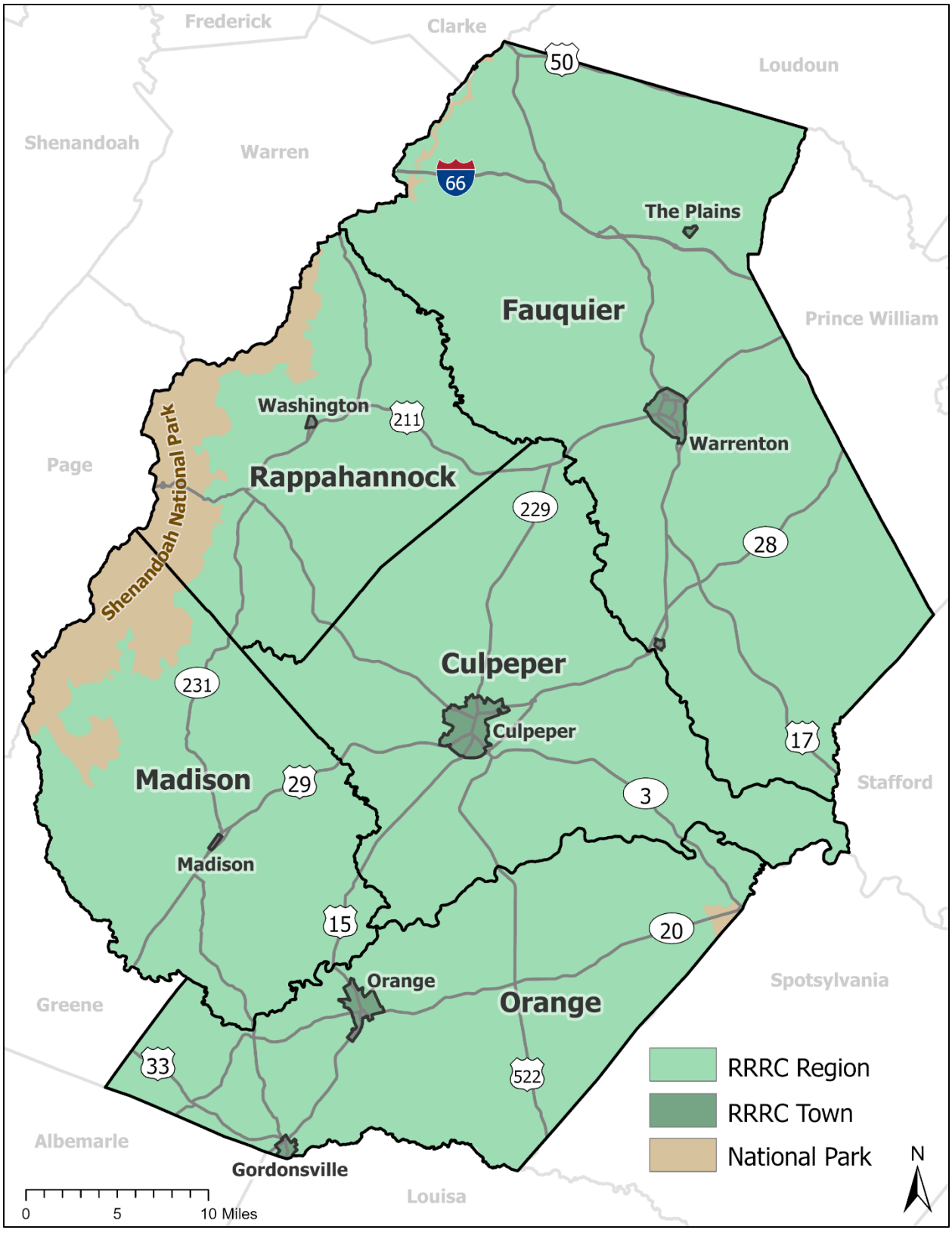
Wildfire Risk Analysis Update

Rappahannock-Rapidan Regional Commission
Planning District 9

Rappahannock Rapidan
Regional Commission
420 Southridge Parkway, Suite 106
Culpeper, VA 22701
April 27, 2022

The Rappahannock–Rapidan Region



Wildfire Risk Analysis

Introduction and Background

The Rappahannock-Rapidan Region is comprised of the Counties of Culpeper, Fauquier, Madison, Orange & Rappahannock and the Towns of Culpeper, Gordonsville, Madison, Orange, Remington, The Plains, Warrenton & Washington in the Commonwealth of Virginia. The density and abundance of forested and wildlands in the Rappahannock-Rapidan Region, in conjunction with periods of high fire danger weather, lead to increased risk of wildfires in the area.

Located just southwest of Washington D.C., the Rappahannock-Rapidan Region lies within both Virginia's Piedmont and Blue Ridge physiographical zones and encompasses over 1,965 square miles of diverse terrain. As a result, the Region consists of large quantities of forests and wildlands, including Shenandoah National Park. Much of the Region is located near or adjacent to these wooded areas, where heavy and dense vegetation serves as a source to fuel wildfires.

Human elements alongside natural and physiographical factors play a role in the risk of wildfires as well. The Region has a growing population of over 180,000, with community development increasing and encroaching upon these previously mentioned wooded areas expanding the Wildland-Urban Interface. This expansion not only raises the likelihood of wildfires occurring due to the uptick in human activity, but it also puts more human life, property, and infrastructure at risk.

This development along with other natural factors such as topography, which helps facilitate the spread of wildfires, all increase the overall danger and risk wildfires pose throughout the region.

Purpose and Process

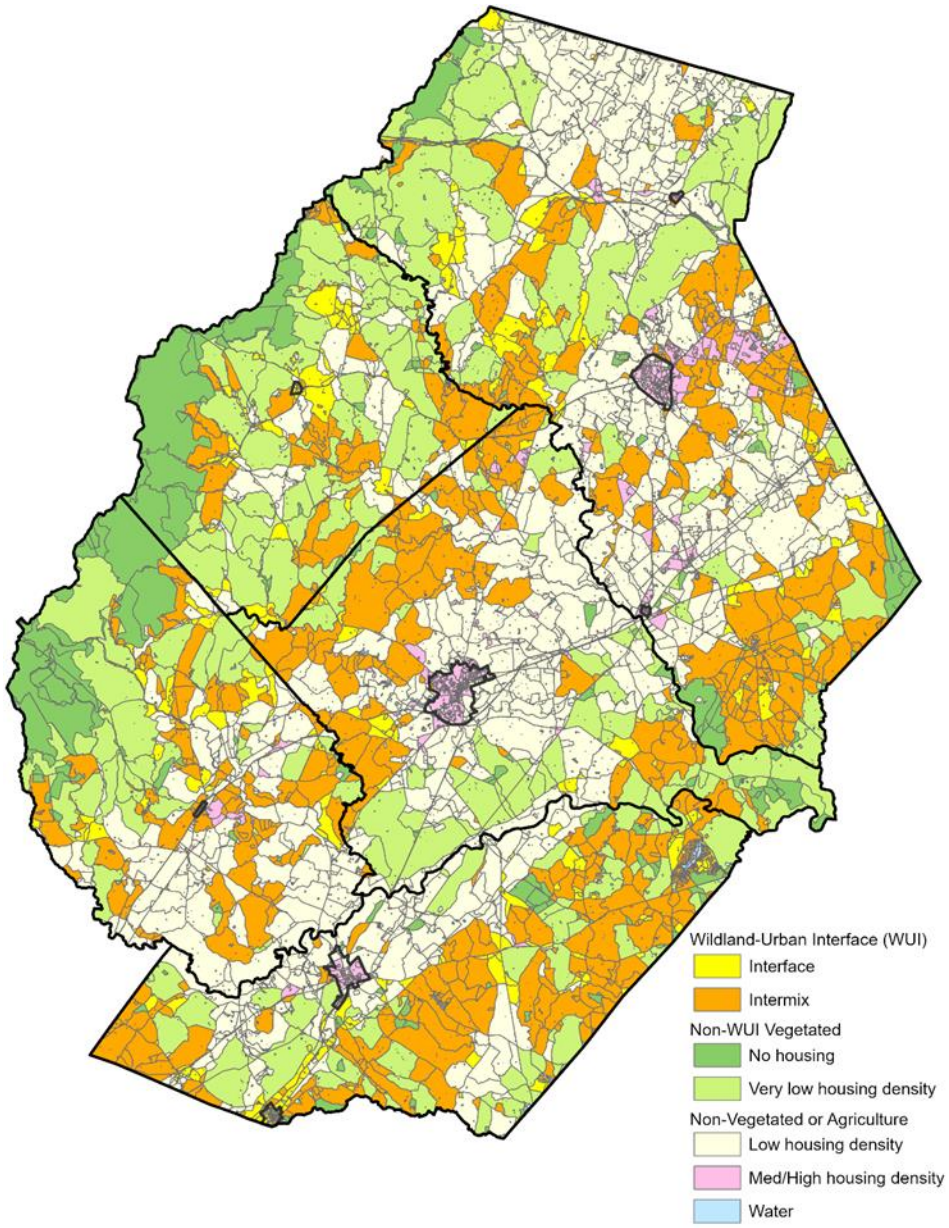
There are three major goals that this wildfire risk analysis update wishes to accomplish. First is the creation of a new regional risk map that helps identify and raise public awareness to areas of high-risk for wildfire development and advancement. Second is to examine the spatial relationships between these high-risk areas with woodland home communities and future growth areas throughout the Region. Third is to act as a blueprint for data collection and analysis for future hazard mitigation planning efforts not only within the Rappahannock-Rapidan Region but for other localities as well. These objectives will be achieved by the utilization of a new regional spatial wildfire risk assessment model.

