LANDFIRE Remap, Summary Description
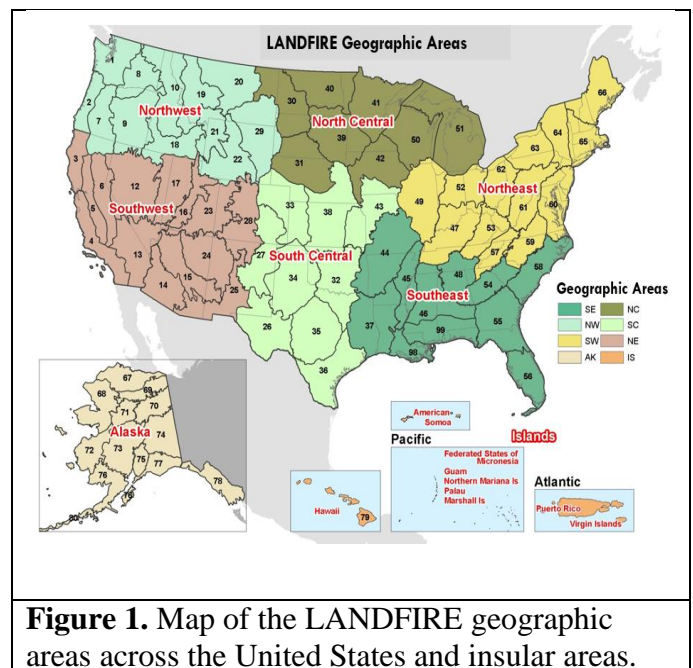
September 2015

Introduction

The purpose of this summary paper is to provide information about the current plan to remap the nationwide LANDFIRE products of vegetation and fuels data.

The LANDFIRE Program, since 2004, has strived to produce comprehensive, consistent, and scientifically based suites of mapped products and associated databases for the United States and territories. These products depict the nation's major ecosystems and wildlife habitats with the highest accuracy and currency possible. Over a decade has passed since the development of the first LANDFIRE base map, LANDFIRE National circa 2001 (LF c2001), and an overhaul of the data products is needed to maintain their functionality and relevance. An evaluation was conducted to identify needs, costs, and benefits for a remap which resulted in a business plan for remap. The business plan identifies the remap effort and the overall vision and purpose for the LANDFIRE Program. Opportunities have been identified, as a part of this remap, to enhance the suite of national-scale land cover, vegetation, fuel, and fire products to meet needs for decision making and sustainable planning processes.

This document is presented in a question and answer format addressing questions likely to be posed by current and potential LANDFIRE users.

What is LANDFIRE?

LANDFIRE, also known as the Landscape Fire and Resource Management Planning Tools Program, is a vegetation, fire, and fuel characteristic data creation program managed by both the U.S. Department of Agriculture (USDA) Forest Service (FS) and the U.S. Department of the Interior (DOI) with involvement from The Nature Conservancy (TNC). LANDFIRE represents the first and only complete, nationally consistent collection of over 20 geo-spatial layers (e.g. vegetation, fuel, disturbance, etc.), databases, and ecological models that can be used across multiple disciplines to support cross-boundary planning, management, and operations across all lands (30 meter pixel resolution) of the United States and insular areas (Figure 1). LANDFIRE data products are designed to be used at a large landscape-scale in support of strategic vegetation, fire, and fuels management planning to evaluate management

Figure 1. Map of the LANDFIRE geographic areas across the United States and insular areas.

alternatives across boundaries. LANDFIRE data products facilitate national- and regional-level strategic planning and reporting of wildland fire and natural resource management activities.
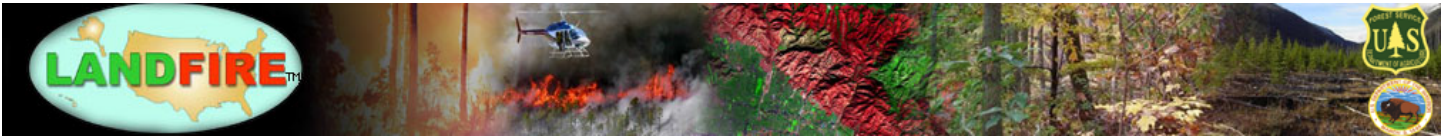
Why was LANDFIRE developed?

