The LANDFIRE Project

Supporting Fire and Land Management Across the Nation

a unique collaboration

USDA Forest Service
Department of the Interior
The Nature Conservancy

LANDFIRE

Acknowledgements

Front cover photos: Colorado mountains by Dave Sacher; drip torch by Ronald Myers
Back cover photos: Oak woodland by John Andre/USDA Forest Service; Rapid Assessment mapping by Jeannie Patton/The Nature Conservancy; prescribed burn by Christopher J. Helzer © 2009 The Nature Conservancy

Project

A unique collaboration among the USDA Forest Service, the Department of the Interior and The Nature Conservancy

The Landscape Fire and Resource Management Planning Tools Project — LANDFIRE — is a multi-partner project designed to produce a consistent suite of standardized, multi-scale spatial data layers and models. The maps and data describe vegetation and wildland fuel and fire regimes across the United States, and are designed to facilitate national and regional level strategic planning and reporting of wildland fire management activities.

Not only is this collaboration a rarity, the LANDFIRE data are unique. Products include more than twenty 30-meter raster spatial layers of vegetation structure and composition, fire behavior, fire effects, fire regimes and dynamic vegetation models for all major ecosystems in the United States. With these products in hand, federal, state and private organizations have data that can be used to ask and answer important questions, test hypotheses, utilize current science and expert opinion and run alternative scenarios that can support broad-scale strategic planning and land management decisions.
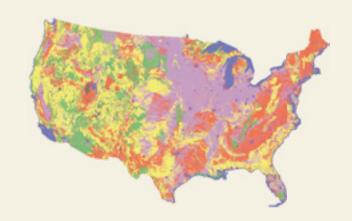
Scale

Gapless data and products are intended for use in large, landscape-scale applications. LANDFIRE data products can be used effectively for planning and reporting wildland fire management activities at three levels:

- National = includes all states
- Regional = covers single large states or groups of smaller states
- - Sub-regional landscapes and Fire Management Units = includes significant portions of states or multiple federal administrative entities.

Stories from the Field

Practical applications in the field show the importance of LANDFIRE National data. On the following pages, you will read a sampling of stories that illustrate how data are being used every day to advance strategic planning, provide valuable historical context and support appropriate land management.

application stories

Michigan Fire Needs Assessment
Prioritizing restoration efforts

Evaluating Ecological Sustainability in the Southwest
Using vegetation models to perform assessments

State and Private Partnership Assists Land Managers
Leveraging capacity to manage diverse landholdings

Federal Fire Planning Saves Lives, Property and Money
Strategic and tactical decision-making pays off

Genies in a Bottle: Conservation Action Planning
Maximizing return on management investment

Conserving and Restoring California's Bodie Hills
Collaboration supports management decisions

Short Stories
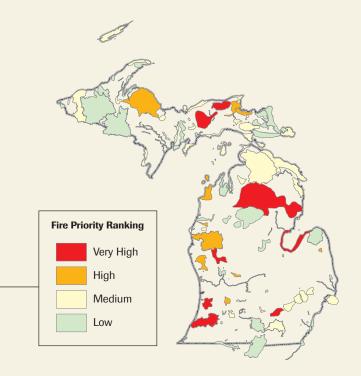Thumbnail sketches of LANDFIRE in the field

© Greg Seamon

Michigan Fire Needs Assessment
Prioritizing restoration efforts

Natural fire return intervals range from three to 3,000 years in Michigan, in ecosystems from coarse sand to moist and fertile soils. Estimates indicate that, historically, more than 1.5 million acres burned annually. Because Michigan is a fire-prone state and fires have been suppressed for over a century, there are significant changes in vegetation that have led to changes in biodiversity. Restoring natural fire regimes and fire-adapted ecosystems is not a trivial matter; therefore, The Nature Conservancy's Michigan chapter undertook a fire needs assessment to help project leaders prioritize restoration efforts in selected conservation areas.

Using the Conservancy's ecoregional planning process, project leaders learned that the landscapes most likely to represent Michigan's lost biodiversity ranged from the northwest to southeast corners of the state and should be the first landscapes targeted for action.

Assessing fire priorities is complex business. The planning team undertook significant research to inform their decisions, including determining the conservation value of priority areas, deciding whether the areas under consideration were irreplaceable and examining the potential for project leverage and feasibility. Information gleaned from expert opinion and Geographic Information Systems (GIS) analysis and data proved invaluable.

