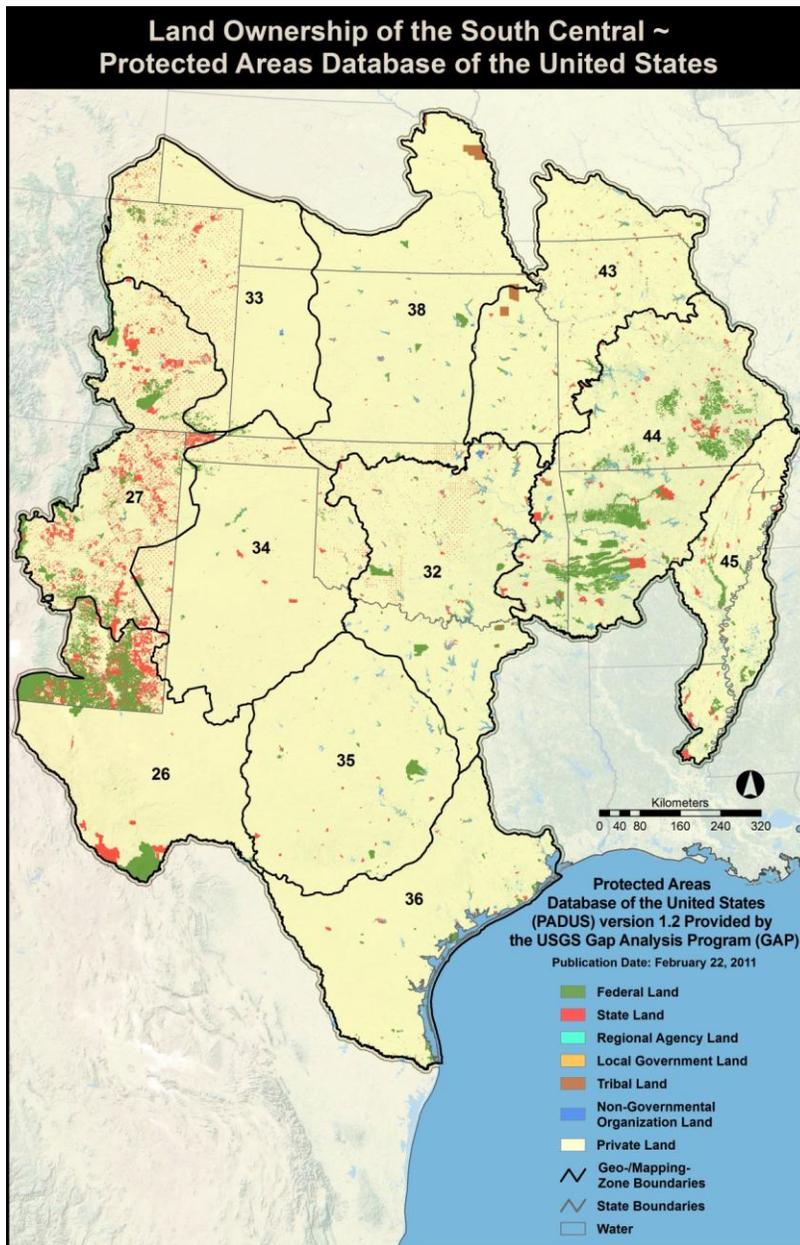


Figure 3 – Land ownership categories for the SC GeoArea.

Within a given GeoArea, land ownership is important because the condition of the landscape, including disturbances, may be a direct result of ownership mission and management activities. A summary of land ownership segmentation across the SC GeoArea is provided in Table 4.

Table 4 – Categories of land ownership, number of acres, and percentages of total GeoArea by category for the LF SC GeoArea.

Table 4. Acreage of Land Ownership Categories for the SC GeoArea.		
Land Ownership	Acres	Percent of GeoArea
Federal Government	16,069,248	3.9
Government and/or Private	877,948	0.2
Local Government	144,398	0.1
Private	391,220,773	93.1
State Government	11,081,652	2.6
Tribal	36,510	0.0
Water	224,896	0.1
Total	419,655,425	100.0

2.2 LANDFIRE Reference Database

2.2.1 Product Description

LF 2008 mapping was supported by a large database of field-referenced data. The LANDFIRE Reference Database (LFRDB) includes vegetation and fuel data from over 800,000 geo-referenced sampling units located throughout the United States. These data were amassed from numerous sources, and, in large part, from existing information resources of outside entities, such as the USFS FIA Program, the USGS National Gap Analysis Program (GAP), and State natural heritage programs. Vegetation data drawn from these sources and used by LF include natural community occurrence records, estimates of canopy cover and height per plant taxon, and measurements (such as diameter, height, crown ratio, crown class, and density) of individual trees. Fuel data included biomass estimates of Downed Woody Material (DWM), percent cover and height of shrub and herb layers, and canopy base height estimates. Digital photos of the sampled units, when available, were archived.

A subset of the full suite of field-sampled data used in the production of LF deliverables is available for public access, as stipulated in the 2004 LF Executive Charter. In accordance with agreements between LF and its data contributors, certain proprietary or otherwise sensitive data were removed to create this publically available version of the LFRDB. There are over 275,000 sampling units from 260 different sources located throughout the United States available for public use.

2.2.2 LANDFIRE Reference Database Update Process

The following is a summary of key steps the LF production team conducted to complete the LFRDB component of LF 2001/2008. These methods were subject to revision and update upon the completion of all LF 2001/2008 GeoArea processing.

- acquired geo-referenced, field-sampled vegetation and fuel data from existing national and local programs - This work required extensive communication with representatives of governmental and non-governmental entities throughout the U.S. and work with FIA staff to draw all relevant data
- maintained a catalog and archive of all acquired data and metadata in their original formats using the existing LF data-catalog template and file structure
- assessed and prepared acquired data for LF processing - this work required thorough inventorying of acquired geospatial data (in tabular format or as shapefiles, coverages, geodatabases, etc.) with

LANDFIRE 2001 and 2008 Methods and Results

regard to distribution and information content and removal of records with irreconcilable geospatial or information errors/omissions

- converted relevant/viable data into LF format such that they conformed to standards defined in the data dictionaries for the AutoKey Database to accurately assign EVT to plots that have species composition (species and cover) attributes and LFRDB - this required using intermediate to advanced techniques for relational database management, manipulation and management of point and vector geospatial data, and regular documentation of data-conversion processes and quality-control measures
- acquired and incorporated into the LFRDB all ancillary spatial data needed for LF production (such as data extracted from LF base and product layers) - this required support from FIA staff and representatives of other entities that provide data with plot locations that must remain confidential
- derived and incorporated into the LFRDB any attributes necessary for LF production but not acquired as part of the original data sets - this included the derivation of canopy cover and height estimates from FIA tree records, fuel loading estimates from DWM records, un-compacted crown ratios from compacted crown ratios, vegetation map-unit assignments from the Ecological Systems AutoKey, canopy fuel attributes from FuelCalc (Reinhardt, 2006) (a tool to compute surface and canopy fuel loads and characteristics from inventory data), and various attributes from the Forest Vegetation Simulator (FVS; Dixon 2002) and its Fire and Fuels Extension (FFE; Reinhardt and Crookston 2003).
- checked for information and spatial errors as detailed in the LFRDB Quality Assurance (QA) checklist, and, once removed or appropriately identified, distributed the inaugural LFRDB for LF production
- maintained and updated the LFRDB after the inaugural posting by archiving relevant LF production information, including results of Quality Assurance / Quality Control (QA/QC) on LFRDB records performed by mapping teams and additional data as requested/permitted by LF mapping teams and leadership

2.2.3 LANDFIRE Reference Database Update Results

Final deliverables for the SC GeoArea consisted of a catalog (spreadsheet) and archive (file system) of all acquired data, an AutoKey Database (Microsoft Access® database) which was developed to quickly and accurately assign EVT to plots that has species composition (species and cover) attributes for the SC GeoArea, a LFRDB (Microsoft Access® database) for the SC GeoArea, and documentation of data conversion processes and QC measures taken during the data-loading stages.

The final LFRDB product for the SC GeoArea resulted in a large number of sampling events derived from various data sources, including the following:

- 50,722 geo-referenced sampling events were contained within the SC LFRDB.
- 64 different sources of data were contributed by Federal, State, and private entities.
- 27% of data were submitted in response to the LF data call (http://www.landfire.gov/participate_refdata.php) and 73% of data were acquired by LF personnel through direct data sharing agreements (USFS FIA), websites such as the NPS Data Store and Northwest and Alaska Fire Research Clearinghouse or agency database systems (USFS-Natural Resource Information System and Field Sampled Vegetation

LANDFIRE 2001 and 2008 Methods and Results

- 5,251 Forest Inventory and Analysis (FIA) sampling events were added to the LFRDB for LF 2001/2008 (3,434 sampling events were new and 1,817 were resampled locations).

A significant amount of vegetation and fuel data were acquired and compiled from many different sources for LF National and LF 2001/2008. The LFRDB team was able to acquire nearly three-quarters of the data archived in the SC LFRDB from data sharing agreements, websites, and/or agency databases. Data contributions submitted in response to the data call were also important, accounting for 27% of the sampling events. Major data contributions can be accredited to the USFS, the rest of the data came from multiple of sources. Table 5 shows a breakdown of the data contribution profile for the SC LFRDB.

Table 5 – Data contribution profile for the SC LFRDB.

Table 5 SC LANDFIRE Reference Database Data Contributions		
Data Contribution Profile	Samples	Percent
USFS	25,604	50.5
Multi Agency	21,252	41.9
State	2,236	4.4
Department of Defense	419	0.8
NPS	380	0.7
BLM	367	0.7
Non-Governmental Organizations/Private	320	0.6
Municipal	144	0.3
FWS	0	0.0
BIA	0	0.0
Total	50,722	100.0

For LF 2001/2008, the LFRDB team acquired and incorporated additional data into the existing LFRDB to facilitate the improvement and updating of several LF data products. Data provided by FIA contain a complete set of attributes necessary for updating LF products, so efforts were focused on converting and adding these data. During LF 2001/2008, several improvements were made to FIA data processing procedures, including updates to the way forest canopy cover and height metrics were derived and improvements to the LFRDB database schema that allowed for the archiving of repeat measures. There were 5,251 new FIA sampling events added to the SC LFRDB for LF 2001/2008. The SC LFRDB also contains a significant amount of vegetation data, including information on community occurrence, species composition, vegetation structure, exotic plants, and fuel. Table 6 provides a summary of data types by percent distribution for the SC GeoArea. Community occurrence data include natural community or cover type classifications; species composition data include canopy cover estimates per plant taxon; vegetation structure data include height measurements per life form or plant taxon; exotic plant data include occurrence or cover estimates of exotic plants; and fuel data include composition and characteristics of surface and/or canopy fuel.

Table 6– Percent distribution of data types for SC LFRDB.

Table 6. SC LANDFIRE Reference Database Plot Summary		
Data Type	Samples	Percent*
Community Occurrence Records	14,352	28
Species Composition	33,482	66
Structure	15,469	30
Exotics	8,827	6
Fuels	2,888	17

**Percent occurrence of the listed data types within the LFRDB. The percentages do not total to 100% because a plot may have more than one data type. For example, a plot may have both species composition and fuel data whereas another plot may only have community occurrence records. The 5,251 new FIA plots that were added to the LFRDB provided species composition, structure, and fuel data, but not the other data types listed.*

2.3 Biophysical Settings

2.3.1 Product Description

The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the biophysical environment and an approximation of the historical disturbance regime. BpS is a refinement of the Environmental Site Potential (ESP) layer. In this update, we attempted to incorporate current scientific knowledge regarding the functioning of ecological processes – such as fire – in the centuries preceding non-indigenous human influence. Map units were based on NatureServe's (NS) Ecological Systems classification; a nationally consistent set of mid-scale ecological units (Comer et al. 2003).

LF used these classification units to describe BpS, which differed from their intended use as units of existing vegetation. As used in LF, map unit names represent the natural plant communities that may have been present during the reference period. Each BpS map unit was matched with a model of vegetation succession. The LF BpS concept is similar to the concept of potential natural vegetation groups used in mapping and modeling efforts related to Fire Regime Condition Class (FRCC; Schmidt et al. 2002; www.frcc.gov).

2.3.2 Biophysical Settings Layer Enhancements

One objective for LF 2001/2008 was to simplify the BpS map layer by reclassifying similar systems into BpS Groups. New names were assigned to better reflect the floristic make-up of the grouped systems and to include the appropriate fire regime (I thru V), and a vegetation model was chosen that best represented the grouped systems.

This task included a review of all BpS model descriptions and the Model Tracker Database (MTDB) for each mapping zone. MTDB is an Access database application developed by TNC specifically for the LF Program. MTDB contains a very detailed description of every Ecological System mapped by LF, including physiographic characteristics, biological characteristics, and disturbance regime of each system and the individual succession classes within that system, as defined by local experts. In addition, all review comments are contained within MTDB to allow readers to understand the evolution of the models through the development and review processes LF team members assessed all model transition states, reference conditions, fire-regime groups, and ancillary information to determine similarities between

BpS. At the end of this process, a grouping strategy was proposed and implemented. The final step was the development of a lookup table relating LF National BpS map units and LF 2001/2008 Grouped BpS map units. Redundant and/or similar BpS models were collapsed into one group, and the original LF National BpS codes have corresponding LF 2001/2008 grouped BpS codes.

For certain mapping zones, non-forest BpS map units were remapped using SSURGO data that were not available in the West during the LF National BpS mapping process. The process started by establishing a cross-walk between SSURGO Ecological Site polygon data and BpS units. These cross-walk assignments were based primarily on similar dominant vegetation types and additional information such as elevation, ecoregion, and subsection, to distinguish between possible BpS assignments. Next, a map of BpS map units was built and assignments were made to existing SSURGO ecological site polygon data. Based on these data, cross-walked polygons were sampled to develop pseudo plots (a method to address a lack of field data using existing plot and geospatial data) using the ERDAS Imagine© NLCD sampling tool (a remote sensing application for geospatial raster data processing). A map was created for the entire map zone using the models output from See5© using the pseudo plots of BpS map units. The last production step was to combine this new map with the LF National BpS map in order to update BpS in non-forest areas.

2.3.3 Fire Regime Products

Five layers [Mean Return Interval (MFRI), Percent of Low Severity (PLS) fire, Percent of Mixed Severity (PMS) fire, Percent Replacement Severity (PRS) fires, and Fire Regime Groups (FRG)] characterizing modeled historical fire regimes were produced based on the BpS and linkage with the Refresh Model Tracker (RMT). This linkage provides the probability of replacement, mixed, and surface fires. MFRI was calculated as the reciprocal of the sum of these probabilities (which is the probability of fire of any severity), grouped into classes and then combined with the non-vegetated types from the Succession Classes (SCLASS) layer. The PLS, PMS, and PRS layers were calculated respectively as the ratio of the probability of surface, mixed, and replacement fires to the probability of any fire. The FRG was based on a combination of the MFRI and average fire severity from the FRCC Guidebook (FRCC, 2010), as displayed in Table 7 and Table 8 showing the comparisons between LF National and LF 2001.

Table 7– The Fire Regime Groups by frequency and PRS for vegetation types within each regime as described in the FRCC Guidebook.

Table 7. Fire Regime Groups, Frequency, and Severity		
Fire Regime Group Name	Frequency (years)	Severity Percent
FRG I	0-35	PRS < 75
FRG II	0-35	PRS ≥ 75
FRG III	35-200	PRS < 75
FRG IV	35-200	PRS ≥ 75
FRG V	200+	all

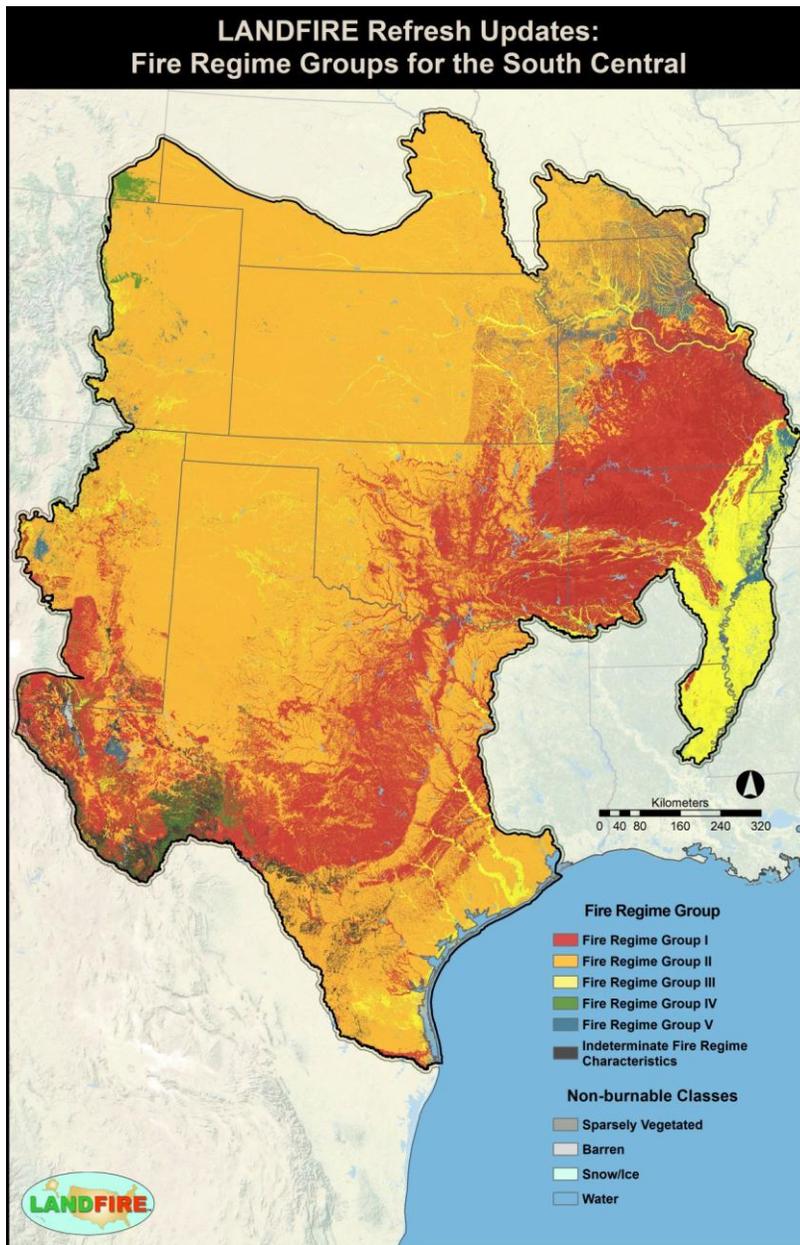


Figure 4 – Map of the SC GeoArea depicting LF Fire Regime Groups in the absence of modern human intervention with possible aboriginal fire use.

Table 8 – Comparison of acreage mapped and percent change by Fire Regime Groups in LF National and LF 2001 versions of LF data.

Table 8. Fire Regime Group Comparison			
Fire Regime Group Name	LF National (acres)	LF 2001 (acres)	Percent Change
FRG I	98,980,972	111,802,344	13.0
FRG II	250,995,489	245,281,369	-2.3
FRG III	29,817,350	36,221,603	21.5
FRG IV	9,041,922	3,081,679	-65.9
FRG V	10,150,377	8,341,217	-17.8
Water	7,008,420	6,802,912	-2.9
Barren	1,275,299	1,347,422	5.7
Sparsely Vegetated	62,520	59,298	-5.2
Indeterminate Fire Regime	12,789,394	7,183,899	-43.8

2.4 Disturbance Mapping

2.4.1 Product Description

LF disturbance data were developed to provide temporal and spatial information related to landscape change for determining vegetation transitions over time and making subsequent updates to LF vegetation, fuel, and other data. Disturbance data include attributes associated with disturbance year, type, and severity. These data were developed through use of Landsat satellite imagery, local agency derived disturbance polygons, and other ancillary data establishing disturbance grids for each year.

2.4.2 Disturbance Mapping Objectives

Changes in the landscape are pervasive and occur continually. For LF data to remain current, a process was needed to integrate spatial temporal landscape changes into the suite of LF products.

The objective of this process was to map the location, extent, type, and severity of major disturbances for the entire United States. To achieve this objective, several data sets needed to be integrated into one product. Not all types of data were available in all areas. The disturbance mapping process was performed at the LF mapping zone scale.

2.4.3 Disturbance Mapping Process

In accordance with a provision in the LF Charter regarding the directive to regularly update LF products, disturbances to the landscape were identified using a process referred to as Remote Sensing of Landscape Change (RSLC; Vogelmann et al. 2010). The RSLC process includes multiple data sources and processes, including remotely sensed imagery, a spatial database of events, and field assessments. In order to capture disturbance on the landscape, LF worked with the University of Maryland researchers on vegetation (forest) change detection using archived Landsat Time Series Stacks (LTSS; Huang et al. 2009). LF used a vegetation change and tracking algorithm called the Vegetation Change Tracker (VCT; Huang et al. 2010). VCT tracks a vegetation index through a LTSS in order to identify landscape changes. VCT data were developed for each year identifying disturbed areas as well as disturbance severity. As part of the VCT processing, the Normalized Burn Ratio (NBR, Key et al. 2006) was calculated for each input scene. Severity was determined from the Landsat imagery by calculating both the minimum and the maximum NBR value for each pixel for the years 1999 to 2008 from the VCT output. The minimum NBR was then subtracted from the maximum NBR. The result was classified into high, medium, and low severity levels based on a statistical comparison with the MTBS, Burned Area Reflectance Classification (BARC), and Rapid Assessment of Vegetation Condition after Wildfire (RAVG) fire severity data also available for the area.

Since disturbance type, or causality, was not determined in the VCT process, a spatial analysis was conducted comparing the VCT output to buffered (1-kilometer) LF 2008 disturbance Event data, which were provided to LF by various local, regional, and national agencies and organizations as part of the LF data contribution opportunity. Disturbance type and year information were included as attributes for each polygon and transferred to the disturbance grids in this process. Data inputs on location of Federal

LANDFIRE 2001 and 2008 Methods and Results

Agency lands were included using the Protected Areas Database of the United States (PAD-US; <http://www.protectedlands.net/padus/>). PAD-US is a product of GAP, which shows land management status representing public and private land ownership, and conservation lands that are assigned a conservation status for biodiversity preservation and natural, recreational, or cultural uses. PAD-US and its “GAP Status” attribute were used to inform causality for disturbances outside of disturbance Event polygons. While not identifying a precise type of disturbance, this analysis provides information useful for narrowing down the types of disturbance that would be expected to occur in a given location.

Wildland fire disturbance data are developed through a multistep process. Inputs to this process include fire mapping data obtained from the MTBS, BARC, and RAVG fire mapping efforts. These three data sets were merged together to map the extent and severity of wildland fires.

Subsequently, all disturbance types were processed, creating ten disturbance grids, one for each year from 1999 to 2008. Each grid was attributed with year, disturbance type (if known, otherwise a description of possible types), severity, and the data sources used to create the data.

In addition to these yearly disturbance grids, an integrated composite of vegetation disturbance data was developed according to the following priorities, in order of importance: time since disturbance, type, and severity for the entire ten year period. The disturbance types included the following:

- Recent fire activity (1999 through 2008)
- Mechanical treatments that do not remove material from the site (Mechanical Add)
- Mechanical treatments that do remove material from the site (Mechanical Remove)
- Wind disturbance
- Insect and disease

The severity of the disturbance was described as high, moderate, or low. Following are the general guidelines for categorizing:

- High = >75% of above-ground vegetation mortality
- Moderate = 25 to 75% above-ground vegetation mortality
- Low = <25% above-ground vegetation mortality

Time since disturbance was separated into three categories (or time steps), including the following:

- 1 year post disturbance
- 2-5 years post disturbance
- 6-10 years post disturbance

2.4.4 Disturbance Mapping Results

Disturbance categories were mapped and tabulated for the entire SC GeoArea (Table 9). Across all lands, 2 percent of the GeoArea was mapped as disturbed from 1999 to 2008, leaving 98 percent undisturbed. On Federal lands, 8 percent of the GeoArea was mapped as disturbed, leaving 92 percent undisturbed. We recognize that certain types of disturbances are missed in the mapping process, particularly subtle change such as decline of certain forest cover types affected by insects or disease.