In 2000, the Government Accountability Office (GAO) stated that "Federal land management agencies do not have adequate data for making informed decisions and measuring the agencies' progress in reducing fuels." In 2002, GAO reported (GAO-02-259) that "Data are not available to better prioritize communities and projects for funding," and concluded that "On the basis of our review, LANDFIRE is the only proposed research project so far that appears capable of producing consistent national inventory data for improving the prioritization of fuel projects and communities." LANDFIRE began with a prototype in 2002 and was officially chartered in 2004 by the Wildland Fire Leadership Council based on the need of accurate, complete, and comparable data for all lands.

How is LANDFIRE data made and how is it being used?

There are several documents that detail how LANDFIRE data is produced and how data are used and they are available through these websites: http://landfire.gov/library_list.php and http://www.landfire.gov/lf_applications.php.

What is a "Remap" in LANDFIRE?

According to the Merriam-Webster dictionary the definition of REMAP is: *to map again*; also**:** *to lay out in a new pattern.*

A LANDFIRE remap is defined as performing a comprehensive mapping effort that uses new data (e.g., Landsat 8 and new point and field data) to create a new base map data suite that represents contemporary conditions, rather than using change detection techniques, look up table transitions, or modeling to represent current conditions. A remap differs from an update, which is a vegetation and fuels mapping effort focused primarily on the existing base product suite to more accurately represent current conditions and account for landscape disturbances.

The simple response to the question – "What is a LANDFIRE remap?" is LANDFIRE will produce a completely new base map data suite that is as reflective of ground conditions as possible for a given time period.

The remap effort will provide an opportunity for the LANDFIRE Program to evaluate past production processes and methods of using remotely sensed and field data for map development. This review includes exploring mapping methods to maximize the use of the available data and past mapping efforts, and provide a characteristic representation of contemporary conditions for areas that are undergoing change. Much of this change has been invisible to date due to the gradual changes of continual vegetation growth occurring across the landscape. Organizing existing data will facilitate the identification of new aspects that need to be considered and potentially incorporated into this remap.

LANDFIRE will retain data that meets certain quality standards and remains valid for current conditions. This will be integrated with new data from Landsat 8, field evaluations, and disturbance polygons.
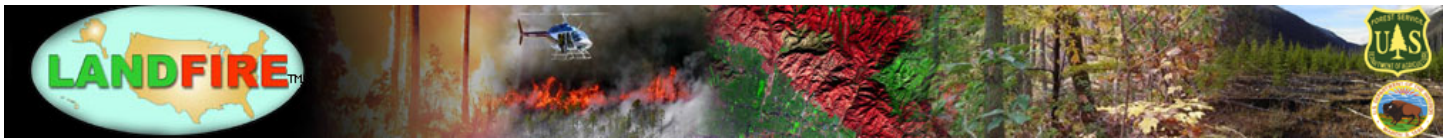
Why should a LANDFIRE remap be started now and when would it be completed?

The first LANDFIRE mapping effort began in 2004 based on Landsat data with a time stamp of 2001. As a result, today's LANDFIRE mapped data products maintain this 2001 foundation. The data are approximately 15 years old and as much as 10-20% of the landscape has experienced change. Many changes have been captured using disturbance/change detection information and incorporating anticipated vegetation succession and growth. However, subtle vegetation and landscape changes may not be reflected in the current LANDFIRE product versions. New data (remotely sensed and field plot) are available from Landsat 8 with data from NRCS / NRI, FIA and other contributors or partners which will result in improved data products.

LANDFIRE was developed through an interagency partnership between DOI, USFS, and TNC and the original plan was to conduct a remap after 10 years as outlined in the operations and maintenance plans. The remap didn't start as scheduled due to budget sequestration and budget reductions from 2011 through 2013. The current plan is to begin a three year remap effort in 2016 or 2017. The uncertainty with a specific year is due to a new project at the United States Geological Survey (USGS) called Land Change Monitoring, Assessment and Projection (LCMAP). LCMAP has USGS leadership support and is focused on providing data of historical land change with contemporary land change as it occurs using all available data in a continuous change detection and classification which enable detection of changes when pixels deviate from the "normal" condition. The remap will take approximately three years to complete. This length of time is needed to gather, review and process new data sources, and create comprehensive national products. Under this plan, accounting for uncertainty with the start, remapped products will be delivered incrementally as they are produced approximately 2018 through 2020 when the last areas are completed.

Starting soon provides future benefits where contemporary data with improved quality are available for analyses and planning decisions; otherwise the alternative is to continue to rely on updated vegetation and fuels data using change detection techniques, look up table transitions, or modeling to represent contemporary conditions.

