Reviewing & Modifying LANDFIRE
Spatial Products
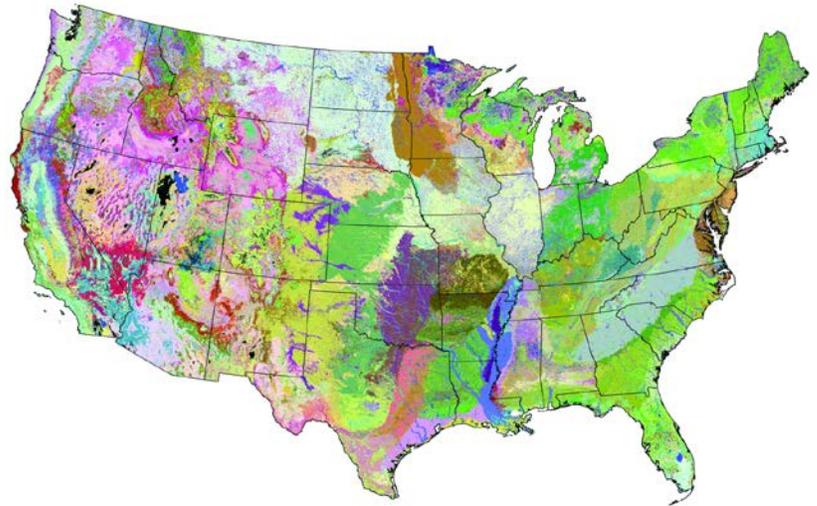
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Introduction

Purpose

The purpose of this document is to provide an introduction to concepts, processes and tools that will allow users to review LANDFIRE spatial products and alter those products as needed for local application.

Background

LANDFIRE created more than 20 fire and vegetation-related geospatial datasets covering the entire United States. Processes are in place to improve and update selected spatial products on a periodic basis. The datasets were developed for national and regional level strategic planning and reporting, but because of their comprehensive and complete nature there is a demand for them for finer scale applications. The applicability of LANDFIRE data varies by location and specific use. Users are therefore strongly encouraged to carefully review the datasets to determine their suitability on a project-by-project basis. Given appropriate review and local modification as needed, there are uses for these data at sub-regional scales, including:

1. landscape-scale assessments, such as those required in forest certification or in developing NEPA alternatives,
2. creating maps for outreach and communication efforts,
3. fire and fuels planning and decision support, such as Community Wildfire Protection Plans or fire behavior modeling for wildland fire incidents, and
4. setting management priorities based on landscape composition and condition.

Why Modify

Users may want to modify LANDFIRE spatial data for several reasons:

1. to improve the spatial agreement,
2. to change the thematic resolution (e.g. lump or split mapping units),
3. to crosswalk to a local classification,
4. to update for landscape changes that occurred since mapping (e.g. LANDFIRE National (LF_1.0.0) products are based on circa 2001 imagery; LANDFIRE 2008 Refresh (LF_1.1.0) products are updated to circa 2008 using submitted polygons and change detection; for more information review LANDFIRE's VERSION COMPARISON information), and/or
5. to represent changes in fuel layers based upon temporal variability (e.g. peat soils being exposed in drought situations or exotic annual grasses being present in some years but not others).

The applicability of LANDFIRE data will depend on the spatial product, the location of interest and the specific use. A careful review of the data will help the users determine if modifications are needed.

Reviewing Spatial Data

All spatial data, regardless of the source, should be reviewed prior to use, and LANDFIRE data are no exception. The level of time and effort dedicated to review will vary depending on project needs and objectives. For example, site level project planning (e.g. stand treatments) will likely require a more thorough data inspection than broad scale strategic planning (e.g. forest plan, regional needs assessment). Specifying how you intend to use the data and the types of decisions that it will support is the critical first step in the data review process. These factors will determine the level of spatial accuracy and thematic detail required.

Are you suffering from My Favorite Pixel Syndrome (MFPS)?

Did LANDFIRE incorrectly map your favorite pixel? Consider the symptoms, risk factors and treatment for MFPS before proceeding.