The process of developing a new regional risk map includes the development of a regional spatial Wildfire Risk Assessment Model utilizing a wide range of data sources. Such a model will allow for the methodologies used in this document to be used again as newly updated data becomes available. This model began development following the Virginia Department of Forestry's Statewide Wildfire Risk Assessment model from 2003. This model was updated with new data sources and tweaked to fit more closely to the Rappahannock-Rapidan region as opposed to a blanket statewide model.

Creating a new regional risk map that identifies high, moderate and low risk areas, along with making accessible the associated data layers created or compiled to create this regional risk map will not only help prevention and mitigation planning but also disaster response readiness towards wildfires in the future as well.

Wildland-Urban Interface (WUI)

The Wildland-Urban Interface (WUI) is described by the U.S. Fire Administration as the zone of transition between unoccupied land and human development. Intermix WUI are areas where housing and vegetation intermingle; interface WUI are areas with housing in the vicinity of contiguous wildland vegetation. The aim of WUI is to show areas within the region that are of higher risk of wildfire development, and acts as a good basis of comparison to the new regional risk map developed for this wildfire risk analysis update



	Intermix		Interface		WUI (total)		Non-WUI	
Culpeper	102.8 mi²	26.9%	8.2 mi²	2.1%	111 mi²	29.0%	271.5 mi²	71.0%
Fauquier	151.9 mi²	23.3%	28.2 mi²	4.3%	180.1 mi²	27.7%	471.1 mi²	72.3%
Madison	65.2 mi²	20.2%	14.1 mi²	4.4%	79.3 mi²	24.6%	242.6 mi²	75.4%
Orange	127.8 mi²	37.2%	19.8 mi²	5.8%	147.7 mi²	43.0%	195.6 mi²	57.0%
Rappahannock	45.5 mi²	17.0%	18.2 mi²	6.8%	63.7 mi²	23.8%	203.3 mi²	76.2%
RRRC Region	493.2 mi²	25.0%	88.6 mi²	4.5%	581.8 mi²	29.5%	1384.1 mi²	70.5%

Wildfire Risk Assessment Model and Data Inputs

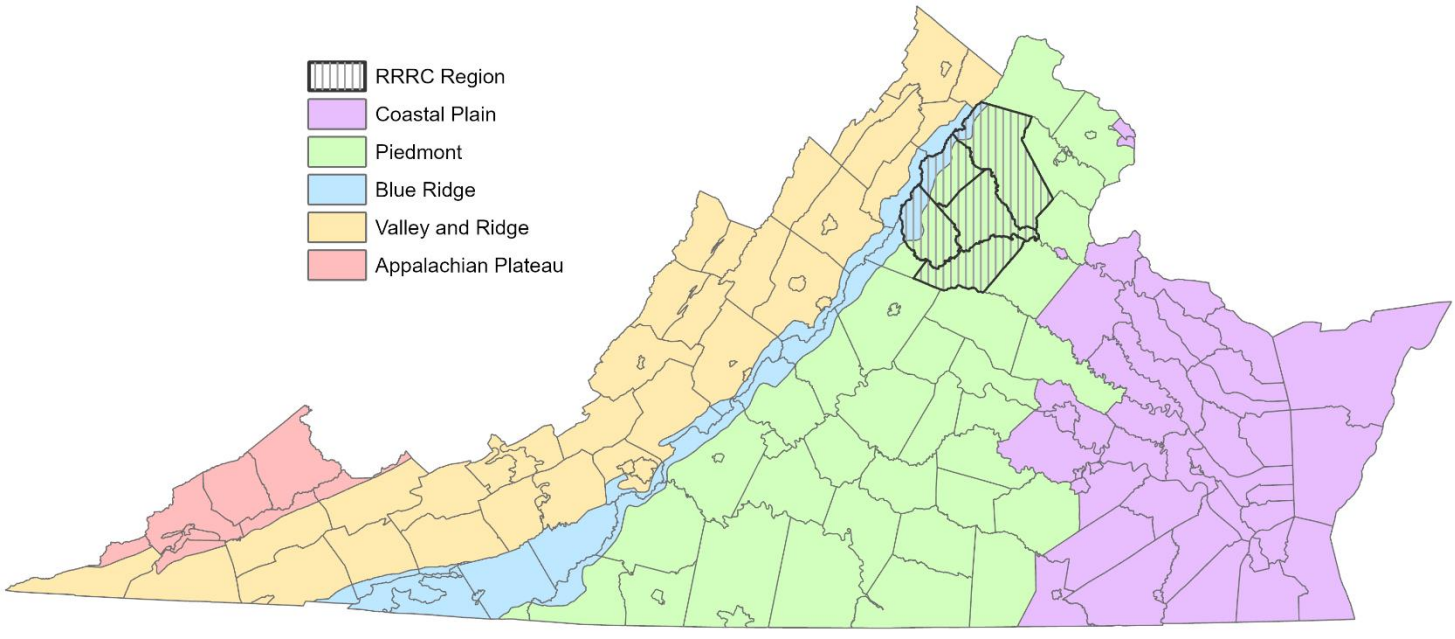
The Wildfire Risk Assessment Model created by RRRC for this wildfire risk analysis update closely follows the methodologies and data sources used by the Virginia Department of Forestry's Statewide Wildfire Risk Assessment model from 2003. These models used are a raster-based weighted aggregate model, which combines all the various data inputs at varying degrees of importance to output a single wildfire risk map.

It was determined that by VDOF that historical fire incidents, land cover, topographic characteristics, population density, and distance to roads were critical variables in a wildfire risk analysis. RRRC gathered each of these data inputs and more from a variety of local, state, and federal sources.

