Northeast Wildfire Risk Assessment
Geospatial Work Group

Area Assessment – Phase 1
January 2010

Executive Summary

The need to have a general baseline geospatial assessment of fire risk which will include an identification of the wildland urban interface areas and communities at risk from wildfire is critical to the Northeastern Area (NA), State Forestry agencies, and the Federal lands of the northeast and midwest US. The projected increase in population, pressure for land use change, the effects of climate change, and declining state budgets, will result in more complex fire suppression strategies. Fire management programs must continue to operate strategically and efficiently to meet this paradigm.

In the State and Private Forestry Redesign, states will be required to prepare State Forest Resource Assessments and Strategies. It is suggested in national and regional guidance for geospatial analyses to identify priority areas for wildfire risk mitigation.

Objectives

- To identify the areas in the northeast and Midwest which are prone to wildfire.
- To identify where hazard mitigation practices would be most effective in reducing fire risk within each state.
- To identify and prioritize Communities at Risk from wildfire.
- To focus resources in the areas of greatest need within each state.

Project Status

A Steering Committee with representation from states within the compact areas, Forest Service NA, NRS and R9, DOI agencies and The Nature Conservancy collaborated to develop this project. The group agreed on the objectives the project would address, the scope of the project, an approach to the assessment methodology, and completed a needs assessment for the state level Community at Risk*[1] map. The committee decided to develop a two tiered assessment at the area level and the state level. The assessment product for the twenty state area of the Northeastern Area has been completed.

A Geospatial Work Group (GWG) was convened in April 2009 to review data inputs for the draft area assessment and state assessment models. The GWG reviewed data elements, reclassified selected data sets and tested various scenarios to develop the draft area assessment model. Through a series of conference calls and web meetings, the area model was further refined to the project described below. The components which were considered but later discarded are included in Appendix A.

[1] Community at Risk as defined in the National Association of State Foresters documents: Field Guidance Identifying and Prioritizing Communities at Risk, June 27, 2003; and the Briefing Paper Communities at Risk: Commitments and Expectations, January 10, 2006. A community is defined as "a group of people living in the same locality and under the same government" (*The American Heritage Dictionary of the English Language*, 1969). A community is considered at risk from wildland fire if it lies within the wildland/urban interface as defined in the federal register (*FR Vol. 66, No. 3, Pages 751-754, January 4, 2001)*. In the context of the National Fire Plan, "communities-at-risk" refers to communities that at are at risk from destruction or damage from wildfire.

Participants in the GWG included representatives of the following organizations: Michigan DNR; Ohio DNR; Wisconsin DNR; The Northeast Forest Fire Compact; The Nature Conservancy; USFS Northern Research Station; USFS Region 9 National Forest System; and USFS Northeastern Area State and Private Forestry.

Model Schematic and Area Assessment:
The NWRA area assessment is comprised of three modules: Fuels, Wildland Urban Interface (WUI) and Topography. These are combined using a weighted overlay to develop an output assessment. A mask is used to eliminate urban areas and open water from consideration to produce the final area assessment.

The following weights were used to determine the percent influence for each input layer:
Fuels– 80 %
WUI – 10%
Topography – 10%

The map is intended to be a general depiction of the wildfire risk (areas prone to wildfire) across the twenty northeastern states.

Due to variances in the reliability of the input data; the scale at which this analysis was conducted; and the range of fuels and wildfire conditions present throughout the area, conclusions based on the findings of this analysis should be carefully considered. The GWG agreed by consensus that this map generally depicts the relative wildfire risk. It should not be used to describe wildfire risk at the local level.

Recommended guidelines for appropriate display of data:
Using data with 30-meter resolution, the NWRA is primarily a regional planning tool designed to describe broad regional trends. Inquiries regarding units smaller than multi-state regions should be posed to regional experts who may have conducted finer-resolution risk assessments and are familiar with local variation.

To conduct this assessment, the GWG imposed the following data rules:

- Use best available data sets - data development was not feasible.
- Data should be consistent across the 20 state area.
- Data gaps should be identified for consideration in future versions of the NWRA Area Assessment map.

Following is an illustration of the area assessment model for the Northeast Wildfire Risk Assessment as well as the area assessment map.