To determine irreplaceability and conservation value, scientists consulted data from the Michigan Natural Features Inventory that had been collected for decades, while leverage was based on Conservancy staff's expert opinion, based on locations of the conservation areas and nearby owners' land

Fire Priority Ranking

- Very High
- High
- Medium
- Low

management policies. All information was grounded in fire-centric and ecological condition data sets provided by LANDFIRE.

LANDFIRE's Mean Fire Return Interval (MFRI) spatial data quantify the average period between fires under the modeled historical fire regime. Reference condition models for each Ecological System (aka Biophysical Settings, or BpS) — developed in expert modeling workshops that were held nationally over two years — provided fire regime information for each BpS. To get spatial data, GIS analysts "spread" fires across the landscape using LANDSUM to obtain pixel-by-pixel estimates of MFRI. As illustrated in the accompanying chart, roughly 700,000 acres of Michigan would have had an MFRI of 0-10 years historically, mostly in grassland and oak ecosystems, and were mainly low-severity surface fires. The map of averaged MFRI indicates the conservation sites that are historically the most dependent upon fire.
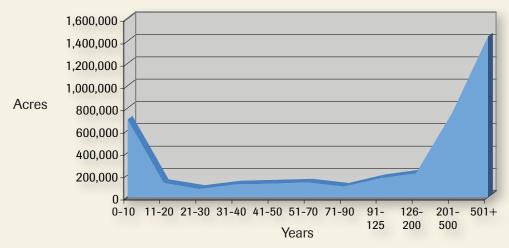
LANDFIRE's Fire Regime Condition Class (FRCC), a metric that compares ecological reference conditions with current conditions in terms of vegetation structure and composition, was used to identify the conservation sites that were least departed from ecological reference conditions. By assessing FRCC per conservation area, Michigan chapter staff could estimate how much work lay ahead. However, because FRCC does not include a fire component, it was combined with MFRI to estimate how much work could be undertaken in fire-dependent ecosystems.

The assessment showed that seven of 157 conservation sites ranging from fire-independent northern hardwood forests to extremely fire-dependent grassland sites had a priority level of Very High (see map). For example, the Two Hearted River conservation site has relatively low FRCC (not prohibitively departed = restoration has a good chance of success), a high number of fire-dependent conservation targets and is relatively fire dependent as a whole due to the conifer and wetland ecosystems. Additionally, feasibility and leverage rankings are fairly high in this conservation area due to increased levels of public land ownership and low population/road density. Low FRCC + high fire dependence + high feasibility + high leverage = higher probability of success when restoring fire-adapted ecosystems.

Overall, the LANDFIRE data sets provided the ecosystem-level information that led to a reliable and valuable assessment. Had LANDFIRE data not been used, this particular analysis would lack complete data coverage for the state and/or it would have relied upon disparate data sets.

The term "model" often conjures up post-doctoral work and shelves of technical manuals. While science-based, LANDFIRE reference models were created by subject matter experts — fuels specialists, ecologists and silviculturalists — not people who specialize in modeling. The modeling software, Vegetation Dynamics Development Tool, is relatively easy to use and is available at no cost, making it ideal for collaborative learning and exploring ecosystem dynamics. (www.landfire.gov)
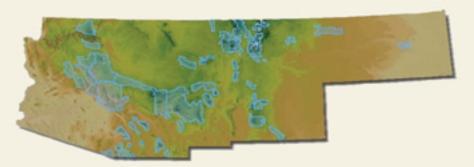
Distribution of Modeled Reference Condition Fire Return Interval in Michigan

Evaluating Ecological Sustainabilty in the Southwest
Using vegetation models to perform assessments

USDA Forest Service Region 3

The USDA Forest Service Region 3 covers 22.3 million acres in the southwestern United States and includes 11 national forests and three national grasslands. The LANDFIRE project's Vegetation Dynamics Models (VDM) helped planners develop the ecological assessments required by the Forest Plan Revision process for the Region. The assessments are designed to evaluate the ecological sustainability of forest and grassland resources by examining key indicators including biological diversity, natural range of variability and the current condition of the Region's ecosystems.