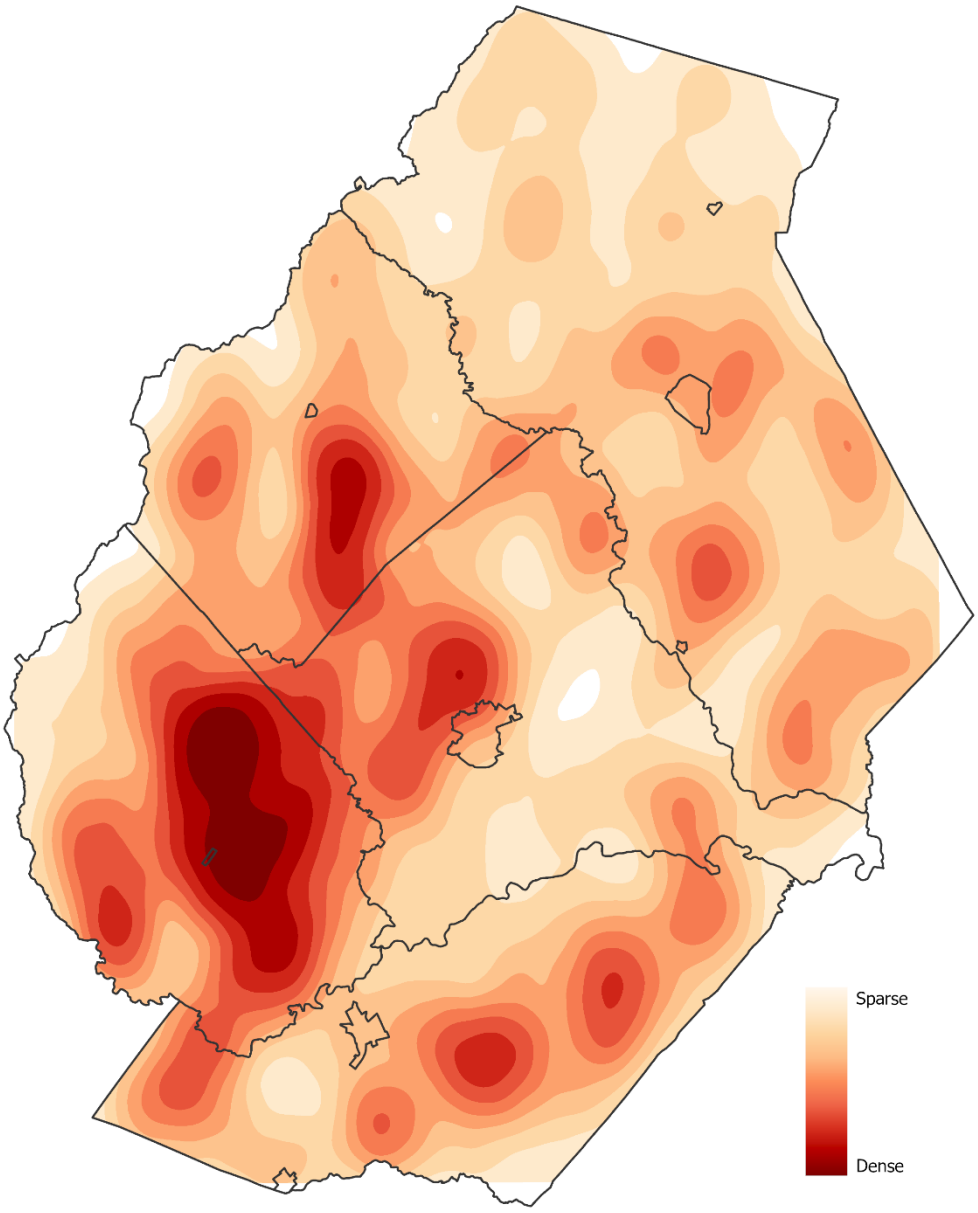
Each data input included in the Wildfire Risk Assessment Model was given its own weight of importance to better reflect their individual impact on the overall increase of wildfire risk in a given area. The weights assigned to each data input (especially topographic) differ depending on the physiographic zone being represented because the topographic characteristics of the landscape can change dramatically across the Region.

Since the Rappahannock-Rapidan Region covers areas under both the Piedmont and Blue Ridge physiographic zones, different weights were given following the VDOF Wildfire Risk Assessment guidelines, were slightly tweaked with new data inputs not found in the old VDOF model. The full list of data inputs and their weights are found below:

Data Input	Blue Ridge Weight	Piedmont Weight
Density of Historical Wildfires	24%	24%
Land Cover	27%	35%
Percent Slope (of topography)	8%	3%
Slope Orientation/Aspect	10%	2%
Population Density	12%	14%
Distance to Roads	6%	7%
Railroad Buffer	4%	5%
Proximity to Fire Hydrants	3%	4%
Road Density and Developed Areas	6%	6%



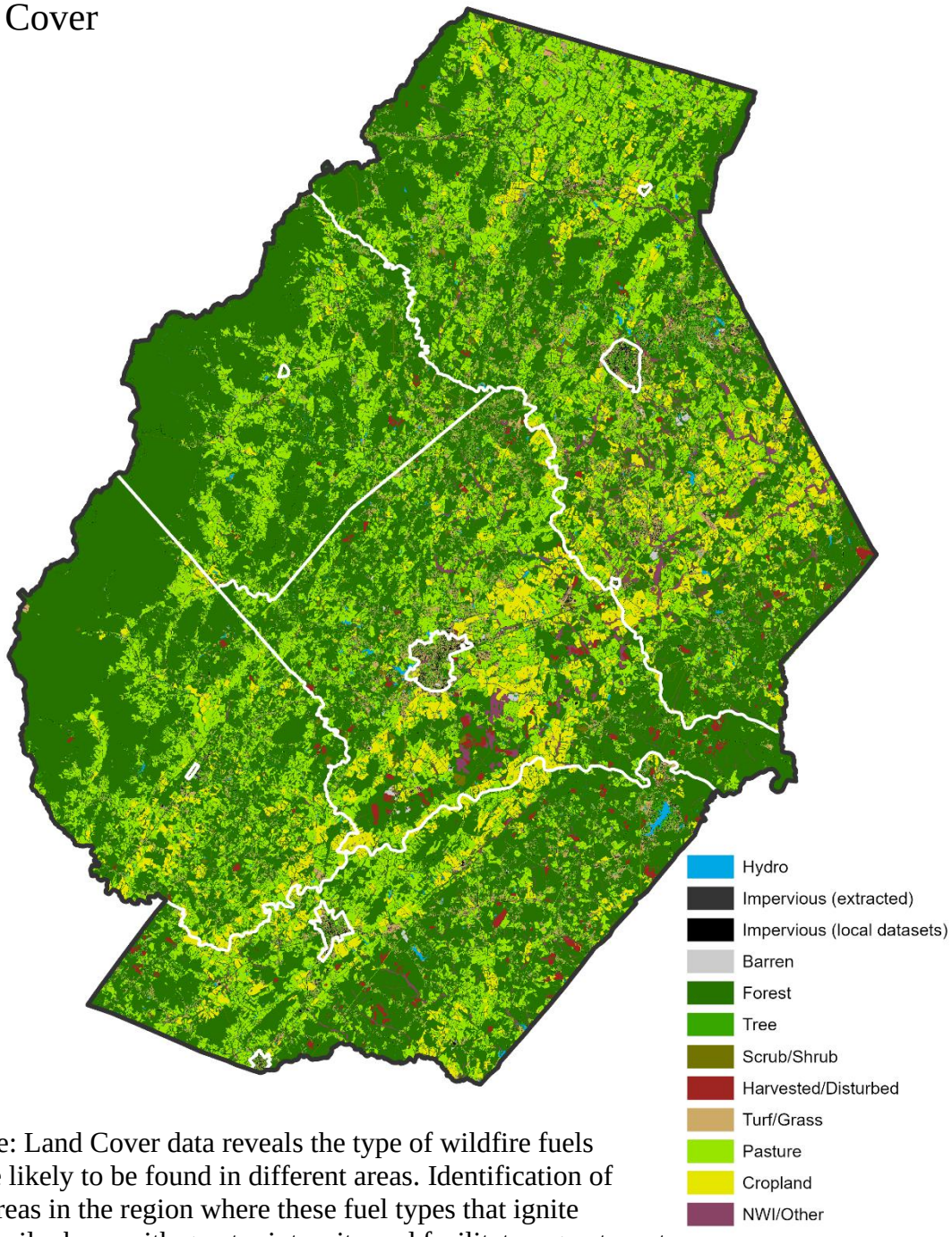
Density of Historical Wildfires



Premise: Wildfire density was mapped to identify areas where wildfires have historically been relatively prevalent and relatively absent. It is assumed that these spatial patterns will remain similar in the future.