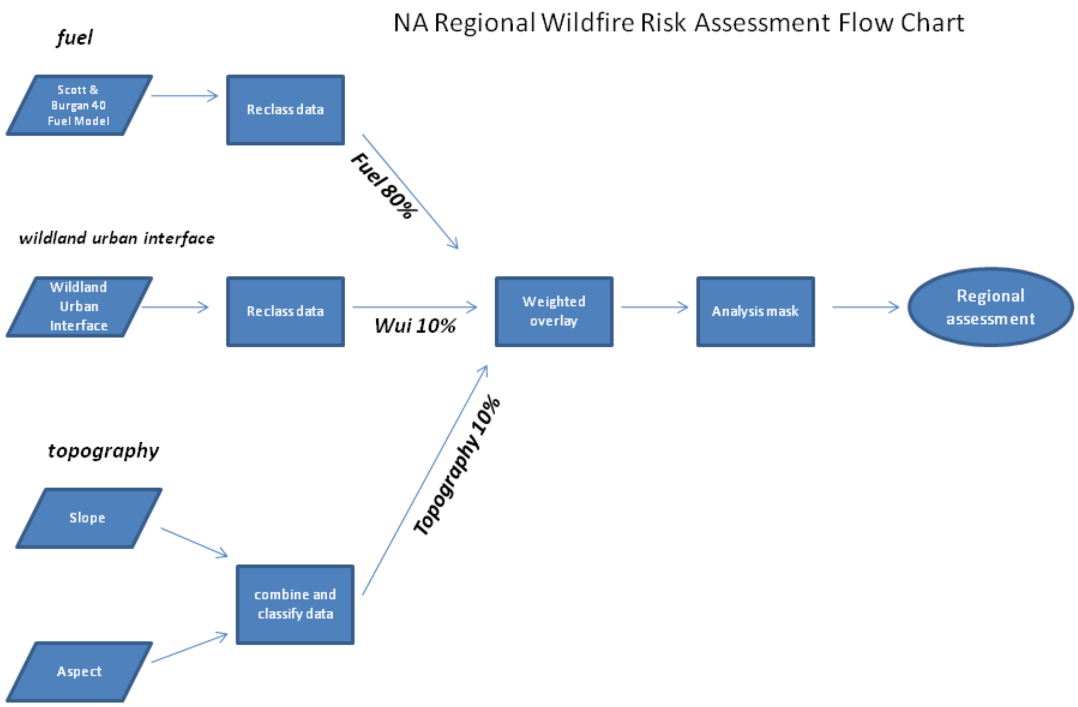
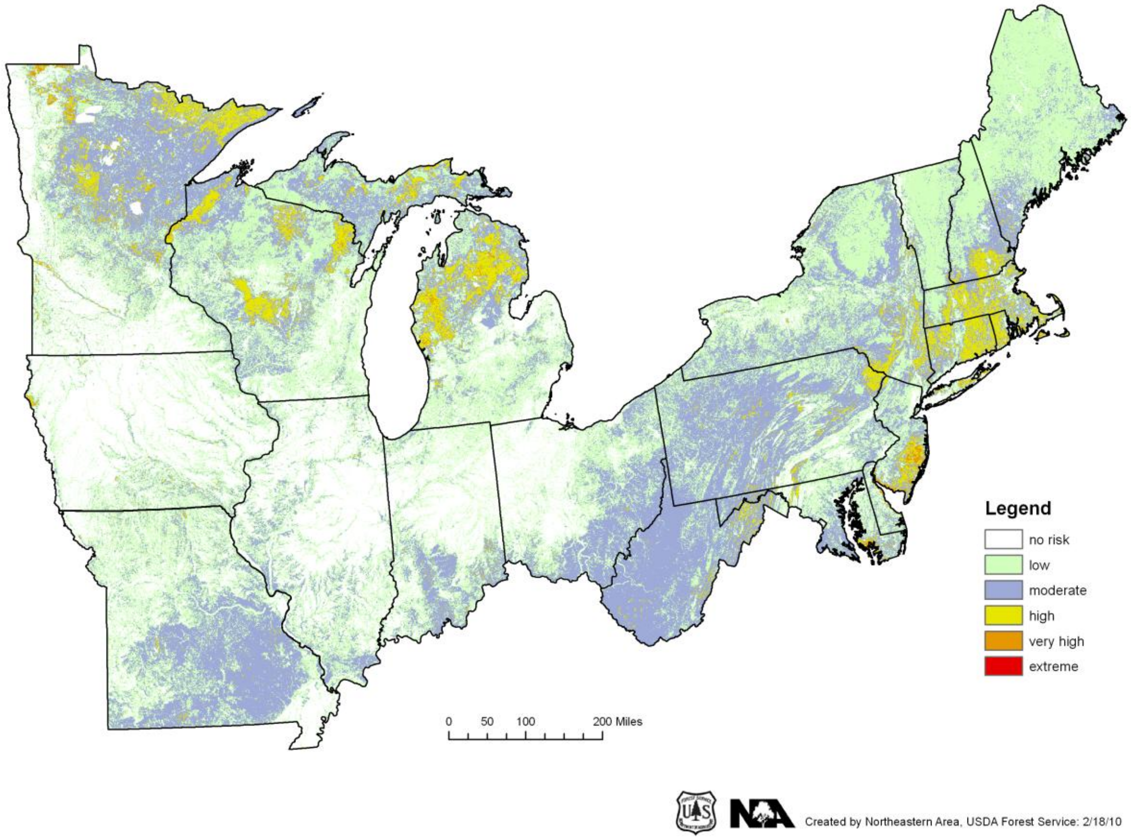


Figure 1 – NWRA Area Assessment Model

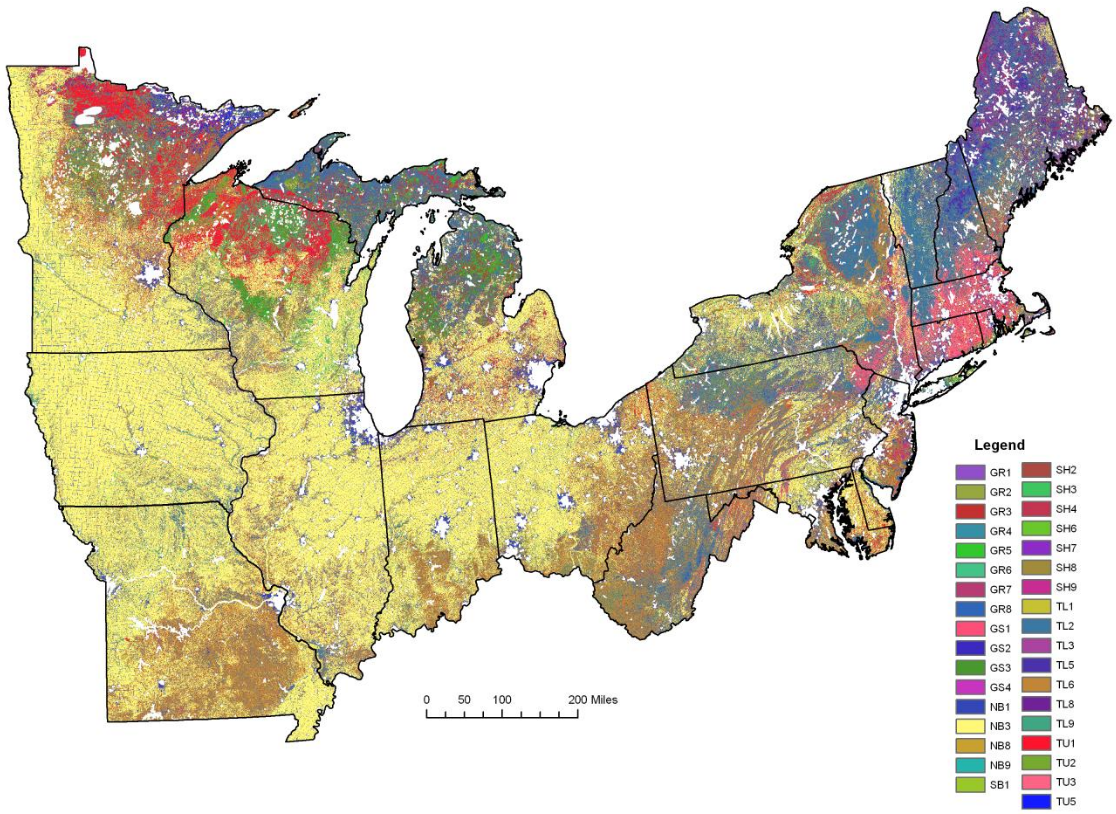


Map1 – NWRA Map

Methodology

Fuels Module:

Data used: LANDFIRE Scott and Burgan 40 Fire Behavior Fuel Model



Map 2 - LANDFIRE Data Layer – Scott and Burgan Fire Behavior Fuel Models

Data Source – LANDFIRE

DATA SUMMARY: These fire behavior fuel models represent distinct distributions of fuel loadings found among surface fuel components (live and dead), size classes and fuel types. The fuel models are described by the most common fire carrying fuel type (grass, brush, timber litter or slash), loading and surface area-to-volume ratio by size class and component, fuelbed depth and moisture of extinction. Further detail can be found in Scott and Burgan (2005)[2] and Rothermel

[2] 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.

