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Wildfire Risk to Communities:

Methods for developing spatial datasets of landscape-wide wildfire risk components for the United States

A white paper included with:

Scott, Joe H.; Dillon, Gregory K.; Callahan, Michael N.; Jaffe, Melissa R.; Vogler, Kevin C.; Olszewski, Julia H.; Karau, Eva C.; Lazarz, Mitchell T.; Short, Karen C.; Riley, Karin L.; Finney, Mark A.; Grenfell, Isaac C. 2024. Wildfire Risk to Communities: Spatial datasets of landscape-wide wildfire risk components for the United States, Second Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2020-0016-2

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TABLE OF CONTENTS

INTRODUCTION

Background

The Wildfire Risk to Communities project (WRC) was created in response to direction by the U.S. Congress in the 2018 Consolidated Appropriations Act (i.e., 2018 Omnibus Act, H.R. 1625, Section 210: Wildfire Hazard Severity Mapping). That legislation directed the USDA Forest Service to develop and publish, within two years, national geospatial products depicting wildfire hazard and risk for communities across the United States. The focus of the legislation was firmly on communities. The intent was to help U.S. communities understand components of their relative wildfire risk profile, the nature and effects of wildfire risk, and actions they can take to mitigate risk.

To meet the intent of the Omnibus Act, the Forest Service formed a team of experts to develop the necessary data and build a website for effective delivery of information to communities. The team consisted of wildfire analysts from the Fire Modeling Institute (FMI), part of the Forest Service's Rocky Mountain Research Station (RMRS), and wildfire modeling and geospatial data experts at Pyrologix, LLC. A non-profit partner, Headwaters Economics, also became a critical player in developing the public-facing website with interactive maps and charts, and clear communication targeted to local government officials and private citizens who could take actions to mitigate risks in their communities.

The result of those initial efforts was the Wildfire Risk to Communities website (www.wildfirerisk.org) that was launched in April 2020. The data products published in that initial rollout were built on the nationwide wildfire hazard data from Short et al. (2020a), and they represented the first time wildfire risk to communities had been mapped nationally with consistent methodology down to the level of individual communities (Scott et al. 2020a, 2020b). The data provided foundational information for comparing the relative wildfire risk among populated communities in the United States.

Data Update

Wildfire hazard reflects the overall likelihood and probable intensity of wildfire, and it is not static through time. It is influenced by the condition of vegetation and other burnable materials (i.e., fuels) and by temperature, moisture, and other dynamic elements of the fire environment. When the first version of WRC data was released in 2020, they were based on ground conditions as of the end of 2014. This lag of six years reflects the enormous amount of work involved in updating vegetation and fuel maps across the United States and the running wildfire simulation modeling for such a large area. It was always our intent that those initial data products would be the first of many versions, with data updates as frequently as possible and practical.

This second release of WRC data (WRC 2.0) represents the first update to our initial data products. The methods used to generate the hazard and risk data for this update differ in many ways from those used in the initial 2020 release. For updated annual Burn Probability, we collaborated with scientists at the RMRS Missoula Fire Sciences Lab to perform a new set of wildfire simulations covering the Conterminous United States (CONUS), Alaska, and Hawaii using the FSim large fire simulator. Details on that effort can be found in Dillon et al. (2023). Important differences in the hazard data from version 1.0 to version 2.0 include:

- The fuelscape (set of spatial data layers that describe fuels, vegetation, and topography inputs for fire behavior modeling) used for WRC 1.0 represented conditions at the end of 2014, whereas the fuelscape used for this update represents conditions at the end of 2020.
- The overall fire occurrence time period used for WRC 1.0 is 1992 – 2015, whereas the fire record used for this update includes 1992 – 2020.
- The period of daily temperature and precipitation observations used to generate input weather for WRC 1.0 modeling was 1979 – 2012. The period used for WRC 2.0 was 2004 – 2018, both shorter and more recent.