Data Preparation: Point locations for wildfires occurring in the years 2002- 2018 would be obtained from George Washington and Jefferson National Forests and Shenandoah National Park. A kernel density function was applied to show the areas where these wildfires have been more densely located historically.

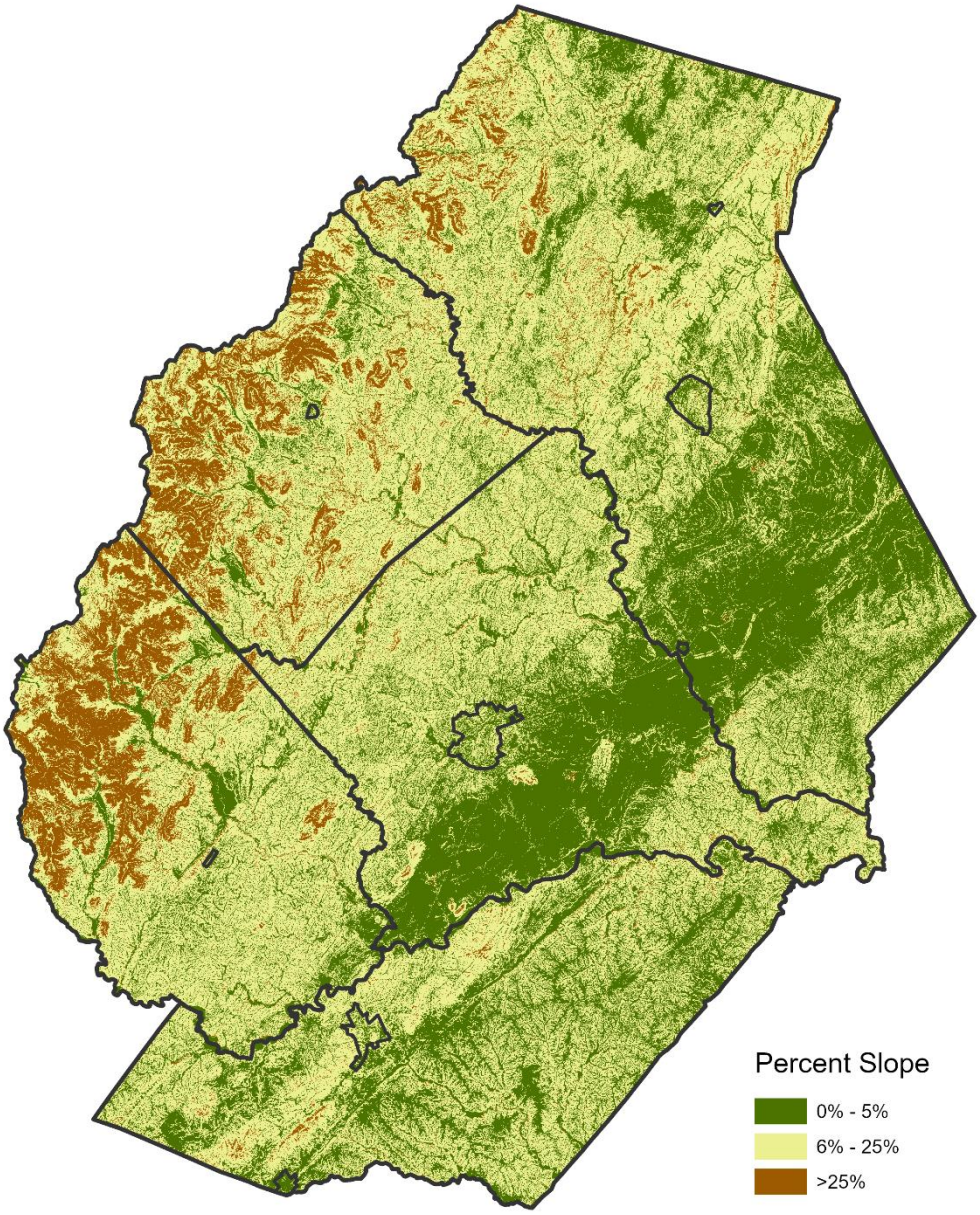
Land Cover



Premise: Land Cover data reveals the type of wildfire fuels that are likely to be found in different areas. Identification of these areas in the region where these fuel types that ignite more easily, burn with greater intensity and facilitate a greater rate of wildfire advancement can help predict future wildfire patterns.

Data Preparation: The Virginia Geographic Information Network (VGIN) 1 meter landcover dataset was used to score each landcover class based on the type of wildfire fuels present there.