(1983)[3]. This data layer contains a complete set of fire behavior fuel models for use with Rothermel's fire spread models. Characteristics of the new fuel model set, its development and its relationship to the original set of 13 fire behavior fuel models can be found in Burgan (2005).

Reclassification
The reclassification data was supplied by Terry Gallagher, USFS. The data was reclassed using the following methodology.
Using the Fuel Model Comparison Chart[4], the predicted flame lengths were determined for each of the 40 Scott and Burgan Fire Behavior Fuel Models under two sets of fire weather and fuel conditions:

Average fire season
Slope: 0%
Dry fuel moisture: 1 hr – 6%; 10 hr – 7%; 100 hr - 8%
Fuels: 30% Herbaceous; 60% Woody
Wind Speed: 6 mph

Drought condition
Slope: 0%
Dry fuel moisture: 1 hr – 3%; 10 hr – 4%; 100 hr - 5%
Fuels: 30% Herbaceous; 60% Woody.
Wind Speed: 6 mph

The resulting flame length outputs were then correlated to a ranking based on Rothermel's Fireline Intensity Interpretations[5]. Each FBFM received a ranking of 0-5. The 40 S&B FBFM data was reclassed under both conditions and the output data was examined by the GWG.

It was determined by the Geospatial Work Group in the comparison of the 'average' and 'drought' reclassed map products that the 'drought' condition data results reflected FBFM conditions across the area than the data from the average fire season conditions. The group determined that the drought map would be used in the model.

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[3] Rothermel, Richard C. 1983. How to predict the spread and intensity of forest and range fires. Gen. Tech. Rep. INT-143. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 161 p.
This manual documents procedures for estimating the rate of forward spread, intensity, flame length, and size of fires burning in forests and rangelands. Contains instructions for obtaining fuel and weather data, calculating fire behavior, and interpreting the results for application to actual fire problems. This is a companion publication to "INT-GTR-142: Field procedures for verification and adjustment of fire behavior predictions" by R. C. Rothermel and G. C. Rinehart.

[4] 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. Chart shown in Appendix B. See pages 8-12.
This report describes a new set of standard fire behavior fuel models for use with Rothermel's surface fire spread model and the relationship of the new set to the original set of 13 fire behavior fuel models. To assist with transition to using the new fuel models, a fuel model selection guide, fuel model crosswalk, and set of fuel model photos are provided.

[5] Rothermel, Richard C. 1983. How to predict the spread and intensity of forest and range fires. Gen. Tech. Rep. INT-143. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 161 p.

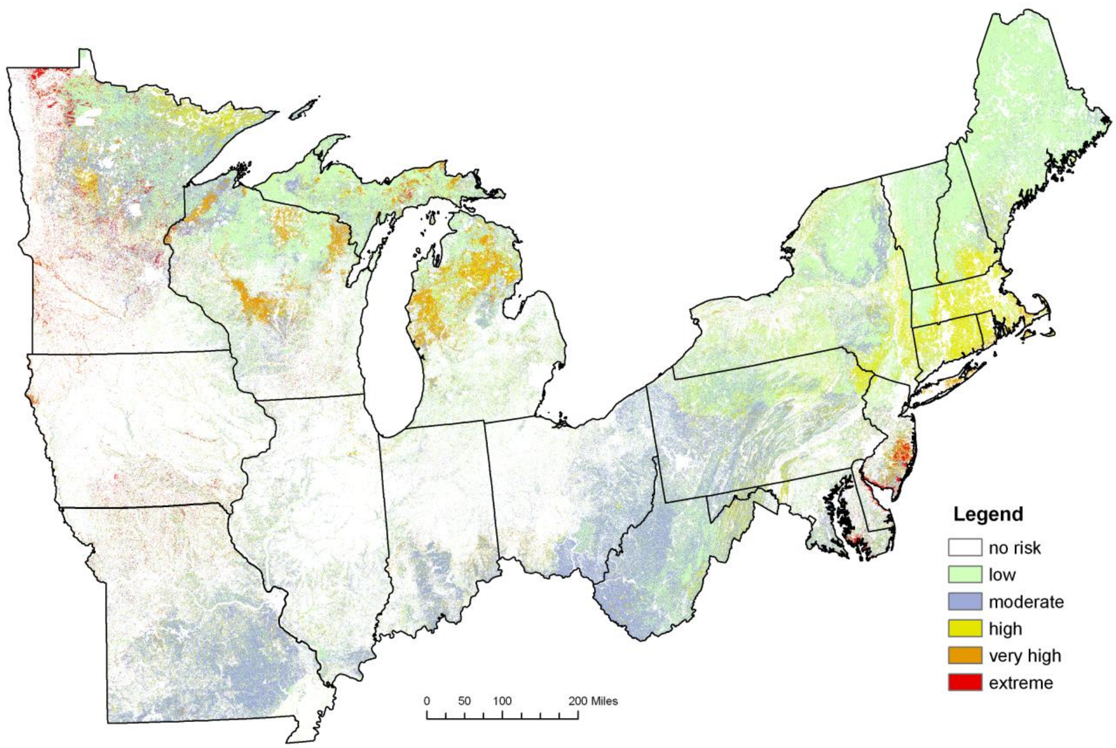
Data values for pixels:
Zero value class is non-burnable.
Low –1
Moderate – 2
High – 3
Very High – 4
Extreme - 5

The following table shows the data that was derived from the reclassification methodology. The corresponding map product is displayed after the data.