Table 10 through Table 14 provides a detailed listing of mapped disturbance by type on all lands and Federal lands.

Table 9 –Total mapped disturbances area and percent by land ownership category for the SC GeoArea.

Table 9. Disturbance Acreage by Land Ownership			
Land Ownership	Category	Acres	Percent Ownership
All Lands	No Disturbance	411,917,653	98
All Lands	All Disturbances	8,204,089	2
Federal Lands	No Disturbance	14,735,516	92
Federal Lands	All Disturbances	1,333,732	8

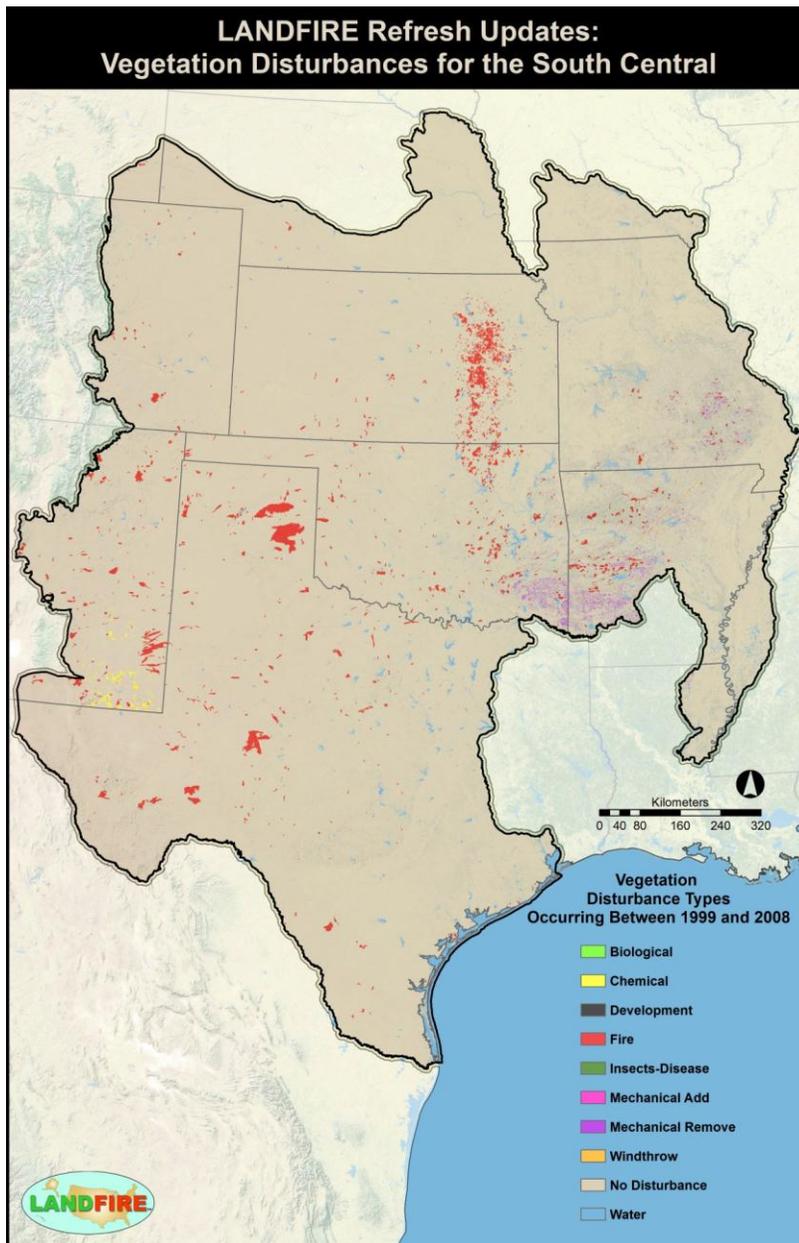


Figure 5 – Map of vegetation disturbance types (fire, mechanical, etc.) mapped for the SC GeoArea from 1999 to 2008.

Table 10 – Number of acres mapped as affected by fire disturbance for severity classes of low, moderate, and high with the period of years since disturbance between All Lands and Federal Land ownership for the SC GeoArea.

Table 10. Area Affected by Fire Disturbance				
Land Ownership	Category	Severity	Time Since Disturbance	Acres
All Lands	Fire	Low	One Year	1,097,770
All Lands	Fire	Low	Two to Five Years	3,843,093
All Lands	Fire	Low	Six to Ten Years	848,186
All Lands	Fire	Moderate	One Year	250,126
All Lands	Fire	Moderate	Two to Five Years	331,467
All Lands	Fire	Moderate	Six to Ten Years	80,537
All Lands	Fire	High	One Year	15,027
All Lands	Fire	High	Two to Five Years	34,106
All Lands	Fire	High	Six to Ten Years	17,246
Federal Lands	Fire	Low	One Year	188,769
Federal Lands	Fire	Low	Two to Five Years	389,273
Federal Lands	Fire	Low	Six to Ten Years	216,335
Federal Lands	Fire	Moderate	One Year	35,296
Federal Lands	Fire	Moderate	Two to Five Years	51,177
Federal Lands	Fire	Moderate	Six to Ten Years	35,664
Federal Lands	Fire	High	One Year	6,431
Federal Lands	Fire	High	Two to Five Years	6,663
Federal Lands	Fire	High	Six to Ten Years	9,567

Table 11 – Number of acres mapped as affected by the Mechanical Add disturbance by severity classes of low, moderate, and high with the period of years since disturbance between All Lands and Federal Land ownership for the SC GeoArea.

Table 11. Area Affected by Mechanical Add Disturbance				
Land Ownership	Category	Severity	Time Since Disturbance	Acres
All Lands	Mechanical Add	Low	One Year	580
All Lands	Mechanical Add	Low	Two to Five Years	16,739
All Lands	Mechanical Add	Low	Six to Ten Years	21,542
All Lands	Mechanical Add	Moderate	One Year	231
All Lands	Mechanical Add	Moderate	Two to Five Years	4,377
All Lands	Mechanical Add	Moderate	Six to Ten Years	5,242
All Lands	Mechanical Add	High	One Year	19
All Lands	Mechanical Add	High	Two to Five Years	475
All Lands	Mechanical Add	High	Six to Ten Years	902
Federal Lands	Mechanical Add	Low	One Year	476
Federal Lands	Mechanical Add	Low	Two to Five Years	15,233
Federal Lands	Mechanical Add	Low	Six to Ten Years	18,467
Federal Lands	Mechanical Add	Moderate	One Year	197
Federal Lands	Mechanical Add	Moderate	Two to Five Years	3,501
Federal Lands	Mechanical Add	Moderate	Six to Ten Years	4,158
Federal Lands	Mechanical Add	High	One Year	12
Federal Lands	Mechanical Add	High	Two to Five Years	292
Federal Lands	Mechanical Add	High	Six to Ten Years	483

Table 12 – Number of acres mapped as affected by the Mechanical Remove disturbance by severity of classes of low, moderate, and high with the period of years since disturbance between All Lands and Federal Land ownership for the SC GeoArea.

Table 12. Area Affected by Mechanical Remove Disturbance				
Land Ownership	Category	Severity	Time Since Disturbance	Acres
All Lands	Mechanical Remove	Low	One Year	34,718
All Lands	Mechanical Remove	Low	Two to Five Years	79,810
All Lands	Mechanical Remove	Low	Six to Ten Years	119,442
All Lands	Mechanical Remove	Moderate	One Year	57,707
All Lands	Mechanical Remove	Moderate	Two to Five Years	190,539
All Lands	Mechanical Remove	Moderate	Six to Ten Years	359,302
All Lands	Mechanical Remove	High	One Year	30,024
All Lands	Mechanical Remove	High	Two to Five Years	134,600
All Lands	Mechanical Remove	High	Six to Ten Years	222,655
Federal Lands	Mechanical Remove	Low	One Year	4,902
Federal Lands	Mechanical Remove	Low	Two to Five Years	27,642
Federal Lands	Mechanical Remove	Low	Six to Ten Years	36,754
Federal Lands	Mechanical Remove	Moderate	One Year	1,625
Federal Lands	Mechanical Remove	Moderate	Two to Five Years	7,064
Federal Lands	Mechanical Remove	Moderate	Six to Ten Years	12,679
Federal Lands	Mechanical Remove	High	One Year	364
Federal Lands	Mechanical Remove	High	Two to Five Years	1,992
Federal Lands	Mechanical Remove	High	Six to Ten Years	3,345

Table 13 – Number of acres mapped as affected by Windthrow and Insects and Disease disturbance by severity classes of low, moderate, and high with the period of years since disturbance between All Lands and Federal Land ownership for the SC GeoArea.

Table 13. Area Affected by Windthrow and Insect/Disease Disturbances				
Land Ownership	Category	Severity	Time Since Disturbance	Acres
All Lands	Insects-Disease	Low	Two to Five Years	26
All Lands	Insects-Disease	Low	Six to Ten Years	208
All Lands	Windthrow	Low	One Year	52,800
Federal Lands	Windthrow	Low	One Year	1,797

Table 14 – Number of acres mapped as affected by Chemical, Biological, and Development disturbances by severity classes of low, moderate, and high with the period of years since disturbance between All Lands and Federal Land ownership for the SC GeoArea.

Table 14. Area Affected by Chemical, Biological, or Development Disturbances				
Land Ownership	Category	Severity	Time Since Disturbance	Acres
All Lands	Chemical	Low	One Year	160,076
All Lands	Chemical	Low	Two to Five Years	151,829
All Lands	Chemical	Low	Six to Ten Years	42,614
All Lands	Development	Low	Two to Five Years	31
All Lands	Development	Low	Six to Ten Years	41
All Lands	Development	Moderate	Six to Ten Years	2
Federal Lands	Chemical	Low	One Year	116,840
Federal Lands	Chemical	Low	Two to Five Years	107,178
Federal Lands	Chemical	Low	Six to Ten Years	29,482
Federal Lands	Development	Low	Two to Five Years	31
Federal Lands	Development	Low	Six to Ten Years	41
Federal Lands	Development	Moderate	Six to Ten Years	2

2.5 Existing Vegetation

2.5.1 Product Description

The existing vegetation layers for each LF mapping zone include: Existing Vegetation Type (EVT), Existing Vegetation Cover (EVC), and Existing Vegetation Height (EVH). All three layers were originally mapped using predictive landscape models based on extensive field-referenced data, satellite imagery, biophysical gradient predictor layers, and classification and regression trees. Various parts of these existing vegetation layers were edited and refined as part of LF 2001/2008. The EVT layer represents the current dominant vegetation using map units derived from NS’s Ecological Systems vegetation classification. The EVC layer represents the average percent cover of existing vegetation for a 30 meter grid cell. The EVH layer represents the average height of the dominant/co-dominant vegetation for a 30 meter grid cell.

2.5.2 LF 2001: Enhancements to Existing Vegetation Products

With the release of LF National data products, several areas in the EVT layer were identified for improvement. In 2009, leadership direction and funding were provided to implement these improvements for the conterminous States. In Table 15 through Table 31 and Table 34 and Table 35 of this report, comparisons are made between the LF National data product and the LF 2001 product and the LF 2001 and the LF 2008 updated products. It is important to note that in the majority of cases, the percent changes between the National and LF 2001 / 2008 are a result of classification and product differences and not actual changes on the ground. LF staff developed a series of steps to improve LF National vegetation data. In addition, problems with the LF National Forest Canopy Cover (CC) documented by Scott (2008) needed to be addressed. Generally, CC values were too high, accuracy was relatively low, and seam lines sometimes existed within mapping zones or between adjacent mapping zones. New metrics of tree cover and tree height were developed using tree plot data (Toney et al. 2009) and new tree cover and height maps were developed. Also, the amount of barren mapped in the EVT was adjusted by a series of processes, include rectifying barren areas with NLCD, removing water on

slopes, classification of surface mines, and reclassifying areas depicted as barren in the fuel layers that were not classified as barren in the LF National EVT layer.

2.5.2a Enhancements to Existing Vegetation Type

As part of the enhancements, revisions were made to the international boundaries to coincide with existing data sets. For the United States/Canada border, data from the International Boundary Commission (<http://www.internationalboundarycommission.org/boundary.html>) were incorporated. For the United States/Mexico border, data from the International Boundary and Water Commission (<http://www.ibwc.state.gov/>) and the U.S. - Mexico Border Environmental Health Initiative (<http://borderhealth.cr.usgs.gov/projectindex.html>) were incorporated. Gaps in LF data were filled with either LF National existing vegetation from the 3-km buffer developed around each mapping zone or NLCD2001 land cover data.

At the beginning of LF National, the NLCD2001 land cover layer was partially complete, creating inconsistencies in land cover classes between the final NLCD2001 land cover and LF National layers. Improvements to the LF existing vegetation layers attempted to synchronize these two layers. First, natural land cover classes were reclassified to anthropogenic land cover classes based on the NLCD2001 land cover product. Where NLCD2001 was classified as a natural land cover class and LF layers were classed anthropogenic land cover, LF data were reclassified to the most dominant natural land cover class. Also in this process, herbaceous wetland vegetation types from the NLCD2001 product were mapped to the LF National EVT product. Riparian EVTs mapped in LF National that coincided with stream networks one pixel wide were removed from the existing vegetation layers.

To address potentially burnable agricultural classes, information from the National Agricultural Statistics Survey (NASS; <http://www.nass.usda.gov/>) and PAD-US was incorporated into the LF 2001 EVT layer. On non-Federal lands where NASS and NLCD2001 agricultural classes were coincident, NASS classification took precedence. Where NASS and NLCD2001 agricultural classes were not coincident, both classes were retained. Agricultural classes were removed on most Federal lands and assigned a natural EVT. Most revised agricultural classes resulted in burnable fuel models.

In order to address potentially burnable urban the NLCD2001 low and medium intensity urban classes were modeled to “developed” NLCD natural vegetation classes. Roads were reintroduced using the National Transportation Statistics (<http://www.bts.gov/>) layer and filtered by adjacent lifeform. If canopy fire spread was possible, the roads were removed. NLCD2001 classes 21 and 22 received a burnable fuel model, while classes 23, 24, and 25 remained non-burnable.

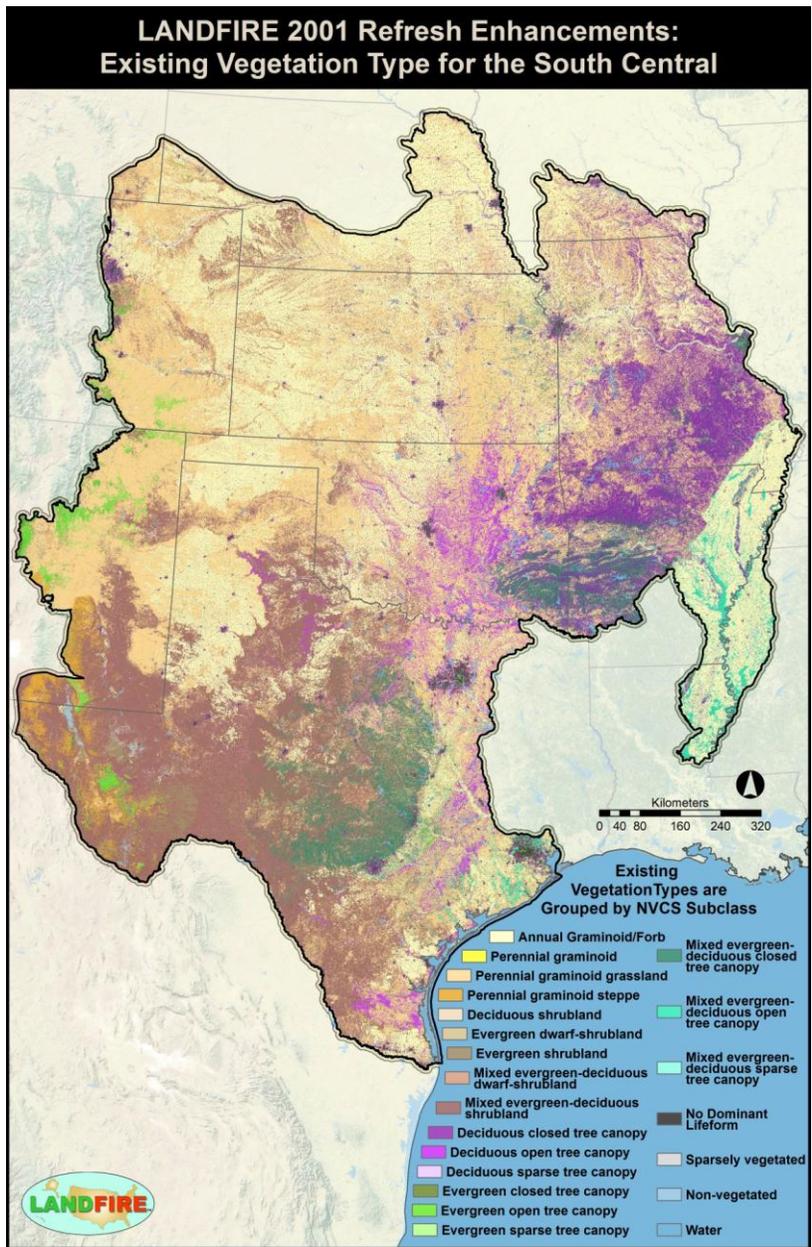


Figure 6 – Map of Existing Vegetation Type layer that was enhanced as part of the LF 2001 updates by incorporating user feedback and additional data.

Table 15 – Acreage of LF agricultural Existing Vegetation Type Groups and percent change on All Land ownerships in the SC GeoArea between LF National and LF 2001.

Table 15. Agricultural Type Comparisons across All Lands			
Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
Agriculture-Cultivated Crops and Irrigated Agriculture	95,959,017	16,926,426	-82.4
Agriculture-Pasture and Hay**	38,774,450	40,123,117	3.5
NASS-Close Grown Crop	0	21,964,860	100.0
NASS-Fallow/Idle Cropland**	0	7,569,827	100.0
NASS-Orchard**	0	23,828	100.0
NASS-Pasture and Hayland**	0	2,235,523	100.0
NASS-Row Crop	0	46,043,813	100.0
NASS-Row Crop-Close Grown Crop	0	1,901,044	100.0
NASS-Vineyard	0	9	100.0
NLCD-Herbaceous Semi-dry**	0	103,365	100.0
NLCD-Herbaceous Semi-wet**	0	57,562	100.0

* Denotes burnable vegetation type in LF 2001

Table 16 – Acreage of LF agricultural Existing Vegetation Type Groups and percent change on Federal Land ownership in the SC GeoArea between LF National and LF 2001

Table 16. Agricultural Type Comparisons across Federal Lands			
Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
Agriculture-Cultivated Crops and Irrigated Agriculture	414,347	97,783	-76.4
Agriculture-Pasture and Hay**	227,709	146,573	-35.6
NASS-Close Grown Crop	0	72,478	100.0
NASS-Fallow/Idle Cropland**	0	49,648	100.0
NASS-Orchard**	0	352	100.0
NASS-Pasture and Hayland**	0	38,083	100.0
NASS-Row Crop	0	134,558	100.0
NASS-Row Crop-Close Grown Crop	0	1,190	100.0
NLCD-Herbaceous Semi-dry**	0	77,264	100.0
NLCD-Herbaceous Semi-wet**	0	30,197	100.0

* Denotes burnable vegetation type in LF 2001

Table 17 – Acreage of LF urban (developed) Existing Vegetation Type Groups and percent change on All Lands in the SC GeoArea between LF National and LF 2001.

Table 17. Developed Lands Comparisons across All Lands			
Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
Developed-High Intensity	677,309	503,106	-25.7
Developed-Low Intensity	4,492,809	2	-100.0
Developed-Medium Intensity	1,630,173	1,051,973	-35.5
Developed-Open Space	13,148,941	1	-100.0
Developed-Roads	0	10,478,254	100.0
Developed-Upland Deciduous Forest	0	1,162,959	100.0
Developed-Upland Evergreen Forest	0	348,219	100.0
Developed-Upland Herbaceous	0	4,777,688	100.0
Developed-Upland Mixed Forest	0	570,476	100.0
Developed-Upland Shrubland	0	1,763,972	100.0

Table 18 – Acreage of LF urban (developed) Existing Vegetation Type Groups and percent change on Federal Lands in the SC GeoArea between LF National and LF 2001.

Table 18. Developed Lands Comparisons across Federal Lands			
Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
Developed-High Intensity	11,263	9,506	-15.6
Developed-Low Intensity	51,949	0	-100.0
Developed-Medium Intensity	20,373	14,374	-29.5
Developed-Open Space	216,159	0	-100.0
Developed-Roads	0	196,783	100.0
Developed-Upland Deciduous Forest	0	29,633	100.0
Developed-Upland Evergreen Forest	0	13,046	100.0
Developed-Upland Herbaceous	0	56,481	100.0
Developed-Upland Mixed Forest	0	15,994	100.0
Developed-Upland Shrubland	0	34,600	100.0

Table 19– Acreage of LF riparian and wetland Existing Vegetation Type Groups and percent change in the SC GeoArea between LF National and LF 2001.

Table 19. Riparian/Wetland Comparisons				
Land Ownership	Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
All Lands	Atlantic Coastal Marsh	261,886	63,576	-75.7
All Lands	Atlantic Swamp Forests	91,792	88,939	-3.1
All Lands	Depressional Wetland	706,349	478,041	-32.3
All Lands	Eastern Floodplain Forests	7,952,142	6,823,426	-14.2
All Lands	Eastern Small Stream Riparian Forests	712,874	532,172	-25.4
All Lands	Inland Marshes and Prairies	529,147	272,571	-48.5
All Lands	Introduced Woody Wetland Vegetation	174,815	167,727	-4.1
All Lands	NLCD-Herbaceous Wetlands	0	1,558,184	100.0
All Lands	Western Riparian Woodland and Shrubland	3,905,397	2,923,272	-25.2
Federal Lands	Atlantic Coastal Marsh	90,866	22,255	-75.5
Federal Lands	Atlantic Swamp Forests	16,311	12,999	-20.3
Federal Lands	Depressional Wetland	52,119	22,758	-56.3
Federal Lands	Eastern Floodplain Forests	503,343	467,781	-7.1
Federal Lands	Eastern Small Stream Riparian Forests	12,354	7,745	-37.3
Federal Lands	Inland Marshes and Prairies	55,901	12,970	-76.8
Federal Lands	Introduced Woody Wetland Vegetation	188	158	-16.0
Federal Lands	NLCD-Herbaceous Wetlands	0	252,022	100.0
Federal Lands	Western Riparian Woodland and Shrubland	137,282	100,977	-26.5

Table 20 – Acreage of LF barren Existing Vegetation Type Groups and percent change in the SC GeoArea between LF National and LF 2001.

Table 20. Barren Comparison				
Land Ownership	Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
All Lands	Barren	1,275,299	1,347,422	5.7
Federal Lands	Barren	138,292	155,758	12.6

Table 21 – Acreage of LF water Existing Vegetation Type Groups and percent change in the SC GeoArea between LF National and LF 2001.