For the remaining hazard measures, which are all related to fire intensity, we did not use FSim's flame-length probability results. Instead, we used WildEST, a fire characteristics modeling utility developed by Pyrologix[1]. WildEST performs a comprehensive set of FlamMap[2] (Finney 2006) runs spanning the full range of weather-related characteristics that occur during a fire season and then integrates those runs into a variety of results based on the relative likelihood of those weather types occurring. WildEST accounts for the influence of non-heading fire intensity (i.e., backing and flanking fire, not in the primary direction of fire growth) using the relative distribution of fire intensity around an elliptical fire perimeter (Scott 2020). These FlamMap-based WildEST results were chosen for this update over FSim's fire intensity results because they are calculated at the native 30-m resolution of the fuel data, which provides significantly greater spatial detail than the 270-m resolution of the FSim data.

For this update, the WildEST results produced are:

- flame-length probabilities (FLPs)
- conditional Flame Length (CFL)
- flame-length exceedance probabilities for flame lengths of
    - four feet (FLEP4; the limit of manual control),
    - eight feet (FLEP8; the limit of mechanical control).

From those primary results we produced all-lands rasters for Conditional Risk to Potential Structures and Risk to Potential Structures (described below).

In addition, we calculated Wildfire Hazard Potential at a 30-m cell size using the 30-m WildEST FLPs instead of the FSim FLPs. Additional details on the methods used for intensity-related measures are provided later in this document.

Another reason for periodic updates to the WRC data — beyond changes in wildfire hazard (as captured by the modeling efforts mentioned above) — is that the communities, and the buildings and homes within them that may be at risk, also change over time. In this update, we also

[1] Reference in this report to any product, service, enterprise, or individual, including any written works (i.e., books, articles, papers), is not an endorsement and does not imply official government sanction or endorsement of those entities or their views.

[2] https://www.firelab.org/project/flammap

incorporated new and improved building footprint datasets as well as updated population and housing-unit information from the U.S. Census Bureau. Those updates influence the suite of data products published separately that focus specifically on populated areas.

This purpose of this white paper is to provide a description of the methods used in updating the spatial datasets representing landscape-wide characteristics of wildfire hazard and risk for the WRC 2.0 data release. There are two companion papers: one that describes methods for populated areas datasets, and one that details the process we used to summarize those data for communities in the United States (Jaffe et al. 2024) and delineate Community Wildfire Risk Reduction Zones (Dillon et al. 2024).

Data Overview

The data included in this publication depict components of wildfire hazard and risk for all lands in the United States. The focus is on exposure of housing units to wildfire if a home were present at each location across the landscape. We do not consider exposure of other assets or resources that might be affected by wildfire.

A related assessment of wildfire hazard and risk in the populated areas of the nation – where housing units are currently present – is provided and documented in a separate publication (Jaffe et al. 2024).

When the data for WRC 1.0 were published, the landscape-wide data publication (Scott et al. 2020) included tabular summaries of hazard and risk by states, counties, and communities. The accompanying white paper included descriptions of the summary fields and methods. With this release for WRC 2.0, we have chosen to include tabular summaries and descriptions with the data publication for the Community Wildfire Risk Reduction Zones (Dillon et al. 2024) because those zones were used in the summary process.

DATA AND METHODS

Input Datasets

The input datasets used to produce the updated 30-m all-lands hazard and risk data for the Wildfire Risk to Communities project include datasets related to fuel and topography, land cover, and burn probability. We describe those input datasets in the following sections.

The most recent version of LANDFIRE data available at the time of processing was the foundation for fuel, topography, and land cover. The required data exist in three different spatial domains; each domain used a different spatial reference (projection) (see table below).

Spatial domain	LANDFIRE version		Projection
Conterminous U.S. (CONUS)	2.2.0	LF 2020	Albers CONUS
Alaska (AK)	2.2.0	LF 2020	Albers AK
Hawaii (HI)	2.2.0	LF 2020	Albers HI

Fuel and topography

The Burn Probability raster for this update (see below) was produced using fuel and topography data from LANDFIRE 2.2.0. This version of LANDFIRE data reflects fuel disturbances occurring through the end of 2020. One minor edit to the off-the-shelf fuel data was required to calibrate fire occurrence in northern Minnesota[3].