40 Scott and Burgan FBFM Risk Ranking (10/2009)			
FBFM40	Fuel Model Name	Flame Length*	Risk Ranking
NB1	Urban/Developed	0	0
NB3	Agricultural	0	0
NB8	Open Water	0	0
NB9	Bare Ground	0	0
GR1	Short, Sparse Dry Climate Grass	3	1
GR2	Low Load, Dry Climate Grass	7	2
GR3	Low Load, Very Coarse, Humid Climate Grass	11	3
GR4	Moderate Load, Dry Climate Grass	13	4
GR5	Low Load, Humid Climate Grass	17	4
GR6	Moderate Load, Humid Climate Grass	22	5
GR7	High Load, Dry Climate Grass	28	5
GR8	High Load, Very Coarse, Humid Climate Grass	37	5
GS1	Low Load, Dry Climate Grass-Shrub	5	2
GS2	Moderate Load, Dry Climate Grass-Shrub	8	3
GS3	Moderate Load, Humid Climate Grass-Shrub	13	4
GS4	High Load, Humid Climate Grass-Shrub	23	5
SH2	Moderate Load, Dry Climate Shrub	7	2
SH3	Moderate Load, Humid Climate Shrub	3	1
SH4	Low Load, Humid Climate Timber-Shrub	11	3
SH6	Low Load, Humid Climate Shrub	13	4
SH7	Very High Load, Dry Climate Shrub	19	4
SH8	High Load, Humid Climate Shrub	14	4
SH9	Very High Load, Humid Climate Shrub	24	5
TU1	Low Load Dry Climate Timber Grass Shrub	3	1
TU2	Moderate Load, Humid Climate Timber-Shrub	5	2
TU3	Moderate Load, Humid Climate Timber-Grass-Shrub	11	3
TU5	Very High Load, Dry Climate Timber-Shrub	10	3
TL1	Low Load Compact Conifer Litter	1	1

TL2	Low Load Broadleaf Litter	1	1
TL3	Moderate Load Conifer Litter	1	1
TL5	High Load Conifer Litter	3	1
TL6	Moderate Load Broadleaf Litter	4	2
TL8	Long Needle Litter	5	2
TL9	Very High Load Broadleaf Litter	7	2
SB1	Low Load Activity Fuel	4	2

**Predicted flame length for each fuel model was determined by using the Fuel Model Comparison Chart with the following parameters: 0% slope; Dry fuel moisture: 1 hr – 3%; 10 hr – 4%; 100 hr - 5%;Fuels: 30% Herbaceous; 60% Woody at a Midflame Wind Speed of 6 mph.*



Map 3 - NWRA 40 Scott and Burgan Fire Behavior Fuel Model – Drought condition - reclassified

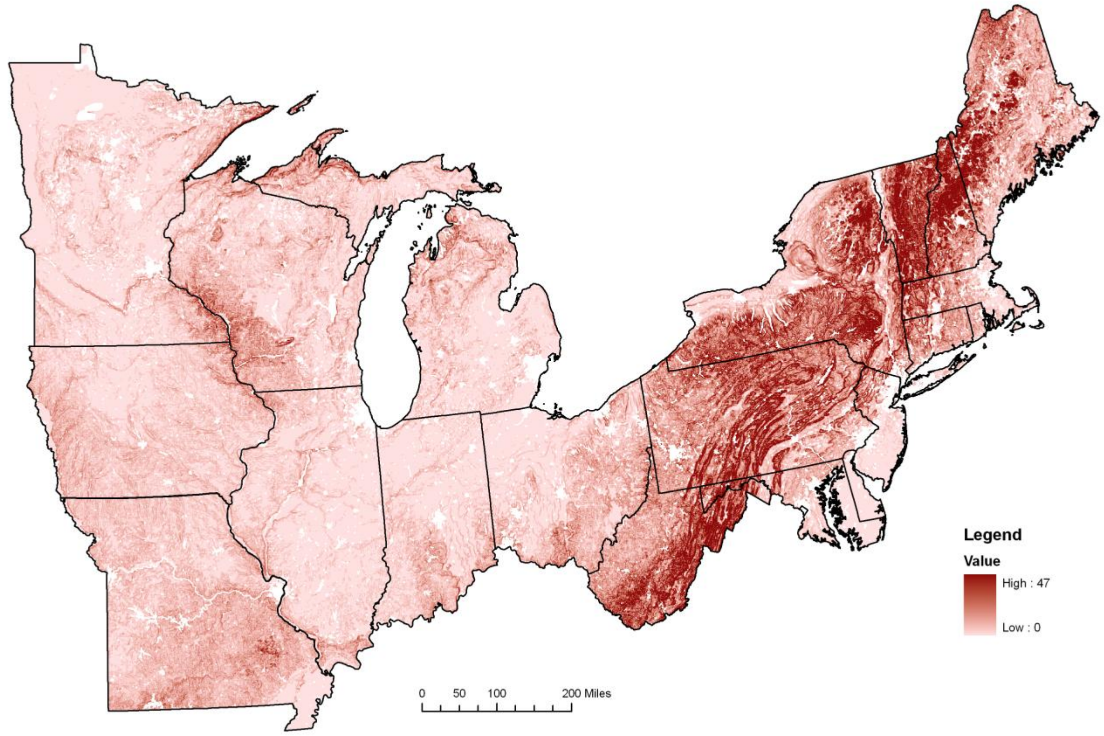
Interpretation

The first map shown, LANDFIRE Scott and Burgan 40 Fire Behavior Fuel Models, shows the relative distribution of fuel models in the twenty northeast and Midwest states. The reclassified map shown above illustrates how these fuel models correlate to wildfire risk under a general set of conditions in which all areas of the study area would experience wildfire activity.

Topography Module

The topography module combines two LANDFIRE data layers: Slope and Aspect. The purpose of the Topography Module is to account for those contributory aspects of topography which can increase wildfire risk across the area. The reclassification of each layer is described below.