Error! Reference source not found.. Water Comparison				
Land Ownership	Existing Vegetation Type Groups	National (acres)	LF 2001 (acres)	Percent Change
All Lands	Open Water	7,008,420	6,802,912	-2.9
Federal Lands	Open Water	445,169	428,806	-3.7

2.5.2b Enhancements to Existing Vegetation Cover

EVC was updated for forested areas using several dates of Landsat imagery and derived layers. Landsat scenes from leaf-off, leaf-on, and spring dates, along with tasseled-cap images and texture images derived from tasseled-cap images of the three image dates were used. Elevation Derivatives for National Applications (EDNA) data products were used, including Digital Elevation Model and derivatives (slope and aspect). EDNA is a multi-layered database derived from a version of the National Elevation Dataset, which has been hydrologically conditioned for improved hydrologic flow representation (<http://edna.usgs.gov/>).

Training sites derived from FIA plot records were classified to tree canopy cover using a FIA stem-mapping algorithm (Toney et al. 2009). Plot data records were filtered based on FIA disturbance attributes and location-specific Landsat image dates to obtain tree canopy cover training sites. Some plots were omitted from the training set if they had significant disturbances (such as cutting, fire, or wind) recorded after the most recent location-specific image date in the multi-temporal Landsat mosaics.

Regression tree modeling was conducted using Rulequest's® Cubist program. Spatial data layers were then rebuilt to produce the final geospatial layer of CC. Layers were visually checked for seam lines and presence of clouds and other issues or artifacts in the imagery; these were addressed by eliminating problem source data or by making localized revisions to the maps.

The desired outcome of this analysis was to map a statistical distribution of CC values consistent with the distribution expected for spatial wildland fire analysis (Scott and Reinhardt 2005; Stratton 2006). CC rarely exceeds 70 percent in western U.S. forest types, but is somewhat higher in the multi-storied forests of the eastern U.S. The distribution of stem-mapped FIA plot canopy cover was generally consistent with the distribution as evaluated in the wildland fire behavior models. The modeling enhancements based on this FIA approach have improved the data with earlier problems of CC values being too high. The improved CC maps were combined with the existing shrub and herb components to produce the final improved EVC layer.

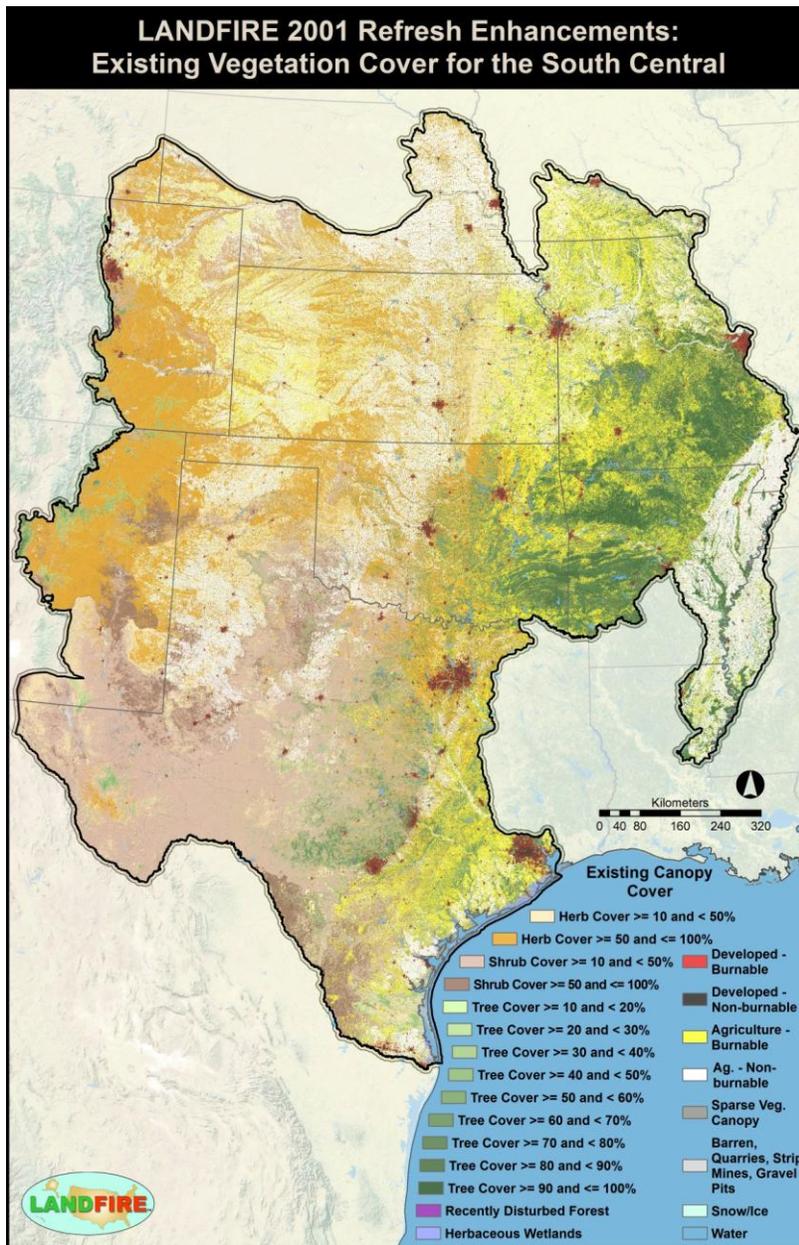


Figure 7 – Map of Existing Vegetation Cover layer that was enhanced as part of the LF 2001 update by incorporating user feedback and additional data.

Table 22 – Existing Vegetation Cover: Forest Canopy Cover – Comparison between LF National and Refresh 2001 tree cover classes and percent change in the SC GeoArea by ownership categories.

Table 22. Tree Cover Comparison				
Land Ownership	Percent Tree Cover	National (acres)	LF 2001 (acres)	Percent Change
All Lands	>= 10 and < 20	5,142,891	943,651	-81.7
All Lands	>= 20 and < 30	4,253,223	3,583,398	-15.8
All Lands	>= 30 and < 40	4,185,175	8,086,682	93.2
All Lands	>= 40 and < 50	4,561,513	6,032,301	32.2
All Lands	>= 50 and < 60	5,079,836	9,394,692	84.9
All Lands	>= 60 and < 70	5,728,875	12,250,365	113.8
All Lands	>= 70 and < 80	7,846,682	21,200,743	170.2
All Lands	>= 80 and < 90	23,717,965	5,840,797	-75.4
All Lands	>= 90 and <= 100	8,991,399	46,436	-99.5
Federal Lands	>= 10 and < 20	145,315	36,880	-74.6
Federal Lands	>= 20 and < 30	180,595	247,647	37.1
Federal Lands	>= 30 and < 40	169,771	281,845	66.0
Federal Lands	>= 40 and < 50	182,560	233,198	27.7
Federal Lands	>= 50 and < 60	217,109	341,361	57.2
Federal Lands	>= 60 and < 70	286,678	728,708	154.2
Federal Lands	>= 70 and < 80	480,197	3,153,919	556.8
Federal Lands	>= 80 and < 90	3,769,564	1,293,985	-65.7
Federal Lands	>= 90 and <= 100	1,015,326	5,914	-99.4

2.5.2c Enhancements to Existing Vegetation Height

The EVH improvement and enhancement process focused on Forest Canopy Height (CH). The CH remapping relied on values derived from FIA plot data using a stand height algorithm. FIA plots falling within a given map zone (including a 3-km buffer) were included. The buffer was extended outwards for zones that had very few plots within them in an attempt to expand the data pool. Geospatial data used in the modeling of CH included Landsat imagery, topography data, and a basal area weighted canopy height product developed by Kelldorfer et al. (2004) using Shuttle Radar Topography Mission data. For each zone, predictor variables determining CH were identified and used to build a regression tree model. Continuous values of CH were then mapped without regard to underlying life form for each mapping zone in the GeoArea. The final step grouped the predicted continuous CH values into LF EVH classes and merged these with the shrub and herbaceous EVH components from LF National to create the new LF 2001 EVH layer.

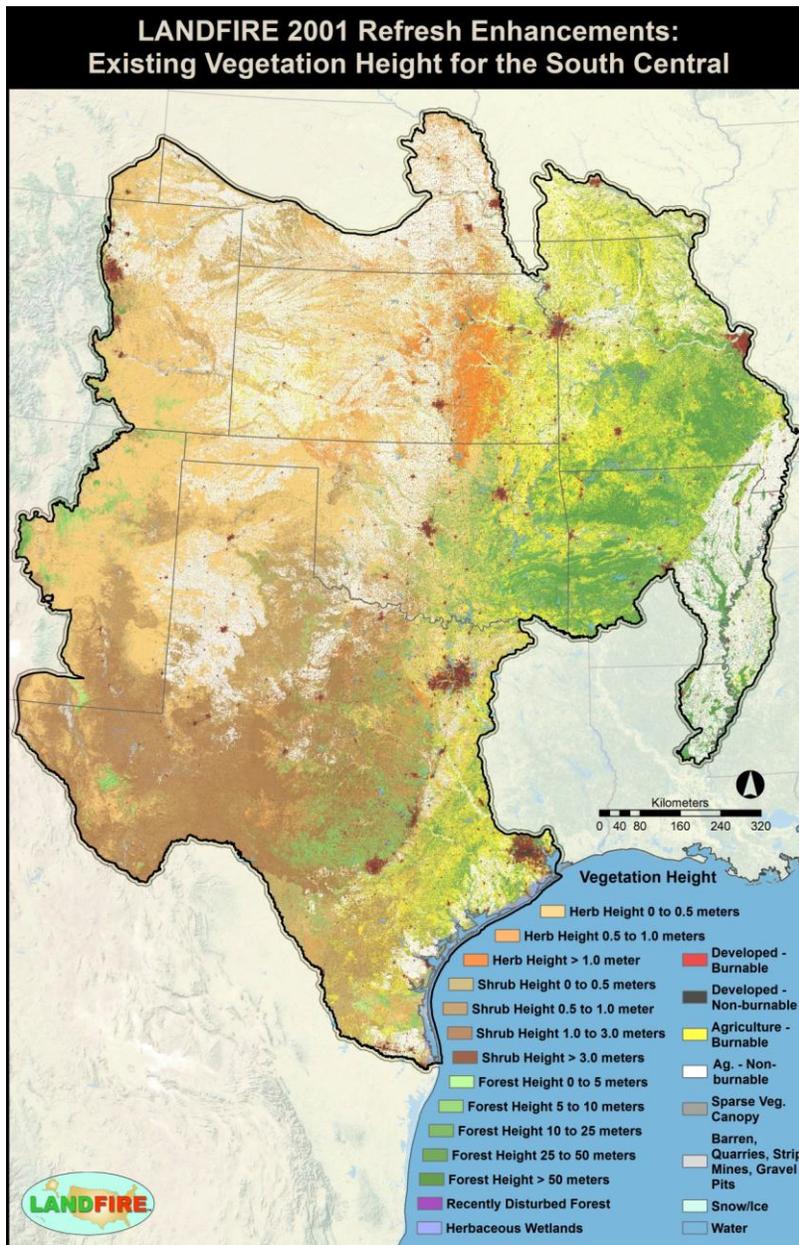


Figure 8 – Map of Existing Vegetation Height layer that was enhanced as part of the LF 2001 update by incorporating user feedback and additional data.

Table 23 – Acreage of LF Forest Canopy Height categories and percent change in the SC GeoArea by ownership categories.

Table 23. Tree Height Comparison				
Land Ownership	Height (m)	National (acres)	LF 2001 (acres)	Percent Change
All Lands	0 to 5	9,221,120	3,943,306	-57.2
All Lands	5 to 10	20,870,782	19,361,831	-7.2
All Lands	10 to 25	38,907,373	42,648,917	9.6
All Lands	25 to 50	508,284	1,425,012	180.4
Federal Lands	0 to 5	584,742	283,567	-51.5
Federal Lands	5 to 10	902,059	722,858	-19.9
Federal Lands	10 to 25	4,919,103	5,053,061	2.7
Federal Lands	25 to 50	41,210	263,970	540.6

2.5.3 LANDFIRE 2008: Updates to Existing Vegetation Products

The primary focus for updating the LF existing vegetation layers was to characterize changes in vegetation attributes in areas that had disturbance activities from 1999 - 2008. Additionally, the update included changes in vegetation attributes within these disturbance areas due to tree growth and regeneration.

As discussed in section 2.4, disturbance mapping for LF 2008 was the result of several efforts that included data derived in part from remotely sensed land change methods, MTBS, and the LF 2001/2008 Events data contribution opportunity. Data contributed from various State Federal and local sources were paired with remote sensing techniques to produce disturbance maps identifying disturbance type, location, and severity.

The spatial layers created by disturbance mapping identified the areas where EVT, EVC, and EVH needed to be transitioned into new vegetation classes. Forest transitions were modeled using the FVS and FFE. Non-forest transitions were assigned using information from a variety of sources from the literature. A Vegetation Transition Data Base (VTDB) was developed for each GeoArea to generate vegetation transitions that were assigned to each EVT, EVH, and EVC for every disturbance and its severity. The VTDB was used to perform an update query that modified the existing attribute tables associated with EVT, EVH, and EVC layers.

2.5.3a Updates to Existing Vegetation Type

Information from a variety of sources was used to inform vegetation transition assignments. A series of tables created in a VTDB were used to update attribute tables for the LF 2008 EVT layer.

In forested EVTs, low and moderate severity disturbance did not change EVT. Stand-replacing events such as high severity fire and timber harvests in forested EVTs were transitioned to an herbaceous or shrubland EVT with a cover and height appropriate for an early seral expression of that EVT and for that geographic location. It was assumed that some herbaceous and shrub communities would transition to forested communities. These sites were typically within formerly forested communities where non-forested EVTs occurred in areas of older, not recent disturbance. In these situations, shrub and herbaceous communities were transitioned to an appropriate forested EVT. Relationships between ESP and these shrub and herbaceous communities were used to predict the new forested EVT at a particular

LANDFIRE 2001 and 2008 Methods and Results

site. Successional class A in the Vegetation Dynamics Development Tool (VDDT) models (ESSA 2005) informed cover and height estimations for 2008 EVT assignments and 2008 cover and height transitions.

In shrub EVTs, all fire severities were considered stand-replacing, so all burned non-forested polygons were replaced by an herbaceous EVT that would be found in that area. Chemical treatments were assumed to be performed on exotic species, so a native herbaceous community for that local or regional area replaced the introduced EVT. Mechanical treatments were treated similarly to fire disturbances and transitioned to an herbaceous community. Introduced annual grasses replaced some shrub-dominated EVTs in lowland areas (for example, Western US Great Basin and Columbia Plateau shrubland EVTs). In herbaceous EVTs, disturbed areas were not transitioned to different EVTs due to the fact that these communities rapidly reestablish themselves after disturbance.

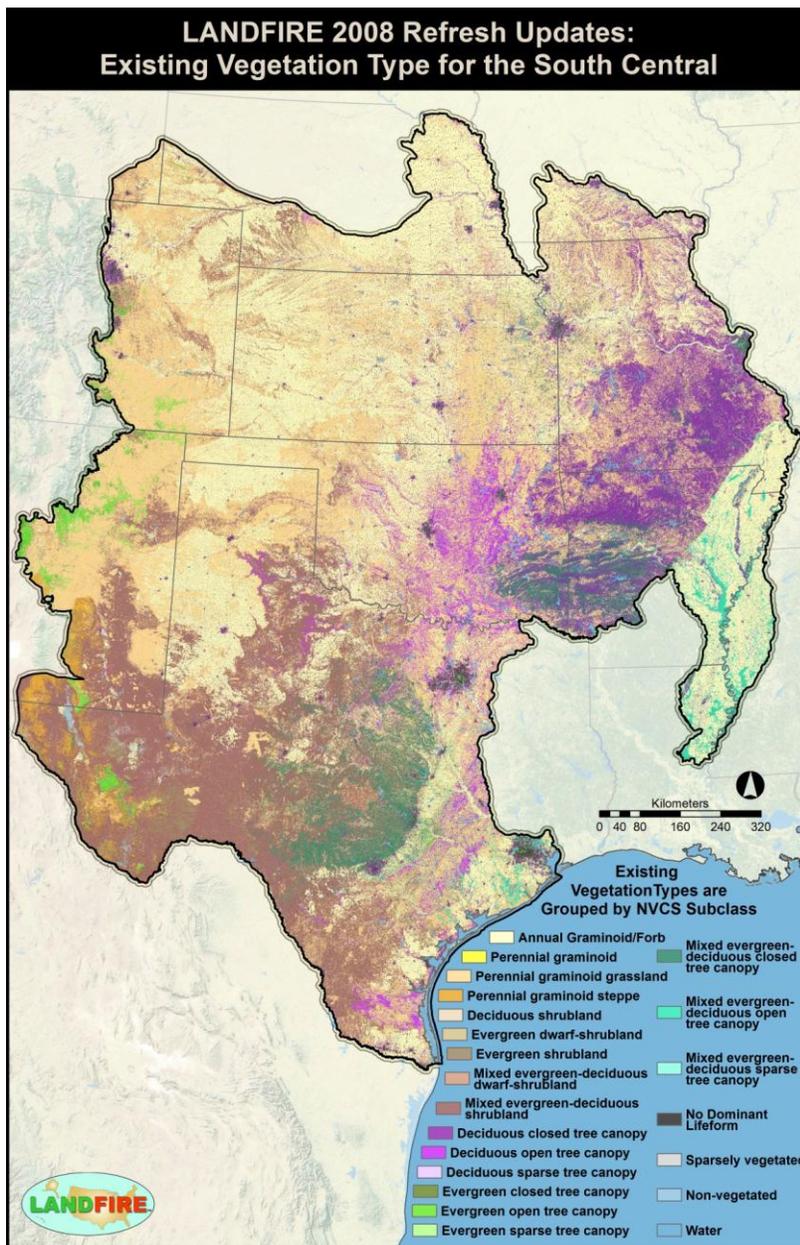


Figure 9 – Map of Existing Vegetation Type layer for the SC GeoArea depicting vegetation changes with disturbances for 1999 - 2008.

Table 24 – Comparison of acreage of forested Existing Vegetation Type Groups between LF 2001 and LF 2008 on All Lands and Federal Lands in the SC GeoArea.

Table 24. Forested Existing Vegetation Type Groups Comparison: All Lands			
Existing Vegetation Type Groups	LF 2001 (acres)	LF 2008 (acres)	Percent Change
Aspen Forest, Woodland, and Parkland	2,594	2,581	-0.5
Aspen-Mixed Conifer Forest and Woodland	1,365	1,363	-0.2
Atlantic Swamp Forests	88,939	84,663	-4.8
Beech-Maple-Basswood Forest	1,893,306	1,882,277	-0.6
Bigtooth Maple Woodland	49,713	49,321	-0.8
Black Oak Woodland and Savanna	293,202	290,894	-0.8
Bur Oak Woodland and Savanna	27,944	24,048	-13.9
Conifer-Oak Forest and Woodland	45	45	0.0
Douglas-fir-Grand Fir-White Fir Forest and Woodland	3,341	3,276	-2.0
Douglas-fir-Ponderosa Pine-Lodgepole Pine Forest and Woodland	25,597	25,152	-1.7
Eastern Floodplain Forests	6,823,426	6,551,541	-4.0
Eastern Small Stream Riparian Forests	532,172	525,057	-1.3
Glades and Barrens	292,933	288,251	-1.6
Hardwood Flatwoods	94,755	93,467	-1.4
Introduced Woody Wetland Vegetation	167,727	156,997	-6.4
Juniper Woodland and Savanna	107,524	107,319	-0.2
Juniper-Oak	1,281,881	1,300,259	1.4
Limber Pine Woodland	608	604	-0.7
Lodgepole Pine Forest and Woodland	12	12	0.0
Longleaf Pine Woodland	124	120	-3.2
Managed Tree Plantation	664,385	656,126	-1.2
Montane Oak Forest	6,434	6,434	0.0
Mountain Mahogany Woodland and Shrubland	514	514	0.0
Pine Flatwoods	288,389	267,703	-7.2
Pinyon-Juniper Woodland	2,447,366	2,463,968	0.7
Ponderosa Pine Forest, Woodland and Savanna	429,546	424,598	-1.2
Post Oak Woodland and Savanna	16,890,303	17,704,913	4.8
Ruderal Forest	1,006,259	969,477	-3.7
Shortleaf Pine Woodland	471,370	471,677	0.1
Shortleaf Pine-Oak Forest and Woodland	4,720,773	4,708,833	-0.3
Spruce-Fir Forest and Woodland	5,551	5,270	-5.1
Sweetgum-Water Oak Forest	901,667	893,415	-0.9
Texas Live Oak	871,996	1,038,115	19.1
Western Riparian Woodland and Shrubland	2,923,222	3,092,665	5.8
White Oak-Beech Forest and Woodland	218,723	215,276	-1.6
White Oak-Red Oak-Hickory Forest and Woodland	24,062,579	24,629,752	2.4

Table 25 – Comparison of acreage of forested EVT Groups between LF 2001 and LF 2008 on Federal Lands in the SC GeoArea.

Table 25. Forested Existing Vegetation Type Groups Comparison: Federal Lands			
Existing Vegetation Type Groups	LF 2001 (acres)	LF 2008 (acres)	Percent Change
Aspen Forest, Woodland, and Parkland	87	87	0.0
Aspen-Mixed Conifer Forest and Woodland	122	122	0.0
Atlantic Swamp Forests	12,999	12,914	-0.7
Beech-Maple-Basswood Forest	114,452	114,681	0.2
Bigtooth Maple Woodland	4,823	4,810	-0.3
Black Oak Woodland and Savanna	4,429	4,382	-1.1
Conifer-Oak Forest and Woodland	22	22	0.0
Douglas-fir-Grand Fir-White Fir Forest and Woodland	2,344	2,279	-2.8
Douglas-fir-Ponderosa Pine-Lodgepole Pine Forest and Woodland	12,324	11,925	-3.2
Eastern Floodplain Forests	467,781	462,410	-1.2
Eastern Small Stream Riparian Forests	7,745	7,696	-0.6
Glades and Barrens	63,188	62,897	-0.5
Hardwood Flatwoods	7,668	7,650	-0.2
Introduced Woody Wetland Vegetation	158	151	-4.4
Juniper Woodland and Savanna	27,386	27,371	-0.1
Juniper-Oak	51,310	51,306	0.0
Limber Pine Woodland	10	10	0.0
Managed Tree Plantation	24,804	24,733	-0.3
Montane Oak Forest	4,429	4,429	0.0
Mountain Mahogany Woodland and Shrubland	0	0	0.0
Pine Flatwoods	8,530	8,492	-0.5
Pinyon-Juniper Woodland	424,980	435,618	2.5
Ponderosa Pine Forest, Woodland and Savanna	90,386	86,566	-4.2
Post Oak Woodland and Savanna	327,456	345,540	5.5
Ruderal Forest	23,741	23,329	-1.7
Shortleaf Pine Woodland	48,298	48,333	0.1
Shortleaf Pine-Oak Forest and Woodland	1,230,541	1,230,322	0.0
Spruce-Fir Forest and Woodland	9	9	0.0
Sweetgum-Water Oak Forest	41,404	41,371	-0.1
Texas Live Oak	33,917	34,027	0.3
Western Riparian Woodland and Shrubland	100,977	105,395	4.4
White Oak-Beech Forest and Woodland	13,723	13,706	-0.1
White Oak-Red Oak-Hickory Forest and Woodland	3,224,453	3,233,947	0.3

Table 26 – Comparison of acreage of shrubland Existing Vegetation Type Groups between LF 2001 and LF 2008 across land ownerships in the SC GeoArea.