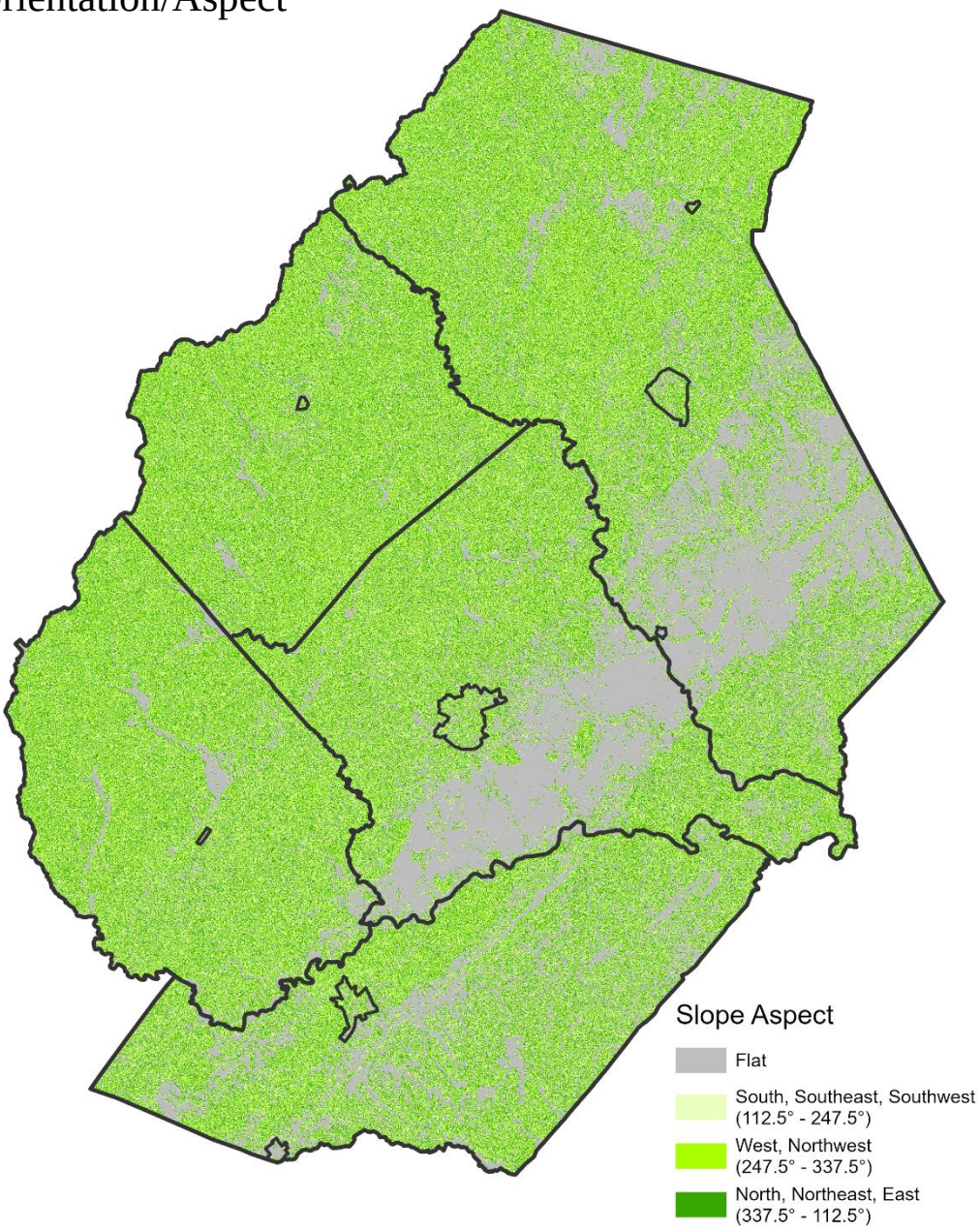
Percent Slope



Premise: Through convective pre-heating, wildfires generally advance up-hill. Generally, steeper slopes cause greater pre-heating and ease of ignition. As a result, steeper slopes were assigned higher values to reflect this effect in our overall analysis.

Data Preparation: Percent slope was calculated from the U.S. Geological Survey's National Elevation Dataset (1m resolution) using the “Slope” spatial analyst tool in ArcGIS Pro. The resulting slope grid was classified into three classes: 0 - 5%, 6 - 25% and > 25%. These classes were then assigned values of 1, 5 and 10 respectively.

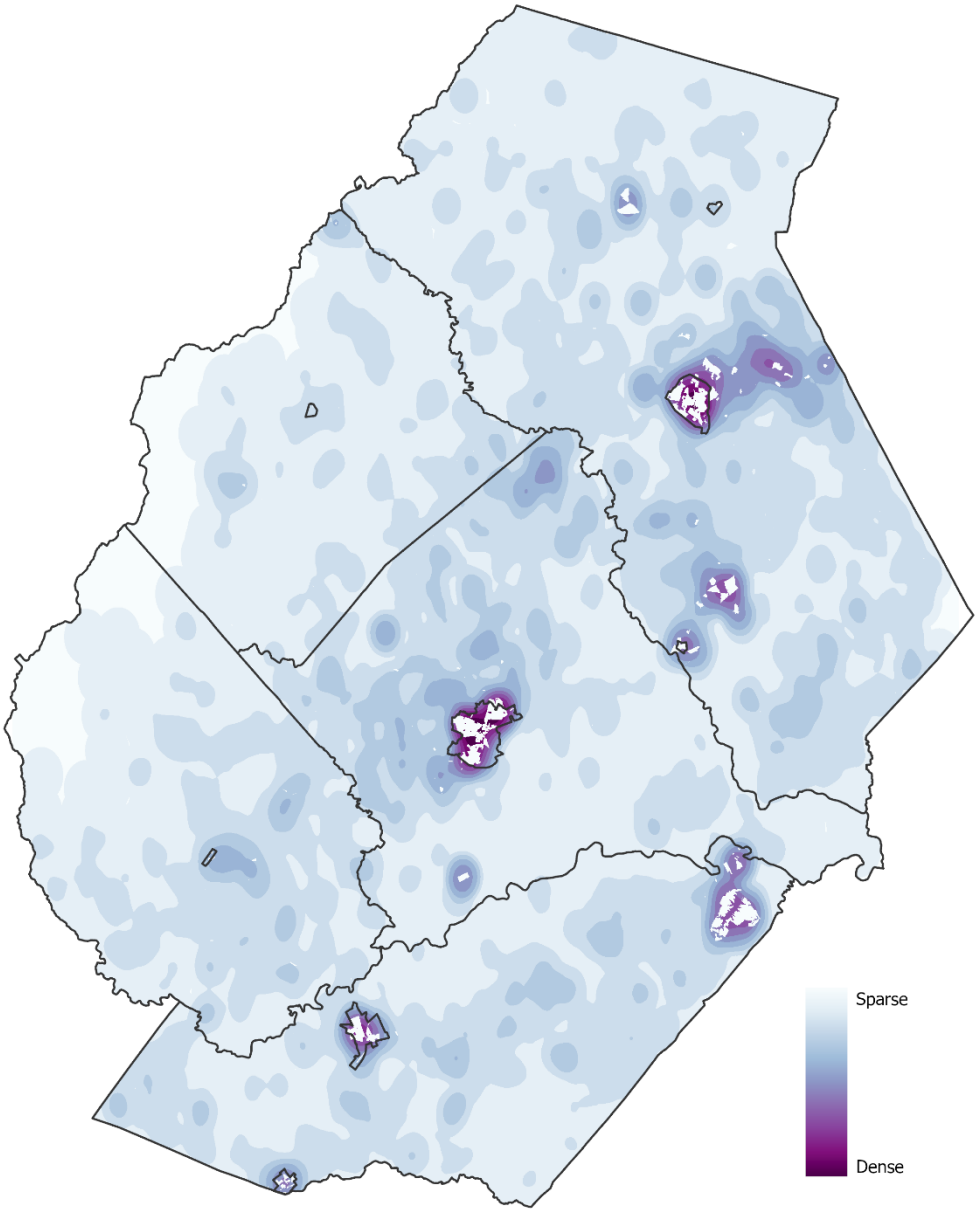
Slope Orientation/Aspect



Premise: Slopes that generally face south receive more direct sunlight than those generally facing north. Direct sunlight in turn dries fuels and thereby creates conditions that are more conducive to wildfire ignition. Additionally, drier fuels generally increase the intensity of a wildfire and facilitate faster fire advancement.

Data Preparation: Slope aspect was derived from the U.S. Geological Survey's National Elevation Dataset (1m resolution) using the “Aspect” spatial analyst tool in ArcGIS Pro. Areas where the slope is less than 5% were a “flat” value of zero. Slopes facing S, SE, and SW (112.5° - 247.5°), were assigned a value of 10. Slopes facing W and NW (247.5° - 337.5°) were assigned a value of 5. The remaining slopes, N, NE, and E (337.5° – 112.5°), were assigned a value of 1.

