

Tools, courses, and learning pathways offered by the National Interagency Fuels, Fire, and Vegetation Technology Transfer

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Abstract

Technological advances in the area of fuel and wildland fire management have created a need for effective decision support tools and technology training. The National Interagency Fuels Committee and LANDFIRE have chartered a team to develop science-based learning tools for assessment of fire and fuels and to provide online training and technology transfer to help managers implement fuels, fire, and vegetation assessment technology for fire risk mitigation and ecosystem restoration. The team is called the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT). NIFTT has developed and maintains several GIS tools and associated user resources. In addition, NIFTT offers online courses that facilitate the implementation of these tools as well as courses focusing on topics related to the assessment of fuels, fire, and vegetation in forests and rangelands. NIFTT has also developed “Learning Pathways” to assist independent learning, which provide easy-access to related learning materials in an order designed for optimal learning efficiency. Lastly, NIFTT hosts a website (www.nifft.gov) and helpdesk (helpdesk@nifft.gov) where users can access additional information and direct comments and questions.

Additional keywords: GIS, online resources, independent learning, LANDFIRE

Introduction

Fire exclusion in the 1900’s altered wildland fuel characteristics, vegetation structure, landscape patterns, and fire regimes, leading to uncharacteristic behavior, severity, frequency, and size of wildland fires (Covington *et al.* 1994; Rollins *et al.* 2001; Hann *et al.* 2003; Rollins 2009). The introduction of invasive species in native plant communities has altered fire behavior and fire regimes (Dewey *et al.* 1995), and the wildland-urban interface has become a focal area for human-environment conflict, including wildland fire (Radeloff *et al.* 2005). Since the mid-1980s, an increase in large wildfire frequency, longer fire duration, and a longer wildfire season have been observed, associated with increased spring and summer temperatures and an earlier spring snowmelt in the western U.S. (Westerling *et al.* 2006; Rollins 2009). These changes in wildland fire characteristics and associated costs for fire suppression have inspired scientists and managers to learn about the role of fire in ecosystems, and wildland fire management is currently transitioning towards strategies in which fire suppression is balanced with approaches to re-introduce wildland fire into ecosystems (Gollberg *et al.* 2001). Recent recommendations for

future wildland fire management, summarized by Gollberg *et al.* (2001), emphasize the need to: 1) Focus on wildland fire management tools that are grounded in ecological research and principles; 2) Develop a national approach to the mapping of fuels and to the integration of spatial technology, geographic information systems (GIS), and remote sensing; 3) Improve technology development, transfer, and communication between developers and users; and 4) Engage in training that incorporates the latest developments in remote sensing, GIS, communication technologies, and information management. At the same time, natural resource management is shifting towards managing ecological systems and individual species at the landscape-scale rather than focusing on small-scale projects (Forbis *et al.* 2007). The National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT), formed in 2005, addresses many of these identified needs and future directions in wildland fire management.

NIFTT's mission is to assist federal, state, and private land managers in the development and implementation of effective fuels, fire, and vegetation assessment technology for addressing risks related to severe fire behavior, fire effects, and departed ecosystems. NIFTT operates under the Rocky Mountain Research Station (RMRS) Wildland Fire Management RD&A and is sponsored by the U.S. Forest Service and the Department of Interior (DOI). NIFTT partners with the University of Idaho's Fire Research And Management Exchange System (FRAMES), The Nature Conservancy (TNC), and the RMRS Fire Modeling Institute (FMI). To date, NIFTT has developed a number of computer-based tools and six online courses focusing on technology transfer relating to stand- and landscape-scale assessments of fuels, fire and vegetation dynamics. NIFTT also contributes to fire and fuels education by hosting educational material for the National Wildfire Coordinating Group (NWCG). NIFTT's tools and courses have been well received by natural resource managers, and over 1700 students have registered for the online courses. Students registering for NIFTT courses come from a variety of sectors, but most are affiliated with the USDA Forest Service and the Department of Interior (DOI). In 2010, 32% and 35% of the registering students were affiliated with the USDA Forest Service and DOI, respectively, while the remaining 33% of the students came from the private, state, and university sectors. In addition to online course delivery, NIFTT offers in-person workshops on topics relating to the analysis of fuels and fuels treatments at stand and landscape scales.