Table 26. Shrubland Existing Vegetation Type Groups Comparison				
Land Ownership	Existing Vegetation Type Groups	LF 2001 (acres)	LF 2008 (acres)	Percent Change
All Lands	Big Sagebrush Shrubland and Steppe	20,477	20,369	-0.5
All Lands	Chaparral	68,813	62,878	-8.6
All Lands	Creosotebush Desert Scrub	5,780,161	5,615,633	-2.9
All Lands	Deciduous Shrubland	1,560,818	1,479,771	-5.2
All Lands	Desert Scrub	11,586,889	11,158,902	-3.7
All Lands	Grassland and Steppe	4,659,166	4,644,440	-0.3
All Lands	Greasewood Shrubland	7,047	6,723	-4.6
All Lands	Introduced Riparian Vegetation	47,674	45,703	-4.1
All Lands	Juniper-Oak	10,964,897	10,450,714	-4.7
All Lands	Low Sagebrush Shrubland and Steppe	372,977	354,967	-4.8
All Lands	Mesquite Woodland and Scrub	36,924,294	34,504,304	-6.6
All Lands	Ruderal Forest	2,354,047	1,808,352	-23.2
All Lands	Salt Desert Scrub	969,163	927,024	-4.4
All Lands	Sand Shrubland	9,156,175	8,377,700	-8.5
All Lands	Succulent Desert Scrub	2,044,509	1,949,919	-4.6
All Lands	Transitional Shrub Vegetation	93,066	82,188	-11.7
All Lands	Western Riparian Woodland and Shrubland	50	50	0.0
Federal Lands	Big Sagebrush Shrubland and Steppe	749	746	-0.4
Federal Lands	Chaparral	23,389	21,476	-8.2
Federal Lands	Creosotebush Desert Scrub	913,653	864,361	-5.4
Federal Lands	Deciduous Shrubland	90,064	73,054	-18.9
Federal Lands	Desert Scrub	1,600,971	1,461,241	-8.7
Federal Lands	Grassland and Steppe	1,110,851	1,110,663	0.0
Federal Lands	Greasewood Shrubland	898	888	-1.1
Federal Lands	Introduced Riparian Vegetation	2,955	2,917	-1.3
Federal Lands	Juniper-Oak	271,642	256,503	-5.6
Federal Lands	Low Sagebrush Shrubland and Steppe	17,009	16,079	-5.5
Federal Lands	Mesquite Woodland and Scrub	944,643	854,172	-9.6
Federal Lands	Ruderal Forest	17,327	11,864	-31.5
Federal Lands	Salt Desert Scrub	23,408	22,210	-5.1
Federal Lands	Sand Shrubland	169,120	159,065	-6.0
Federal Lands	Succulent Desert Scrub	162,398	159,129	-2.0
Federal Lands	Transitional Shrub Vegetation	605	523	-13.6

Table 27 – Comparison of acreage of herbaceous Existing Vegetation Type Groups between LF 2001 and LF 2008 across land ownerships in the SC GeoArea.

Table 27. Herbaceous Existing Vegetation Type Group Comparison				
Land Ownership	Existing Vegetation Type Groups	LF 2001 (acres)	LF 2008 (acres)	Percent Change
All Lands	Alpine Dwarf-Shrubland, Fell-field and Meadow	66	66	0.0
All Lands	Atlantic Coastal Marsh	63,576	62,423	-1.8
All Lands	Atlantic Dunes and Grasslands	111,579	108,019	-3.2
All Lands	Depressional Wetland	478,041	445,011	-6.9
All Lands	Glades and Barrens	216,677	194,464	-10.3
All Lands	Grassland	3,883,214	4,294,644	10.6
All Lands	Inland Marshes and Prairies	272,571	225,332	-17.3
All Lands	Introduced Annual and Biennial Forbland	58,330	48,209	-17.4
All Lands	Introduced Annual Grassland	2,609,092	2,348,707	-10.0
All Lands	Introduced Perennial Grassland and Forbland	3,374,300	3,116,755	-7.6
All Lands	Mixedgrass Prairie	18,655,637	16,932,941	-9.2
All Lands	Modified-Managed Prairie Grassland	14,813,681	13,012,219	-12.2
All Lands	NLCD-Herbaceous Semi-dry	103,365	98,507	-4.7
All Lands	NLCD-Herbaceous Semi-wet	57,562	57,188	-0.7
All Lands	NLCD-Herbaceous Wetlands	1,558,184	1,356,657	-12.9
All Lands	Prairies and Barrens	101,693	73,236	-28.0
All Lands	Sand Prairie	2,587,042	2,572,134	-0.6
All Lands	Shortgrass Prairie	37,708,634	36,864,914	-2.2
All Lands	Tallgrass Prairie	10,114,532	8,524,907	-15.7
All Lands	Transitional Herbaceous Vegetation	2,764,900	2,647,792	-4.2
Federal Lands	Alpine Dwarf-Shrubland, Fell-field and Meadow	0	0	0.0
Federal Lands	Atlantic Coastal Marsh	22,255	22,054	-0.9
Federal Lands	Atlantic Dunes and Grasslands	34,563	33,723	-2.4
Federal Lands	Depressional Wetland	22,758	22,206	-2.4
Federal Lands	Glades and Barrens	29	29	0.0
Federal Lands	Grassland	179,381	372,888	107.9
Federal Lands	Inland Marshes and Prairies	12,970	10,932	-15.7
Federal Lands	Introduced Annual and Biennial Forbland	1,648	1,612	-2.2
Federal Lands	Introduced Annual Grassland	197,296	189,750	-3.8
Federal Lands	Introduced Perennial Grassland and Forbland	25,552	24,239	-5.1
Federal Lands	Mixedgrass Prairie	110,957	116,539	5.0
Federal Lands	Modified-Managed Prairie Grassland	169,258	154,883	-8.5
Federal Lands	NLCD-Herbaceous Semi-dry	77,264	72,935	-5.6
Federal Lands	NLCD-Herbaceous Semi-wet	30,197	29,854	-1.1
Federal Lands	NLCD-Herbaceous Wetlands	252,022	219,834	-12.8
Federal Lands	Prairies and Barrens	11,422	9,452	-17.3
Federal Lands	Sand Prairie	57,252	60,833	6.3
Federal Lands	Shortgrass Prairie	1,850,212	1,943,822	5.1

Federal Lands	Tallgrass Prairie	115,009	99,825	-13.2
Federal Lands	Transitional Herbaceous Vegetation	100,486	103,021	2.5

2.5.3b Updates to Existing Vegetation Cover

Transitions in the forested component of EVC due to disturbance and succession were modeled using the FVS and FFE. These transitions were applied to the LF 2001 CC layer to create the LF 2008 CC layer.

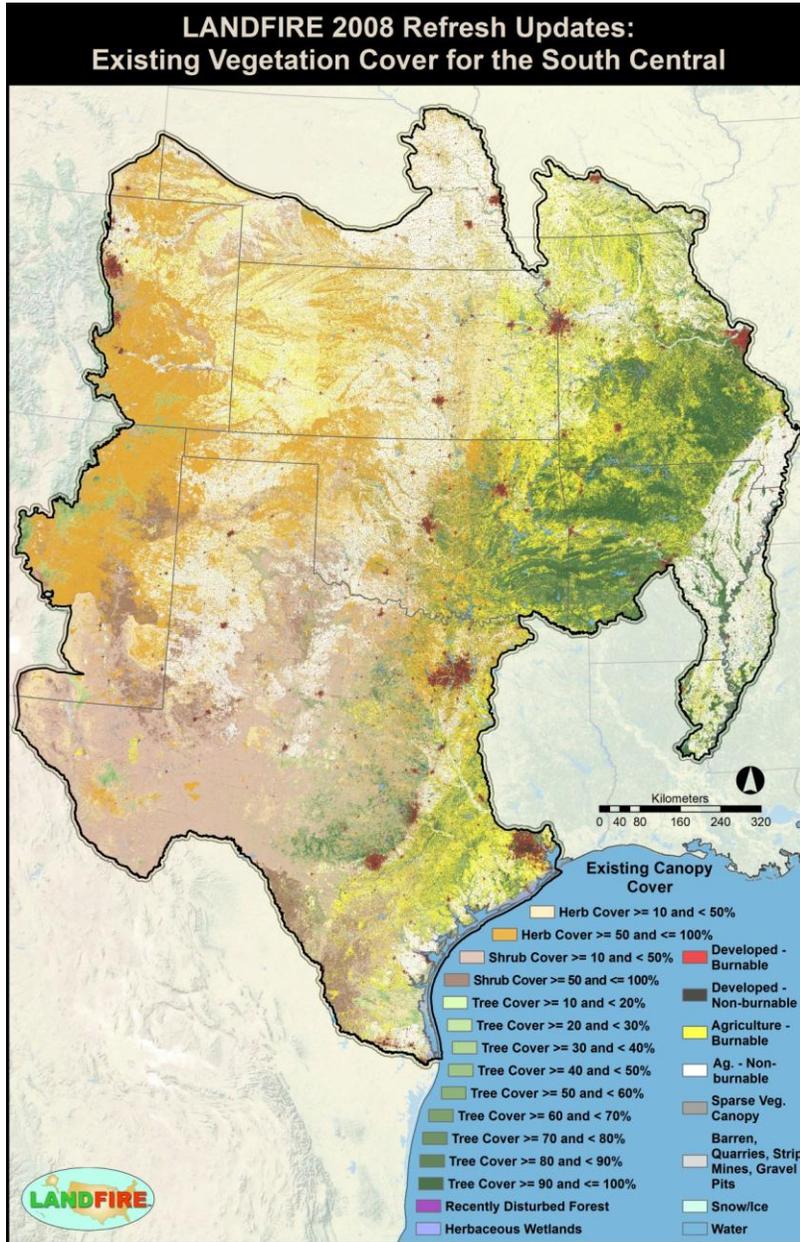


Figure 10 – Map of Existing Vegetation Cover for the SC accounting for vegetation changes with disturbances for 1999 - 2008.

Table 28 – Existing Vegetation Cover: Tree Cover – Comparison between LF 2001 and 2008 Refresh.

Table 28. Tree Cover Comparison				
Land Ownership	Percent Tree Cover	LF 2001 (acres)	LF 2008 (acres)	Percent Change
All Lands	>= 10 and < 20	943,651	1,097,272	16.3
All Lands	>= 20 and < 30	3,583,398	2,986,190	-16.7
All Lands	>= 30 and < 40	8,086,682	9,034,591	11.7
All Lands	>= 40 and < 50	6,032,301	4,809,064	-20.3
All Lands	>= 50 and < 60	9,394,692	5,200,178	-44.7
All Lands	>= 60 and < 70	12,250,365	6,561,471	-46.4
All Lands	>= 70 and < 80	21,200,743	14,894,355	-29.8
All Lands	>= 80 and < 90	5,840,797	23,832,611	308.0
All Lands	>= 90 and <= 100	46,436	84,724	82.5
Federal Lands	>= 10 and < 20	36,880	57,715	56.5
Federal Lands	>= 20 and < 30	247,647	223,479	-9.8
Federal Lands	>= 30 and < 40	281,845	297,284	5.5
Federal Lands	>= 40 and < 50	233,198	203,074	-12.9
Federal Lands	>= 50 and < 60	341,361	218,273	-36.1
Federal Lands	>= 60 and < 70	728,708	258,721	-64.5
Federal Lands	>= 70 and < 80	3,153,919	1,930,383	-38.8
Federal Lands	>= 80 and < 90	1,293,985	3,161,756	144.3
Federal Lands	>= 90 and <= 100	5,914	10,113	71.0

2.5.3c Updates to Existing Vegetation Height

Transitions in the forested component of EVH due to disturbance and succession were modeled using FVS/FFE. These transitions were applied to the LF 2001 CH layer to create the LF 2008 CH layer. Using FIA plot data for forested vegetation types, the model was calibrated to disturb the sites with a variety of disturbance types and severities.

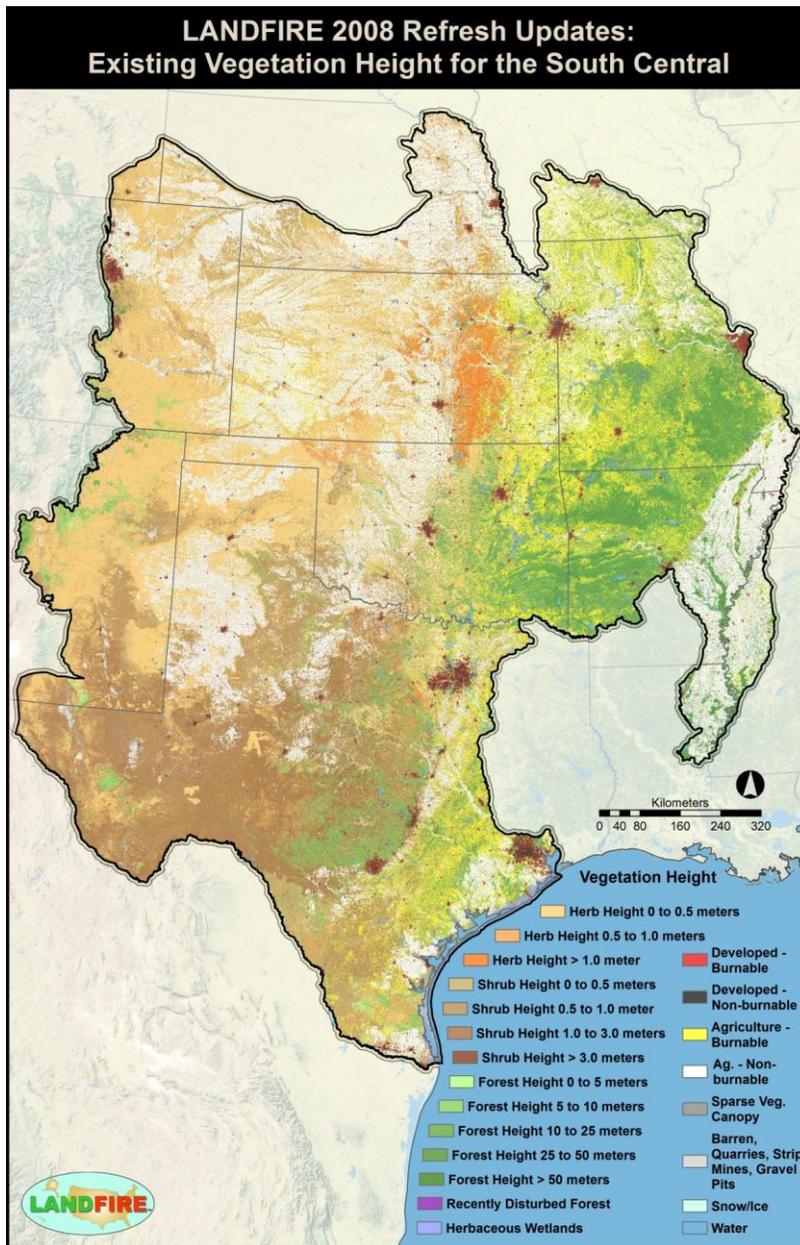


Figure 11 – Map of Existing Vegetation Height for the SC GeoArea accounting for vegetation changes from disturbances for 1999 - 2008.

Table 29 – Existing Vegetation Height: Tree Height – Comparison between LF 2001 and 2008 Refresh.

Table 29. Tree Height Comparison				
Land Ownership	Height (m)	LF 2001 (acres)	LF 2008 (acres)	Percent Change
All Lands	0 to 5	3,943,306	6,280,527	59.3
All Lands	5 to 10	19,361,831	15,127,067	-21.9
All Lands	10 to 25	42,648,917	45,696,274	7.2
All Lands	25 to 50	1,425,012	1,396,588	-2.0
Federal Lands	0 to 5	283,567	330,636	16.6
Federal Lands	5 to 10	722,858	554,382	-23.3
Federal Lands	10 to 25	5,053,061	5,212,214	3.2
Federal Lands	25 to 50	263,970	263,566	-0.2

2.6 Fire Behavior

2.6.1 Product Description

The LF fuels data describe the composition and characteristics of both surface and canopy fuel. Geospatial products include Fire Behavior Fuel Model 13 (FBFM13; Anderson, 1982), Fire Behavior Fuel Model 40 (FBFM40; Scott and Burgan, 2005), and the Canadian Forest Fire Danger Rating System (CFFDRS; Stocks et al. 1989), Forest Canopy Bulk Density (CBD), Forest Canopy Base Height (CBH), CC, and CH. The landscape file (.LCP) is the data format required for many fire behavior and effects models and was provided as well. These data can be implemented within models to predict wildland fire behavior and fire effects and are useful for strategic fuel treatment prioritization and tactical assessment of fire behavior and effects.

The primary effect of the improvements to the LF National layer, from a fuel and fire behavior perspective, was an enhanced mapping of EVC and EVH. The re-mapped EVC had the most effect on the fuel grids and their subsequent modeled fire behavior characteristics.

2.6.2 LF 2001 Enhancements to Fire Behavior Products

With the release of LF National, the user community alerted the LF team to some problems with the fire behavior and fuel attributes. The LF 2001 data set was created in part to address a number of these issues by instilling methods of calculating fuel attributes based on new EVC and EVH layers. Some of the issues raised were:

- CBH was too high for many of the forested systems
- CBD was too low for many of the forested systems
- The combination of FBFM 40/13 and the CBH layers did not produce the expected fire behavior characteristics
- High CC caused high wind reduction factor

2.6.2a Enhancements to Surface Fuel

The FBFM40/13 fuel model grids for LF National were based on input provided by regional fuel specialists and the LF fuel team. Surface fuel models were dependent upon the type of vegetation

LANDFIRE 2001 and 2008 Methods and Results

described in the EVT layer, the amount of cover and/or closure in the overstory of the vegetation from EVC, and the height of the vegetation expressed by EVH. Fuel model assignments were given break points of EVC and EVH for each EVT to determine the fuel model. For instance, in a forested EVT in an open condition, a grass or shrub model would be used in the low cover rule set to describe the surface fuel. As the stand closed in the higher EVC classes, a timber understory or timber litter model would often be used in a subsequent rule set.

With the inclusion of a new method to determine EVC and EVH, the rule sets that were created for FBFM40/13 at workshops with regional specialists remained the same, but the pixels on the map covered by a particular rule set shifted depending on the change in cover and/or height of the vegetation. Although herbaceous, shrub, and tree life forms were mapped in the EVC and EVH products, the forested or treed EVTs were affected by the new approach in cover and height. The change in number and location of pixels that changed fuel models was dependent on the change in cover or height in the forested EVTs.

Many acres in the higher CC classes in LF National were remapped in LF 2001 to lower CC classes, affecting the amount of acres in the various surface fuel assignments. The height classes were also affected, which caused acres to shift from the 0-5 meter class into the higher height classes – often resulting in a change of surface fuel assignment. Some rule sets seemed like duplicates, but were in fact different rules, depending on whether the forested vegetation was available for crown fire.

Upon preliminary completion of the layers and before final processing of LF 2001 fuel layers, all the surface fuel models for CONUS were assembled by EVT and Map Zone. This was done to identify those areas along neighboring map zones having major discrepancies with fire behavior characteristics for surface fuel models of similar EVT and that had resulted from the calibration process. The concern was that new seam lines within the data would exist, in terms of fire behavior outputs, if significant differences in surface fuel models occurred within the same vegetation type and with nothing more than a map zone boundary between them. Some smoothing of the surface fuel model layer was completed within the bounding map zones. This was based on the fuel models selected, average fire season day criteria, and the fire behavior characteristic of rate of spread for the fuel models in question.

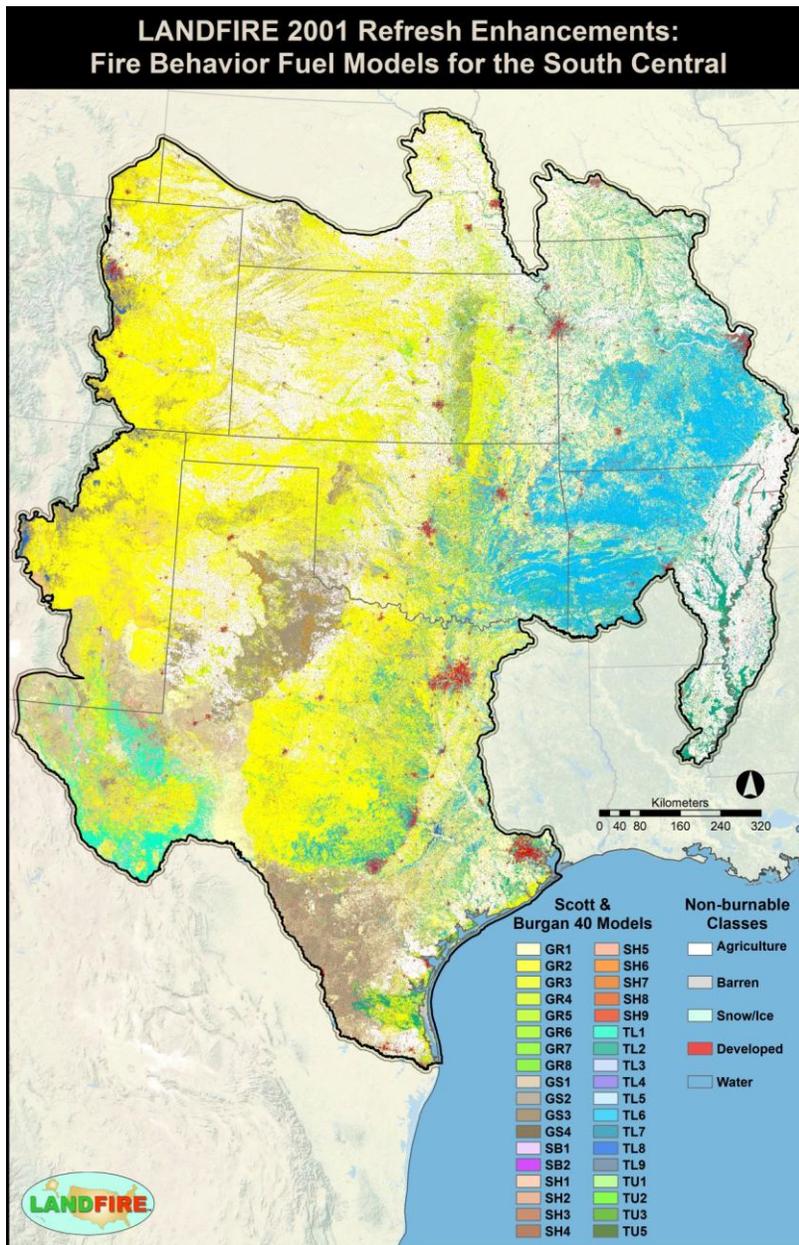


Figure 12 – LF 2001 Fire Behavior Fuel Model 40 for the SC GeoArea

2.6.2b Enhancements to Canopy Fuel

The LF canopy layers CC, CH, CBH, and CBD relate to and were sensitive to changes in EVC and EVH. The CC and CH layers were directly affected by the changes in EVC and EVH, and the grids for CBH and CBD were calculated from the new values in CC and CH. The CBH data layer was developed through exploratory analysis of the LF plot data and statistically analyzed to search for relationships between the plot level variables and CBH. Unfortunately, no such relationship could be gleaned between these variables. It was determined that CBH would be represented through an averaging method based on combinations of EVT and coarser groupings of EVT with EVH and EVC categories.

The CBD data layer was also developed through exploratory analysis of the LF plot data. The entire LF plot data compiled for the western United States were statistically analyzed to search for relationships

between the plot level variables and CBD. A General Linear Model (GLM) was developed that expresses the relationship between CBD and CC, CH, and EVT (Reeves et al. 2009).