Slope

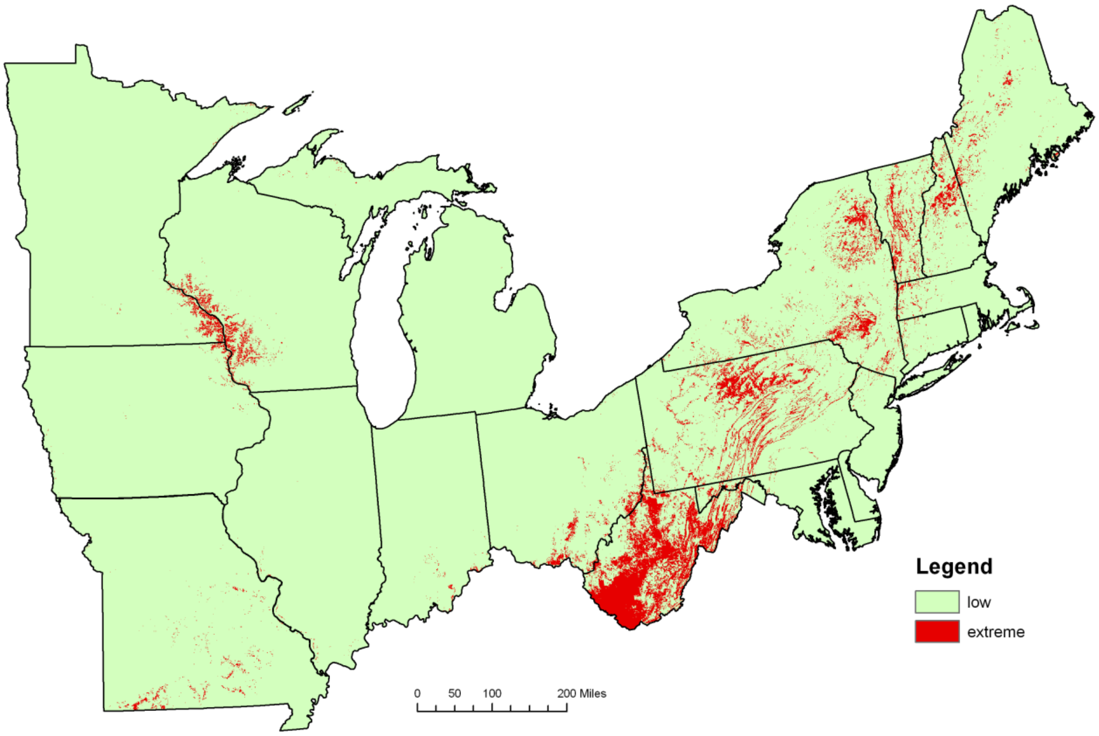


Map 4 - LANDFIRE Data Layer: Slope

Data Source – LANDFIRE
Purpose:
The slope grid provides value between 0 and 90 degrees that represent the deviation from the horizontal elevation.

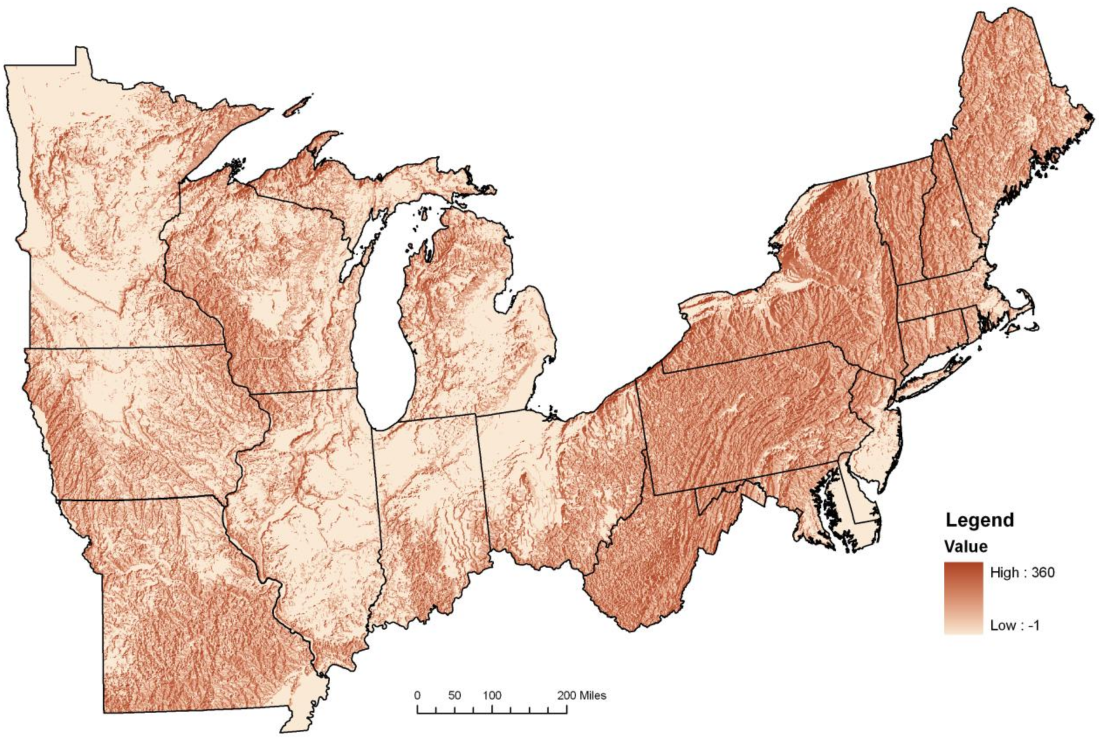
Data value of pixels:
Low – 1
Extreme - 5

The slope map used in the Topography Module identifies only those pixels where slope is greater than 20%.