NIFTT's technology transfer products are designed to use the spatial data developed by LANDFIRE (www.landfire.gov), but spatial datasets developed via other methods can also be made compatible and used with NIFTT tools. LANDFIRE produces a comprehensive suite of over 20 spatial data layers across the United States. Specific data layers include: biophysical settings, existing vegetation type, canopy cover and height, environmental site potential, fire behavior fuel models, fire regime class, and fire effects fuel model layers. LANDFIRE data development methods are described in detail by Rollins (2009) and Reeves *et al.* (2009). Existing vegetation and wildland fuel layers are being updated through the 'LANDFIRE Refresh' (www.landfire.gov) to maintain the currency of data sets. Changes resulting from recent (1999-2008) natural disturbances and management activities are included in the LANDFIRE Refresh maps, and Refresh corrects discrepancies that were detected after the original LANDFIRE National maps were completed.

NIFTT tools

NIFTT tools (Fig. 1) are designed to help users learn how to access, edit, and analyze input data to assess fire behavior, fire effects, and ecological departure. All tools are compatible with ArcGIS software (ESRI 2009) versions 9.0 – 9.3 and are continuously updated to be compatible with new versions of ArcGIS and new Windows platforms (e.g., Windows 7).

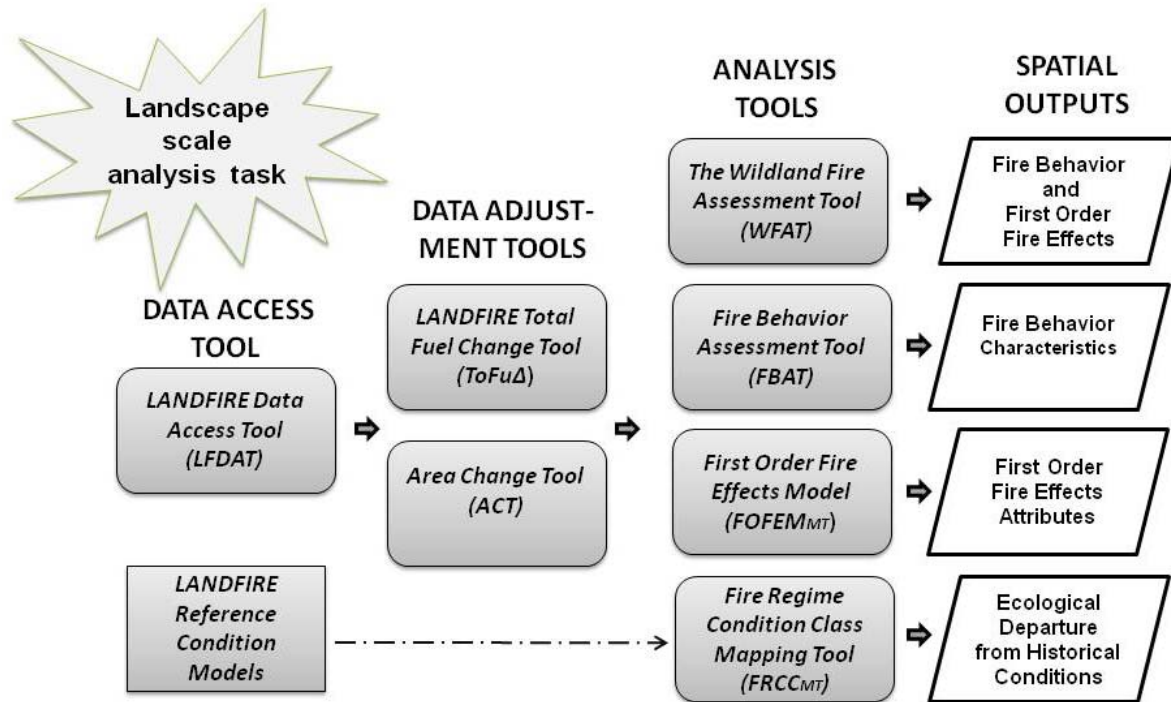


Fig. 1. An overview of NIFTT's GIS tools.

Landscape-scale analysis requires spatial data inputs. LANDFIRE provides a number of base data layers, such as biophysical setting and existing vegetation type, cover, and height. The LANDFIRE Data Access Tool allows the user to download LANDFIRE data directly into ArcMap. The Area Change Tool is designed to update LANDFIRE data to reflect changes resulting from natural disturbance or management activities. Surface and canopy fuels can be updated in the LANDFIRE Total Fuel Change Tool. The updated data layers can be processed in the Wildland Fire Assessment Tool, Fire Behavior Assessment Tool, or First Order Fire Effects Model Mapping Tool to produce spatial outputs of fire behavior characteristics and first order fire effects. The current distribution of vegetation structural classes can be compared to historical conditions, and ecological departure can be calculated across the landscape using the Fire Regime Condition Class Mapping Tool.