2.6.2c Modeled Fire Behavior Using LF 2001 Enhanced Products

The Wildland Fire Assessment Tool (WFAT), an ArcMap™ (part of the Esri ArcGIS Desktop suite) tool that uses FlamMap (Finney 2006) to spatially model fire behavior, was used to estimate potential fire behavior using fuel data from LF National and LF 2001. FlamMap is a fire behavior mapping and analysis program that computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.) over an entire landscape for constant weather and fuel moisture conditions. Three fire behavior outputs from these simulations were then compared to quantify changes in LF fuel mapping improvements (Table 30). The WFAT runs used a simulation landscape and a representative Remote Automated Weather Station (RAWS) for each analysis. Fire weather data were generated from the RAWS data for the selected station. The 98th percentile fire weather was used as an input to WFAT to ensure that the conditions were adequate and that WFAT would simulate the burning of the vast majority of pixels in FRG 1-4 (see Table 7 above for FRG definitions).

Table 30 – Comparison of fire behavior characteristics derived from LF National and LF 2001 for Federal Lands in the SC GeoArea.

Table 30. Fire Behavior Comparison – LF National and LF 2001			
Fire Behavior Characteristic	LF National (acres)	LF 2001 (acres)	Percent Change
Flame Length (feet)			
No Fire	1,533,582	1,129,628	-26.3
Low(>0 and <=4)	8,059,347	8,456,454	4.9
Moderate (>4 and <=11)	5,825,981	6,091,376	4.6
High (> 11)	650,338	391,790	-39.8
Spread Rate (chains/hour)			
No Fire	1,533,582	1,129,628	-26.3
Low (>0 and <=5)	6,497,339	6,542,081	0.7
Moderate (>5 and <=50)	2,607,820	3,042,060	16.7
High (>50)	5,430,507	5,355,480	-1.4
Crown Fire			
No Fire	1,533,582	1,129,628	-26.3
Surface Fire	14,425,642	14,816,460	2.7
Passive Crown Fire	50,887	57,528	13.1
Active Crown Fire	59,137	65,632	11.0

2.6.3 LF 2008 Updates to Fire Behavior Products

The LF 2008 process was a modeled attempt to update the vegetation and fuel characteristics depicted in the circa 2001 imagery (LF National) to the more current period of 2008. The main purpose of this process was to incorporate vegetation growth and disturbance over the time period. Regarding fuel characteristics, the changes in surface fuel models (FBFM40, FBFM13) in the disturbed areas were

incorporated according to expert opinion, whereas the changes in canopy characteristics were modeled through FVS/FFE.

2.6.3a Updates to Surface Fuel

The FBFM40 and FBFM13, canopy fuels were transitioned from their original assignment in LF 2001 based on type, intensity, and the time since disturbance. Vegetation outside of disturbed areas maintained the same surface fuel model unless there was some change in the EVT. Vegetation was transitioned using the process explained in Section 2.4.3.

Time since disturbance was separated into two categories, or time steps, for surface fuel: 0-5 years post disturbance and 6-10 years. The only exceptions to these categories were in geographic areas with very prolific vegetation growth, such as the Southeast and Hawaii. In such areas, the time steps were 0-3 years post disturbance and 4-10 years. For each time step, one FBFM40 and one FBFM13 were assigned to represent the surface fuel characteristic for the period. Generally, the first step was visualized as a full growing season and the second step was seven years post disturbance. The transitions of surface fuel models in disturbed areas were assigned by the LF fuel team and then sent to regional experts for review and editing.

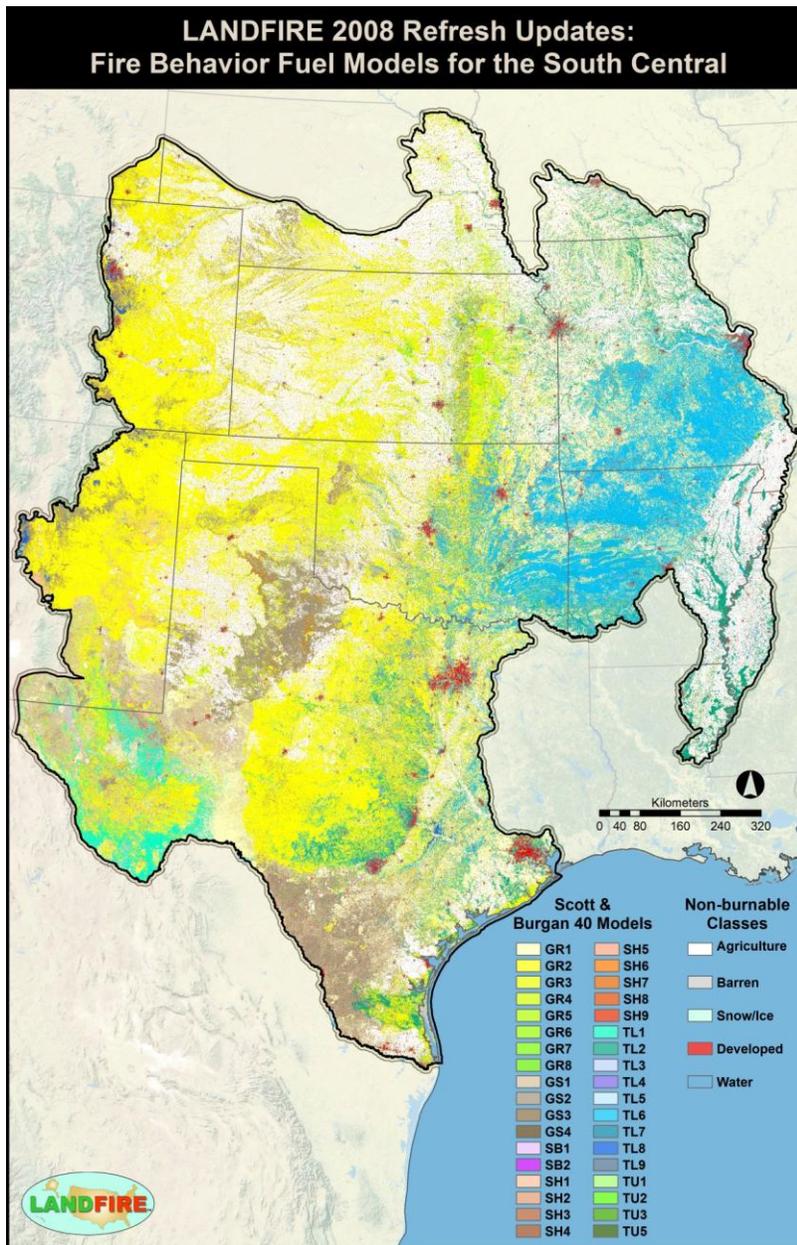


Figure 13 – LF 2008 Fire Behavior Fuel Model 40 for the SC GeoArea.

2.6.3b Updates to Canopy Fuel

The changes in canopy attributes and the growth in non-disturbed areas were modeled through FVS/FFE. Values for CC, CH, and CBD were recalculated using the 2008 EVC, EVH and EVT. The coefficients of change in the CBH attributes were applied to the usual calculation of CBH based on the type, severity, and time since disturbance. Time since disturbance was implemented in three time steps for canopy fuel to reduce the number of fuel model changes to account for; 1) immediately after the disturbance, 2) 2-5 years post disturbance and 3) 6-10 years post disturbance. For each time step, a CBD value was calculated using the GLM and the updated LF 2008 EVT, EVC and EVH data layers.

The FVS/FFE outputs from these simulations provided disturbance and succession transitions for LF CBH and forested EVTs. The CBH data layers were updated leveraging a coefficient of change that is

LANDFIRE 2001 and 2008 Methods and Results

calculated using a non-disturbed CBH value (derived from FVS) and a disturbance/severity/time step specific CBH value. This coefficient of change was applied against the LF National data in the LF Total Fuel Change Tool (www.nifft.gov). The vegetation transitions were mapped by intersecting the integrated 10-year disturbance map with the LF 2001 vegetation layers. A transition predicted by FVS/FFE was assigned to every disturbance and EVT, height, and cover class on the map. This transition provides the needed data to map LF 2008 EVT in areas where forested EVTs were disturbed or may have succeeded to different conditions.

2.6.3c Modeled Fire Behavior Using LF 2008 Updated Products

The WFAT was used to estimate potential fire behavior using fuel data from LF 2001 and LF 2008. Three fire behavior outputs from these simulations were then compared to quantify changes in LF fuel mapping improvements (Table 31). The WFAT runs used a simulation landscape and a representative RAWS for each analysis. Fire weather data were generated from the RAWS data for the selected station. The 98th percentile fire weather was used as an input to WFAT to ensure that the conditions were adequate and that WFAT would simulate the burning of the vast majority of pixels in FRG 1-4.

Table 31 – Comparison of fire behavior characteristics derived from LF 2001 and LF 2008 for Federal Lands in the SC GeoArea.

Table 31. Fire Behavior Comparison – LF 2001 and LF 2008			
Fire Behavior Characteristic	LF 2001 (acres)	LF 2008 (acres)	Percent Change
Flame Length (feet)			
No Fire	1,129,628	1,189,584	5.3
Low(>0 and <=4)	8,456,454	8,417,157	-0.5
Moderate (>4 and <=11)	6,091,376	6,061,635	-0.5
High (> 11)	391,790	400,872	2.3
Spread Rate (chains/hour)			
No Fire	1,129,628	1,189,584	5.3
Low (>0 and <=5)	6,542,081	6,540,736	0.0
Moderate (>5 and <=50)	3,042,060	2,916,961	-4.1
High (>50)	5,355,480	5,421,967	1.2
Crown Fire			
No Fire	1,129,628	1,189,584	5.3
Surface Fire	14,816,460	14,757,045	-0.4
Passive Crown Fire	57,528	67,336	17.1
Active Crown Fire	65,632	55,284	-15.8

2.7 Fire Effects

2.7.1 Product Description

The LF fire effects data layers describe the composition and characteristics of both surface fuel loadings and canopy fuel loadings, including FCCS (Ottmar et al. 2007) and FLM (Lutes et al. 2009). These

LANDFIRE 2001 and 2008 Methods and Results

geospatial products may be used within models to predict the effects of wildland fire. These data are useful for strategic fuel treatment prioritization and tactical assessment of fire behavior and effects.

FCCS defines a fuelbed as the inherent physical characteristics of fuel that contribute to fire behavior and effects (Riccardi et al. 2007). It is a set of measured or averaged physical fuel characteristics of a relatively uniform unit on the landscape that represents a distinct fire environment. An FCCS fuelbed can represent any scale or precision of interest. In FCCS, fuelbeds represent realistic fuel conditions and can accommodate a wide range of fuel characteristics in six horizontal fuel layers called strata (Ottmar et al. 2007). The strata include canopy, shrub, non-woody vegetation, woody fuel, litter/lichen/moss, and ground fuel. Each stratum was further divided into 16 categories and 20 subcategories to represent the complexity of wildland and managed fuel. FCCS fuelbeds were developed by the Fire and Environmental Applications Team (FERA) at the USFS Pacific Wildland Fire Sciences Laboratory to represent important fuel types in the United States. They contain data from the following sources: regional workshops; published literature; USFS photo series, general technical reports, and research papers; other government literature and large databases (such as the NPS and FIA); masters and doctoral theses; white papers, field data, and other unpublished data; and expert opinion.

The LF FLM classification system used for CONUS was based on unique sets of fuel characteristics that simplified the input of fuel loadings into fire effects models. FLMs can be used to simulate smoke emissions and soil heating. An FLM fuelbed is defined as all combustible material below two meters and above mineral soil. These fuels are commonly referred to as surface fuels and include live and dead herbaceous and shrub material, DWM, duff, and litter. Fire behavior and fire effects are the result of the combustion process of the fuel. The size and spatial distribution of smaller diameter combustible material, for example, affects fire behavior, whereas fire effects are dependent on the intensity and duration of the combustion of all fuel. This generalization suggests that a fuel classification system that emphasizes significant differences in fire behavior will not be the same as a classification that identifies differences in fire effects. The FLMs developed for LF were designed to uniquely identify significant differences in two fire effects: maximum surface soil heating and total fine particulate matter emissions less than 2.5 micrometers in diameter (PM_{2.5}).

2.7.2 LF 2001 Enhancements to Fire Effects Products

2.7.2a Enhancements to the Fuel Characterization Classification System fuelbeds

The FCCS fuelbeds mapping relied almost entirely on the LF EVT layer. In cases where an FCCS fuelbed represented a certain seral stage or density class of a particular EVT, the LF EVC layer and EVH layer were also used for mapping FCCS fuelbeds. In addition, the NLCD mapping zone layer, which was used for LF mapping, was used to reflect broader eco-regional variation in FCCS fuelbeds. The mapping process was a collaborative effort between LF and FERA.

The following were the steps involved in the FCCS mapping process. First, the construction of an initial cross-walk of FCCS fuelbeds to LF EVTs using the Society of American Foresters and Society of Range Management classification scheme was used as a link for each completed LF mapping zone. Second, FCCS fuelbeds were identified that did not match well with LF EVT map units. These new fuelbeds were then created and assigned all FCCS attributes. A final cross-walk was constructed that included all new

LANDFIRE 2001 and 2008 Methods and Results

fuelbeds identified in the previous step. The final step used a map rule set tied to the cross-walk to produce the final FCCS fuelbed layer for each mapping zone.

With the inclusion of a new method to determine EVC and EVH, the rule sets that were created for FCCS remained the same, but the pixels on the map that each rule applied to shifted, depending on the change in tree cover and/or height of the tree cover in forested EVT. Table 32 and Table 33 display the FCCS rule sets developed for EVT 2027 and 2028 in mapping zone 7. LF National and LF 2001 depict the change in acreage between data versions. For example, Table 32 depicts the rule sets and the appropriate FCCS fuelbeds. The number of acres and the percent of each EVT that meet those criteria are also shown. These are examples of the rulesets for two EVTs in mapping zone 7, Table 33 The amount of area affected by each rule set changed significantly. However, although the area affected by each rule set changed, the rule sets remained the same between LF National and LF 2001.

Table 32 – LF National Mapping Zone 07 Fuel Characteristic Classification System fuel rule sets and number of acres based on the range of Existing Vegetation Cover and Existing Vegetation Height values.

Table 32. LF National Fuel Rule Sets					
EVT	Percent Cover	Range of Height (m)	FCCS	Acres	Percent EVT
2027 Med Dry-Mesic Mixed Conifer	10 - 19	0 - 25	4	43,706	3.9
2027 Med Dry-Mesic Mixed Conifer	10 - 19	25 - 50	16	4,769	0.4
2027 Med Dry-Mesic Mixed Conifer	20 - 100	0 -10	4	62,724	5.6
2027 Med Dry-Mesic Mixed Conifer	20 - 100	10 -50	16	1,013,952	90.1
2028 Med Mesic Mixed Conifer	10 - 19	0 - 25	4	124,959	4.8
2028 Med Mesic Mixed Conifer	10 - 19	25 - 50	7	2,471	0.1
2028 Med Mesic Mixed Conifer	20 - 100	0 -10	4	65,584	2.5
2028 Med Mesic Mixed Conifer	20 - 100	10 -50	7	2,409,345	92.6

Table 33 – LF 2001 Mapping Zone 07 Fuel Characteristic Classification System fuel rule sets and number of acres based on the range of new Existing Vegetation Cover and Existing Vegetation Height values.

Table 33. LF 2001 Fuel Rule Sets					
EVT	Percent Cover	Range of Height (m)	FCCS	Acres	Percent EVT
2027 Med Dry-Mesic Mixed Conifer	10 - 19	0 - 25	4	14,036	1.2
2027 Med Dry-Mesic Mixed Conifer	10 - 19	25 - 50	16	205	0.0
2027 Med Dry-Mesic Mixed Conifer	20 - 100	0 -10	4	31587	2.8
2027 Med Dry-Mesic Mixed Conifer	20 - 100	10 -50	16	1,083,071	95.9
2028 Med Mesic Mixed Conifer	10 - 19	0 - 25	4	47,479	1.8
2028 Med Mesic Mixed Conifer	10 - 19	25 - 50	7	1,688	0.1
2028 Med Mesic Mixed Conifer	20 - 100	0 -10	4	10,161	0.4
2028 Med Mesic Mixed Conifer	20 - 100	10 -50	7	2,552,843	97.7

2.7.2b Enhancements to the Fuel Loading Models

LANDFIRE 2001 and 2008 Methods and Results

Following the methods outlined by Lutes et al. (2009) and Sikkink et al. (2009), fire effects modeling was conducted using the First Order Fire Effects Model (FOFEM) version 5.9 to simulate PM2.5 smoke emissions, soil heating, and fuel consumption. Pseudo-plots with loading attributes were developed for grasslands using the loading data from FCCS. For some FLMs, the shrub loading in the LF National attributes from Sikkink et al. (2009) summed shrub and herb loading into shrub loading. Fire effects were run on these data for a comparison with a professional judgment split of the loading between shrub and grass. The burnable agriculture and burnable urban types with loading attributes were also included in these data. A series of iterative cluster analyses of fire effects, fuel loading, and data subsets were then performed to (1) validate the addition of grassland models, (2) separate shrub loading into shrub and herb loading, (3) cross-walk the NLCD types to an FLM, and (4) evaluate whether the classification was adequate to deal with post-disturbance conditions. The results indicated that the addition of three grassland models with low, moderate, and high grass fuel loading, in combination with the separation of shrub and grass loading, greatly enhanced the separation of the fire effects clusters and achieved objectives. The burnable agriculture and burnable urban types with fuel loading were cross-walked to an FLM model. These analyses resulted in 30 FLMs, with some adjustment in the loading attributes.

FLM mapping methods applied rules developed from the LFRDB plot data for assignment of a given FLM to various combinations of EVT, EVC, and EVH. For the western U.S., fuel bed measurements of coarse woody debris (CWD), fine woody debris, duff, and litter were compiled from the LFRDB for 24 LF zones. These data and subsequent rules were then used for mapping FLM in the SC GeoArea. Of 17,708 fire effects records, 2,813 had the necessary measurements to key to a FLM. The following procedures outline how plot level data were used to create seamless maps for all LF zones.

A fuelbed measurement majority method was applied to map FLMs. This mapping process included the following steps:

1. Fire effects data were compiled from the LFRDB from all available LF zones.
2. These data were classified to their appropriate FLM.
3. The majority FLM was identified based on existing vegetation database attribute combinations.
4. FLM layers were produced and processed using a pixel populating routine.

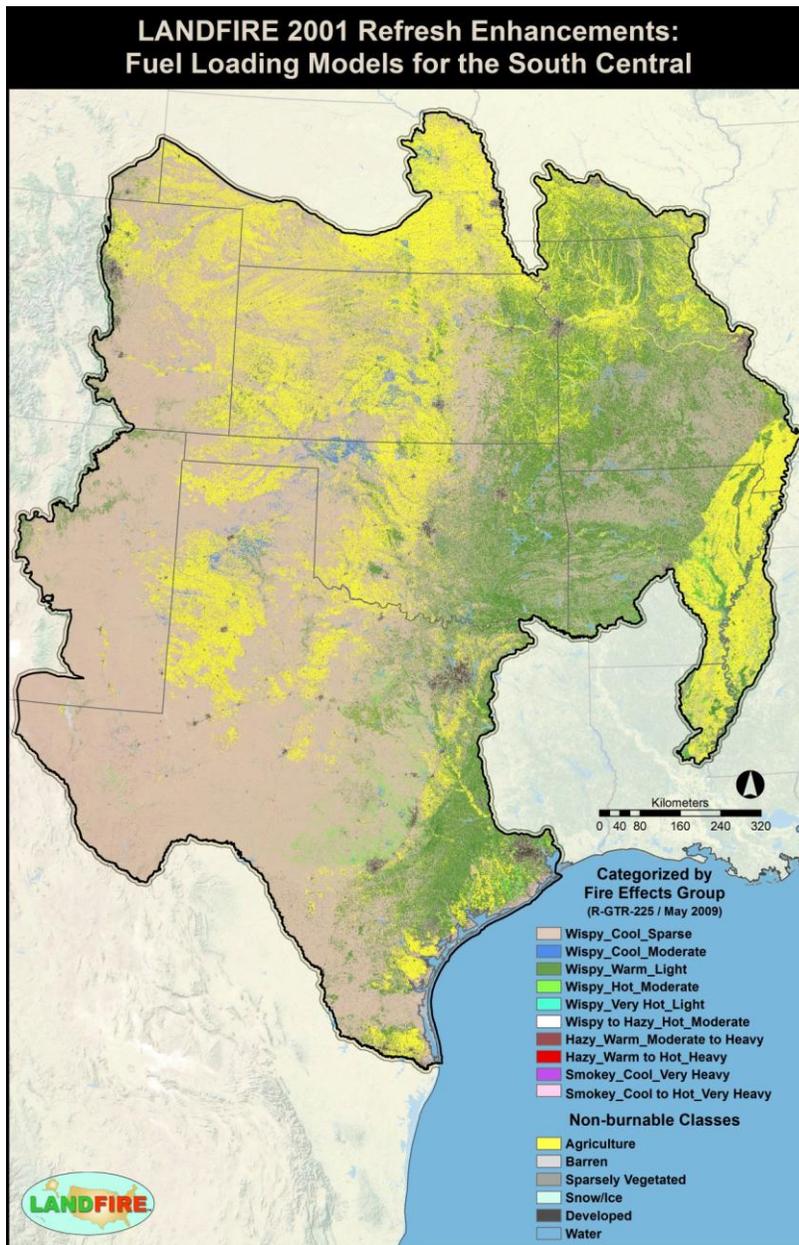


Figure 14 – LF 2001 Fuel Loading Models for the SC GeoArea. FLM categories are from Rocky Mountain Research Station General Technical Report 225.

2.7.2c Modeled Fire Effects Using LF 2001 Enhanced Products

The WFAT can also be used to spatially model fire effects using FOFEM, and was used to estimate potential fire effects using fuel loading data from LF National and LF 2001. Three fire effects outputs from these simulations were then compared to quantify changes in LF FLM mapping improvements (Table 34). The WFAT runs used a simulation landscape and a representative RAWS for each area. Fire weather data were generated from the RAWS data for the selected station. The 98th percentile fire weather was used as an input to WFAT. The FLM grids provided the loadings data for these simulations.

Table 34 –Comparison of fire effect characteristics derived from LF National and LF 2001 for Federal Lands in the SC GeoArea.

Table 34. Fire Effect Characteristics Comparison - LF National to 2001			
Fire Effect Characteristics	LF National (acres)	LF 2001 (acres)	Percent Change
Particulate Production:			
No Burnable Fuels	1,533,374	1,129,402	-26.4
No Burn In Fuels	208	225	8.2
Low (>0 and <=250 lb/ac)	445,564	14,378,046	3,126.9
Moderate (>250 and <=1000 lb/ac)	7,520,188	508,718	-93.2
High(>1000 lb/ac)	6,569,914	52,857	-99.2
Soil Heating:			
No Burnable Fuels	1,533,374	1,129,402	-26.4
No Burn in Fuels	208	225	8.2
No Effect	5,800,907	14,278,099	146.1
Low (>0 and <=3 cm)	5,684,820	283,708	-95.0
Moderate (>3 and <=8 cm)	1,677,121	368,176	-78.1
High(>8 cm)	1,372,818	9,638	-99.3
Fuel Consumption:			
No Burnable Fuels	1,533,374	1,129,402	-26.4
No Burn in Fuels	208	225	8.2
Low (>0 and <=33 %)	9	847,177	9,412,978.0
Moderate (>33 and <= 66 %)	453,080	2,706,043	497.0
High (>66 %)	14,082,577	11,386,401	-19.0

2.7.3 LF 2008 Updates to Fire Effects Products

2.7.3a Updates to Fuel Characterization Classification System Fuelbeds

The same mapping rules that were used for LF 2001 were used for LF 2008 in areas not disturbed by either fire, mechanical removal of surface fuel, or mechanical or wind addition of surface fuel. However, pixels that were affected by disturbances between 1999 and 2008 were adjusted using a simple rule set that modified the original FCCS assignment based on disturbance type, severity, and time since disturbance.