The WildEST modeling was performed on a fuelscape provided by the Risk Management Assistance (RMA) program of the USDA Forest Service Fire & Aviation Management office. The 2023 RMA fuelscape was used for its 2023 national wildfire risk assessment.[4] LANDFIRE 2.2.0 surface and canopy fuel input rasters were updated to reflect fuel disturbances that occurred in 2021 and 2022 using a simplified process developed for keeping a fuelscape up-to-date (Gannon, personal communication). The fuels used for modeling intensity, therefore, reflected conditions as of the end of 2022.

For use in the WRC project, the 2023 RMA fuelscape was updated with the same edit described above for northern Minnesota.

Land cover

We used the LANDFIRE FBFM40 raster data to identify burnable vs non-burnable and habitable vs uninhabitable land covers. Non-burnable land cover was defined as areas mapped by LANDFIRE as any of the non-burnable fuel models in the Scott and Burgan Fire Behavior Fuel Models (FBFM40) raster: urban (91), permanent snow/ice (92), non-burnable agriculture (93), open water (98) and bare ground (99) (LANDFIRE 2020, Scott and Burgan 2005). We considered everything else burnable land cover. The burnable land cover raster was used at both 30-m and 270-m resolution in our raster processing described below. Habitable land cover was defined as all land cover types except open water and permanent snow/ice.

Burn probability

The Burn Probability (BP) input dataset (Dillon et al. 2023) was developed by the USDA Forest Service RMRS Missoula Fire Sciences Lab and Pyrologix. They used the fire simulation system (FSim; Finney et al. 2011) to simulate at least 20,000 fire season iterations in each of 136 distinct regions of contemporary wildfire activity (pyromes) across the United States (Short et al. 2020b). In each pyrome, modeling outputs were calibrated to fire occurrence records representing the period 2006-2020 (Short 2022). The resulting national dataset of annual burn probability has a spatial resolution of 270 m. In the national 270-m dataset, all burnable pixels at the 270-m cell size have valid non-zero values, and all non-burnable pixels have a value of zero.

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[3] The canopy base height was lowered in two EVTs historically prone to crown fire behavior. Without the adjustment, fire simulations resulted in underburns only, so both probability and intensity were underpredicted.

[4] https://experience.arcgis.com/experience/f9d7f7f920494c3db43a23a8dffe4664

Fire Intensity

This version of WRC wildfire intensity data uses the WildEST utility rather than using intensity results from FSim. For the nationwide simulations used in the Wildfire Risk to Communities project, FSim is limited to a relatively coarse resolution of 270-m for both burn probability and fire intensity. By using WildEST we were able to use the native 30-m resolution fuelscape available from LANDFIRE. As noted above, this process also allowed us to capture the effects of wildfires and other fuel disturbances that occurred through the end of 2022. Disturbances can alter the potential intensity of future fires more directly than they affect burn probability. Pairing more current, and finer-resolution intensity data (*circa* 2023) with slightly older (*circa* 2021) burn probability provided a viable solution for producing the most current national risk maps possible with available data and technology.

The WildEST utility used here is a custom implementation of the USDA Forest Service FlamMap fire modeling system (Finney 2006) that produces landscape-scale spatial data representing flame-front characteristics. WildEST incorporates the USDA Forest Service WindNinja model[5] (Forthofer et. al 2014) to adapt the general wind speed and wind direction to reflect the influence of topography, and also makes use of the dead fuel moisture conditioning feature of FlamMap, so sheltered fuel complexes (higher canopy cover or more northerly aspect, for example) have higher dead fuel moisture contents than exposed fuel complexes.

WildEST uses FlamMap to calculate headfire intensity (i.e., in the primary direction of fire growth) for the full range of possible weather conditions, which are classified into 216 weather types based on wind speed (nine classes), wind direction (eight classes) and fine dead fuel moisture content (three classes), and then uses the relative frequency of each weather type to give weight to each FlamMap run.

For producing flame-length probabilities (FLPs), spread in non-heading directions was accounted for using the approach described by Scott (2020).