The LANDFIRE Data Access Tool (LFDAT; Toney *et al.* 2009) allows users to download LANDFIRE spatial data directly from ArcMap via a custom made LFDAT toolbar. Specifically,

the user can define the download area by simply drawing the boundary of the desired extent in ArcMap, select desired LANDFIRE layers, and then downloaded data for that specific area directly into ArcMap. The tool automates the processing of downloaded zip files by unzipping and merging data into seamless raster formats ready for spatial analysis. LFDAT helps the user to automatically project LANDFIRE data to a desired map projection. NIFTT recommends that all users periodically consult the LANDFIRE website (www.landfire.gov) or the LANDFIRE Data Distribution Site (<http://landfire.cr.usgs.gov/viewer/>) for data updates.

Even though LANDFIRE data are updated via LANDFIRE Refresh, local events such as recent wildland fires, hurricanes, or insect infestations may not yet be included in the data. Accurate analysis requires that these changes be reflected in the GIS data layers. The Area Change Tool (ACT; Hutter *et al.* 2009) is an ArcMap toolbar that can help users update LANDFIRE layers (or other GIS data) to reflect recent changes caused by natural or human-induced disturbance events. ACT streamlines the editing of raster data layers and allows the user to edit multiple raster layers simultaneously. For example, the user can enter a recent fire perimeter into ArcMap and use the ACT toolbar to update the vegetation characteristics for several raster data sets within the fire perimeter. Typically, a fire alters canopy bulk density, canopy base height, canopy cover, canopy height, existing vegetation type, fire behavior fuel model, fire effects fuel model, and succession class. The LANDFIRE Total Fuel Change Tool (ToFuΔ; Smail and Martin *et al.* 2010) is specifically designed to allow users to update LANDFIRE fuel data directly in ArcMap. Fire and fuel managers and scientists can use ToFuΔ to develop rule sets for updating fuel data based on the existing vegetation type, existing vegetation cover, existing vegetation height, and biophysical setting – which are GIS layers available from LANDFIRE. Fuel characteristics can be updated for both surface and crown fuels. Through ToFuΔ, users can: 1) calculate area and percent existing vegetation type changed per fuel rule, 2) compare surface and crown fire behavior characteristics and interpret the transition for passive crown fire initiation, 3) create and graph custom fuel models, and 4) create distribution graphs to show vegetation structure and quantity.

NIFTT provides several spatial analysis tools focusing on the analysis of fire behavior, fire effects, and ecological departure. The Wildland Fire Assessment Tool (WFAT)¹ combines two previously developed NIFTT tools: the Fire Behavior Assessment Tool (FBAT; Hamilton *et al.* 2007) and the First Order Fire Effects Model Mapping Tool (FOFEM_{MT}; Hamilton *et al.* 2009). WFAT allows the user to spatially model wildland fire behavior and first order fire effects. The tool provides an interface between ArcMap, FlamMap (Finney 2006), and the First Order Fire Effects Model (FOFEM; Reinhardt *et al.* 1997), combining their strengths into a spatial fire effects analysis tool in a GIS. NIFTT recommends that users have a good understanding of fire behavior, fire effects, and fuel model concepts as well as experience using non-spatial systems such as BehavePlus, NEXUS, and FOFEM before attempting to use WFAT. WFAT requires spatial inputs of fuel models, canopy characteristics, and topographic and weather data, similar to those required by FARSITE (Finney 1998) and FlamMap (Finney 2006). A FARSITE Landscape

¹*Hamilton D, Jones J (In preparation) Wildland Fire Assessment Tool (WFAT) for ArcGIS 9.2-9.3 (version 2.2.0). National Interagency Fuels, Fire, and Vegetation Technology Transfer. Available on-line at www.nifft.gov.

(LCP) File can also serve as input to WFAT. Fire behavior outputs include flame length, rate of spread, fireline intensity, fuel moisture, and fire type. Fire effects outputs include post-fire or consumed fuel loadings, emissions, soil heating, and tree mortality.

Altogether, over 50 spatial output layers can be generated by WFAT, although it is highly recommended to limit the number of outputs to those relevant to the proposed analysis question. WFAT can help fire and fuel managers locate potential fuel treatment units, develop a prescription for those units, and evaluate the effects of proposed treatment on potential fire behavior and fire effects. WFAT saves fire managers the time and effort of converting data between multiple formats for use in ArcMap and FlamMap and gives managers the option of using downloadable data from the LANDFIRE Data Distribution Site (<http://landfire.cr.usgs.gov/viewer/>) as their GIS input layers.