2.7.3b Updates to Fuel Loading Models

The same mapping rules that were used for LF 2001 were used for LF 2008 in areas not disturbed by either fire, mechanical removal of surface fuel, or mechanical or wind addition of surface fuel. However, pixels that were affected by disturbances prior to 2008 were adjusted using a simple rule set that modified the original FLM assignment based on disturbance type, severity, and time since disturbance.

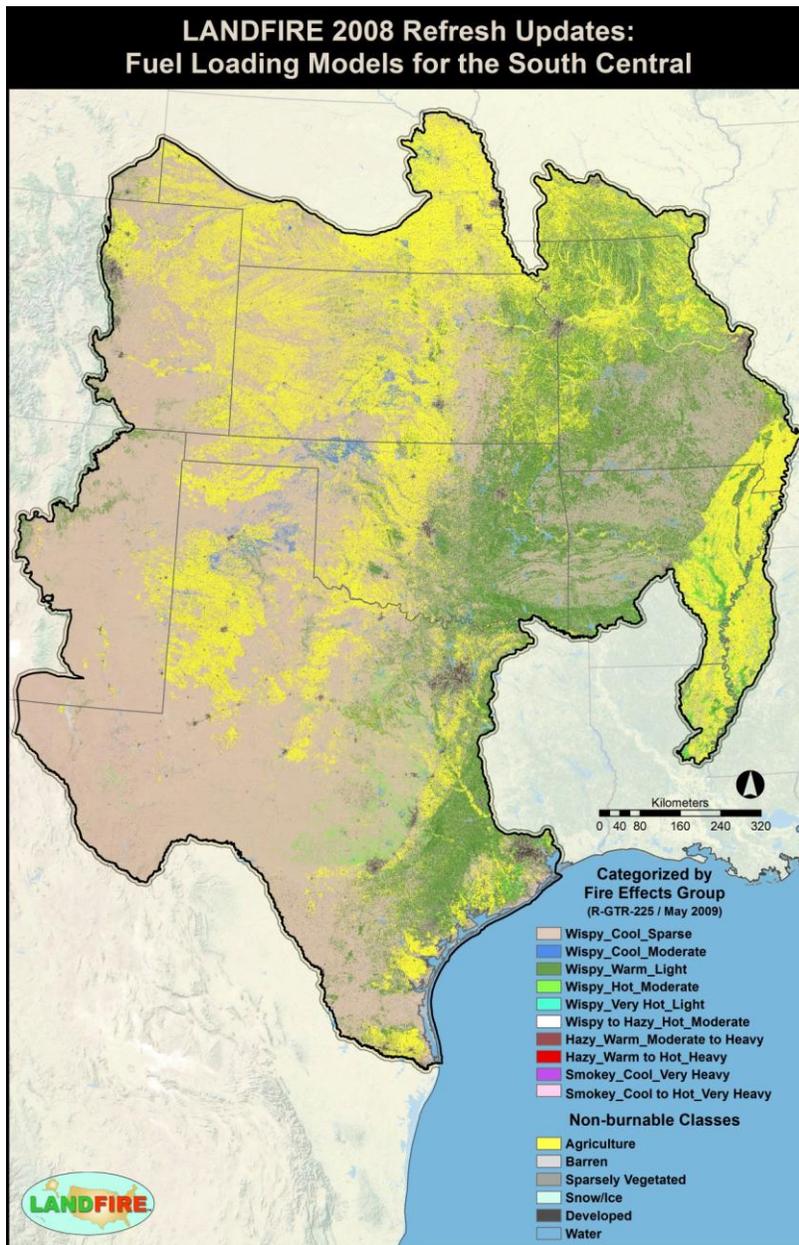


Figure 15 – LF 2008 Fuel Loading Models for the SC GeoArea. Categories are from the Rocky Mountain Research Station General Technical Report 225.

2.7.3c Modeled Fire Effects Using LF 2008 Updated Products

WFAT was used to estimate potential fire effects using fuel loading data from LF 2001 and LF 2008. Three fire effects outputs from these simulations were then compared to quantify changes in LF fuel loading mapping improvements (Table 35). The WFAT runs used a simulation landscape and a representative RAWS for each area. Fire weather data were generated from the RAWS data for the selected station. The 98th percentile fire weather was used as an input to WFAT. The FLM grids provided the loadings data for these simulations.

Table 35 – Comparison of fire effect characteristics derived from LF 2001 and LF 2008 for Federal Lands in the SC GeoArea.

Table 35. Fire Effect Characteristics Comparison– LF 2001 to LF 2008			
Fire Effect Characteristics	LF 2001 (acres)	LF 2008 (acres)	Percent Change
Particulate Production:			
No Burnable Fuels	1,129,402	1,189,359	5.3
No Burn In Fuels	225	225	0.0
Low (>0 and <=250 lb/ac)	14,378,046	14,222,524	-1.1
Moderate (>250 and <=1000 lb/ac)	508,718	608,407	19.6
High(>1000 lb/ac)	52,857	48,733	-7.8
Soil Heating:			
No Burnable Fuels	1,129,402	1,189,359	5.3
No Burn in Fuels	225	225	0.0
No Effect	14,278,099	14,245,032	-0.2
Low (>0 and <=3 cm)	283,708	267,356	-5.8
Moderate (>3 and <=8 cm)	368,176	362,160	-1.6
High(>8 cm)	9,638	5,117	-46.9
Fuel Consumption:			
No Burnable Fuels	1,129,402	1,189,359	5.3
No Burn in Fuels	225	225	0.0
Low (>0 and <=33 %)	847,177	1,012,630	19.5
Moderate (>33 and <= 66 %)	2,706,043	1,564,202	-42.2
Hige (>66 %)	11,386,401	12,302,832	8.05

2.8 Fire Regime Products

2.8.1 Product Description

Broad-scale alterations of historical fire regimes and vegetation conditions have occurred in many landscapes in the U.S. through the combined influence of land management practices, fire exclusion, ungulate herbivory, insect and disease outbreaks, climate change, and invasion of non-native plant species. The LF program produced maps of historical fire regimes and historical vegetation conditions using a state and transition model, VDDT. The LF program also produced maps of current vegetation and measurements of current vegetation departure from simulated historical reference conditions. The LF 2001/2008 update was accomplished by using the FRCC Mapping Tool (FRCCMT; Jones and Tirmenstein, 2012) to perform the FRCC calculations as defined in the Interagency Fire Regime Condition Class Guidebook (FRCC, 2010). FRCCMT relied on the use of a variety of spatial inputs, including the BpS and SCLASS layers and LF 2001 Fire Regime Landscape layers.

SCLASS categorizes current vegetation composition and structure in up to five successional states defined for each LF BpS Model. Two additional categories define uncharacteristic vegetation components that were not found within the compositional or structural variability of successional states

LANDFIRE 2001 and 2008 Methods and Results

defined for each BpS model, such as exotic species. These succession classes were similar in concept to those defined in the FRCC Guidebook. The FRCC data layer categorizes departure between current vegetation conditions and reference vegetation conditions according to the methods outlined in the FRCC Guidebook. This departure index is represented using a 0 to 100 percent scale, with 100 representing maximum departure. The departure index was then classified into three condition classes. It is important to note that the LF FRCC approach differs from that outlined in the FRCC Guidebook as follows: LF FRCC was based on departure of current vegetation conditions from reference vegetation conditions only, whereas the Guidebook approach also includes departure of current fire regimes from those of the reference period. As such, LF has made a transition from calling these products FRCC data products to Vegetation Condition Class (VCC). Similarly, the FRCC departure has been changed to Vegetation Departure Index (VDEP).

2.8.2 LF 2001 Enhancements to Fire Regime Products

2.8.2a Enhancements to Summary Units

The LF 2001 fire regime product was developed to provide a spatial summary unit for processing within each GeoArea using the FRCCMT. The layer was developed by combining the Hydrologic Unit Code (HUC; USGS and NRCS, 2011) and the FRCC layer and clipping this combined raster to each GeoArea boundary. The FRCC layer was then summarized by HUC codes 8, 10, and 12. The fire regime product is one of five inputs used in analyzing departure with FRCCMT, allowing for scale-appropriate analyses for each stratum according to its associated FRG (FRCC, 2010). The outputs from FRCCMT differ as the landscape used to report those results changes in size and/or shape. It is therefore important to select appropriately sized landscapes when using FRCCMT. In addition to the fire regime product, FRCCMT assesses the FRCC metrics by BpS within the landscape watersheds, using the smaller sub-watersheds denoted by the HUC 12 code to calculate FRCC for BpS in FRG 1 and 2, the watersheds denoted by the HUC 10 code to calculate FRCC for BpS in FRG 3, and the larger sub-basins denoted by the HUC 8 code to calculate FRCC for BpS in FRG 4 and 5.

2.8.2b Enhancements to Succession Classes

The SCLASS layer was created by linking the BpS Group attribute in the BpS layer with the RMT data and assigning the SCLASS attribute. This geospatial product displays a reasonable approximation of SCLASS, documented in the RMT. The current successional classes and their historical reference conditions were compared to assess departure of vegetation characteristics; this departure can be quantified using methods such as FRCC. SCLASS rules for each BpS were designed to meet the following criteria: 1) represent the existing locations of a BpS SCLASS on the landscape and 2) meet the input requirements for the FRCCMT. User feedback had identified two primary issues with the LF National BpS SCLASS rules.

1. Many of the rules in the RMT database conflicted due to overlapping cover and height ranges.
2. Some life-forms that were mapped within a given BpS should not have been included based on the BpS model description for the SCLASS. These cases are referred to as “life-form mismatches.”

BpS models and SCLASS rules were evaluated against the BpS model descriptions and adjusted to accurately reflect the intent of the model. In some cases the cover and height values either matched or

LANDFIRE 2001 and 2008 Methods and Results

remained similar to the original model. In other cases the cover and height values were adjusted considerably. The SCLASS rule revision process eliminated overlap between cover and height ranges of the SCLASS rules for a given BpS. Overlapping rules were edited so that only one rule applied to each pixel. In some cases correcting the overlapping values resulted in cover or height values that were one or more categories above or below the original model.

In the case of life-form mismatches, the life-forms that were mapped as part of the BpS but not allowed by the SCLASS rules were reviewed and reassigned to an uncharacteristic class and the probable source of the error was documented.

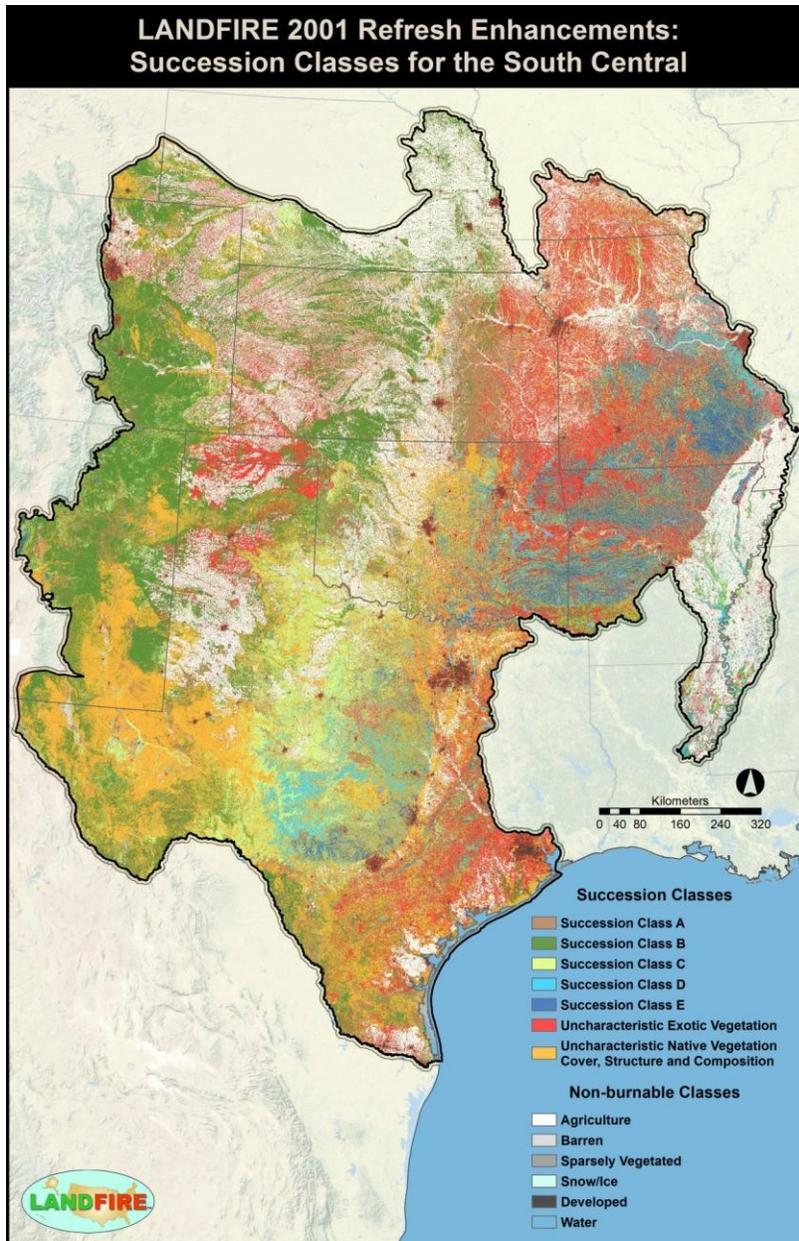


Figure 16 – Map of LF 2001 enhancements of the Succession Classes layer for the SC GeoArea.

2.8.2c Enhancements to Vegetation Departure

Unlike previous versions of LF data, reference conditions of percent composition for each of the characteristic SCLASS were derived from modeling workshops with the intent to approximate the definitions outlined in the FRCC Guidebook. Modelers used the VDDT, which uses state and transition landscape modeling to simulate the effect that disturbance and management actions have on a landscape over time. The results of this modeling are stored in the LF RMT.

The current conditions were derived from the corresponding version of the LF SCLASS data layer. The areas currently mapped to agriculture, urban, water, barren, or sparsely vegetated BpS units were not included in the FRCC calculation; thus, FRCC is based entirely on the remaining area of each BpS unit that is occupied by valid SCLASS. To calculate the Stratum Vegetation Departure, FRCCMT used the BpS layer along with a HUC within the layer to stratify the SCLASS layer. Once the SCLASS layer was stratified by a HUC and BpS, FRCCMT was able to calculate the Current Percent Composition for each SCLASS within each BpS at the appropriate HUC level.

FRCCMT then used the Current Percent Composition for each of the SCLASS within a BpS/HUC along with the corresponding Reference Percent Compositions for that BpS from the Reference Condition Table to calculate the Stratum Vegetation Departure, which is described above. The Stratum Vegetation Departure grid was calculated by comparing the Reference Percent Composition of each SCLASS to the Current Percent Composition, summing the smaller of the two for each of the SCLASS to determine the Stratum Similarity. This value was then subtracted from 100 to determine the Stratum Vegetation Departure. The VCC grid is a 3-category classification of the Stratum Vegetation Departure based on the following thresholds:

1. VCC I: Stratum Vegetation Departure of 0 to 33
2. VCC II: Stratum Vegetation Departure of 34 to 66
3. VCC III: Stratum Vegetation Departure of 67 to 100

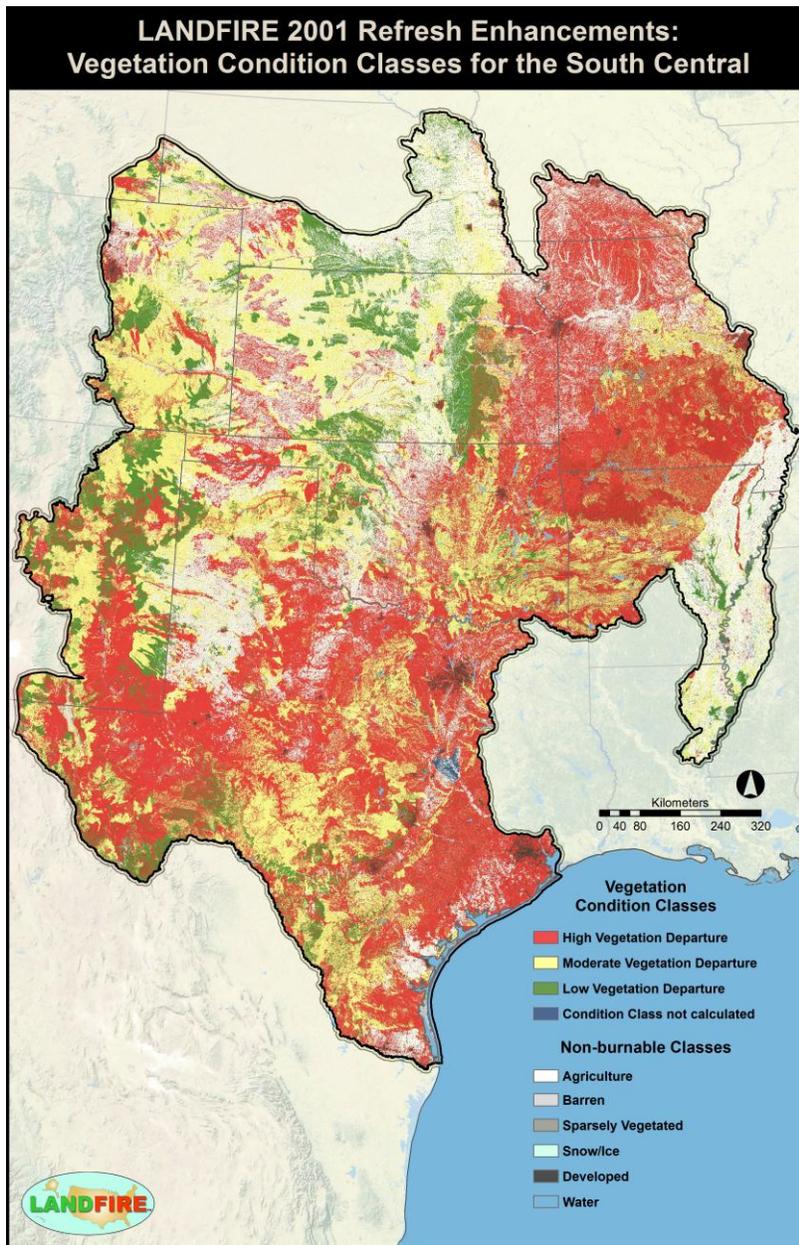


Figure 17 – Map of Vegetation Condition Class for the SC GeoArea from LF 2001 enhancements.

2.8.3 LF 2008 Updates to Fire Regime Products

2.8.3a Updates to Succession Classes

The same SCLASS mapping rules that were used for LF 2001 were used for LF 2008. Mapping rules were applied to LF 2008 EVT, EVC, and EVH layers to map the LF 2008 SCLASS layer.

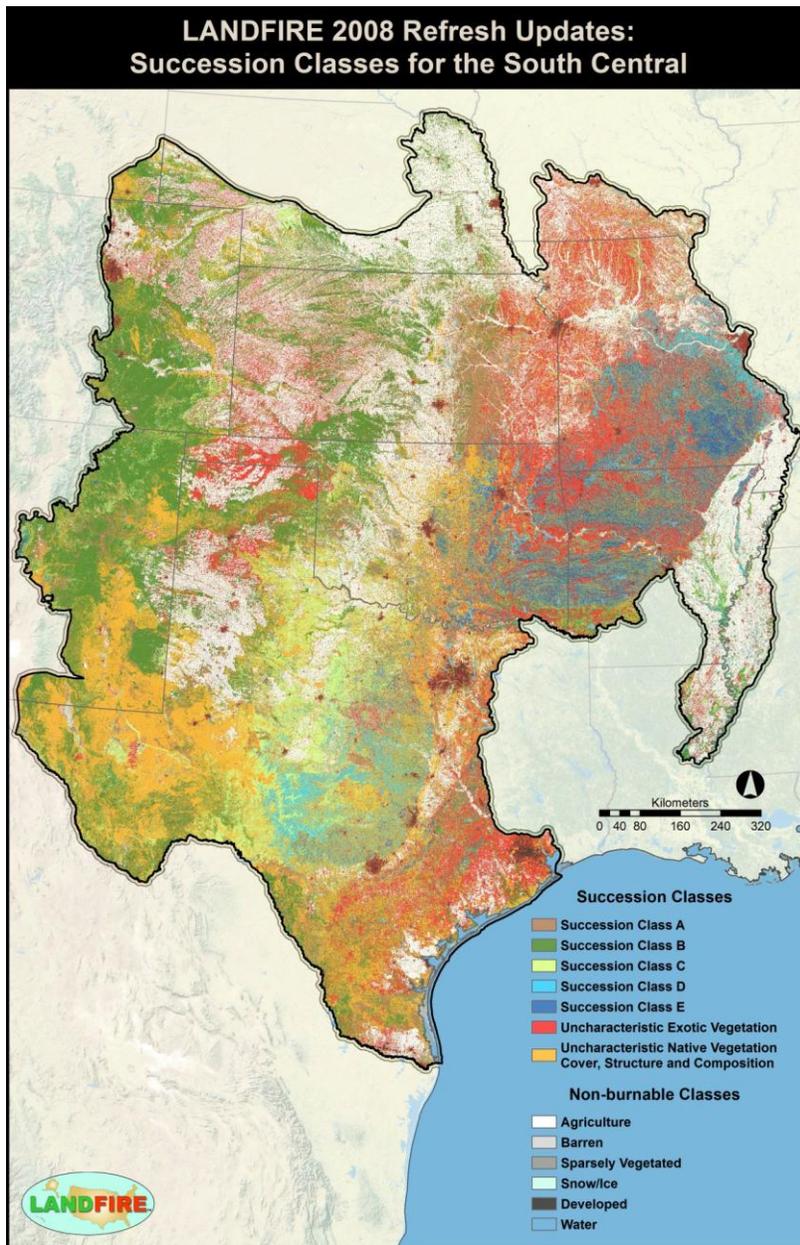


Figure 18 – Map of LF 2008 updates of the Succession Classes layer for the SC GeoArea.

2.8.3b Updates to Vegetation Departure

FRCCMT was used to calculate the current percent composition for each of the LF 2008 SCLASS within a BpS/HUC along with the corresponding reference percent compositions for that BpS from a reference condition table to calculate the LF 2008 stratum vegetation departure. The LF 2008 VCC grid was derived from a 3-category classification of the stratum vegetation departure as defined in Section 2.8.2c.