What will happen in the LANDFIRE remap?

The remap effort will not simply repeat steps and efforts of past processes but will leverage changes and advancements in data and science to support the development and production of the next generation of data products. This remap will include review of previous LANDFIRE versions, LF c2001, LF 2008, LF 2010, LF 2012, and assess the quality of each (inclusive of quality assessments, after action reviews, questionnaires, customer feedback, etc.).
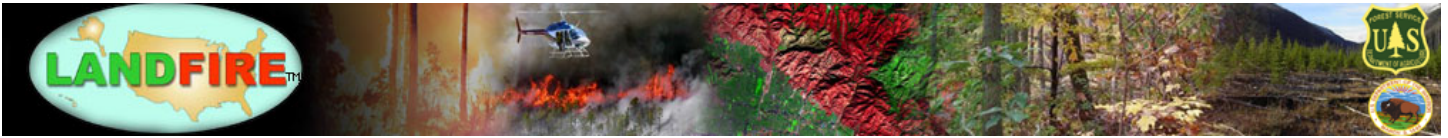
Elements of the remap include:

➢ Use Landsat 8 (space-based moderate-resolution land remote sensing and increased number of data bands) data with a 2015 circa date.
➢ Use ground-based field plot and polygon data
  o Previously contributed data that has been archived in preparation for this remap.
  o Forest Inventory Analysis (FIA) data – based on Memorandum of Understanding (MOU) with USDA FS.
  o National Resource Inventory (NRI) data – based on a MOU with Natural Resources Conservation Service (NRCS).
  o Additional data obtained or contributed (http://www.landfire.gov/participate_refdata_sub.php) as part of the January 31, 2015 data call or a follow on data call in 2016 as the schedule is finalized based on assessing LCMAP capability. If you have missed previous submission dates, please get your data in as soon as possible. More information on how these data may be used is available at: (http://www.landfire.gov/participate_refdata.php).
➢ Work with new partner such as the USGS Gap Analysis Program (signed MOU).
➢ Common/nation-wide vegetation mapping classifications
  o Use of Ecological Systems classification and alignment with the National Vegetation Classification Standard (NVCS).
    ▪ Includes additional map units to address non-natural land cover, such as urban or agriculture, or non-vegetated lands, such as barren, rock, or water.
    ▪ Use sequence tables and auto-keys to assign plot data to Ecological Systems and NVCS vegetation classifications.
➢ Vegetation changes in areas or landscapes where vegetation is not changing as rapidly as other areas.
➢ New or updated data sets such as new imagery, new or updated field/plot data, partnership data and improvements in algorithms.
  o The addition of these new or updated data have great potential to improve the quality of the LANDFIRE data products especially in areas where lower or limited plot data were available for LF c2001.
➢ Produce a new foundational base to work from for subsequent updates and inform future remaps.
➢ The remap effort will deliver the full suite of products for vegetation, fire behavior, fire effects, and fire regime, as well as some products added in recent updates. Table 1 illustrates products under consideration for delivery with remap.
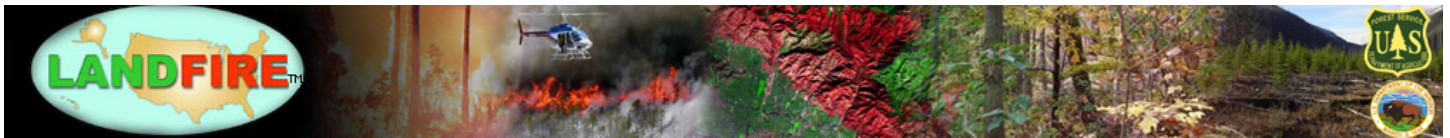
Table 1. LANDFIRE 2015 Remap Draft Deliverables list provides an outline of possible information that will be produced by data theme, product name, product name abbreviation, number of product, as well as deliverables by portion of the country and insular areas.