Symptoms   *May experience shortness of breath, queasiness and/or general discomfort when looking at the vegetation type LANDFIRE mapped in your backyard.*

Risk Factors   *You may be at risk of developing MFPS if you: have little experience with national or regional datasets, hand draw stands on photos or take a lens and/or a prism into the field for work.*

Rx   *Understand the scale and intended use of the data.*

The applicability of LANDFIRE products will vary by product, location and specific use. Local review and modification (as needed) is highly recommended! Read Scale and Use of LANDFIRE Products for more information.

❑ **Evaluate the general patterns over the project area as-a-whole**
  - o Are the locations of forest, shrub and grasslands generally accurate?
  - o Do the mapped types appear to be in the correct ecological niches (e.g. mesic types found on north slopes, drier types on south slopes, riparian types in riparian zones)?

❑ **Locate major features**
  - o Are large agricultural areas mapped in the correct locations?
  - o Are major rock and barren features mapped correctly?
  - o Are major disturbances reflected in the layer (e.g. a major recent wildfire)?

❑ **Review the classes or types**
  - o Are the types you expect present in appropriate locations (e.g. fire regime five should be mapped at higher elevations)?
  - o Are there types mapped that don't seem appropriate for the analysis area?
  - o Is the relative distribution of types appropriate?

❑ **Look for mapping artifacts and seamlines**
  - o Are there abrupt and/or artificial changes in map classes?
  - o Do you see seamlines at map zone (Figure 1) boundaries?

❑ **Assess local or systematic issues**
  - o Is a vegetation type consistently mislabeled (e.g. the oak vegetation type should always be Oak Forest and Woodland, not Oak Savanna)?

Figure 1. National Land Cover Database (NLCD) map zones used by LANDFIRE.

Reviewing the Vegetation Layers

LANDFIRE maps three related vegetation concepts using map units derived from NatureServe's ECOLOGICAL SYSTEMS classification, a nationally consistent set of mid-scale ecological units.

- EXISTING VEGETATION TYPE (EVT) - vegetation present on a site current to the date of the imagery and ancillary datasets used for mapping (e.g. LANDFIRE Refresh 2008 (LF_1.1.0) uses 1999-2003 imagery updated for disturbances, management and succession to 2008)
- ENVIRONMENTAL SITE POTENTIAL (ESP) - the potential late-seral vegetation that could exist on a site given the current climate (e.g. precipitation and growing degree days) and physical environment (e.g. soil and topography) but in the absence of disturbance.
- BIOPHYSICAL SETTINGS (BpS) - the potential late-seral vegetation that could exist on a site given the current biophysical environment and an approximation of the historical disturbance regime. LANDFIRE's use of Ecological Systems to describe BpS differs from their intended use as units of existing vegetation. Each Ecological System was further refined and quantitatively modeled to represent LANDFIRE's BpS concept. Read the VEGETATION DYNAMICS MODELS description documents for each BpS for more information.

Understanding these three concepts and how they relate to one another on the landscape in various ways may help inform your review. For example, on an eastern oak site an oak savannah BpS could be mapped at the same location as an oak forest and woodland ESP and EVT. Historically (i.e. in the BpS layer) fire disturbances would have maintained open conditions but in the absence of disturbance (i.e. in the ESP layer) or with fires suppression (i.e. in the EVT layer) the same site can support more trees. Similarly, on a southern pine forest site the BpS and ESP layers could indicate a long leaf pine forest and woodland but the EVT layer might show that the site has been converted to a loblolly pine plantation.

The NATURESERVE EXPLORER is a searchable online database that contains detailed information on each Ecological System.

Reviewing the Fire Regime Condition Class Layer

The LANDFIRE FIRE REGIME CONDITION CLASS (FRCC) layer quantifies the amount that current (i.e. current to the date of the imagery and ancillary data used for mapping) vegetation has departed from the estimated historical vegetation reference conditions in three classes: low departure, moderate departure and high departure. It is created using the LANDFIRE Succession Class layer, which is an integration of the EVT, Existing Vegetation Height (EVH) and Existing Vegetation Cover (EVC) layers, to calculate current conditions in conjunction with the LANDFIRE vegetation dynamics models and the BpS layer which quantify reference conditions. It is therefore difficult to assess the FRCC layer without first assessing these input layers. To learn more about how LANDFIRE calculates FRCC read DEVELOPING THE LANDFIRE FIRE REGIME DATA PRODUCTS.

