Wildland Fire and Hazard Mitigation Plan

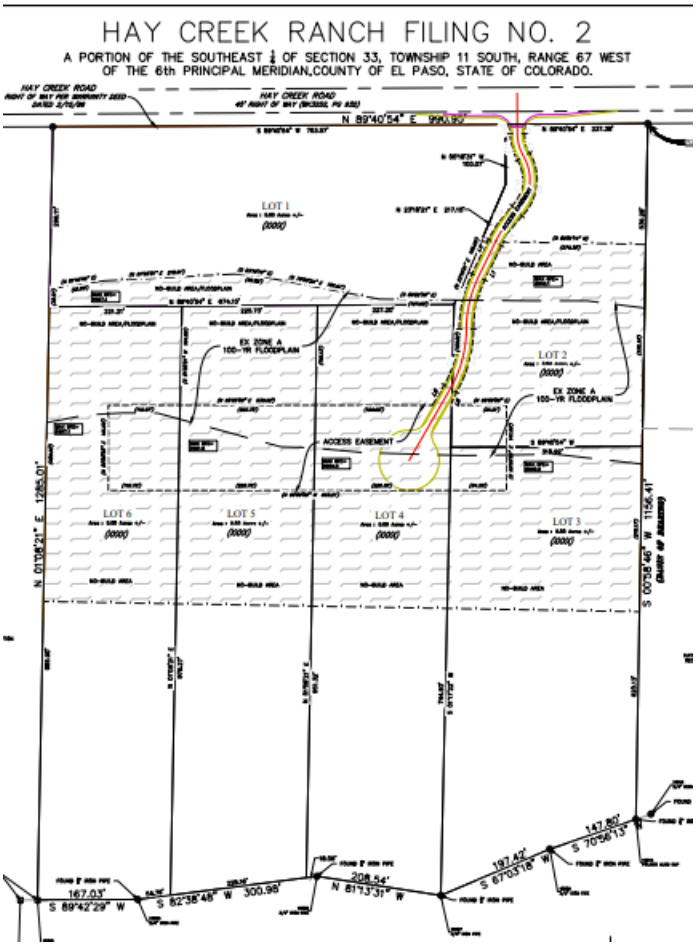
Hay Creek 2 Subdivision

Prepared by: Vertex Consulting Services LLC

Colorado State Forest Service

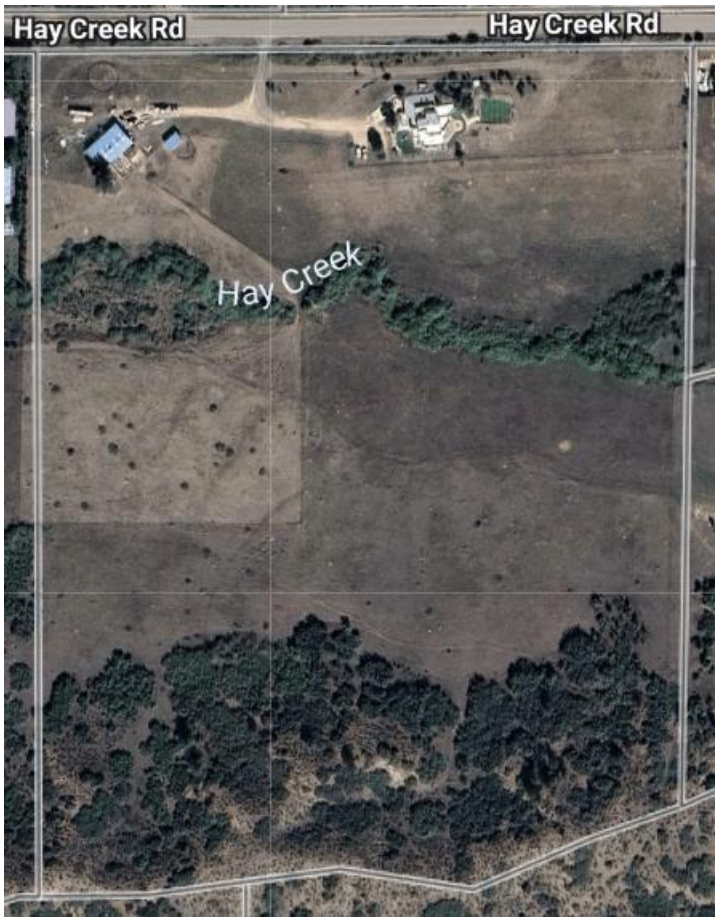
Proposed Development

The Subdivision includes a total of 6 single family rural residential parcels on 30.05 acres located south of Hay Creek and west of Highway 25 to the south of the Town of Monument. The proposed development is in compliance with the Fire Protection and Wildfire Mitigation Section of Chapter 6 of the Land Development Code.



Site Description:

The site has one single family residence and a barn, which will remain in the western portion of the property. The remainder of the site is vacant. The site is currently zoned RR-5. The property is within the Tri-Lakes Monument Fire Protection District. Approximately 70% of the site is vegetated with native grasses. Scrub oak can be found along the far southern boundary of the property.



Cistern Provision:

The property owner has entered into an agreement with the adjacent Hay Creek Subdivision to utilize their existing underground 33,0000-gallon tank for fire suppression as well as the use of the Dunston pond located to the west on Hay Creek. No municipal water will be provided. All of the proposed lots will be on well water and septic tanks.