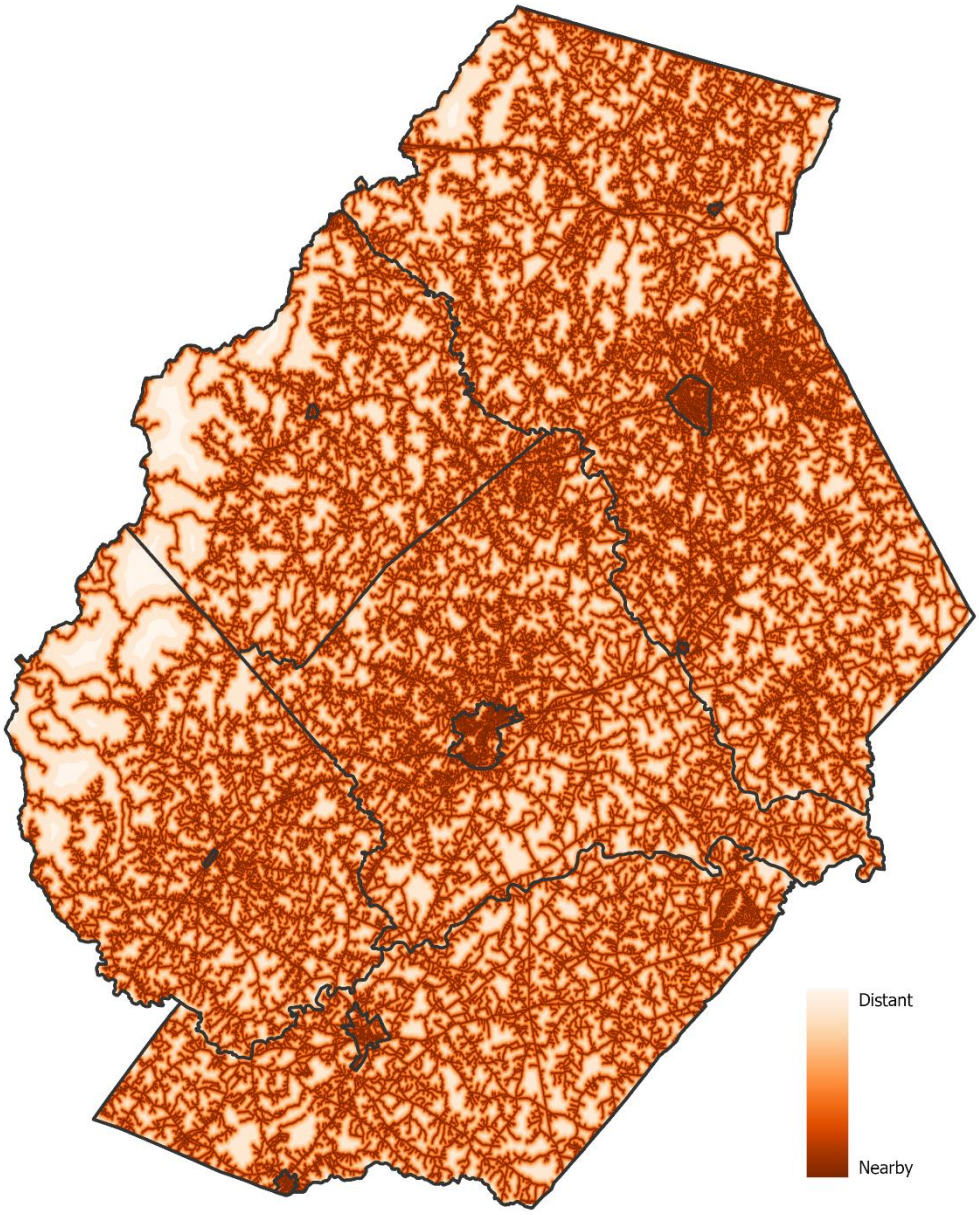
Population Density



Premise: An overwhelming majority of the wildfires in the Commonwealth are ignited intentionally or unintentionally by humans. The general understanding is that as population density increases, more opportunities for wildfire ignition will exist. But once the density reaches a threshold, the resulting urbanization decreases the presence of wildland fuels. This relative absence of fuels generally produces a negative impact on the wildfire risk.

Data Preparation: Population per square mile was calculated from the 2020 US Census Bureau Blocks, then the “Density” function in ArcGIS Pro was used to create a kernel population density grid. Values in the output grid that were greater than 1500 people per square mile were assigned a value of zero and the remaining cells were then reclassified into ten interval classes ranging in values from 1 to 10 using the quantile classification method.

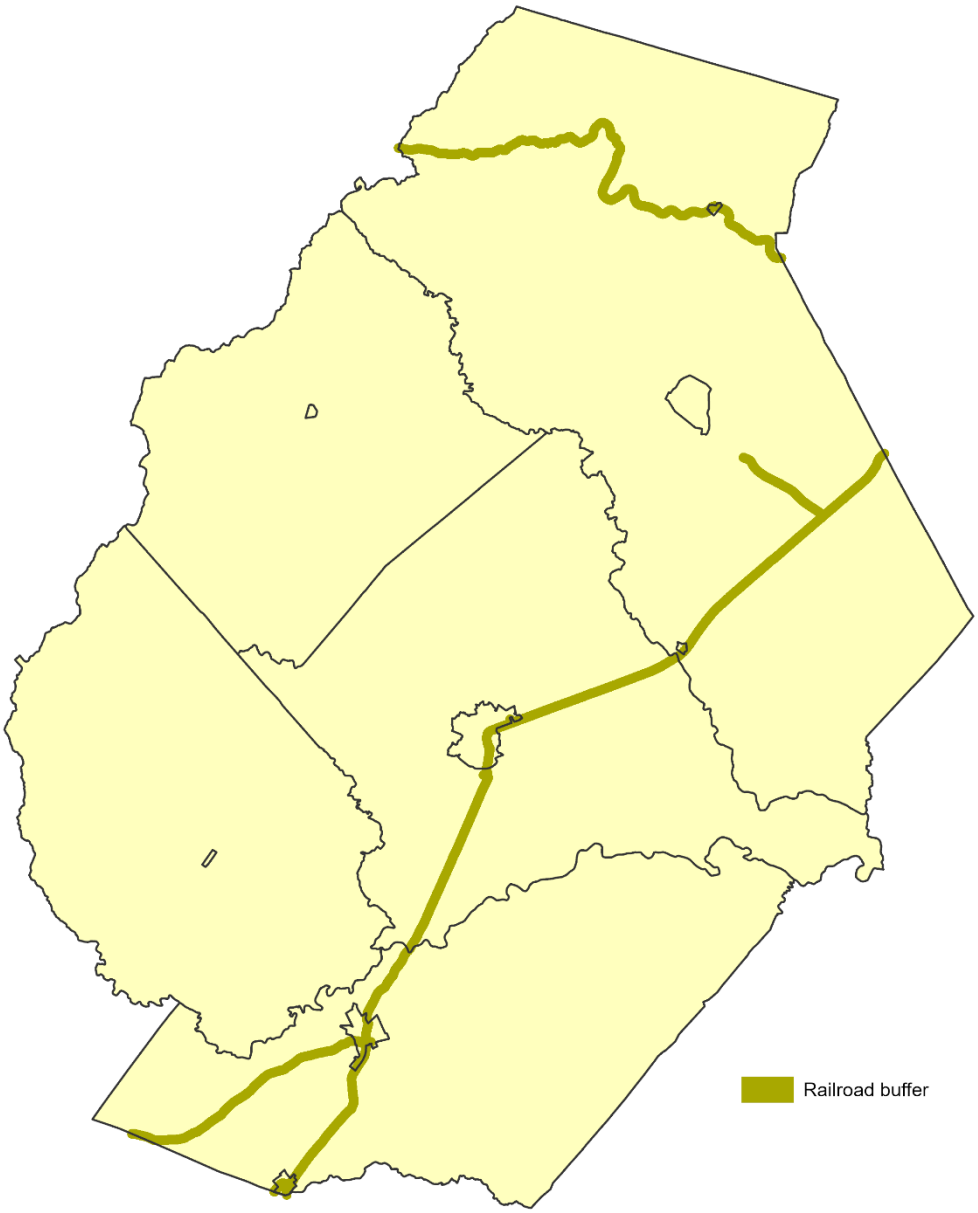
Distance to Roads



Premise: A distance to roads layers was also included to further capture the human/wildfire causal relationship. Travel corridors increase the probability of human presence which could in turn result in wildfire ignition. Hence, areas closer to roads will attain a higher ignition probability and these areas were assigned higher values to reflect this increased risk.