Methods

The approaches used to produce the national wildfire hazard datasets do not account for fire spread into developed housing areas that are typically mapped as non-burnable. LANDFIRE data show most developed areas as “non-burnable” because those areas are not covered by wildland fuel and are therefore not appropriate for simulation with wildland fire spread models. As a result, the simulated wildfires do not penetrate into developed housing areas. Wildfires have been known to ignite urban conflagrations that spread through developed areas for quite some distance. These events are rare, but their effects are devastating. Fire scientists are working toward the ability to simulate fire spread in both wildland and developed urban and suburban fuels. Until such models are available for use within a Monte Carlo simulator such as FSim, post-processing of modeling results can emulate penetration of wildfire into otherwise non-burnable developed urban areas.

[5] https://www.firelab.org/project/windninja

For the Wildfire Risk to Communities project, we attempted to mimic the effects of wildfire penetration into communities by estimating burn probability and fire intensity in otherwise non-burnable areas adjacent to burnable fuels using GIS methods for spatially smoothing data. Fires originating in smaller blocks of contiguous fuel are assumed to have less ability to ignite urban conflagrations. To account for this, we identified and set aside patches of burnable fuel less than 500 ha in size (Stewart et. al, 2007) that were wholly surrounded by non-burnable fuels. These islands often represent urban parks and other relatively small remnants of natural vegetation interspersed in mostly developed settings. Details of this approach are described later in this document.

Specific methods for each dataset are described in the sections that follow.

Burn Probability (BP)

Burn probability (BP) is a 30-m raster representing the *circa* 2021 annual likelihood of burning in a given location. The effects of fuel disturbances that occurred in 2021 or later are not reflected in this BP raster. BP is referred to as Wildfire Likelihood in the Wildfire Risk to Communities web application. We generated the Wildfire Risk to Communities BP raster using a multi-stage raster geoprocessing-based resampling and smoothing processes applied to the most recent nationwide 270-m BP results from Dillon et al. (2023). To be most useful to communities, we downscaled the national results to a finer spatial resolution. The downscaling method we developed for this project involved resampling to a finer resolution, a process we refer to as raster upsampling. We did not re-simulate wildfire hazard at finer resolution than the native national FSim resolution of Dillon et al. (2023) or use statistical downscaling methods common with broad-scale climate data. Our raster upsampling approach, described in detail below, instead used a series of iterative resampling steps. We chose to upsample to the native 30-m resolution of the nationally-available LANDFIRE fuel and vegetation data (LANDFIRE 2.2.0). Following the upsampling step we then “oozed” BP into adjacent developed areas, as described below.

Step 1: Upsampling

We used the following six-step raster upsampling process to convert the national 270-m BP raster to 30-m resolution.

1. Convert zero values to nodata in 270-m data
2. Two successive 3x3 moving-window averages at 270 m
3. Revert remaining nodata pixels back to zero at 270 m
4. Resample to 30-m resolution (cubic convolution method)
5. Set BP to zero for open water and snow/ice land covers at 30 m
6. Set negative BP to zero

The first step in the upsampling process was to convert the 270-m pixels with a BP value of zero to nodata. This enables the second step to work as desired. In step 2, we used two successive 3x3 moving-window means on the 270-m raster to smooth the data and fill in the 270-m cells for which BP was initially zero. This process replaced many zero values in the 270-m data with the mean of the non-zero cells immediately surrounding them. The two low-pass filters at 270-m resolution filled in pixels within 540 m of a burnable pixel. In step 3, we then reverted the remaining nodata values back to zero and then, in step 4, resampled the resulting raster to 30 m using cubic convolution. The cubic convolution resampling method does some interpolation among the upsampled 30-m cells within each 270-m cell. In step 5, we used a processing mask derived from the 30-m LANDFIRE fuels data to set the BP to zero for open water and snow/ice land covers. The cubic convolution also resulted in some BP values below zero, and we set these back to zero in step 6.