Map 5 - NWRA Slope – selected data

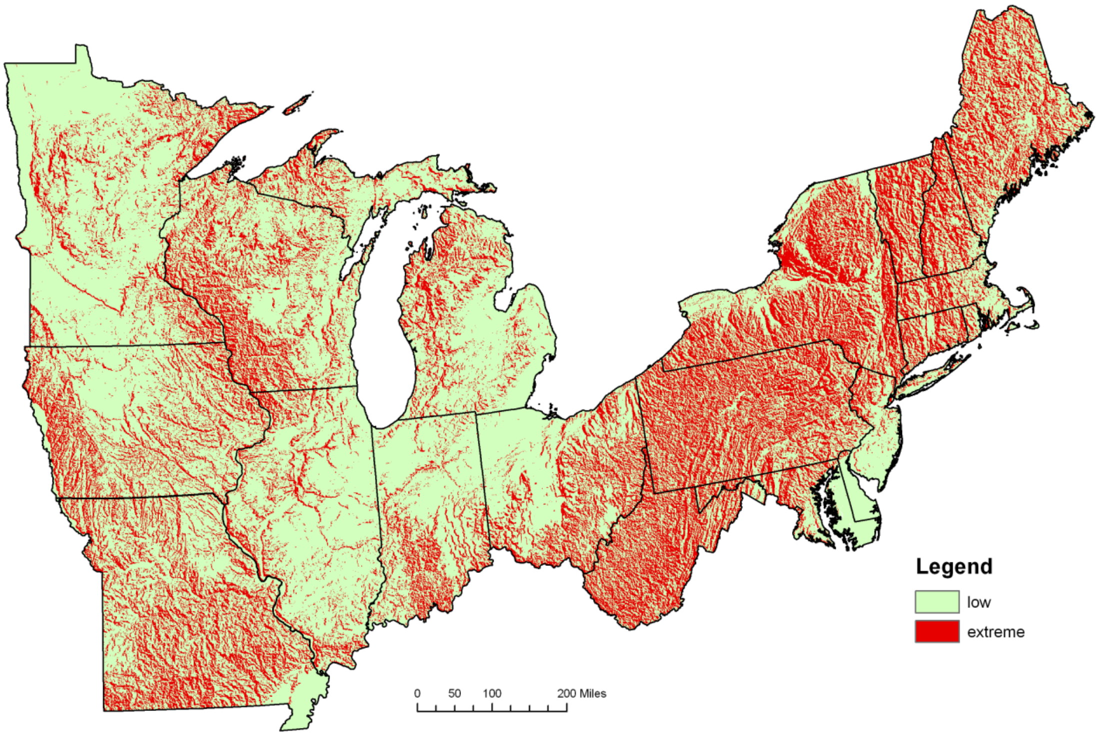
Aspect



Map 6 - LANDFIRE Data Layer - Aspect

Data Source – LANDFIRE

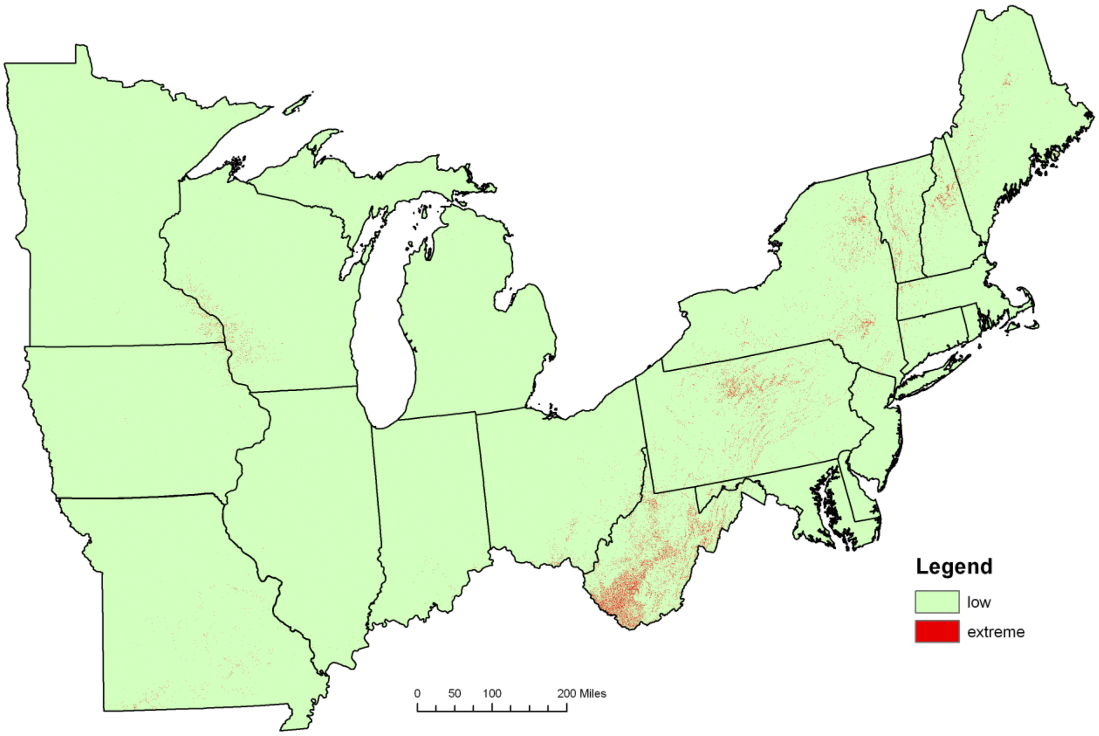
For the purposes of this project, this map identifies those pixels which range between 135 and 315 degrees. Within this range, solar heating of fuels is expected to contribute to an increase in the wildfire risk.
Data value of pixels:
Low – 1
Extreme – 5



Map 7 - NWRA Aspect – selected data

Topography Module
The topography input combines the NWRA Slope and NWRA Aspect maps. The output map contains only those pixels which have both slope greater than 20% and the aspect is between 135 and 315.

Value of Pixels
Low – 1
Extreme – 5



Map 8 – NWRA Topography Module

Wildland Urban Interface Module
This module addresses the ignition potential caused by human activity in the model. The occurrence and location of wildland fire reflects the activities of humans who cause fires and potentially increase the wildland fire risk factor. Data that may typically illustrate this would include fire occurrence data. In the Northeastern Area, fire occurrence data is not currently collected in a consistent manner to apply to an area assessment with reliability. It is recognized that a missing component is the incidence of wildfire due to humans while recreating. Inclusion of this type of data would enhance the human caused element.