Data Preparation: Roads features from the US Census Bureau's TIGER data were run through the “Euclidean Distance” spatial analysist tool in ArcGIS Pro. The output grid was then reclassified into 10 interval classes from 1 to 10 using the quantile classification method, with 10 representing areas in closest proximity to roads and 1 representing areas furthest from roads.

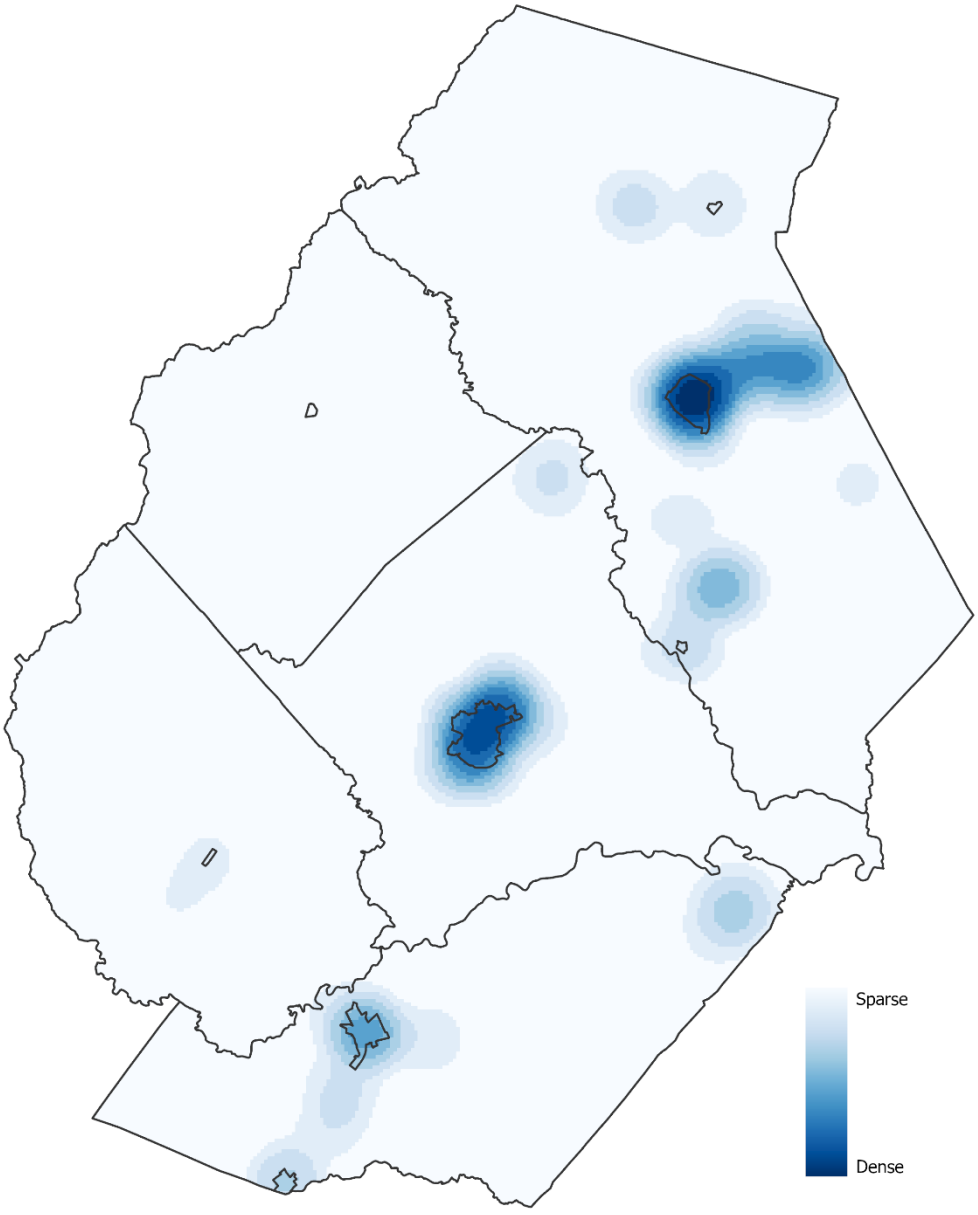
Railroad Buffer



Premise: Railroad operations can produce sparks that may ignite a wildfire. However, about 2% of the wildfires occurring in the Commonwealth were reported to have been ignited from railroad use. As a result, a quarter-mile buffer of Virginia railroads was included, but was weighted low.

Data preparation: Using railroad line features from data produced by the Virginia Department of Transportation, a quarter-mile buffer of railroads was generated. The resulting buffer polygon was directly rasterized and all cells were assigned a value of five.

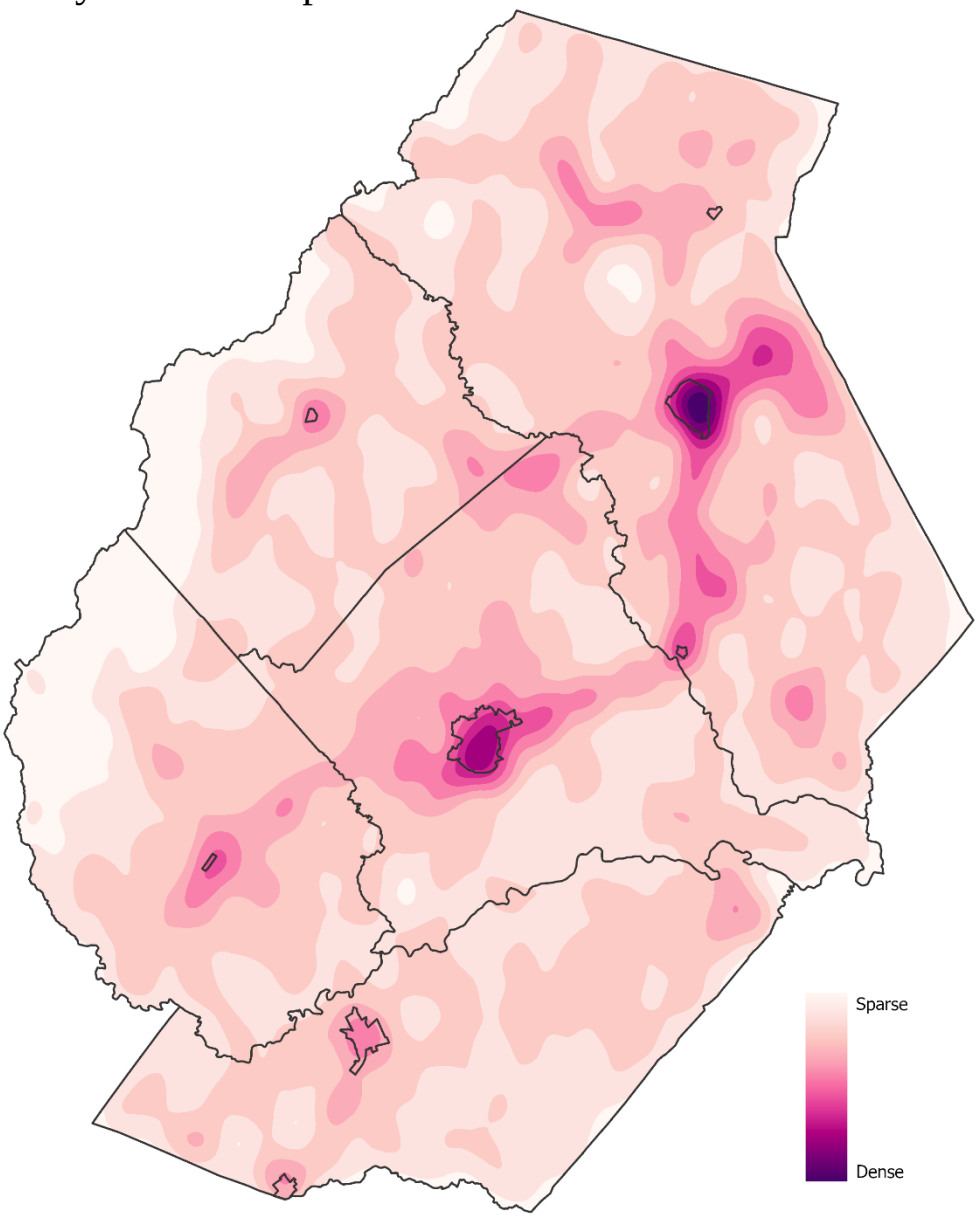
Proximity to Fire Hydrants



Premise: Areas that are located close to fire hydrants will enable a more quick and effective response to wildfires. This would allow for easier mitigation of such a disaster.