Documenting Historical Conditions
LANDFIRE VDM description documents provided information about historical conditions (pre-European settlement) for each vegetation type. The description of vegetation communities and disturbance regimes contained in each model description provided regional planners with an ecological framework for understanding each vegetation type, its reference conditions and current trends.

Analyzing Trends
Although LANDFIRE VDMs are designed to represent reference conditions, regional planners modified them to analyze current trends and predict future conditions. For example, local information was used to determine the current fire frequency, the probability of insects and disease and the nature and prevalence of management activities. This information was translated into annual probabilities that were added to the VDMs in place of the reference condition probabilities.

Determining Ecological Departure
Planners ran multiple simulations into the future for periods that ranged from 10 to 1,000 years, depending on the vegetation type, to predict potential future conditions. The results were then compared to the

LANDFIRE reference conditions, and a vegetation departure metric, Fire Regime Condition Class, was calculated for each projection to determine future departure. The results helped the planning team estimate potential future departure of various vegetation types, assuming that current trends in fire frequency, insect and disease probability, and management activities continue.

LANDFIRE Tools
VDMs in conjunction with other LANDFIRE and local data provided what the planning team needed to determine departures in a timely, cost-effective way for the entire region. Planners could then determine where changes to existing forest plans could best be applied in order to achieve desired future conditions.

Photo taken ca 1920, represents a vegetation state similar to the reference condition in Southwestern pinyon juniper woodland.

The same area in 1999 depicts the increased density of juniper (a departure from reference conditions), possibly as a result of fire suppression.

"The results helped the planning team estimate potential future departure of various vegetation types, assuming that current trends in fire frequency, insect and disease probability, and management activities continue."
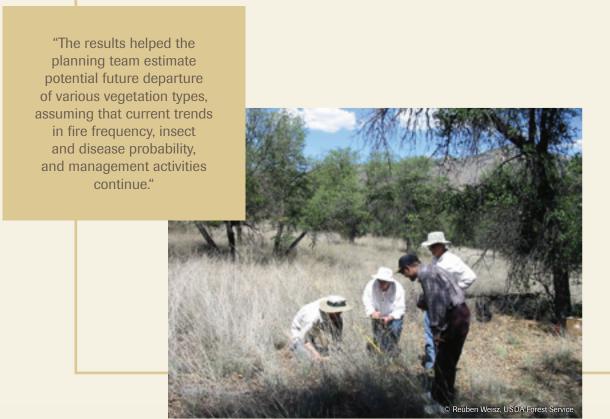
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State and Private Partnership Assists Land Managers

Leveraging capacity to manage diverse landholdings

The State and Private Forestry (S&PF) organization of the USDA Forest Service helps to ensure that forest landowners have the best technical, educational and financial assistance available to help them achieve their objectives in an environmentally beneficial way. This federal investment leverages the capacity of state forestry agencies and their partners to manage state and private lands and produce ecological, social and economic benefits for the American people.

Originally conceived in 2007 and codified in the 2008 Farm Bill, Redesigning is a new approach within State and Private Forestry aimed at helping partners identify the greatest threats to forest sustainability and to accomplish meaningful, landscape-level change in high-priority areas. As a part of the Redesign, each state is required to complete a state-wide Assessment and Strategy for Forest Resources. According to the Forest Service, "The Assessments provide an analysis of forest conditions and trends in the state and delineate priority rural and urban forest landscape areas. The Resource Strategies provide long-term plans for investing state, federal and other resources to where they can most effectively stimulate or leverage desired action and engage multiple partners. The State Assessments and Strategies will be used by states to target program delivery and develop competitive proposals for addressing priority landscape areas and issues." (www.fs.fed.us/spf/redesign)

While each state is responsible for developing its own analytic process using guidelines and/or themes specified by S&PF, LANDFIRE's potential benefits for the Redesign have been demonstrated in at least three states. Colorado, New Mexico and Hawai'i each utilized LANDFIRE National spatial layers in their redesign processes under the leadership of their local Nature Conservancy chapter.

Why was LANDFIRE chosen? Spatial data sets that are state-wide and consistent, and that contain multiple, compatible, natural resource-related layers are rare and LANDFIRE provides those for every state in the country. Further, the data can be applied in more areas than fire alone. Many other Redesign themes, such as insect and disease susceptibility, water quality, wildlife habitat, fragmentation and more, are also informed using LANDFIRE products. While not suitable for every application, any analysis that covers large areas and multiple owners should review and consider using LANDFIRE products when local data are not available or are insufficient.