Theme	Product Name	Abbreviation	LF 2015 (LF 2.0.0)			
			CONUS	AK	HI	IA
Reference	LF Reference Database	LFRDB	x	x	x	x
	Public Events Geodatabase_1999_YEAR		x	x	x	x
	Forest Vegetation Simulator Ready Database	FVSRDB	x	x	x	x
Disturbance	Disturbance (YEAR)	DISTYEAR	x	x	x	x
	Fuel Disturbance	FDISYEAR	x	x	x	x
	Vegetation Disturbance	VDISTYEAR	x	x	x	x
	Vegetation Transition Magnitude	VTMYEAR	x	x	x	x
	Forest Vegetation Transitions Database	FVTDB	x	x	x	x
	Non-Forest Vegetation Transitions Database	NFVTDB	x	x	x	x
	Forest Vegetation Simulator Disturbance Database	FVSDDB	x	x	x	x
Vegetation	Biophysical Settings	BPS	x	x	x	x
	Environmental Site Potential	ESP	-	-	-	x
	Existing Vegetation Cover	EVC	x	x	x	x
	Existing Vegetation Height	EVH	x	x	x	x
	Existing Vegetation Type	EVT	x	x	x	x
	Dominant Cover Type	DCT	x	x	?	?
	Attributed data – Crosswalks to Society of American Foresters/Society for Range Management/NVCS > for EVC, EVH, EVT, DCT	XW	x	x	?	?
Fuel	13 Anderson Fire Behavior Fuel Models	FBFM13	x	x	x	x
	40 Scott and Burgan Fire Behavior Fuel Models	FBFM40	x	x	x	x
	Landscape File	LCP	x	x	x	x
	Canadian Forest Fire Danger Rating System	CFFDRS	x^	x	--	--
	Forest Canopy Bulk Density	CBD	x	x	x	x
	Forest Canopy Base Height	CBH	x	x	x	x
	Forest Canopy Cover	CC	x	x	x	x
	Forest Canopy Height	CH	x	x	x	x
	Fuel Characteristic Classification System Fuelbeds	FCCS	x	x	?	?
	Fuel Loading Models	FLM	?	?	?	?
	Fuel Ruleset Database	FRD	x	x	x	x
Fire Regimes	Fire Regime Groups	FRG	x	x	x	x
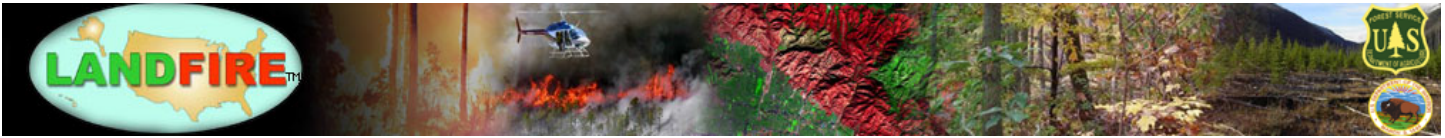
Theme	Product Name	Abbreviation	LF 2015 (LF 2.0.0)			
			CONUS	AK	HI	IA
	Mean Fire Return Interval	MFRI	x	x	x	x
	Percent Low-Severity Fire	PLS	x	x	x	x
	Percent Mixed-Severity Fire	PMS	x	x	x	x
	Percent Replacement-Severity Fire	PRS	x	x	x	x
	Succession Classes	SCLASS	x	x	x	x
	Vegetation Condition Class	VCC	x	x	x	x
	Vegetation Departure Index	VDEP	x	x	x	x
	Vegetation Dynamics Models	VDM	x	x	x	x
Topographic	Aspect	ASP	x	x	x	x
	Elevation	DEM	x	x	x	x
	Slope	SLP	x	x	x	x

CONUS = Continental United States
AK = Alaska
HI = Hawaii
IA **=** Insular areas of the United States
x = Products likely to be done as part of the remap
- = Not likely to be done as part of a remap given historical potential vegetation has not changed
-- = Not available or produced for this area
x^ = As applicable based on data, geography, and improvements
**?** = Question of data availability and/or future inclusion

More information on each of the LANDFIRE data products can be found at: http://www.landfire.gov/data_overviews.php.

What is the potential for improvement in data quality by incorporating Landsat 8?

Data from the Landsat 8 Operational Land Imager (OLI) have somewhat different characteristics from previous Landsat sensors. OLI collects data in bands similar to previous sensors with slightly different wavelengths that provide greater ability to differentiate spectral data. OLI also collects data in additional bands, such as a coastal/aerosol band and a cirrus cloud detection band that when included with a quality assessment (QA) band will indicate areas of data anomalies, clouds, cloud shadows, etc. thus refining the quality of the data. This information will make combining multiple dates of imagery easier because pixels containing unwanted features can be masked out using the QA band and replaced by data from other scenes. The signal to noise ratio of OLI is higher than that of previous sensors and the data are yielding increased radiometric resolution that provides for an increased ability to discriminate vegetation and land cover types, leading to increased quality of LANDFIRE data products.