Step 2: Estimating wildfire hazard in developed areas (Oozing)

As mentioned above, we attempted to mimic wildfire penetration into developed ("non-burnable") areas adjacent to large, contiguous areas of wildland fuels. A first step in doing this was to identify islands of burnable fuel smaller than 500 ha using the 30-m burnable-fuel raster. We then temporarily set the non-zero BP values within the patches to nodata. This prevented oozing BP values from those patches, reflecting the relatively low probability of small, vegetated patches to start urban conflagrations. For all other areas mapped with non-zero BP values (in contiguous patches larger than 500 ha), we expanded BP values into adjacent non-burnable areas through the following process:

1. Set nodata pixels in the 30-m upsampled BP raster to zero, except in areas of open water, snow/ice, and the small burnable islands.
2. Run three successive 510-m moving-window averages (i.e., 510-m radius, circular focal means). This effectively allowed BP values to spread into developed areas, bare ground, and agricultural areas, but not into water, snow, ice, and small burnable islands.
3. After smoothing, set the final BP value in small burnable islands to the larger of their original value and the smoothed value.

This method results in BP values that rapidly diminish with increasing distance into non-burnable areas.

The total distance BP values are spread into non-burnable areas using this approach is 1,530 m (approximately 1 mile), as the cumulative result of three iterative focal mean operations. This total distance is slightly less than the 2.4-km (1.5-mile) distance from large, contiguous areas of wildland vegetation currently used to map the "interface" category of Wildland Urban Interface (WUI) in the United States (Urban Wildland Interface Communities 2001; Radeloff et al. 2023). In a study of buildings destroyed in 70 large wildfires from 2000 to 2018, Caggiano et al. (2020) found that all structures lost to wildfire were within 850 m (approximately 0.5 mile) of wildland vegetation. Some notable and destructive fires from the past several years — the Coffee Park portion of the 2017 Tubbs Fire, the 2021 Marshall Fire, the 2023 Lahaina Fire — have destroyed homes closer to 1.5 km (1 mile) from wildlands. Therefore, we feel our distance of approximately 1 mile strikes a balance between being conservative and pragmatic and is generally consistent with published science and recent observations.

Conditional Flame Length (CFL)

Conditional Flame Length (CFL) is a 30-m raster representing the mean headfire flame length at a given location if a fire were to occur. It is a measure of average wildfire intensity. CFL was calculated using a process based on WildEST flame-length results. FlamMap was executed 216 times, producing flame-length rasters reflecting a range of weather types – combinations of wind speed, wind direction and moisture content scenario. These 216 flame-length rasters were combined into a weighted mean as the sum-product of flame-length and weather-type probability across all weather types.

$$CFL = \sum_{i=1}^{216} FlameLength_i \times WeatherTypeProbability_i$$

Conditional Flame Length was not oozed into developed areas.

Flame Length Exceedance Probability—4 feet (FLEP4)

FLEP4 is a 30-m raster representing the conditional probability that flame length at a pixel will exceed 4 feet if a fire occurs. FLEP4 indicates the potential that wildfire intensity will be beyond the ability of hand crews to control. We generated the Wildfire Risk to Communities FLEP4 by first using the same WildEST process used for CFL to produce flame-length probabilities (FLPs) (described above). FLEP4 is found by summing the FLPs that represent flame lengths above 4 feet after accounting for spread and intensity in non-heading directions (Scott 2020). As with all wildfire intensity rasters presented here, it represents fuel characteristics at the beginning of the 2023 fire season.

FLEP4 was not oozed into developed areas.

Flame-length exceedance probability—8 feet (FLEP8)

FLEP8 is a 30-m raster representing the conditional probability that flame length at a pixel will exceed 8 feet if a fire occurs. FLEP8 indicates the potential for high wildfire intensity that is considered the limit of mechanical fire control. We generated the Wildfire Risk to Communities FLEP8 raster by first using the same WildEST process used for CFL to produce flame-length probabilities (FLPs) (described above). FLEP8 is found by summing the FLPs that represent flame lengths above 8 feet after accounting for spread and intensity in non-heading directions (Scott 2020). As with all wildfire intensity rasters presented here, it represents fuel characteristics at the beginning of the 2023 fire season.

FLEP8 was not oozed into developed areas.

Exposure Type

We generated the Exposure Type raster by applying the oozing process described above for burn probability using the LANDFIRE 2.2.0 fuels data as the primary input. First, we assigned a value of one to all burnable pixels and a value of 0 in all non-burnable pixels in the 2023 RMA fuelscape. Then we applied the spatial oozing used for BP (three iterative 510-m focal means) to spread values into otherwise non-burnable areas, using the same steps described above to handle small patches of burnable vegetation and other land cover types.