LANDFIRE products were originally designed for strategic planning applications, for example, state-wide natural resource assessments. Without a consistent, exhaustive data set such as LANDFIRE, most of these analyses would not be financially or technically feasible.

LANDFIRE data products, including download and delivery, are easily available on the internet, thus saving incident managers time and money during fire events. While prior approaches forced managers to gather products from multiple sources — with collection methodologies that were inconsistent or even unknown — smooth, quick access to www.landfire.gov can make a difference.

LANDFIRE products and processes are fully integrated into the Conservancy's Conservation Action Planning process in the Bodie Hills of the Great Basin and Schell Creek Range in Utah. Based upon these successes, the process is being exported to other area projects such as the Signal Peak area and the Mimbres Watershed, both in New Mexico.

Federal Fire Planning Saves Lives, Property and Money
Strategic and tactical decision-making pays off

The original impetus for the LANDFIRE Project came from the U.S. General Accountability Office (GAO). GAO reviews and assessments of the Department of the Interior and USDA Forest Service wildland fire management programs indicated that additional work was needed from the agencies to provide understandable and consistent national processes. LANDFIRE was implemented to produce some of the data both to address the report findings and to provide multiple systems that could support making wall-to-wall, cross-boundary assessments.

The Project was designed from the ground up to produce consistent data products, especially with regard to national and regional applications. However, in addition to the value provided in the national realm, practitioners needed to drill down to more local levels. As fire policy became more flexible regarding suppression and prescribed fire activities, incident management teams often had to make rapid tactical decisions. Although it was designed and developed for the national and regional levels, LANDFIRE provides the spatially comprehensive data set that can be adapted to support local management applications when other data sets are not available. Ultimately, when analyzed and applied appropriately, LANDFIRE data products can support strategic and tactical decision-making.

Fire behavior fuel model products developed in LANDFIRE for all 50 states are fully compatible with the Wildland Fire Decision Support System (WFDSS), the standard tool for federal agencies for documenting

and assessing wildland fire management data to provide decision makers with important information (www.wfdss.usgs.gov). During the 2004-2009 fire seasons, LANDFIRE spatial products proved valuable in the WFDSS process, being used on literally hundreds of fires, including the Tin Cup, Black Cat and Jocko events. According to analyses conducted by the incident managers, $6-8 million in fire suppression costs were saved on the 2005 Dameron and Valley Road Fires alone while still protecting human lives and property.

Further, LANDFIRE spatial products are used in the Fire Program Analysis and Hazardous Fuels Prioritization and Allocation System(s). These interagency fire budgeting and resource allocation processes use LANDFIRE fire behavior fuel model information, along with many other data sets, to determine appropriate budget/resource levels across all agencies in a Fire Management Unit. Again, the consistent and comprehensive nature of LANDFIRE spatial products is a key characteristic that makes them unique and an important resource for this and other applications.

Although LANDFIRE has mainly been used in wildland fire applications to date, the data are important for vegetation, wildlife habitat, carbon/climate assessments and management planning across administrative boundaries and across the country.

> "LANDFIRE spatial products have been used with the Wildland Fire Decision Support System on literally hundreds of fires…. Millions of dollars of fire suppression costs were saved."

Genies in a Bottle: Conservation Action Planning
Maximizing return on management investment

Land managers must administer budgets so that often-limited dollars are invested to benefit ecological biodiversity while also considering the interests of a variety of stakeholders. LANDFIRE's data help planners make strategic decisions efficiently and effectively.

The Nature Conservancy's Efroymson Coaches Network (named after Lori and Dan Efroymson) and the Conservancy's Fire Learning Network and LANDFIRE teams have developed a series of *Genies in a Bottle* workshops — so named because of the "magical" power of LANDFIRE resources — that educate practitioners in the use of LANDFIRE predictive ecological models. As a result of this training, managers can use LANDFIRE products to help determine the viability of focal ecosystem targets, assess potential threats, test alternative management options and develop cost-effective strategies. Ultimately, the goal is to develop landscape-scale Conservation Actions Plans (CAPs) that are vital for the Conservancy's strategic program design.