Caution is advised when comparing the LANDFIRE National (LF_1.0.0) FRCC layer with the subsequent FRCC layers including LANDFIRE 2001 Refresh (LF_1.0.5) and LANDFIRE 2008 Refresh (LF_1.1.0). In each iteration significant changes were made to the methods used to calculate FRCC making it difficult to discern if changes are the result of real world change or the calculation methods. Some of the changes include using a coarser BpS layer, different reference conditions and a different landscape summary unit in LANDFIRE Refresh 2001 (LF_1.0.5) and 2008 (LF_1.0.5).

Reviewing the Fuel Layers

The LANDFIRE FUEL PRODUCT SUITE includes layers that characterize the surface and canopy fuels. Rulesets for creating the 13 and the 40 fuel model layers are based on several inputs including BpS, EVT, EVC and EVH. Because the fuel models are derived from other datasets, it may be most useful to review them in conjunction with other datasets that constrain the fuel environment. Using the fuel products in fire behavior prediction software like FlamMap may help to identify their suitability.

In addition, surface fuel model assignments were based upon the modal (e.g. average) fire season. Consequently, these assignments may need to be adjusted to account for the temporal variability of fuel availability. For example, the availability of peat soils may vary according to the water table and annual grass fuel loadings may vary as a result of earlier precipitation patterns.

Reviewing the Succession Class Layer

The SUCCESSION CLASS (S-Class) dataset characterizes current vegetation conditions with respect to the vegetation species composition, vegetation cover and vegetation height ranges of successional states that occur within each BPS. In other words, S-Class is an attribute of the BpS and therefore must be reviewed in conjunction with the BpS layer. An easy way to do this is to use the *combine* function in ArcGIS to overlay the S-Class and BpS layers (LEARN HOW – WATCH A VIDEO DEMO).

The S-Class layer is derived primarily by integrating BpS, EVC and EVH layers (EVT is also used in some cases). Consequently, a review of the S-Class layer also necessitates a review of the input layers used to derive it. Information on the criteria used to map each S-Class within a BpS is contained in the VEGETATION DYNAMICS MODELS description documents.

Sometime there is a question about a "missing" BpS that is actually an S-Class. For example, in the Great Lakes region (map zones 41, 50 and 51) early-seral Aspen-Birch communities are an S-Class within more than nine BpS and are therefore not represented as a unique unit on the BpS layer. This situation will likely exist wherever

a primary colonizer with a wide ecological amplitude dominates post disturbance sites. Reviewing the BpS and S-Class layer in conjunction with the model descriptions will provide the most complete understanding of each vegetation concept.

Tools & Techniques

This section provides an overview of some common methods for reviewing spatial data. Remember there is no right or wrong way to review data. The important thing is to do it!

Understand the Classification

An initial step for reviewing spatial data is to make sure you understand the classification used. Complete metadata are available for every LANDFIRE spatial product and will offer a good starting point for understanding the mapped classes. In addition, the vegetation map units are thoroughly described in the NATURESERVE EXPLORER.

Evaluate Mapped Classes by Area

Summarize the percent of the landscape in each class using the grid value attribute table to determine if the relative distribution of types is appropriate. LEARN HOW – WATCH A VIDEO DEMO.

Gather Expert Feedback

Explore LANDFIRE maps with someone who is familiar with the area of interest. Begin by looking at the entire landscape to determine if the overall patterns seem appropriate before zooming in to areas of particular interest. Look at the mapped patterns in a hierarchical fashion. For example, on the EVT layer begin by assessing the distribution of vegetation lifeforms (e.g. grass, shrub or tree dominated) by displaying the data based on the "NVCSORDER" field. Then look at broad categories within each lifeform such as evergreen vs. deciduous trees using the "NVCSSUBCLA" field. Finally, review the individual map units (e.g. Columbia Plateau Western Juniper Woodland and Savanna) using the "EVT_NAME" field. Explore mapping along gradients such as elevation, aspect, slope or soil type to assess the mapped distribution of individual classes.

Sample questions to ask an expert reviewer

- Does the list of types (e.g. fuel models or vegetation types) seem reasonable?
- Are there any types that do not seem appropriate for the area?
- After looking at a histogram of acres per type, do you think the representation of each is reasonable?
- Which types are over- or under-represented?
- Do you have data that we could use for comparison or for making adjustments?