Why is the remap being called LANDFIRE 2015 or LF 2015?

LANDFIRE existing vegetation products portray vegetation composition and structure conditions of a given time period. The time period is determined by the average date of Landsat satellite imagery acquisition used for the mapping. In the case of LF c2001 date which indicated that the imagery comprised years 2000 to 2002.
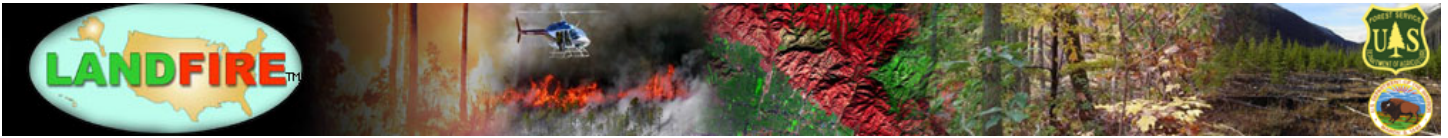
This three year period was necessary in order to piece together a wall-to-wall image across the nation. Data anomalies such as clouds or cloud shadows required data from other years to fill in the gaps. In the case of LANDFIRE 2015 (circa 2015 date), the date or name indicates that the imagery will comprise years 2014 to 2016. The need to build this composite image results in the LANDFIRE remap starting in 2016 or 2017.

Will there be LANDFIRE 2014 or LANDFIRE 2016 updates or do users have to wait until the remap is completed to have updated data?

The LANDFIRE team is completing a plan and drafting the schedule for a LANDFIRE 2014 update, which will be similar to previous updates. For LANDFIRE 2016, the plan is to evaluate how to integrate 2016 disturbances (or possibly annual disturbances) into the remap data so when the LANDFIRE remap product suite is delivered, it would account for these disturbances. Similar to previous schedules, information on these projects will be discussed on the LANDFIRE community call and will be posted at http://www.landfire.gov/lf_schedule.php with information on expected delivery dates.

What will happen with previous versions (LF c2001 through LF 2012) of LANDFIRE?

The current LANDFIRE policy is that at least three versions of the data are available and accessible on the Data Distribution Site. These versions include the foundational base map version (LF 2001 until remap effort LF 2015 is complete and delivered) and the two most recent update products, LF 2010, LF 2012, etc.). Previous versions are archived and more information can be obtained about these archives at http://www.landfire.gov/lf_archive.php. Additionally, versions LF 2001 to the most current update will be available as bulk mosaics in zip file format.

## Will previous versions of LANDFIRE be compatible with the remap products?

As stated in the program charter, (July 2012, at http://www.landfire.gov/about.php#planning) "LANDFIRE program deliverables will be compatible with previous products to assist in monitoring changes over time."

LANDFIRE remap LF 2015 products will be comparable, but not identical, to previous versions. There may

not be a one-to-one comparison with some of the data or layers given changes to the data through the incorporation of disturbances, addition of new field plot data, or changes with definitions or summary units. However, the production process of products will have a scientific approach that allows them to be defensible for monitoring change over time. Also, for the purposes of monitoring change over time, the data are developed and designed so they can be analyzed and comparable across different areas of the United States for national and regional planning.
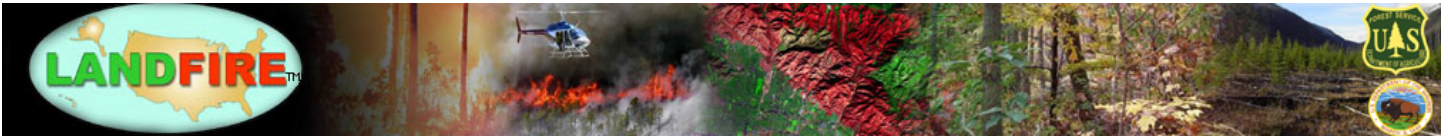
What is the difference between updating vs remapping?

An update is a short-term improvement to the data focusing on areas of change or disturbances and successional vegetation growth approximately every two years.

A remap is a longer-term product which incorporates improvements, innovations, and new data to provide for national currency of the products. A remap is done approximately every 10 -15 years.