The USDA Forest Service conducts watershed assessments in order to understand hydrology, biodiversity and vegetation conditions. LANDFIRE data sets can provide foundations for vegetation structure and composition components that often supply information that would otherwise be unavailable.

The *Genies*/CAP process design has four components:

Identify Conservation Targets by mapping ecological systems across landscapes using geospatial data layers downloaded from LANDFIRE, satellite imagery and remote sensing.

Assess Viability by using landscape-level measures to evaluate ecological conditions, the ecological departure of each landscape from its natural range of variability and reference departures so as to represent current conditions and identify "high risk" vegetation classes.

Assess Future Threats through the use of predictive ecological models and the ecological departure metric.

Develop Conservation Strategies that can improve ecological condition and abate future threats. Through the use of computer simulations, managers can test whether strategies could achieve the highest return on investment and still meet biodiversity goals.

The National Park Service is working with the Conservancy to apply these methods in the Great Basin National Park. The USDA Forest Service and the Bureau of Land Management are focusing on 200,000 acres of basin-and-range lands in eastern Nevada. Further, the U.S. Fish & Wildlife Service is also interested in using these methods for the 1.5 million-acre Desert National Wildlife Refuge.

Conserving and Restoring Bodie Hills
Collaboration supports management decisions

The Bureau of Land Management's Bishop Field Office formed a cooperative agreement with The Nature Conservancy to develop a Conservation Action Plan for approximately 200,000 acres in California's Bodie Hills and northern Mono Basin, a largely unfragmented landscape that includes a diversity of Great Basin ecosystems and only a handful of historic outbuildings. The two organizations and many stakeholders intend to conserve and restore the Bodie Hills by protecting and enhancing its ecological integrity.

LANDFIRE data were a valuable resource that helped the teams assess current ecological conditions. Teams then used predictive ecological models to evaluate possible cost and effectiveness of various management alternatives.

Stakeholders provided significant input to the analysis, which turned up several findings regarding the degree of departure from the natural range of variability, the probable causes of the departure and the potential future departure over the next two decades, assuming the absence of thoughtful ecological management.

Using that information, eight ecological systems were targeted for management action and various strategies were explored using computer simulations to test their effectiveness and return on investment. Because a combined ecologically based and wildfire protection management scenario would meet the conservation and restoration objectives for the least cost for seven of the eight ecological systems, managers chose to use that combination for strategic planning.
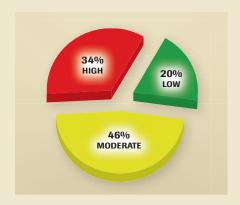
This project has demonstrated the value of collaborative learning, stakeholder input and cost-benefit analysis using LANDFIRE data.

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Conservation organizations, in concert with federal and state agencies and private donors, often work at landscape scales at great cost. The Nature Conservancy and the University of Wisconsin have partnered to develop a process to test potential effectiveness of large-scale strategic planning, such as Working Forest Conservation Easements, using LANDFIRE data and models.

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Ecological Departure

The Nature Conservancy used the LANDFIRE National FRCC map to characterize ecological conditions for the lower 48 states. This analysis showed that approximately two-thirds of the conterminous United States is naturally vegetated and, therefore, is assigned an FRCC ecological departure value. The remaining one-third of land cover is characterized as either agricultural or urban land cover, or sparsely or non-vegetative land cover such as water, snow/ ice or barrens. It was found that within the naturally vegetated areas, approximately three-quarters of the land cover is moderately to highly departed from its reference condition (red and yellow in chart above). Results also showed that two-thirds of the naturally vegetated areas inside federally administered lands are moderately to highly departed.

Regional Fire Risk Assessments

Human and fiscal impacts of wildfire are issues at all scales, from communities and states to large geographical regions. Community Wildfire Protection Plans are designed toward understanding local wildfire threats; states have undertaken tailored analyses specifically to address their needs; regional assessments are under way in every portion of the country, and planners are using LANDFIRE National and LANDFIRE Rapid Assessment data to inform decisions at even larger landscape levels. The Northern Risk Assessment, organized and conducted by the USDA Forest Service, used LANDFIRE data extensively in its analysis. In addition, certain LANDFIRE spatial layers are being considered by both the Southern Wildfire Risk Assessment and the Western Fire Risk Assessment as managers conduct or update their analyses.