Compare to a Reference Dataset

Compare LANDFIRE maps to other data sources such as forest vegetation or GAP maps. To use this technique successfully you must understand the strengths and limitations of the reference dataset. To begin, overlay the two maps using the *combine* function in ArcGIS. LEARN HOW – WATCH A VIDEO. Then, export the value attribute table of the combined grid to a spreadsheet. Finally, evaluate the resulting combinations qualitatively (see example in text box below) and/or quantitatively using an ERROR MATRIX (also called a confusion matrix).

Check Against Geo-Referenced Plot Data

Geo-referenced plot data may be useful for evaluating some LANDFIRE layers. Read EVALUATING LANDFIRE FUEL DATA for more information on how to do this (note: the guidance provided in this document is relevant to all LANDFIRE spatial datasets, not just fuel datasets). Some users have found plot photos from the LANDFIRE REFERENCE DATABASE useful in validating the spatial layers.

Perform a Ground Validation Survey

Bring a hard copy map or lap top into the field and make your comparison on site. Try to evaluate areas that are relatively homogeneous (e.g. a five acre stand of loblolly pine) so that you don't get bogged down trying to assess accuracy pixel by pixel (see My Favorite Pixel Syndrome above).

Use Online Resources

Use GOOGLEEARTH, TERRASERVER or other online imagery sites to locate known areas for comparison with LANDFIRE layers. When comparing against other imagery, remember the temporal framework—the comparison imagery may be a more recent vintage than the LANDFIRE data.

Review Product Quality and Data Notifications

Quantitative assessments of LANDFIRE PRODUCT QUALITY are available for Existing Vegetation Type layers for the entire country, and for BpS in the Western states. These large area assessments provide general guidance on what to expect on your landscape and may help you focus your evaluation efforts, but note that these assessments were done for large regions (called super zones) so their use may be limited when working on smaller landscapes. In addition, many LANDFIRE products have DATA NOTIFICATIONS that help users understand how to best use them.

Qualitative Comparison of a LANDFIRE Map with a Reference Map

On the Hiawatha National Forest the LANDFIRE BpS map was compared with the local ecological land type (ELT) map. The ELT map adequately met the mapping needs on Forest lands but did not cover any of the surrounding private land. The goal of the comparison was to determine if the BpS map could be used when mapped data was needed outside of the Forest boundaries. A qualitative comparison was done by overlaying the ELT and BpS maps using the *combine* function in a GIS and evaluating the combinations using a three class system:

1. **Yes** – LANDFIRE and ELT type matched
2. **Somewhat** – LANDFIRE and ELT type match partially; lifeform (e.g. forest, shrub or grassland), at least two dominant indicator species and edaphic factors were similar
3. **No** – LANDFIRE and ELT type did not match; lifeform, edaphic factors and/or species composition were substantially different

The addition of class number two, which identified partial matches, provided value by allowing users to more readily identify the areas of highest disagreement between the two classifications.

Sample evaluation table comparing the agreement between ELT and BpS maps

| Hiawatha ELT Map	LANDFIRE BpS Map	Match evaluation
Northern Hardwood	Northern Hardwood	yes
Acid Peatland	Alkaline Swamp	somewhat
Jack Pine Barrens	Coastal Wetland	no

After making the comparison on a spreadsheet, the "Match evaluation" column was appended to the LANDFIRE BpS grid attribute table using the *Join* function. The data was then redisplayed based on the "Match evaluation" field providing a spatial representation of map agreement (see map below).

As a result of this evaluation the Hiawatha National Forest team was able to 1) determine that the LANDFIRE BpS map was adequate to cover non-forest lands, and 2) prioritize specific classes and geographies within the LANDFIRE BpS map where improvements could be made.
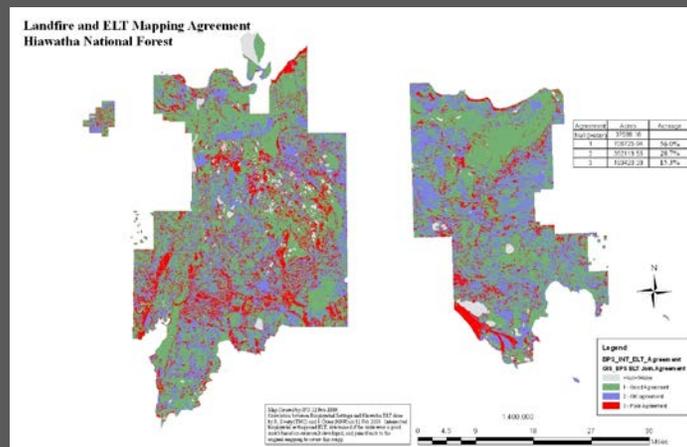
Comparing LANDFIRE BpS Map with General Land Office Public Land Survey Data