The resulting exposure type values range from 0 to 1. Where the underlying land cover is considered burnable in the LANDFIRE fuels data, the value of the Exposure Type raster is 1 indicating pixels where a home would be "directly exposed" to wildfire. Where land cover is non-burnable developed, agricultural, or bare ground and the upsampled and oozed BP is non-zero (i.e., within approximately 1 mile of a 500-ha contiguous area of burnable vegetation), homes would be "indirectly exposed" to wildfire. The value of Exposure Type in these areas is between 1 and 0, varying by distance to burnable fuels, with pixel values decreasing toward 0 as distance from burnable fuel increases. Finally, where the land cover is non-burnable and the upsampled and smoothed BP is zero, the value of the Exposure Type raster is 0 indicating pixels where a home would have little-to-no exposure to wildfire due to its distance from a large contiguous patch of burnable vegetation.

Conditional Risk to Potential Structures (cRPS)

Conditional Risk to Potential Structures (cRPS) is a 30-m raster that represents the potential consequences of fire to a home or other structure at a given location if a fire were to occur there and if a home were located there. It is a measure that integrates the expected range of wildfire intensities with generalized consequences to a structure on every pixel but does not account for the annual probability of fire occurrence. It is analogous to conditional Net Value Change (cNVC) described by Scott and Thompson (2015). cRPS is referred to as Wildfire Consequence in the Wildfire Risk to Communities web application.

We calculated the initial cRPS raster at 30-m by applying one of three response functions representing the relative effect of wildfire on structures (i.e., relative degree of damage or loss) at different intensities to the 30-m flame-length probability (FLP) rasters produced by WildEST. Response functions were developed for three lifeforms separately: grass/herbaceous, shrub, and tree and reflect the assumption that consequence is greatest in tree fuels, lower in shrubs, and lowest in grass fuels, across all intensity levels. A value of 0 means no damage to a structure, and a value of -100 means complete loss. We applied the response function to all pixels across the landscape, even if no structures are present.

The response function values used were:

Lifeform	FLP1	FLP2	FLP3	FLP4	FLP5	FLP6
Tree	-25	-40	-55	-70	-85	-100
Shrub	-20	-35	-50	-65	-80	-95
Grass	-10	-25	-40	-55	-70	-85

We then created the final 30-m cRPS raster by using a modified version of the oozing approach described above for BP that oozes the same distance but does not decay the cRPS values. To avoid decaying cRPS with distance, the cRPS values for nonburnable pixels were set to nodata from zero before the three iterative 510-m moving-window means.

Risk to Potential Structures (RPS)

Risk to Potential Structures is a 30-m raster that integrates wildfire likelihood and intensity with generalized consequences to a home on every pixel. For every place on the landscape, it poses the hypothetical question, "What would be the relative risk to a structure if one existed here?" It asks that question whether a home actually exists at that location or not. This allows comparison of wildfire risk in places where homes already exist to places where new construction may be proposed. This dataset is referred to as Risk to Homes in the Wildfire Risk to Communities web application.

We calculated the RPS raster at 30-m resolution by multiplying the 30-m cRPS raster (representing the intensity and susceptibility components of risk) by the 30-m BP raster (representing wildfire likelihood). Just as cRPS is analogous to conditional Net Value Change (cNVC), RPS is analogous to the expected Net Value Change (eNVC) presented by Scott et al. (2013). The equation for RPS is simply:

$$RPS = cRPS * BP$$

It is important to note that by using consistent response functions for all homes we assume that all homes are equally susceptible to wildfire. In reality, an individual home's ability to survive wildfire is driven largely by local conditions that can be highly affected by a homeowner's or community's efforts toward mitigating wildfire susceptibility. The condition of vegetation in the immediate area around a home (known as the "Home Ignition Zone") and the construction materials used in building a home (Quarles et al. 2010) could result in very different response function values for individual homes (Cohen 2019). Consideration of this local variation in susceptibility is well beyond the scope of the Wildfire Risk to Communities project, and RPS should be considered a landscape metric rather than specific to any one home.