Wildland Urban Interface

Data Source Silvis Lab, University of Wisconsin; USFS

http://silvis.forest.wisc.edu/maps.asp

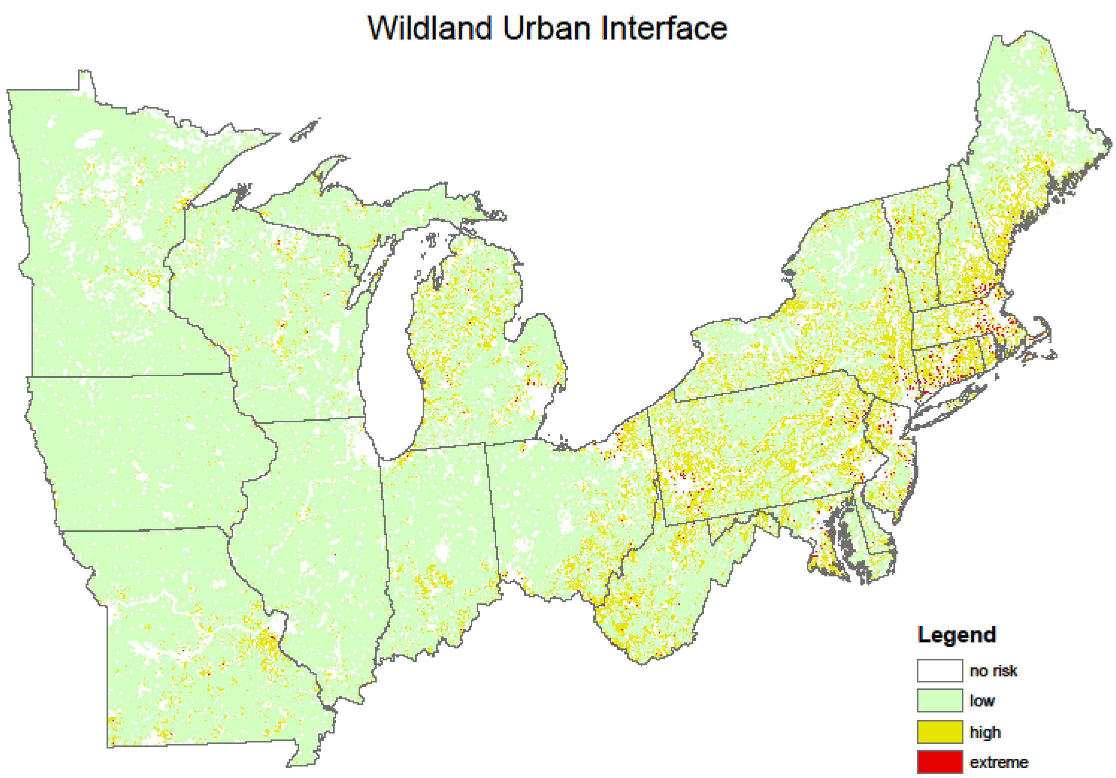
Data Summary: The Wildland Urban Interface (WUI) is the area where houses meet or intermingle with undeveloped wildland vegetation. This makes the WUI a focal area for human-environment conflicts such as wildland fires, habitat fragmentation, invasive species, and biodiversity decline. U.S. Census and USGS National Land Cover Data were used to map the Federal Register definition of WUI (Federal Register 66:751, 2001). Two types of WUI were mapped: intermix and interface. Intermix WUI are areas where housing and vegetation intermingle; interface WUI are areas with housing in the vicinity of contiguous wildland vegetation.

WUI Reclassification

The reclassification scheme for this data in the project was provided by Courtney Klaus, Wisconsin DNR. The Northeastern and North Central data was reclassed using the following methodology.

Extreme: High Density Intermix, Medium Density Intermix, High Density Interface
High: Medium Density Interface, Low Density Interface, Low Density Intermix
Low: All other "non-wui" classifications

Data values for pixels:
Low – 1, High – 3, Extreme - 5



Map 9 – NWRA Wildland Urban Interface Module - reclassified

Data challenges

- *Availability of consistent data for all 20 states* – At times this limited the data that was available for this first version of the area model. An example would be the impact of humans in determining wildfire risk. There is no consistent data collection methodology for recording fire occurrence throughout the 20 states.
- *LANDFIRE data and calibration schedule* – Due to the nature of the LANDFIRE data development and calibration schedule, participation in the calibration sessions was inconsistent. The calibration sessions provided the opportunity for the field to examine the fuel and vegetation layers and work with the LANDFIRE team to modify the data to match ground conditions. Lack of participation for various reasons may account for Fuels Module data not correlating to ground conditions.
- *Errors in original LANDFIRE data* – If a vegetation type is misclassified in the original/underlying data, then it will carry through to the other data products. There are some known errors in the LANDFIRE 40 S&B FBFM data and the Existing Vegetation Type (EVT) data layers. Errors in the original data may be corrected through participation in the LANDFIRE Refresh process which will accept corrections to the data.

Identified Data Gaps/Data Potential

Fire Occurrence – Inconsistent fire occurrence data has been previously identified as a concern. The potential necessity of this data could be tested by combining with WUI data with fire occurrence data in an area/state with complete fire history data sets. Data from the states of West Virginia or New Jersey could be used as an example to test.

Integrated Moisture Index[6] – Iverson et al have developed the Integrated Moisture Index for a study area in Ohio. Soil and topographic features are integrated using GIS into an index which has been shown to be statistically related to many ecological processes which are related to water availability across landscapes including understory vegetation patterns, species richness, and litter depth. Testing within the model would include replacing the topographic data with reclassed IMI data to determine the potential need to develop IMI for future versions of the area assessment.

FlamMap[7] – FlamMap is a fire behavior mapping and analysis program that computes potential fire behavior characteristics over a landscape for constant weather and fuel moisture conditions. The use of FlamMap to produce maps of potential fire behavior characteristics and environmental conditions for the area and used within the fuels module may produce a more refined wildfire risk map.

Insects and Diseases – Incorporation of Forest Health data sets into future versions of the area assessment would be valuable.

Storm damage/large fire events – LANDFIRE data products are current to circa 2000. Large fire events and storm damage which has occurred since the year 2000 are not reflected in the data.

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[6] Louis R. Iverson, Martin E. Dale, Charles T. Scott and Anantha Prasad. A GIS-derived integrated moisture index to predict forest composition and productivity of Ohio forests (U.S.A.). Landscape Ecology **12**: 331–348, 1997

[7] FlamMaphttp://firemodels.fire.org/content/view/14/28/

Participation in LANDFIRE Refresh will update the data products to 2008. Participation in Refresh is important as well as documentation planning for future events.

Testing the model

It is appropriate to test this model by comparison to other data sets or data products to gauge its relative accuracy. Potential testing scenarios for this model include:

- Use of the NASF fire occurrence data as is – overlaying fire occurrence on the final assessment map.
- Large fire occurrence - overlay this data set, if available, on the final assessment map.
- Use of the National Fire Potential map – overlay data on the area assessment
- Use one or more state wildfire risk assessment maps to overlay on the area data for comparison

Future modifications/maintenance of the Area Assessment

Periodic updating of the project will be necessary and the frequency will be dependent on the availability of new data inputs as well as concurrence with the Northeast Forest Fire Supervisors. It is proposed that an interagency group convene every two years beginning in 2011 to review and update the assessment products. New WUI data will be available in 2010. LANDFIRE products will be updated through LANDFIRE Refresh every two years. Data development should occur in preparation for updating the assessment.