Fire Regime Condition Class (FRCC) assesses vegetation and fire regime departure in relation to historical vegetation and fire regimes based on concepts published by Hann and Bunnell (2001), Hardy *et al.* (2001), and Schmidt *et al.* (2002). Departure from historical conditions can cause change to key ecosystem components, such as vegetation characteristics (species composition, structural stage, stand age, canopy cover, and landscape pattern), fuel composition, fire frequency, fire severity, and burning patterns. Examples of other associated disturbances include insect- and disease-induced mortality, livestock and wildlife grazing, and drought. Causes of ecological departure that are initiated by human activities include (but are not limited to) fire suppression, timber harvesting, livestock grazing, introduction and establishment of exotic plant species, and introduced insects and disease (Schmidt *et al.* 2002). Fire Regime Condition Class (FRCC) is an interagency standardized tool for determining the degree of departure from reference condition vegetation and fire regimes. At the national forest and BLM district levels, FRCC is a metric that can be used for prioritizing watershed-scale management activities. FRCC is a required component of Fire Management Plans and can provide decision support regarding how to implement fire-use events for restoring desirable fire regimes. LANDFIRE data layers, adjusted to represent the analysis area, serve as the input data to the Fire Regime Condition Class Mapping Tool (FRCC_{MT}; Hutter *et al.* 2008) and include layers of biophysical settings (BpS), current succession class (S-class), and the landscape reporting unit (commonly drainage basins or hydrologic units). FRCC_{MT} computes the amount of each succession class within the individual biophysical settings and compares this current distribution to the historical reference condition. The output maps depict departure from historical conditions at three levels: S-class, BpS strata, and landscape unit. The departure categories consist of classes 1 through 3, where class 1 depicts areas that are the least departed from historical conditions and class 3 represents the most departed. Currently, FRCC_{MT} accounts only for vegetation composition departure; however, an updated version of FRCC_{MT} that also accounts for fire regime departure is in development. Lastly, the Fire Regime Condition Class Software Application (FRCC_{SA}; Hamilton and Hann 2010) is a non-spatial application for deriving and graphing FRCC. A summary of NIFTT tools and their applications can be found in Fig. 2.

NIFTT Tools	Function and Application
LANDFIRE Data Access Tool (LFDAT)	▪ Downloads LANDFIRE layers directly into ArcMap for a customized extent ▪ Map projection is specified by the user ▪ Automates the attachment of attributes and metadata
Area Change Tool (ACT)	▪ Facilitates editing and combining Arc Grids ▪ Multiple Arc Grids can be edited simultaneously to maintain logical relationships ▪ Arc Grids can be refined/updated to better reflect local conditions
LANDFIRE Total Fuel Change Tool (ToFuΔ)	▪ Facilitates editing LANDFIRE rulesets to create customized surface and canopy fuel layers for local applications ▪ Useful for validating spatial fire behavior outputs ▪ Helps with routine and recurring database management operations
Wildland Fire Assessment Tool (WFAT) <i>Combines the tools FBAT and FOFEM_{MT}</i>	▪ Integrates ArcGIS, FlamMap, and FOFEM ➢ FlamMap estimates fire behavior (e.g., flame length, spread rate, etc.) ➢ FOFEM estimates fire effects (e.g., soil heating, tree mortality, smoke, etc.) ▪ Useful for prioritizing, designing, & evaluating fuel treatment projects ▪ Outputs can be used for deriving “risk” metrics
Fire Regime Condition Class Software Application (FRCC _{SA})	▪ Non-spatial derivation of departure metrics (e.g., FRCC) ▪ Provides tabular and graphic summaries ▪ Provides an efficient means to enter, edit, and store data
Fire Regime Condition Class Mapping Tool (FRCC _{MT})	▪ Spatial derivation of departure metrics (e.g., FRCC) ▪ Capable of assessing multi-million acre landscapes ▪ Provides tabular summaries

Figure 2. A summary of currently available NIFTT tools and their applications.