Wildfire Hazard Potential (WHP)

Wildfire Hazard Potential is a 30-m raster that quantifies the relative potential for wildfire that may be difficult to control. It is an index developed by the U.S. Forest Service to inform prioritization of fuel treatment needs at a national scale (Dillon et al. 2015). WHP integrates wildfire likelihood and intensity with additional factors including historic ignition density of small fires and the relative resistance to control posed by wildfire in different fuel types. Similar to the response functions used in calculating cRPS, WHP also applies weights to different fire intensities. A complete description of the WHP methods is available in Dillon et al. (2015). A national 270-m version of WHP produced entirely from the FSim BP and FLPs produced by Dillon et al. (2023) is available at Dillon (2023).

For this update, we calculated WHP at 30-m resolution using the upsampled BP described above and FLP rasters produced at 30-m resolution using WildEST. This represents the first time WHP has been calculated nationwide using intensity data modeled natively at 30-m resolution. Other input data included the Existing Vegetation Type and Scott and Burgan Fire Behavior Fuel Model rasters from LANDFIRE Version 2.2.0 (LANDFIRE 2020), as well as the most recent national Fire Occurrence Database (Short 2020).

WHP was not oozed into developed areas.

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Reference in this report to any product, service, enterprise, or individual, including any written works (i.e., books, articles, papers), is not an endorsement and does not imply official government sanction or endorsement of those entities or their views.

REFERENCES

Caggiano, Michael D.; Hawbaker, Todd J.; Gannon, Benjamin M.; Hoffman, Chad M. 2020. Building Loss in WUI Disasters: Evaluating the Core Components of the Wildland–Urban Interface Definition. Fire, 3, 73. https://doi.org/10.3390/fire3040073

Cohen, Jack. 2019. An analysis of wildland-urban fire with implications for preventing structure ignitions. White Paper. https://www.eenews.net/assets/2019/01/08/document_gw_02.pdf

Dillon, Gregory K. 2023. Wildfire Hazard Potential for the United States (270-m), version 2023. 4th Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2015-0047-4

Dillon, Gregory K.; Lazarz, Mitchell T.; Karau, Eva C.; Story, Scott J.; Pohl, Kelly A. 2024. Community wildfire risk reduction zones for the United States. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2024-0030

Dillon, Gregory K.; Menakis, James; Fay, Frank. 2015. Wildland fire potential: A tool for assessing wildfire risk and fuels management needs. In: Keane, Robert E.; Jolly, Matt; Parsons, Russell; Riley, Karin. Proceedings of the large wildland fires conference; May 19-23, 2014; Missoula, MT. Proc. RMRS-P-73. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 60-76. https://www.fs.usda.gov/treesearch/pubs/49429

Dillon, Gregory K.; Scott, Joe H.; Jaffe, Melissa R.; Olszewski, Julia H.; Vogler, Kevin C.; Finney, Mark A.; Short, Karen C.; Riley, Karin L.; Grenfell, Isaac C.; Jolly, W. Matthew; Brittain, Stuart. 2023. Spatial datasets of probabilistic wildfire risk components for the United States (270m). 3rd Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2016-0034-3

Finney, M. A. 2006. In: Fuels management—how to measure success: conference proceedings. 2006 March 28-30; Portland, Oregon. Proceedings RMRS-P-41. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 213-220. (647 KB; 13 pages). https://www.fs.usda.gov/research/treesearch/39312

Finney, Mark A.; McHugh, Charles W.; Grenfell, Isaac C.; Riley, Karin L.; Short, Karen C. 2011. A simulation of probabilistic wildfire risk components for the continental United States. Stochastic Environmental Research and Risk Assessment. 25: 973-1000. https://www.fs.usda.gov/research/treesearch/39312

Forthofer, JM, Butler, BW, Wagenbrenner, NS, (2014) A comparison of three approaches for simulating fine-scale surface winds in support of wildland fire management. Part I. Model formulation and comparison against measurements. Int. J. Wildland Fire, 23:969-981. https://doi.org/10.1071/WF12089. https://www.fs.usda.gov/research/treesearch/47006