Data preparation: Fire hydrant data point were collected from local governments and state agencies including the Virginia Department of Forestry. A kernel density function was applied to show the areas where fire hydrants were more densely located.

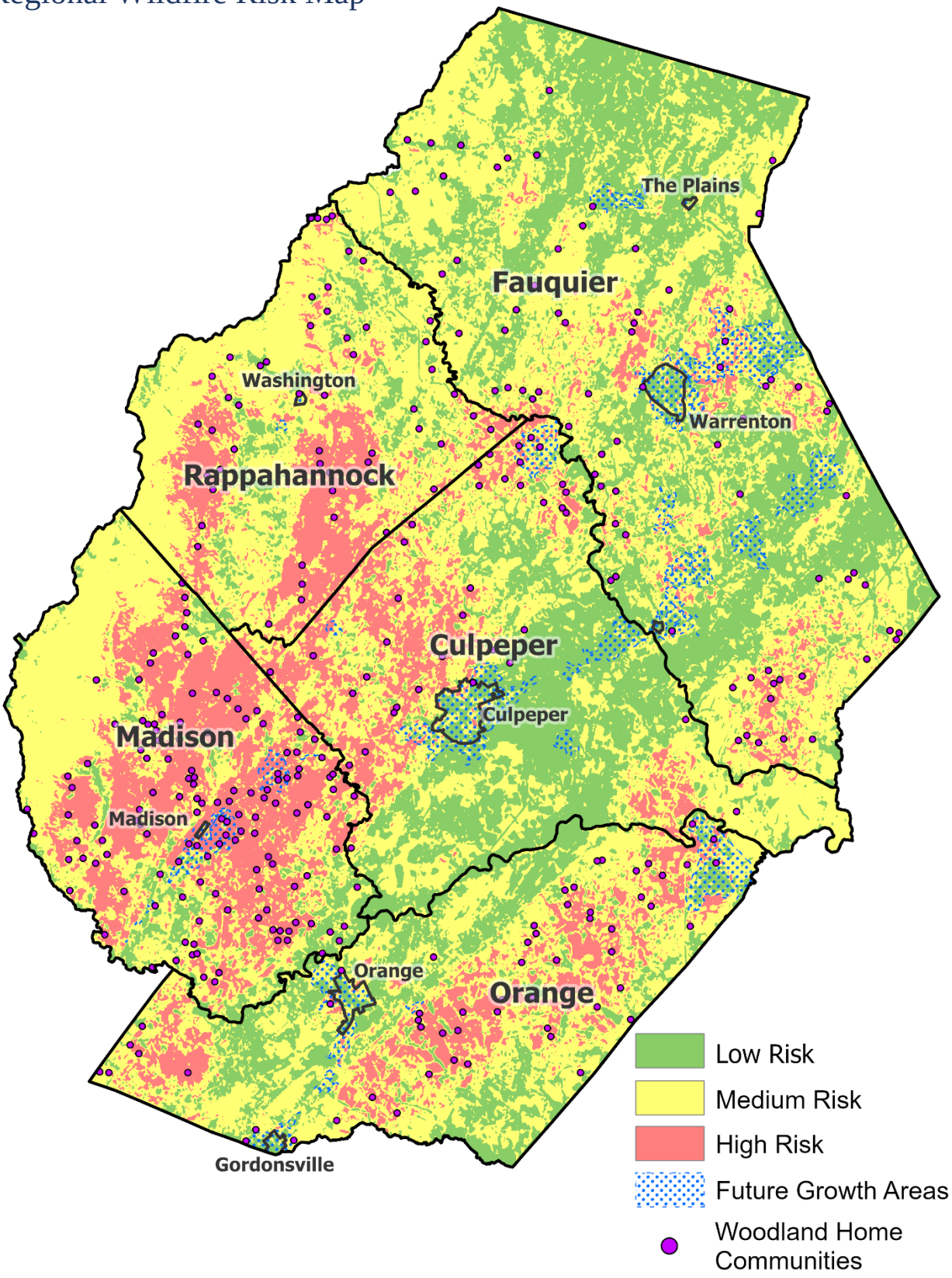
Road Density and Developed Areas



Premise: Areas that contain high road densities and a large percentage of developed land generally feature low amounts of wildland fuels. Furthermore, the wildland fuels that are present are typically fragmented to such a degree that the resulting fire risk is drastically reduced.

Data Preparation: A kernel density function was executed on TIGER roads from the US Census Bureau and cells of the resulting grid with high values were classified into a new raster. If greater than 50% of the cells in these high-density areas contained cells classified as "developed" in the land cover dataset (impervious and/or barren), the value of corresponding cells in the final output of the analysis were reduced by 50%.

Regional Wildfire Risk Map



Data Results and Findings

Locality	Wildfires (1992 - 2018)	Wildfires per Year	Land Area (Square Miles)	Wildfires per Square Mile
Culpeper	188	7.2	383	0.49
Fauquier	276	10.6	652	0.42
Madison	281	10.8	322	0.87
Orange	213	8.2	343	0.62
Rappahannock	164	6.3	267	0.61
RRRC Region	1122	43.1	1967	0.57

Spatial Analysis and Conclusions

Upon closer inspection of the newly created Regional Wildfire Risk Map and the associated data findings, some noticeable patterns and areas of concern are readily apparent. In terms of total land area deemed as being "High Risk", the county of Madison has the highest total amount and percent area. Madison County not only has the highest number of wildfires per year, but it also has the highest number of wildfires per square mile within the Rappahannock-Rapidan Region as well. Madison County also has the highest number of woodland home communities located in "High Risk" areas as well, further exemplifying this issue

Another locality that stands out is the Town of Madison. This is the only town within the Region which solely consists of "High Risk" and "Medium Risk" areas. Every other town within the Region is predominately "Low Risk". This shows that the Town of Madison stands out amongst all the other Towns within the Region as having the highest risk of future wildfire incidents.

When compared to the Wildland-Urban Interface map previously shown in this document, the distribution of Interface and Intermix areas closely aligns with the "High Risk" areas here. This further supports the overall risk these areas have been classified for potential wildfire developments.

On the other end of the scale, Fauquier County stands out as having the highest number of "Low Risk" areas. This again aligns with the wildfire data table above, as Fauquier County has the lowest number of wildfire incidents per square mile within the Rappahannock-Rapidan Region.

With the successful creation and implementation of the Wildfire Risk Assessment Model to create a new Regional Wildfire Risk Map, this opens the door for aiding with future hazard mitigation planning efforts. The Department of Forestry's previous Wildfire Risk Assessment model associated data and maps were published back in 2003, so this update provides a much more accurate assessment of the current wildfire risk conditions in 2021.

One of the goals mentioned previously is to have this update serve as a model or blueprint for future hazard mitigation planning efforts. The data collection, analysis process presented here for the Rappahannock-Rapidan Region can serve as a guideline for other localities to reproduce a wildfire risk map for their own respective jurisdictions. Such data and maps could serve a vital role in local hazard mitigation plans, comprehensive plans, and other emergency management plans in the future.