Update: A LANDFIRE update effort is a vegetation and fuels mapping effort focused primarily on updates to the base product suite due to landscape changes and disturbances. These disturbances might result from a variety of sources or activities including: wildland fire, fuel and vegetation treatments, mortality from insects and disease, storm damage, invasive plants, or other natural or anthropogenic events. Product updates may also include responses to vegetation successional change in forested types, revisions to address discrepancies between map products and known field conditions, as well as specific systematic improvements to the original data. The update strategy applies a consistent approach that combines change detection methods using satellite imagery to detect and characterize landscape disturbances. The primary benefit of an update effort is to reflect recent landscape change and the acquisition of new data. LANDFIRE has been "updating" the data approximately every two years for both location-specific changes with disturbances such as vegetation treatments, forestry harvest, wildland fires, etc., as well as modeling for successional vegetation growth. Updates are produced to provide a representative vegetation state and current fire behavior fuel models.

Updates include these types of elements:

➢ *DISTURBANCE:* For locations that have experienced a disturbance to vegetation due to management treatments like mechanical projects or environmental disturbances (fire, weather, insects) the LANDFIRE existing vegetation type layer is updated to reflect conditions representative of years of the data being mapped or updated (e.g. 2011 & 2012 data). These updates feed into the creation of the next LANDFIRE version. More information on LANDFIRE versions can be found at http://www.landfire.gov/version_comparison.php. The update process takes polygon disturbances or changes where they exist and transitions the vegetation over the time period to provide the updated product. This is done by integrating the annual disturbance layers. The effect of these disturbances on the vegetation is then modeled or predicted using tables of rules for vegetation transitions. These rules link pre-disturbance existing vegetation type, height, and cover and possible disturbance types and severities with post-disturbance existing vegetation type, height, and cover. These combinations result in updated vegetation data as well as fire behavior fuel models. Forested vegetation tables and rules are informed by computer simulations in the Forest Vegetation Simulator (FVS) while non-forest vegetation is informed by a series of simple rule-sets. The FVS approach provides additional data and peer reviewed models that underpin these LANDFIRE deliverables. More information on this process can be found at http://www.landfire.gov/notifications40.php
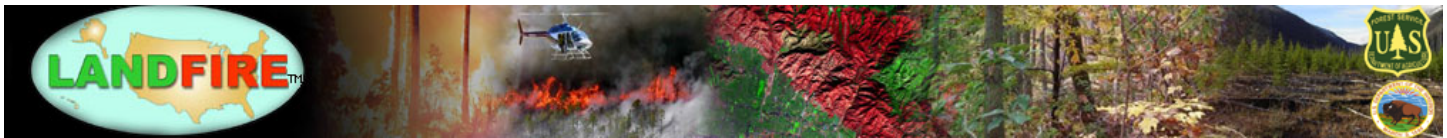
➢ *VEGETATION GROWTH:* The update process includes updates for vegetation succession to account for growth across the landscape. This is a modeled effort which takes into account data from the state and transition models and grows vegetation over-time in the absence of disturbance.

Remap: LF 2015 will be the first national remap. LF 2015 will use consistent methodologies and processes including access to the most current satellite imagery, contemporary data sources, software, and hardware technologies, and will be combined to create a new version that significantly improves upon the updated versions of the legacy LF c2001 products.

The remap will include these types of elements:
➢ Vegetation changes in areas or landscapes where vegetation is not changing as rapidly as other areas.
➢ Incorporation of data sets such as new imagery, new or updated field/plot data, partnership data and improvements in algorithms.
  o The addition of these new or updated data have great potential to improve the quality of the LANDFIRE data products, especially in areas where lower or limited plot data were available for LF National (LF c2001).
➢ Foundational base to work from for subsequent updates and inform future remaps.

As technology improves and data become more available, the need to differentiate between short-term updates versus long-term remaps may no longer exist. The best technology and data may be accommodated more quickly in the future so the map products may be able to reflect national currency of the products faster.

CONCLUSION: What are the highlights of the LANDFIRE remap?

- Current LANDFIRE data products have circa 2001 (Landsat imagery) base data foundation.
- The base data are approximately 15 years old.
- Although only about 10-20% of the landscape has experienced a change, subtle vegetation growth and landscape changes may not be reflective of current conditions.
- The current plan is to begin a three year remap effort in 2016 or 2017.
- The LANDFIRE remap LF 2015 would begin delivery in 2018 (approximately) and finish in 2019 or 2020.

Materials written by Henry Bastian, DOI Business Lead.

Please contact the LANDFIRE Help Desk with any questions.