Jaffe, Melissa R.; Scott, Joe H.; Callahan, Michael N.; Dillon, Gregory K.; Karau, Eva C.; Lazarz, Mitchell T. 2024. Wildfire Risk to Communities: Spatial datasets of wildfire risk for populated areas in the United States. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2020-0060-2

LANDFIRE, U.S. Department of the Interior, Geological Survey. 2020. LANDFIRE 2.2.0 Scott and Burgan Fire Behavior Fuel Models (FBMF40) and Existing Vegetation Type (EVT) layers. https://www.landfire.gov/

Quarles, Stephen L.; Valachovic, Yana; Nakamura, Gary M.; Nader, Glenn A.; and De Lasaux, Michael J. 2010. University of California Agricultural and Natural Resources Publication 8393. Davis, CA: University of California. https://anrcatalog.ucanr.edu/pdf/8393.pdf

Radeloff, Volker C.; Helmers, David P.; Mockrin, Miranda H.; Carlson, Amanda R.; Hawbaker, Todd J.; Martinuzzi, Sebastián. 2023. The 1990-2020 wildland-urban interface of the conterminous United States - geospatial data. 4th Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2015-0012-4

Scott, Joe H. 2020. A deterministic method for generating flame-length probabilities. In: Hood, Sharon M.; Drury, Stacy; Steelman, Toddi; Steffens, Ron, [eds.]. Proceedings of the Fire Continuum-Preparing for the future of wildland fire; 2018 May 21-24; Missoula, MT. Proceedings RMRS-P-78. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 195-205. https://www.fs.usda.gov/research/treesearch/62336

Scott, Joe H.; Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p. https://doi.org/10.2737/rmrs-gtr-153

Scott, Joe H.; Thompson, Matthew P. 2015. Emerging concepts in wildfire risk assessment and management (Publ.). In: Keane, Robert E.; Jolly, Matt; Parsons, Russell; Riley, Karin. Proceedings of the large wildland fires conference; May 19-23, 2014; Missoula, MT. Proc. RMRS-P-73. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 196-206. https://www.fs.usda.gov/treesearch/pubs/49444

Scott, Joe H.; Thompson, Matthew P.; Calkin, David E. 2013. A wildfire risk assessment framework for land and resource management. Gen. Tech. Rep. RMRS-GTR-315. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 83 p. https://doi.org/10.2737/rmrs-gtr-315

Scott, Joe H.; Brough, April M.; Gilbertson-Day, Julie W.; Dillon, Gregory K.; Moran, Christopher. 2020a. Wildfire Risk to Communities: Spatial datasets of wildfire risk for populated areas in the United States. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2020-0060

Scott, Joe H.; Gilbertson-Day, Julie W.; Moran, Christopher; Dillon, Gregory K.; Short, Karen C.; Vogler, Kevin C. 2020b. Wildfire Risk to Communities: Spatial datasets of landscape-wide wildfire risk components for the United States. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2020-0016

Short, Karen C. 2022. Spatial wildfire occurrence data for the United States, 1992-2020 [FPA_FOD_20221014]. 6th Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2013-0009.4

Short, Karen C.; Finney, Mark A.; Vogler, Kevin C.; Scott, Joe H.; Gilbertson-Day, Julie W.; Grenfell, Isaac C. 2020a. Spatial datasets of probabilistic wildfire risk components for the United States (270m). 2nd Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2016-0034-2

Short, Karen C.; Grenfell, Isaac C.; Riley, Karin L.; Vogler, Kevin C. 2020b. Pyromes of the conterminous United States. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2020-0020

Stewart, Susan I.; Radeloff, Volker C.; Hammer, Roger B.; Hawbaker, Todd J. 2007. Defining the Wildland–Urban Interface*,* Journal of Forestry*,* Volume 105, Issue 4, June 2007, Pages 201-207, https://doi.org/10.1093/jof/105.4.201

Urban Wildland Interface Communities Within the Vicinity of Federal Lands that are at High Risk from Wildfire (Notice), 66 F.R. 751 (1/4/2001). https://www.federalregister.gov/documents/2001/01/04/01-52/urban-wildland-interface-communities-within-the-vicinity-of-federal-lands-that-are-at-high-risk-from