Carbon Rapid Assessment

Under the Energy Independence and Security Act, the U.S. Geological Survey is required to analyze biological and geological carbon stocks and fluxes across the nation. As a first step, a "Rapid Assessment" was conducted in late 2009 first to provide quick, initial information. This carbon rapid assessment relied heavily upon nationally consistent, well-documented LANDFIRE project products, such as historical and current vegetation layers.

Northern Sierra Nevada Climate Change Project

A group of organizations committed to protecting the northern Sierra Nevada, the Northern Sierra Partnership, has launched an effort designed to examine how potential future climates could affect the region's flora and fauna. The project goals are to assess the predicted impacts of climate change on the region and identify cost-effective strategies for maintaining ecosystem resilience in the face of such changes. The project will use LANDFIRE vegetation dynamics models and spatial data in conjunction with local data sets to investigate the effects of climate change, including reduced snowpack, elevated temperature and CO_2 enrichment on vegetation into the future.

Hiawatha National Forest

Representatives of Region 9 (northeast United States) of the USDA Forest Service and The Nature Conservancy are collaborating to help regional Forest Service planners incorporate LANDFIRE data into their mix, with a focus on the Hiawatha National Forest. The data are being used to inform the Stone-Moss mid-scale planning effort, a western unit of the Hiawatha project that identifies opportunities for management. Using this analysis, the planning team explored which stages of forest development are under- and/or over-represented. Typically for the Great Lakes, older- and all-ages fire-dependent forest development stages are under-represented. LANDFIRE cross-boundary information can provide a true landscape perspective for planners.

Carbon and Air Quality

The use of fire as a conservation tool is threatened by atmospheric carbon and air quality challenges. Smoke modeling at the landscape scale could become a critical part of the decision-making process in the future regulatory environment. In a partnership between The Nature Conservancy, the University of California-Berkeley and Spatial Informatics Group, smoke emissions predictions from a common fire effects prediction model (CONSUME) using LANDFIRE spatial products were compared to predictions using local plot data on four sites in California. Smoke emission predictions were generally higher when LANDFIRE fuel model data were used as compared with local plot data. However, local plot data often were not extensive, nor did they cross ownership boundaries, and thus may be less useful for very large landscapes or regional analyses.

Value of LANDFIRE

The result of five years of concentrated scientific research, repeated expert review and practice in the field, LANDFIRE National data can be — and are being — used at national, regional and large landscape scales. LANDFIRE products have been vetted by numerous organizations and individuals across the nation who bring decades of practical experience to problem-solving and developing important new knowledge and applications.

Often, the products passed intense examination with flying colors, but when adjustments were needed — especially for use at local scales — colleagues and constituents stepped in with appropriate recommendations. The LANDFIRE philosophy is to provide skilled support and informed experience that can help users adapt LANDFIRE products for specific purposes and locations. The application stories included in this book give a glimpse into some of the ways that LANDFIRE proves its worth.

www.landfire.gov
www.tncfire.org/landfire

Where We Go From Here

The LANDFIRE Project is transitioning to the LANDFIRE Program. Leaders recognize that the investment in LANDFIRE is protected by updating and refining the various products. A plan is currently being implemented to do just that — review major products, improve them where possible, and establish a regular update process. The first step, LANDFIRE Refresh, is under way and scheduled to be completed by 2011.

During Refresh, user comments will be compiled and additional data will be collected. Then systematic improvements will be made to address known mapping issues. Spatial data is being updated to ca 2008 from its ca 2001 date in LANDFIRE National. This concentrated effort will continue through the life span of the LANDFIRE Program, and will focus on bringing the latest science and practical experience to the development of even more useful products and applications.

A Biennial Update process comes into play following Refresh, when vegetation and fuels-related spatial products will be updated using remote sensing methods and field data submitted by contributors. To improve overall efficiency and product quality, the LANDFIRE Program is pursuing strong linkages with other national mapping programs such as the Gap Analysis Program (GAP) and Multi Resolution Land Cover (MRLC).

The LANDFIRE Program is alive, adaptive, and continually evolving, serving multiple users — land planners, ecologists, government and private organizations, scientists and academia, to name a few — in as many ways as possible. We have just scratched the surface of the possibilities. These five years of development provide a solid foundation for the extraordinary work that lies ahead.

In order to help make LANDFIRE live up to its potential, please participate in this important work with us.