In the late 1800s the General Land Office (GLO) conducted public land surveys (PLS) across the US, that include field notes about trees, disturbances and natural resources along the surveyed section lines. Often PLS data is the earliest systematic record of vegetation present in an area and thus a valuable resource for gaining insight into vegetation conditions prior to widespread Euro-American settlement (Powell 2008). For some areas these notes have been converted into GIS data and can be useful to compare with LANDFIRE's BpS dataset to assess general trends. However, there are some important issues to consider. First, the BpS concept explicitly includes succession (i.e. succession classes), whereas the PLS dataset does not. For example, the PLS dataset might have a class labeled "Aspen-Birch". This particular vegetation may be included in several LANDFIRE BpS that span well-drained to moist sites as an early succession class. This means any cross-walking will most likely be one-to-many and will be coarse. Second, just as the BpS dataset would need review in this example, so would the PLS dataset. Schulte and Mladenoff (2001) and others have noted some of the limitations of the PLS data. Third, the spatial resolution of the datasets are very different. PLS vegetation types are presented as either points or polygons, whereas LANDFIRE data are represented as 30m pixel cells. Given these differences, a direct comparison or accuracy assessment between PLS and BpS data may not be appropriate but a qualitative comparison may provide interpretive value.
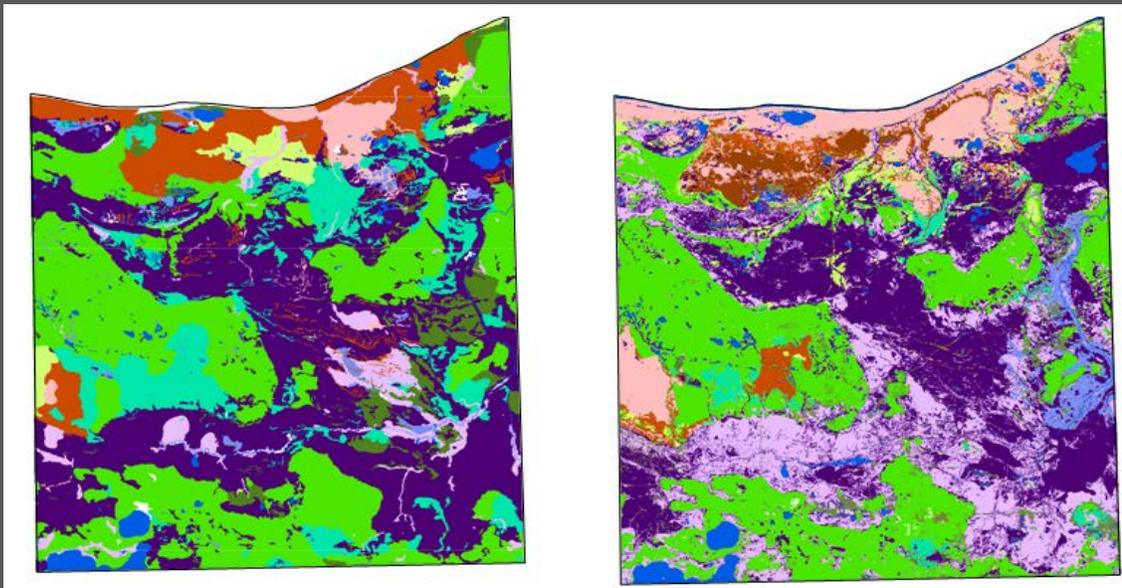
GLO PLS (left) and LANDFIRE BpS (right) maps for Luce County, MI. Map legends were cross-walked so that similar vegetation types could be displayed with the same color where possible. However, direct comparisons are difficult due to one-to- many relationships and the data format (e.g. polygon vs. raster).

Powell, D. 2008. Using General Land Office Survey Notes to Characterize Historical Vegetation Conditions for the Umatilla National Forest.