1. VCC I: Stratum Vegetation Departure of 0 to 33
2. VCC II: Stratum Vegetation Departure of 34 to 66
3. VCC III: Stratum Vegetation Departure of 67 to 100

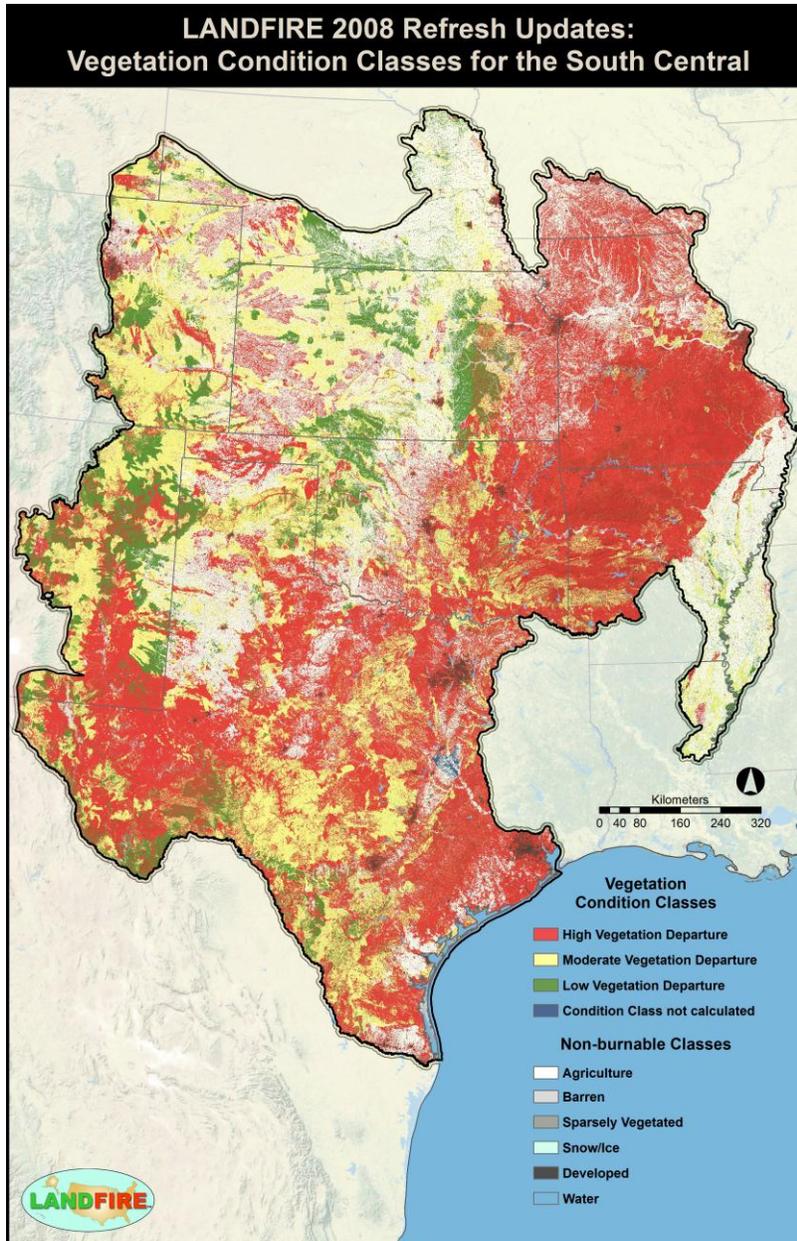


Figure 19 – Map of Vegetation Condition Class for the SC GeoArea from LF 2008 updates.

3.0 FARSITE Comparison of LANDFIRE Fuel

This section evaluates one or more of the LF fuel data sets against known wildland fire perimeters, spread distances, and environmental conditions to determine the efficacy of the data for fire analyses using the FARSITE program doing a comparison between LF data sets with the final perimeters of an actual wildland fire. Fires were selected from one of several sources, either the MTBS Fire Occurrence Database for each of the representative geographic areas, National Interagency Fire Center, or from personal contact with fire personnel related to the fire. The LF data sets that were used throughout this process were FBFM13 and FBFM40, CC, CH, CBH, and CBD from LF National, LF 2001, and LF 2008. Slope, elevation, and aspect were also included as inputs. Below is an example of a comparison between LF data sets with the final perimeters of an actual wildland fire.

3.1 Rock House Fire, 2011

The Rock House Fire occurred in West Texas (map zone 26) near the town of Ft. Davis, TX in early April 2011. The fire burned for several weeks and was contained around May 12, 2011. Texas along with much of the Southwest had been experiencing drought conditions for several years. This dryness, along with very windy conditions throughout the fire season created conditions for one of the worst fire seasons in Texas history. LF fuels data were created to exemplify average or more normal fire season conditions, but an evaluation of the data is warranted to check performance in areas when most of the acres are very dry.

The fire burned to nearly its final size by mid-April. Suppression actions on this fire are unknown, but the extensive spread of the fire on April 9, 2011 indicates that there would have been few if any suppression actions except on the outskirts of Marfa and Ft. Davis, TX. National Fire Danger Rating System Energy Release Component figures showed the area at record setting values (above the 97th percentile in fuel dryness over a seven year average) for the Ft. Davis Remote Automated Weather Station (RAWS), located within the town of Ft. Davis, which is located near the center of the fire. Windy conditions particularly on April 9, 2011 provided for extensive fire spread in the surface fuels and crowning in areas where treed vegetation existed. On April 9, 2011 the fire spread approximately 33 miles in 6 hours as a result of these conditions.

The vegetation of the site covered in the April 9, 2011 fire run, was characterized by LF as a mixture of Apacherian-Chihuahuan Semi Desert Grassland (EVT 2121), Chihuahuan Loamy Plain Desert Grassland (EVT 2503), Madrean Encinal (EVT 2023), and Chihuahuan Mixed Desert Thornscrub (EVT 2100).

An infrared map of the April 29, 2011 created from an aircraft mounted sensor was used as the background for this evaluation, but a one day simulation with Fire Behavior Analyst (FBAN) accounts and weather inputs from the April 9, 2011 were used to depict the 6 hour extreme spread event.

3.1.1 Inputs

For this fire there were many eyewitness observers. Figure 20 is an example of some of the documentation that was available for this fire. It is an account of fire spread and weather conditions which were supplied by the FBAN and were used in this evaluation to verify model inputs.

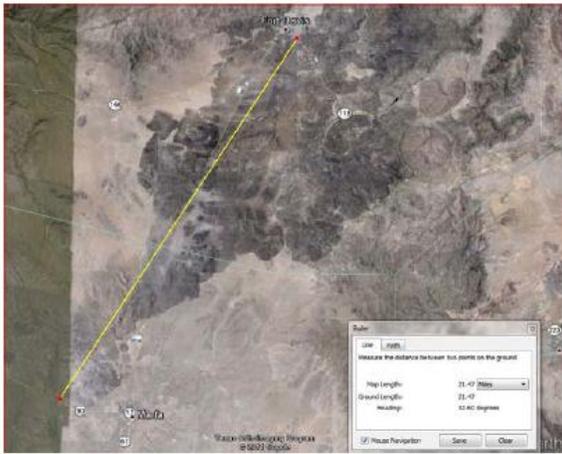
Rockhouse documentation for April 9th 2011 collected by Brad Smith

According to reports the fire started near Marfa at 1230 hours.

The fire traveled 21 miles to Ft. Davis and arrived at approximately 1600 hours according to eyewitness Robert P. (Bill Davis contact)

Bill Davis (TFS employee) witnessed fire crossing highway 17 at Wild Rose Pass at 1800 hours. Wild Rose pass is 11 miles NE of Ft. Davis

Fire traveled 33 miles in 5.5 hours for an average of 6 mph ROS



Marfa to Ft. Davis

21 miles in Approx 3.5 hours

Ft. Davis to Wild Rose Pass

11 miles in Approx 2 hours

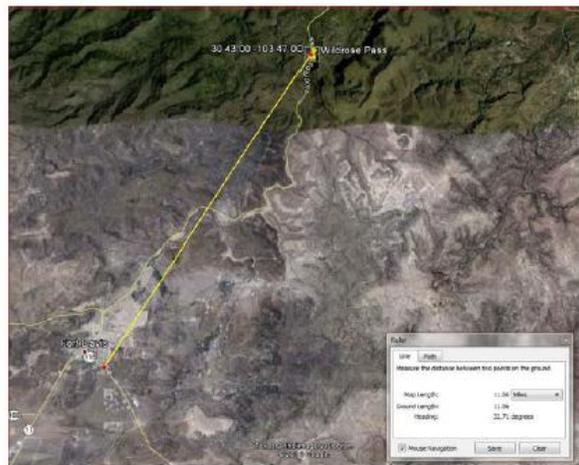


Figure 20 – Example of available information that was evaluated and used to account for fire spread and weather conditions. This information was supplied by the FBAN and was used to verify model inputs.

Weather, wind, and fuel moisture data used in the fire simulation was obtained from the Ft. Davis RAWs located at the north of the April 9, 2011 fire run and the center of the fire area. The other source used for wind data was Meso West readings supplied by the FBAN for Marfa Municipal Airport located in

FARSITE Comparison of LANDFIRE Fuel

Marfa and Alpine-Casparis Municipal Airport located near the city of Alpine, TX. Both airports were near the fire. Ft. Davis RAWS was used for fuel moisture, temperature, and relative humidity. The median value for 10-minute average and maximum gust wind speed was found for each hour for April 9, 2011 for each station. The median values between the three stations were compared, and since there were no significant differences, Ft. Davis wind speed values were used for input into the model for the projection across all versions of LF fuel data. The median wind speeds at Ft. Davis were 25 to 30 mph throughout the burn period of the 9th with maximum wind gusts of 30 to 40 mph. Wind directions within the model were adjusted to a minor degree to ensure fire spread was in the direction of the final perimeter.

Surface fuel models (FBFM40) in all three versions of LF data (LF National; LF 2001; LF 2008) were similar and were predominantly, Grass (GR) GR2 (102) 60%, Grass Shrub (GS) GS2 (121) 25%, Shrub (SH) SH2 (142) 10% and Timber Litter (TL) TL1 (181) 5% in the forest of the simulated area. Nonflammable pixels such as roads make a significant difference in the ability of the simulated fire to spread in grass and grass shrub models. The roads, urban, and barren areas in LF 2001 and LF 2008 are more pronounced and have more of an effect than in LF National. CBH was not a significant factor in this analysis. The areas with canopy fuel were small and separated by grass, grass shrub, and shrubs.

Surface fuels models (FBFM13) were evaluated in the simulations for this report from LF National, LF 2001 and LF 2008 were very similar. The mix of FBFM comprised in this analysis were: FBFM13-1 represents 85%, FBFM13-2 represents 5%, FBFM13-8 depicts 5%, and FBFM13-5 comprises 5% of the analysis area. FBFM13-5 is more evident in LF 2008 and the areas of heavier grass in this version are represented by FBFM13-3.

A 22 hour analysis window representing April 9th was simulated with a 6 hour maximum burn period from noon to 1800. The fire spread from Marfa to Ft. Davis between 1200 and 1600 and from Ft. Davis to Wild Rose Pass between 1600 and 1800. These hours were selected because they corresponded to heavy wind events during the height of daytime hours as well as eye witness reports of fire progression. The ignition location (Figure 21) was located and set at the bottom portion of the perimeter just west of Marfa. Crown fire activity was set to the Scott and Reinhardt method and spotting was enabled at 3% for calibration. With spotting ignition frequency set at 3% in the calibration runs, the simulations did not always cross roads, so spotting ignition frequency was increased to 5% for subsequent simulations. A fuel moisture and environmental conditioning period was used from April 7, 2011 through April 8, 2011 to calibrate the fuels and the weather values were from the Ft. Davis RAWS. Displayed below (Figure 21) is the site for the Rock House Fire with the perimeter of April 29, 2011 and indicates the April 9, 2011 spread event which was modeled for this evaluation.

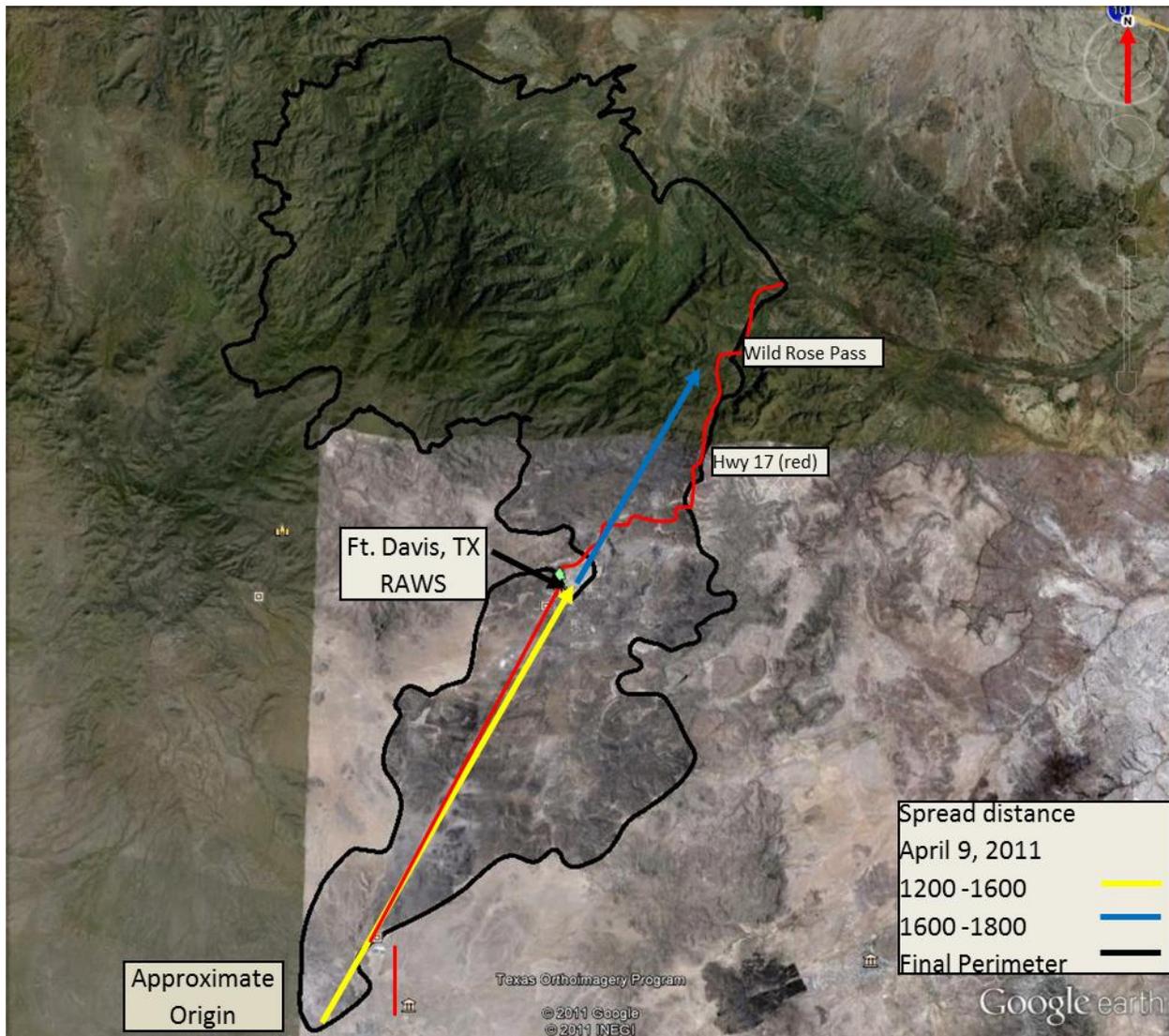


Figure 21– Rock House Fire Spread up to Simulation Period. The fire perimeter covers an area that extends nearly 43 miles from south to north.

3.1.2 Results

The simulation was completed with 30 minute breaks in the wind to enable it to cross Texas State Highway 17 and with maximum gust wind values (Figure 22). These same, or very similar, results were found for all three versions of the FBFM40 landscapes.

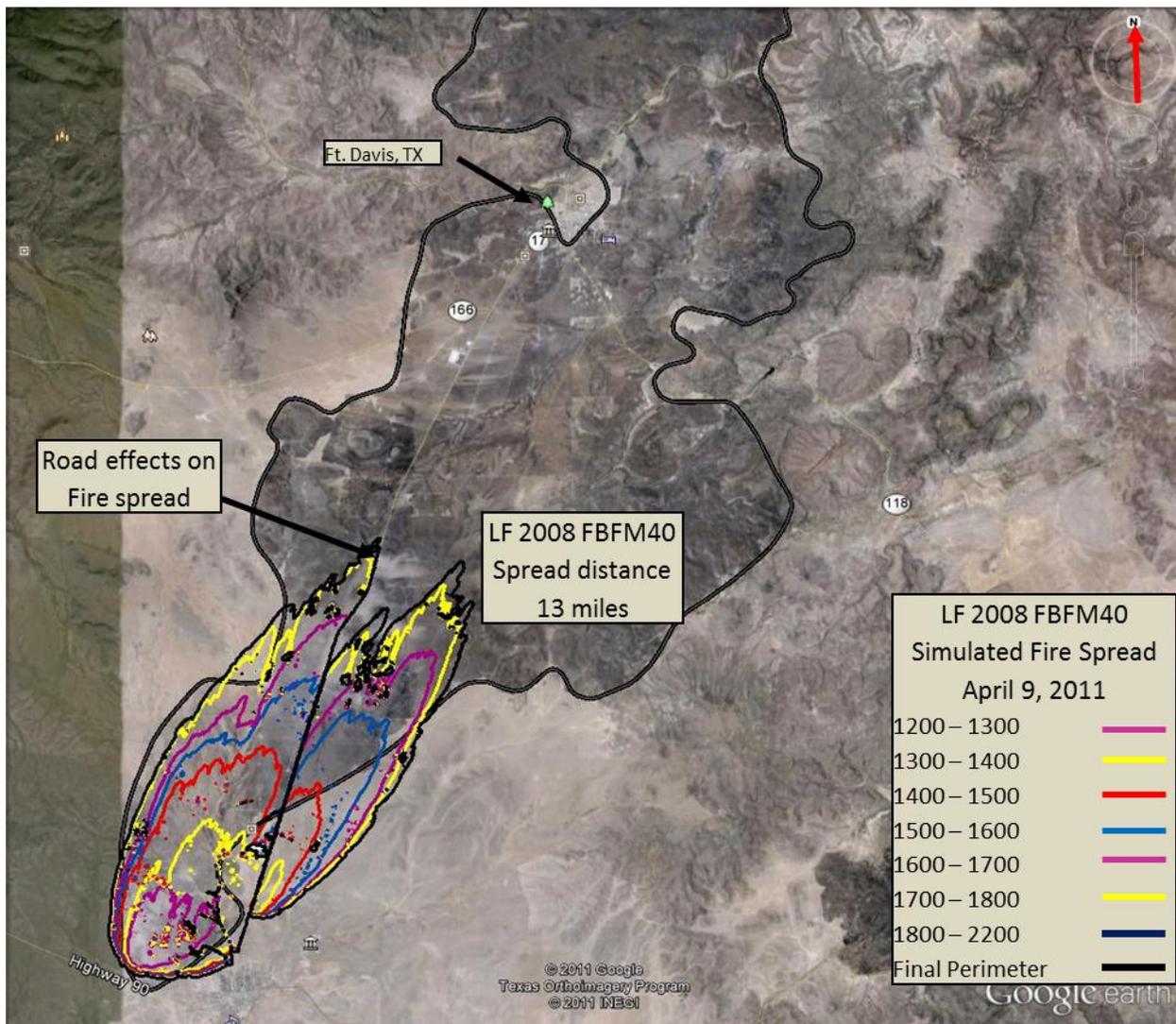


Figure 22 – LF 2008 FBFM40 Fire Simulation Rock House Fire 1200 to 1800 hrs April 9, 2011. The fire perimeter covers an area that extends nearly 43 miles from south to north.

One of the reasons for the FBFM40 landscape lack of performance is from the GR2 (102) which dominates the lower end of the fire area and its set wind limits in the fire behavior models (McArthur, 1969). Fuel model GR2 reaches the point where rate of spread does not increase at a 12.5mph mid-flame wind speed. At that wind limit, the rate of spread for this model is, approximately, 225 ch/hr. Consequently, even if there were no other fuel models and impediments such as roads involved, the maximum spread distance in the wind would be 17 miles in a 6 hour burn period. Several of the grass models in the FBFM40 and FBFM13 have wind limits in the model (FBFM13-1; FBFM40- 101, 102, 103). All of these fuel models were used in the LF data in the analysis area. As can be seen in Figure 23 FBFM13-1 has a much higher rate of spread with a lower wind limit than FBFM40-102.

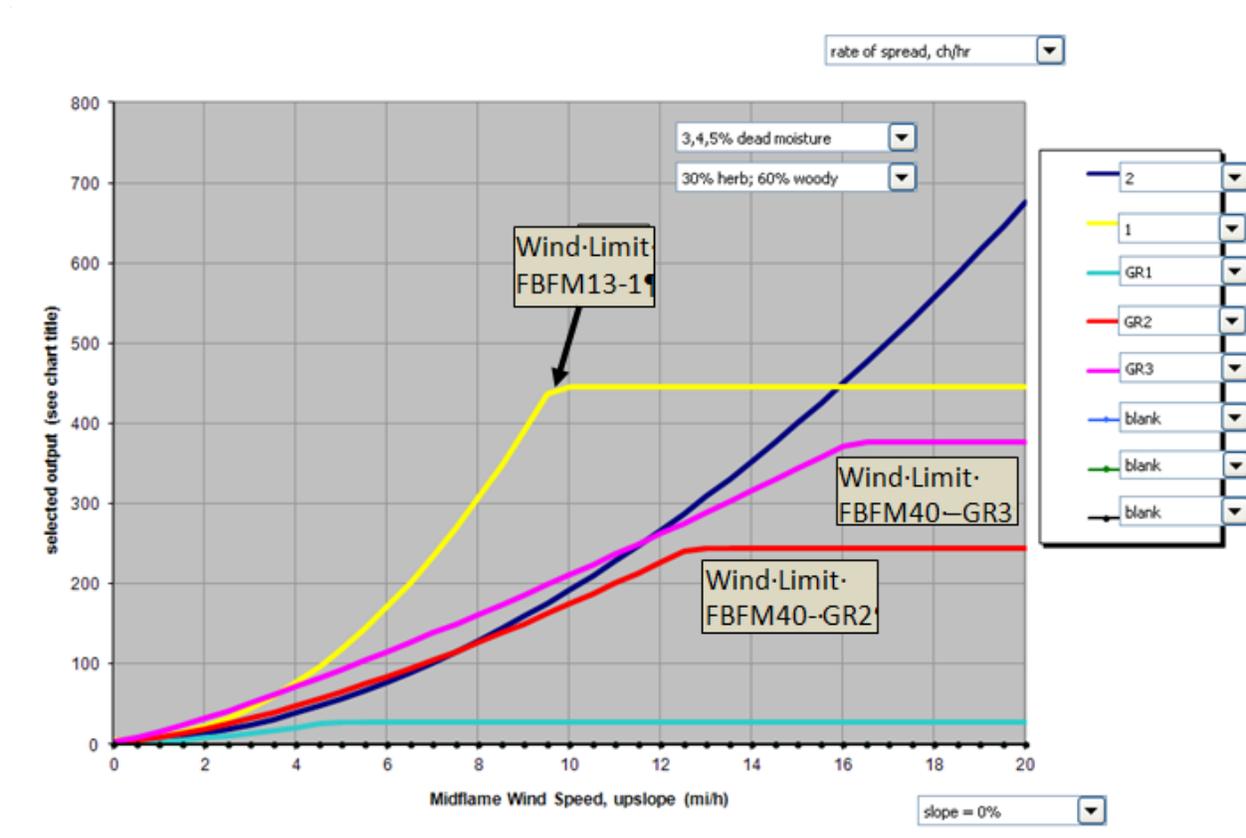


Figure 23 – Comparison of Rates of Spread and Wind Limits between FBFM40 and FBFM13 Models.

The set of FBFM13 were also developed for a “worst case scenario” in depicting fire behavior characteristics. FBFM13-1 is a static model, so there will be less fluctuation from environmental inputs in the model. The LF 2008 FBFM13 surface fuel model layer depicts much of the analysis area as a fuel model 1. Figure 24 displays the same simulation with LF 2008 landscape file FBFM13. The predominant fuel model 1 and median wind speed between the 10 minute average and maximum gust were used.