Online training

NIFTT provides technology transfer to managers and scientists via online courses. Six NIFTT online courses are currently available (Fig. 3), and several new courses are in development; all courses can be accessed through www.nifft.gov. Students can register for and take NIFTT online courses at their convenience. The courses are structured for self-learning, with components such as narrated slide presentations, readings describing important concepts, tutorials, hands-on exercises, self-tests with immediate feedback, and course evaluations. Most NIFTT courses take approximately 3-4 hours to complete; however, some of the more in-depth courses require additional time. The LANDFIRE Concepts, Data, and Methods course reviews fundamental ecological concepts relevant to LANDFIRE, describes the LANDFIRE Program and data resources, and provides instruction regarding how to access and use LANDFIRE data on the job. In the Fire Regime Condition Class course, fundamental FRCC concepts are introduced, and students learn how to estimate FRCC using the Standard Landscape Worksheet Method – a non-spatial field-based approach. Applications of FRCC are demonstrated for a variety of ecosystems, and students are led through hands-on exercises that show how to diagnose FRCC

for an example assessment landscape of the student's choosing. Policy and law implications are also discussed. Students completing the course receive FRCC certification.

The course Introduction to the Fuel Characteristic Classification System (FCCS) gives background on the Fuel Characteristic Classification System (Sandberg *et al.* 2001) and provides instruction on how to download, install, and use the FCCS software. Students learn real-world applications of FCCS, including the mapping of fuelbeds, the development and mapping of custom fuelbeds, and the use of fuelbeds for fire hazard analysis. Exercises walk students through the process of selecting a default fuelbed and help them customize the fuelbed. The Introduction to the 40 Fire Behavior Fuel Models course provides an overview to the Scott and Burgan 40 fire behavior fuel models (Scott and Burgan 2005), demonstrates the resources available for learning about the models, and guides students through model selection. Using Fire Behavior Nomographs to Estimate Fire Behavior Characteristics describes the history and use of nomographs for estimating fire behavior, explains the new fire behavior nomograph format (Scott 2007), illustrates the use of a wind vectoring charts, and describes the use of the new nomographs format for estimating spread rate and flame length for head fires, flanking, and backing fires. The course GIS Tools for Fuels, Fire, & Vegetation Management Using LANDFIRE Data introduces the GIS tools for fire, fuels, and vegetation management described above in the NIFTT Tools section. The course currently includes tool lessons on the First Order Fire Effects Model Mapping Tool (FOFEM_{MT}), the Fire Regime Condition Class Mapping Tool (FRCC_{MT}), and the Area Change Tool (ACT). Additional tool lessons, including WFAT, are currently in development. Lessons include tutorials and hands-on exercises, and students learn interpretation of tool outputs as well as tool applications in day-to-day management.

Course	Objectives
LANDFIRE: Concepts, Data, & Methods	- Introduces the LANDFIRE Project and data products - Increases understanding of data derivation to assist in appropriate application
Fire Regime Condition Class	- Introduces the concepts and derivation of FRCC - Applications of FRCC in a variety of ecosystems - Policy and law implications
Fuel Characteristic Classification System (FCCS)	- Introduces the concepts and structure of the FCCS - Teaches how to install and use the FCCS software - Teaches how FCCS can be applied in the real-world
40 Fire Behavior Fuel Models	- Provides an overview of the Scott & Burgan fuel models - Describes the process for selecting the appropriate fuel model
Using Fire Behavior Nomographs to Estimate Fire Behavior Characteristics	- Describes the history and use of nomographs for estimating fire behavior - Describes the new nomograph format and associated resources
GIS Tools for Fuels, Fire, & Vegetation Management using LANDFIRE Data	- Introduces GIS tools that can be used for downloading, editing, & assessing LANDFIRE data - Familiarizes participants with the purpose and function of NIFTT tools

Fig. 3. A summary of currently available NIFTT online courses and course objectives.

Learning pathways

NIFTT has developed "Learning Pathways" designed to provide guidance to individuals interested in learning specific areas of study. These pathways – available at www.niftt.gov – provide a compilation of materials organized in an order designed for optimal learning efficiency. Learning pathways currently available include Fire Behavior, Fire Effects, and Fire Regimes, and pathways for Spatial Analyses, Vegetation Dynamics, and Integration are in development. The Fire Behavior Pathway includes relevant courses, tutorials, and guides for use in fire behavior-related planning, treatment implementation, and monitoring. The Fire Effects Pathway provides a compilation of courses, tutorials, and guides that will help natural resource professionals better understand fire effects concepts and learn about the latest tools available for planning, treatment implementation, and monitoring. The Fire Regimes Pathway provides information necessary to understand the concepts of natural fire regimes, historical range of variability, biophysical settings, and fire regime condition class. Students learn how to access and download spatial data and how to run the FRCC Mapping Tool and interpret results.

Website and helpdesk

Access to NIFTT tools and associated resources, online course registration, learning pathways, and additional information are available at www.nifft.gov. Comments and questions can be directed to NIFTT via helpdesk@nifft.gov.

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