Schulte, L.A. and D.J. Mladenoff. 2001. The original U.S. public land survey records: their use and limitations in reconstructing pre-European settlement vegetation. Journal of Forestry 99:5-10.

Modifying Spatial Data

Modifying LANDFIRE spatial data involves editing rasters in a GIS environment. This requires some familiarity with GIS software but the LANDFIRE program has developed tools and GIS tutorials to assist users.

Tools

This section provides a brief overview of the tools developed by the NATIONAL INTERAGENCY FUELS, FIRE AND VEGETATION TECHNOLOGY TRANSFER TEAM (NIFTT) to facilitate the raster editing process. These tools are available for free online and have accompanying user guides. They are recommended for users with less GIS experience or those who want to reduce processing steps by allowing the tool to do some of the work for them (e.g. the Area Change Tool will rejoin grid attributes after combining rasters a step that must be performed manually when using the *combine* function).

Area Change Tool
The AREA CHANGE TOOL (ACT) is a software tool that facilitates raster editing. ACT can be used to

- convert the attributes of a shapefile into a raster,
- combine multiple rasters into a single raster,
- edit the value attribute table of a raster,
- convert edited attributes into a new raster, and
- merge an edited raster layer into the original raster layer to create a new layer that incorporates the edits.

ACT is particularly useful when the user wishes to edit several rasters simultaneously so that the logical relationships between the rasters is maintained.

Total Fuel Change Tool
The LANDFIRE TOTAL FUEL CHANGE TOOL (ToFuΔ) is a software tool designed specifically for editing LANDFIRE fuel grids. It allows the user to edit fuel type layers by altering the rule sets used to create them.

GIS Tutorials

Users with more experience or who do not wish to learn new tools such as those discussed above, may want to edit LANDFIRE spatial data directly using GIS software. This section will cover several functions commonly used when editing raster: combining rasters, editing raster attributes and converting an edited raster into a new raster.

Combining Rasters
One of the most basic and useful functions of a GIS is to answer the question "what is on top of what?" For example:
- On which soil types does a BpS occur?

- What elevations does this EVT span?
- What vegetation types are within this fuel model?

The *combine* function allows users to answer these types of questions. LEARN HOW – WATCH A VIDEO.

Editing Raster Attributes

Raster attributes can be edited by making direct modifications to the table or by adding and populating a new field. LEARN HOW – WATCH A VIDEO.

Converting an Edited Raster into a New Raster

Rasters are generally edited by modifying an existing field or making a new field in an existing grid's value attribute table. Users may want to create a new grid based on the edited field in the old grid for further analysis. LEARN HOW – WATCH A VIDEO.

Using LANDFIRE Data with the FRCC MapTool

A FIRE REGIME CONDITION CLASS (FRCC) assessment using the FRCC MAPPING TOOL relies on several interrelated datasets: BpS, S-Class and Reference Conditions. A modification to any one of these datasets may require changes to the others. For example, if you lump Dry-Mesic Douglas-fir-Western Hemlock Forest with Mesic-Wet Douglas-fir-Western Hemlock Forest in the BpS map, you will need to review the S-Class descriptions for these types to determine if modifications need to be made to the S-Class map.

The LANDFIRE Reference Condition table that is available in the FRCC Mapping Tool is attributed with three landscape levels (for more information on landscape levels refer to the FRCC GUIDEBOOK). Before running the tool, these levels should be reviewed to determine their suitability and modified as needed. LEARN HOW – READ A TUTORIAL.

Additional Resources

Background Information

The Raster Primer

Using the LANDFIRE Biophysical Settings Model Descriptions

FRCC Documentation

Data Access

LANDFIRE Data Access Tool

LANDFIRE Data Distribution Site

LANDFIRE Vegetation Dynamics Models

Training

Acquiring and Preparing LANDFIRE Data Tutorial

Area Change Tool (ACT)

LANDFIRE Concepts, Data, and Methods Version 2.0

Tutorials

Overlay Grids Using the *Combine* Function

Calculate the Area for Each Type Mapped in a Grid

Editing Raster Attributes

Making a New Raster

Review and modify FRCC Mapping Tool Reference Conditions Table

Literature

LANDFIRE: a nationally consistent vegetation, wildland fire, and fuel assessment

Spatial fuel data products of the LANDFIRE Project

The LANDFIRE Prototype Project: nationally consistent and locally relevant geospatial data for wildland fire management