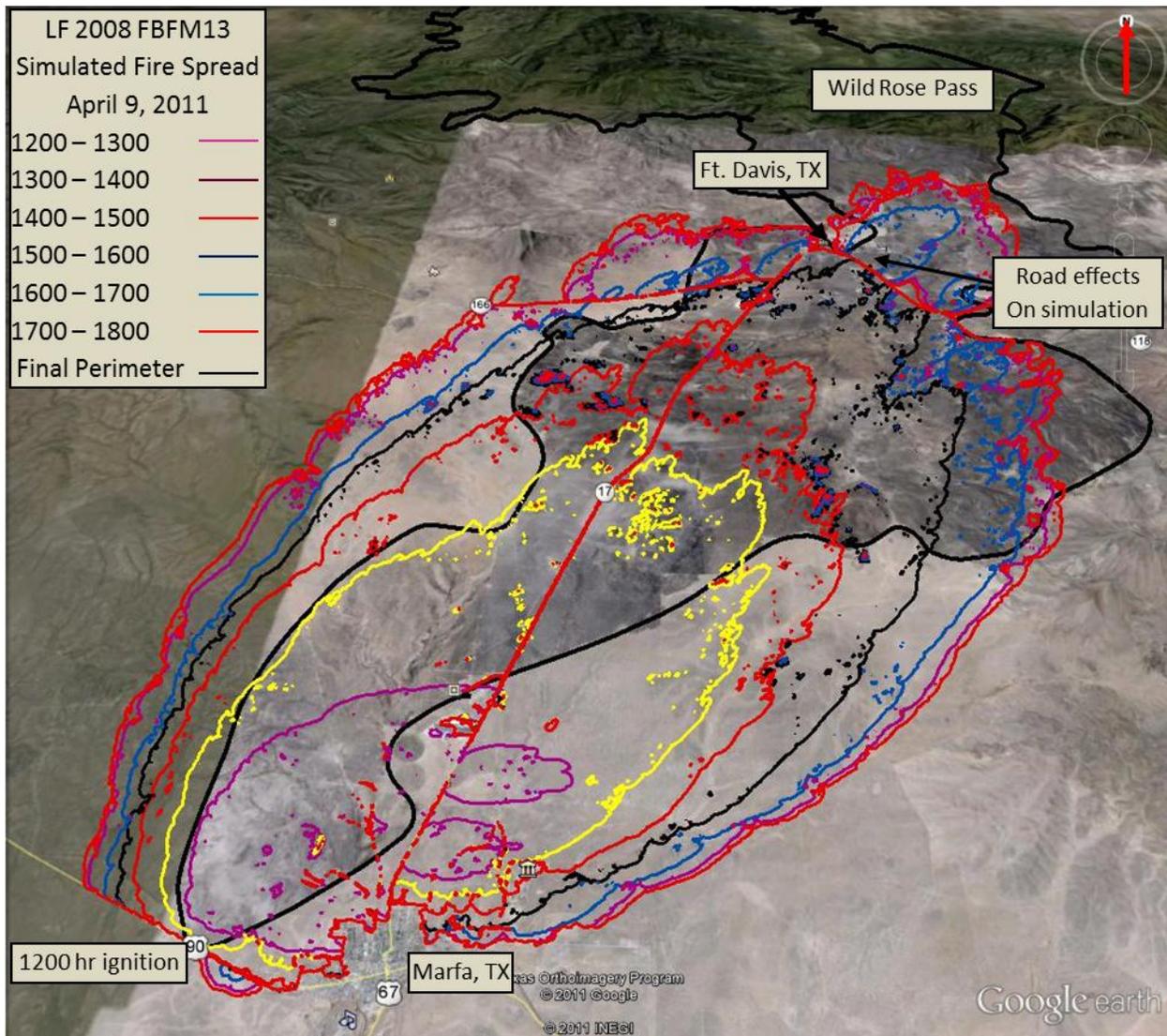


Figure 24 – LF 2008 FBFM13 Fire Simulation Rock House Fire April 9, 2011. The fire perimeter covers an area that extends nearly 43 miles from south to north.

As can be seen in Figure 24 the simulated fire spread reaches Ft. Davis by 1600 hr (black line), but gets hung up crossing Texas State Highway 118 near Ft. Davis. This slowdown in the simulation along with the fire re-crossing Texas State Highway 17 northeast of there at 1800hr (red line) caused the run to fall short of Wild Rose Pass, TX.

In each of the previous simulations wind files were used to insure the wind limit for the fuel model was reached. For FBFM40 landscapes the maximum gust wind speeds were used, and for FBFM13 landscapes the median between the 10 minute average wind and the maximum gust wind speeds were used. Winds were input and used in the model by the half hour in order to adjust wind direction to insure spotting across highways which may have had a slight effect on final fire extent to the northeast.

Only LF 2008 landscapes are displayed in this report; one with FBFM40 and the other with FBFM13. Other versions of the LF data showed similar results in final fire size when compared within their fuel model type. LF National with FBFM40 was similar to Figure 22 (LF 2008) with a little further fire extent

FARSITE Comparison of LANDFIRE Fuel

due to less road effect. LF 2001 FBFM40 simulation was also very similar to Figure 22. These same generalizations apply to the different versions of LF data with FBFM13 landscapes.

For many areas where grass and light grass shrub fuel types exist across the country LF data uses FBFM13-1 and FBFM40-102 in the surface fuel model layers. For worst case scenario fire situations the data users might consider using the FBFM13 surface fuels layer in those instances.

Spotting ignition frequency in FARSITE simulations may need to be increased in these same fuel situations to alleviate road effect in LF 2001 and LF 2008.

4.0 LF 2001/2008 Organization

DOI / USFS Business Leads		USFS	
Henry Bastian	Frank Fay	Don Long	Jeff Jones
Program Manager - EcoSmartt, LLC		University of Idaho	
Doug Oates		Kathy Schon	Eva Strand
USGS Earth Resources Observation Science Center		TNC	
Matt Rollins ¹	Birgit Peterson ²	Jim Smith	Randy Swaty
Don Ohlen ¹	Gretchen Meier ²	Kori Blankenship	Sarah Hagen
Kurtis Nelson ¹	Xuexia Chen ²	Joseph Fargione	Jeannie Patton
Dan Steinwand ¹	Hua Shi ²	Systems for Environmental Management, LLC	
Jim Vogelmann ¹	James Napoli ³		
Joel Connot ³	Jeffrey Natharius ³		
Susan Embrock ³	Stacey Romeo ³		
Jay Kost ³	Tobin Smail ³		
Heather Kreilick ³	Brian Tolk ³		
Charles Larson ³	Aimee Vitateau ³		
Deborah Lissfelt ³	Sheila Kautz ⁴		
Brenda Lundberg ³	Roger Sneve ⁴		
Charley Martin ³			
¹ U.S. Geological Survey ² Arctic Slope Regional Corporation Research and Technology Solutions ³ Stinger Ghaffarian Technologies ⁴ Earth Resources Technology, Inc.		Dale Hamilton	Chris Winne
		Jason Herynk	Ben Hanus
		Jeff Gibson	Cecilia McNicoll
		Colleen Ryan	John Caratti
		Christine Frame	

5.0 Disclaimers

This report and associated LF data are provided "as-is" and without express or implied warranties as to their completeness, accuracy, suitability, or current state thereof for any specific purpose. The LF Program is in no way condoning or endorsing the application of these data for any given purpose. The DOI and USFS manage multiple sets of information and derived data as a service to users of digital geographic data and various databases. No agent of LF shall have liability or responsibility to data users or any other person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the data set. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. government.

These data and related graphics (such as ".gif" or ".jpg" file formats) are not legal documents and are not intended to be used as such. Users take full responsibility for their applications of these data. It is the sole responsibility and obligation of the user to determine whether the data are suitable for the intended purpose and apply those data in an appropriate and conscientious manner.

LF is not obligated to provide updates to the data herein, as they are and shall remain consistent with those used to develop the LF Program products. However, the LF Program will, at its discretion, continue using these and previously supplied and sampled data to update and improve future versions of LF products. Users of these data are requested to inform the LF Program of significant errors to assist with product maintenance activities. Please send your feedback to helpdesk@landfire.gov.

6.0 Additional Information

This section lists some, but of course not all, partners that the LF Program works with and relies on for information and data.

6.1 Landsat



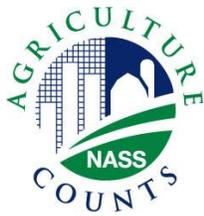
The Landsat program within USGS is a critical partner in the development of LF data products. The 30-meter Landsat imagery constitutes the foundation upon which all data layers were mapped as well as updated. When LF began in 2004, the cost of Landsat data greatly increased costs associated with the development of LF data products. Now that these data are free, costs have decreased and data improvement opportunities similar to the LF 2008 update process are expanding.

6.2 Forest Inventory Analysis



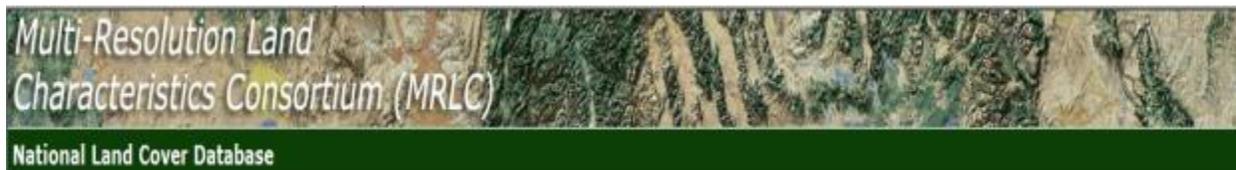
The FIA Program of the USFS provides key information to LF about America's forests. FIA provides a continuous forest census and reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. Given the confidentiality of the FIA data, LF has a memorandum of understanding and supports an FIA employee who works with the FIA data, enabling LF to use this key resource. FIA has changed processes and procedures from a periodic survey to an annual survey and by expanding the scope of data collection to include soil, understory vegetation, tree crown conditions, CWD, and lichen community composition on a subsample of plots. LF will evaluate these data sets in the continual process to improve and update the LF data products.

6.3 National Agricultural Statistics Service



NASS provides valuable agriculture data for the entire United States. These data were extremely useful in assisting to delineate burnable and non-burnable agricultural lands. LF 2001/2008 used NASS data to refine the burnable/non-burnable lands data. LF and NASS will continue to work together in the future on additional LF data product improvements.

6.4 Multi-Resolution Land Characteristics Consortium National Land Cover Database



The Multi-Resolution Land Characteristics Consortium (MRLC) is a group of Federal agencies that coordinates and generates consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. The creation of this consortium (the LF program is a member) has resulted in the mapping of a comprehensive land cover product, termed the NLCD, which is based upon a decadal composite of Landsat satellite imagery and other supplementary data sets.

LF has leveraged the MRLC NLCD2001 land cover product with the development of LF National (circa 2001) data and works to promote nationally complete, current, and consistent data across the nation.

6.5 Writers, Contributors and Technical Editors

Technical Editors	Section Contributors	
Don Long	Henry Bastian	Section 1
Henry Bastian	Don Long	Section 2.3, 2.7, and 2.8
Christine Frame	Brenda Lundberg	Section 2.2
Don Ohlen	Jay Kost	Section 2.4
Joel Connot	Jeff Natharius	Section 2.5
	Heather Kreilick	Section 2.5
	Charley Martin	Section 2.6 and 3.0
	Tobin Smail	Section 2.6
	James Napoli	Section 2.6
	Wendel Hann	Section 2.7 and 2.8

7.0 Glossary

FARSITE—Fire Area Simulator, a fire behavior and growth simulator

Fire Effects—The physical, biological, and ecological impacts of fire on the environment (NWCG 2005).

Fire Occurrence Database—A collection of information about fires including elements such as, date, location, acres, cause, etc.

Landsat Imagery—Thematic Mapper and Enhanced Thematic Mapper Plus image data from the Landsat 5 and Landsat 7 satellites, respectively. Image scenes have a footprint area of approximately 34,000 square kilometers and a pixel resolution of 30 meters.

Monitoring Trends in Burn Severity—Relevant spatial and non-spatial fire data are mapped by the MTBS project. Data elements include the latitude/longitude of the centroid of the MTBS burn scar perimeter.

Normalized Burn Ratio—An index similar to the Normalized Difference Vegetation Index. The primary difference is that NBR integrates the two Landsat bands that respond most, but in opposite ways to burning. The Landsat Thematic Mapper/Enhanced Thematic Mapper Plus bands used to calculate NBR are Band 4 and Band 7. The NBR is calculated as follows: $NBR = (4 - 7) / (4 + 7)$.

Prescribed Fire—Any fire ignited by management actions to meet specific objectives (NWCG 2005).

Remote Sensing Landscape Change— A process composed of four main elements. These are: 1) acquisition and compilation of field data; 2) wildfire burn mapping, as being conducted by the MTBS project; 3) updating and analysis using the VCT; and 4) mapping and incorporation of subtle intra-state changes, such as those related to insects and disease.

Spatial Resolution—The areal extent of the smallest unit, pixel, or feature that can be resolved on an image, map, or surface. Typically expressed as a measure of distance – for example, a 30-meter pixel – but can also be expressed as a unit of area.

Vegetation Change Tracker— The VCT is an automated and highly efficient algorithm for mapping changes in forest cover. The algorithm uses Landsat time series stacks, which are defined as sequences of Landsat images with a nominal temporal interval (for example, one image every year or every two years) for a particular location.

Wildfire—An unplanned, unwanted wildland fire, including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out (NWCG 2005).

Wildland Fire—Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire (NWCG 2005).

8.0 Acronyms

8.1 Acronyms for Agencies and Organizations

Agencies and Organizations	
BIA – Bureau of Indian Affairs	BLM – Bureau of Land Management
DOI – Department of the Interior	FWS – U. S. Fish and Wildlife Service
NASS – National Agricultural Statistics Service	NPS – National Park Service
NS – NatureServe	TNC – The Nature Conservancy
USDA – United States Department of Agriculture	USFS – U. S. Forest Service
USGS – United States Geological Survey	

8.2 Acronyms for Terms, Information, and Systems

Terms, Information, and Systems	
AK – Alaska	BARC – Burned Area Reflectance Classification
BpS – Biophysical Settings	CBD – Canopy Bulk Density
CBH – Canopy Base Height	CC – Canopy Cover
CFA – Crown Fire Activity	CFFDRS – Canadian Forest Fire Danger Rating System
CH – Canopy Height	CONUS – Conterminous United States
CWD – Coarse Woody Debris	DDS – LANDFIRE Data Distribution Site
DWM – Downed Woody Material	EDNA – Elevation Derivatives for National Applications
ERC – Energy Release Component	ESP – Environmental Site Potential
EVC – Existing Vegetation Cover	EVH – Existing Vegetation Height

Acronyms

EVT – Existing Vegetation Type	FBFM13 – Fire Behavior Fuel Model 13, Anderson
FBFM40 – Fire Behavior Fuel Models 40, Scott and Burgan	FCCS – Fuel Characteristic Classification System
FERA – Fire and Environmental Research Applications Team – USFS	FFE – Fire and Fuels Extension
FIA – Forest Inventory and Analysis – USFS	FLM – Fuel Loading Models
FOFEM – First Order Fire Effects Model	FRCC – Fire Regime Condition Class (also known as LF Vegetation Condition Classes [VCC])
FRCCMT – FRCC Mapping Tool	FRG – Fire Regime Group
FVS – Forest Vegetation Simulator	GAP – Gap Analysis Program
GAP – Gap Analysis Program – USGS	GLM – General Linear Model
GR – Grass	GS – Grass-shrub
HI – Hawaii	hrs – hours
HUC – Hydrologic Unit Code	IR – Infrared
LCP – FARSITE landscape file	LF – LANDFIRE
LFDRDB – LANDFIRE Reference Database	LTSS – Landsat Time Series Stacks
MFRI – Mean Fire Return Interval	MRLC – Multi-Resolution Land Characteristics Consortium
MTBS – Monitoring Trends in Burn Severity	MTBS – Monitoring Trends in Burn Severity
MTDB – Model Tracker Database	NBR – Normalized Burn Ratio
NC – North Central	NE – Northeast
NFDRS – National Fire Danger Rating System	NLCD – National Land Cover Database
PAD-US – Protected Area Database of the United States	PLS – Percent of Low-Severity fire
PM2.5 – total fine particulate matter emissions less than 2.5 micrometers in diameter	PMS – Percent of Mixed-Severity fire

Acronyms

PNW – Pacific Northwest	PRS – Percent Replacement-Severity fire
PSW – Pacific Southwest	QA/QC – Quality Assurance / Quality Control
RAVG – Rapid Assessment of Vegetation Condition after Wildfire	RAWS – Remote Automated Weather Station
RMT – Refresh Model Tracker (LF 2001/2008)	RSLC – Remote Sensing of Landscape Change
SC – South Central	SCLASS – Succession Class
SE – Southeast	SH – Shrub
SOW – Statement of Work	SSURGO – Soil Survey Geographic Database
SW – Southwest	TL – Timber litter
TU – Timber-understory	VCC – Vegetation Condition Class formerly known as LF FRCC
VCT – Vegetation Change Tracker	VDDT – Vegetation Dynamics Development Tool
VDEP – Vegetation Departure Index formerly known as LF FRCC Departure Index	VTDB – Vegetation Transition Data Base
WBS – Work Breakdown Structure	WFAT – Wildland Fire Assessment Tool

9.0 References

- Anderson, H.E., 1982, Aids to determining fuel models for estimating fire behavior: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, 22 p.
- Comer, P., Faber-Langendoen, D., Evans, R., Gawler, S., Josse, C., Kittel, G., Menard, S., Pyne, M., Reid, M., Schulz, K., Snow, K., and Teague, J., 2003, Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems: NatureServe, 83 p.
- Dixon, G.E., 2002, Essential FVS: A user's guide to the Forest Vegetation Simulator: U.S. Department of Agriculture, Forest Service, Forest Management Service Center, 240 p.
- ESSA Technologies Ltd., 2007, Vegetation Dynamics Development Tool User Guide, Version 6.0: Prepared by ESSA Technologies Ltd., 196 p.
- Finney, M.A., 2006, An overview of FlamMap fire modeling capabilities, in Fuels Management - How to Measure Success, Portland, OR, Proceedings, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 213-220.
- Homer, C., Huang, C., Yang, L., Wylie, B.K., and Coan, M.J., 2004, Development of a 2001 National Land Cover Database for the United States: Photogrammetric Engineering and Remote Sensing, v. 70, no. 7, p. 829-840.
- Homer, C.G., Ramsey, R.D., Edwards Jr, T.C., and Falconer, A., 1997, Landscape cover-type modeling using a multi-scene thematic mapper mosaic: Photogrammetric Engineering and Remote Sensing, v. 63, no. 1, p. 59-67.
- Huang, C., Goward, S.N., Masek, J.G., Gao, F., Vermote, E.F., Thomas, N., Schleeweis, K., Kennedy, R.E., Zhu, Z., Eidenshink, J.C., and Townshend, J.R.G., 2009, Development of time series stacks of Landsat images for reconstructing forest disturbance history: International Journal of Digital Earth, v. 2, no. 3, p. 195-218.
- Huang, C., Goward, S.N., Masek, J.G., Thomas, N., Zhu, Z., and Vogelmann, J.E., 2010, An automated approach for reconstructing recent forest disturbance history using dense Landsat time series stacks: Remote Sensing of Environment, v. 114, no. 1, p. 183-198.
- Interagency Fire Regime Condition Class Guidebook, 2010, Version 3.0, Homepage of the Interagency Fire Regime Condition Class website, USDA Forest Service, U.S. Department of the Interior, and The Nature Conservancy, Online.
- Jones, J., and Tirmenstein, D., 2012, Fire Regime Condition Class Mapping Tool User's Guide: National Interagency Fuels, Fire, and Vegetation Technology Transfer Team, 114 p.
- Kellndorfer, J., Walker, W., Pierce, L., Dobson, C., Fites, J.A., Hunsaker, C., Vona, J., and Clutter, M., 2004, Vegetation height estimation from Shuttle Radar Topography Mission and National Elevation Datasets: Remote Sensing of Environment, v. 93, no. 3, p. 339-358.

References

- Key, C.H., and Benson, N.C., 2006, Landscape Assessment, in Lutes, D.C., Keane, R.E., Caratti, J.F., Key, C.H., Benson, N.C., Sutherland, S., and Gangi, L.J., eds., FIREMON: Fire effects monitoring and inventory system: Fort Collins, CO, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. LA1-55.
- Lutes, D.C., Keane, R.E., and Caratti, J.F., 2009, A surface fuel classification for estimating fire effects: *International Journal of Wildland Fire*, v. 18, no. 7, p. 802-814.
- Mc Arthur, A.G., 1969, The Tasmanian bushfires of 7th February, 1967, and associated fire behaviour characteristics, in *Mass fire symposium: collected papers*, Canberra, Commonwealth of Australia, Defence Standard Laboratories: Melbourne, Vol 1. Paper A7.
- National Wildfire Coordinating Group, 2005, *Glossary of Wildland Fire Terminology*: Boise, Idaho, National Interagency Fire Center, <http://www.nwccg.gov/pms/pubs/glossary/index.htm>.
- Omernik, J.M., 1987, Ecoregions of the conterminous United States: *Annals - Association of American Geographers*, v. 77, no. 1, p. 118-125.
- Ottmar, R.D., Sandberg, D.V., Riccardi, C.L., and Prichard, S.J., 2007, An overview of the Fuel Characteristic Classification System — Quantifying, classifying, and creating fuelbeds for resource: *Canadian Journal of Forest Research*, v. 37, no. 12, p. 2383-2393.
- Reeves, M.C., Ryan, K.C., Rollins, M.G., and Thompson, T.G., 2009, Spatial fuel data products of the LANDFIRE Project: *International Journal of Wildland Fire*, v. 18, no. 3, p. 250-267.
- Reinhardt, E., and Crookston, N.L., 2003, The Fire and Fuels Extension to the Forest Vegetation Simulator: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 209 p.
- Reinhardt, E., Lutes, D., and Scott, J., 2006, FuelCalc: A method for estimating fuel characteristics, in *Fuels Management - How to Measure Success*, Portland, OR, Proceedings, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 273-282.
- Schmidt, K.M., Menakis, J.P., Hardy, C.C., Hann, W.J., and Bunnell, D.L., 2002, Development of coarse-scale spatial data for wildland fire and fuel management: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 41 p.
- Scott, J., 2008, Review and assessment of LANDFIRE canopy fuel mapping procedures, http://www.landfire.gov/downloadfile.php?file=LANDFIRE_Canopyfuels_and_Seamlines_ReviewScott.pdf.
- Scott, J.H., and Burgan, R.E., 2005, *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 72 p.
- Scott, J.H., and Reinhardt, E.D., 2001, *Assessing Crown Fire Potential by Linking Models of Surface and Crown Fire Behavior*: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 59 p.

References

- Scott, J.H., and Reinhardt, E.D., 2005, Stereo photo guide for estimating canopy fuel characteristics in conifer stands: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 49 p.
- Sikkink, P.G., Lutes, D.C., and Keane, R.E., 2009, Field Guide for Identifying Fuel Loading Models: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 33 p.
- Stocks, B.J., Lynham, T.J., Lawson, B.D., Alexander, M.E., Wagner, C.E.V., McAlpine, R.S., and Dubé, D.E., 1989, Canadian Forest Fire Danger Rating System: An Overview: *The Forestry Chronicle*, v. 65, no. 4, p. 258-265.
- Stratton, R.D., 2006, Guidance on Spatial Wildland Fire Analysis: Models, Tools, and Techniques: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 15 p.
- Toney, C., Shaw, J.D., and Nelson, M.D., 2009, A Stem-map Model for Predicting Tree Canopy Cover of Forest Inventory and Analysis (FIA) Plots, in 2008 Forest Inventory and Analysis (FIA) Symposium, Park City, UT, Conference Proceedings, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, p. 1 CD.
- Vogelmann, J.E., Kost, J.R., Tolk, B., Howard, S., Short, K., Chen, X., Huang, C., Pabst, K., and Rollins, M.G., 2011, Monitoring landscape change for LANDFIRE using multi-temporal satellite imagery and ancillary data: *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, v. 4, no. 2, p. 252-264.