Appendix A

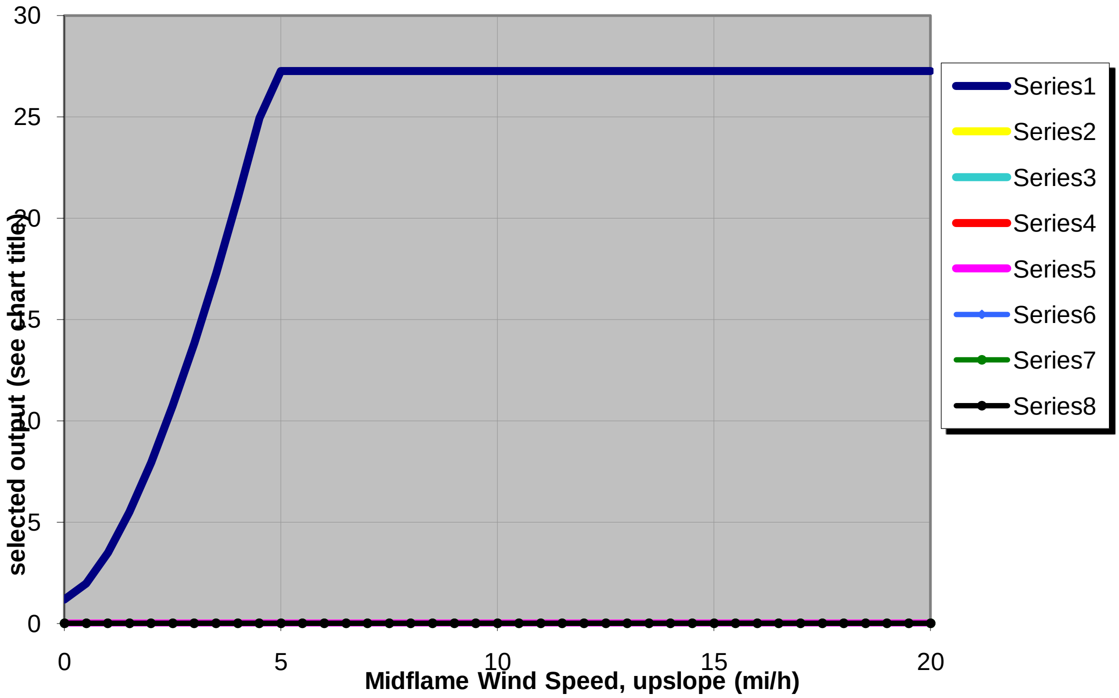
Data elements given consideration in the model but not included

Data considered	**Module**	**Reason for exclusion**
LANDFIRE Environmental Site Potential (ESP)	Fuels	The reclass of the Environmental Site Potential layer was problematic. The group could not determined a consistent method to determine the relative ranking of the type classes within this data.
LANDFIRE Biophysical Setting (BpS)	Fuels	After examination, the group decided to eliminate this layer as it does not reflect the relative fuels risk in the NA.
LANDFIRE Existing Vegetation Type	Fuels	This data is used to develop the Scott and Burgan 40 FBFM data
LANDFIRE Existing Vegetation Cover (EVT)	Fuels	Redundancy issue with EVT and Scott and Burgan 40 FBFM data
Development Risk and Forest Fragmentation data from: http://svinetfc4.fs.fed.us/clearinghouse/index.html	WUI	The WUI data will most likely be better data than Development Risk and Forest Fragmentation. Determined there would most likely be redundancy or no value added to include these data layers.
LANDFIRE Elevation	Topography	Did not provide any value to the model.
STATSGO Soils data http://dbwww.essc.psu.edu/dbtop/doc/statsgo/statsgo_info.html#over		This may be getting too complex for the regional assessment. Landfire data incorporates a lot of the biophysical settings. This data may be used for the vegetation potential on soils and would be useful in determining gaps in vegetation data layer.
NLCD data http://www.epa.gov/mrlc/nlcd-2001.html Land cover, Impervious surfaces and Canopy cover		Canopy cover and understory: In this data set canopy cover data is a percent of forest cover. The base height data is a broad range. So, not sure how much this data would add to the data needed for the project. The data is extrapolated from FIA data then assigned to a large area. Recommend staying with the vegetation height and cover data in Landfire. Forest canopy height is directly derived from the existing vegetation height.

Snow Cover data http://nsidc.org/data/		Derived from the discussion about weather. The only correlation would be in determining the length of fire season: The longer the time without snow cover the longer the fire season. This is not a big factor in the Area assessment. May be useful on the state assessment if the length of the fire season is a significant factor to wildfire risk.
NASF Fire Occurrence data	WUI	Consistent, spatially referenced data is not available for the 20 state area
Wildfire Potential	Fuels	This is 1km data. The metadata on this data set is minimal. Inquiries to the data originators for more information have not been answered. Concerned about the reliability and the ability to document this data.
LANDFIRE Existing Vegetation Height	Fuels	This data is incorporated into the NLCD and Scott and Burgan fuels data.
LANDFIRE Canopy Cover	Fuels	This data is incorporated into the Existing Vegetation Cover data

Appendix B

Fuel Model Comparison Chart



Appendix C

Fireline Intensity Interpretations

Intensity	**Flame length**	**BTU/ft/sec**	**Interpretations**
Low	<4 feet	Less than 100	Direct attack at head and flanks with hand crews, handlines should stop spread of fire
Low-Moderate	4-8 feet	100-500	Employment of engines, dozers, and aircraft needed for direct attack, too intense for persons with hand tools
Moderate	8-11 feet	500-1000	Control problems, torching, crowning, spotting; control efforts at the head are likely ineffective
High	> 11 feet	Greater than 1000	Control problems, torching, crowning, spotting; control efforts at the head are ineffective

Based on: Richard C. Rothermel, How to Predict the Spread and Intensity of Forest and Range Fires, 1983. Gen Tech Repot INT-143 p 59