Fire Department Recommendations:

The property owner met with the Tri-Lakes Monument Fire Protection District prior to submission of the final plat to El Paso County to determine what the Fire District would require in order to ensure safe emergency response. The private roadway meets the minimum radii and width requirements for a fire apparatus. The District has reviewed the proposed subdivision layout, private roadway plans, and wildfire mitigation plan and has provided a fire protection commitment letter in response.

Wildland Fire Risk & Hazard Severity Analysis:

Please review the attached Colorado Wildfire Risk Assessment Summary Report prepared by Colorado State Forest Service.

Defensible Space:

The property is primarily vegetated with native grasses, therefore, it is anticipated that very little mitigation will be required. Each future lot owner will be responsible for maintaining the native grasses and the southern scrub oak areas, as recommended by “The Home Ignition Zone” prepared by the Colorado State Forest Service attached.

2022 Colorado Wildfire Risk Assessment Summary Report

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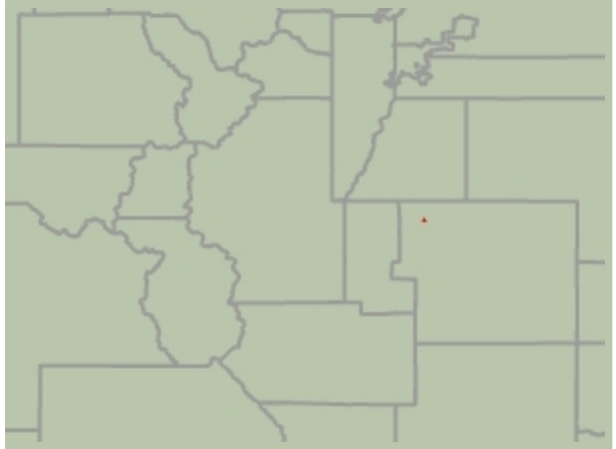
Hay Creek Hull Subdivision



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Report version: 3.0.0
Report generated: 10-24-2024

Table Of Contents

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User should also note that property boundaries included in any product do not represent an on-the-ground survey suitable for legal, engineering, or surveying purposes. They represent only the approximate relative locations.

Introduction

Colorado Wildfire Risk Assessment Report

Welcome to the Colorado Wildfire Risk Assessment Summary Reporting Tool.

This tool allows users of the Risk Reduction Planner application of the Colorado Forest Atlas web portal to define a specific project area and generate information for this area. A detailed risk summary report can be generated using a set of predefined map products developed by the Colorado Wildfire Risk Assessment project which have been summarized explicitly for the user defined project area. The report is generated in PDF format.

The report has been designed so that information from the report can be copied and pasted into other specific plans, reports, or documents depending on user needs. Examples include, but are not limited to, Community Wildfire Protection Plans, Local Fire Plans, Fuels Mitigation Plans, Hazard Mitigation Plans, Homeowner Risk Assessments, and Forest Management or Stewardship Plans. Example templates for some of these reports are available for download on the Colorado Forest Atlas web portal.

The Colorado WRA provides a consistent, comparable set of scientific results to be used as a foundation for wildfire mitigation and prevention planning in Colorado.

Results of the assessment can be used to help prioritize areas in the state where mitigation treatments, community interaction and education, or tactical analyses might be necessary to reduce risk from wildfires.

The Colorado WRA products included in this report are designed to provide the information needed to support the following key priorities:

- Identify areas that are most prone to wildfire
- Plan and prioritize hazardous fuel treatment programs
- Allow agencies to work together to better define priorities and improve emergency response, particularly across jurisdictional boundaries
- Increase communication with local residents and the public to address community priorities and needs

Products

Each product in this report is accompanied by a general description, table, chart and/or map. A list of available Colorado WRA products in this report is provided in the following table.

COWRA Product	Description
Wildland Urban Interface	Housing density depicting where humans and their structures meet or intermix with wildland fuel
Wildland Urban Interface Risk	A measure of the potential impact on people and their homes from wildfire
Wildfire Risk to Assets	The overall composite risk occurring from a wildfire derived by combining Burn Probability and Values at Risk Rating
Burn Probability	Annual probability of any location burning due to wildfire
Terrain Difficulty Index	Reflects the difficulty to suppress a fire given the terrain and vegetation conditions that may impact ground resource access and capabilities
Characteristic Flame Length	A measure of the expected flame length of a potential fire
Fire Intensity Scale	Quantifies the potential fire intensity by orders of magnitude
Fire Type	Potential for canopy fire type for extreme weather conditions (canopy fire potential)
Rate of Spread	The speed with which a fire moves in a horizontal direction across the landscape
Surface Fuels	Characterization of surface fuel models that contain the parameters for calculating fire behavior outputs
Vegetation	General vegetation and landcover types
Watershed Protection Risk	A measure of risk to watershed protection areas based on the potential negative impacts from wildfire.
Riparian Assets Risk	A measure of the risk to riparian areas based on the potential negative impacts from wildfire
Forest Assets Risk	A measure of the risk to forested areas based on the potential negative impacts from wildfire

COWRA Product	Description
Building Damage Potential	Estimates the potential for building loss
Defensible Space Index	The arithmetic mean of the three defensible space components: canopy, fuels, and slope. The colors shown represent the relative range and are the average for all of the buildings in the hexagon.

Wildland Urban Interface

Reflects housing density depicting where humans and their structures meet or intermix with wildland fuels

Colorado is one of the fastest growing states in the Nation, with much of this growth occurring outside urban boundaries. This increase in population across the state will impact counties and communities that are located within the Wildland Urban Interface (WUI). The WUI is described as the area where structures and other human improvements meet and intermingle with undeveloped wildland or vegetative fuels. Population growth within the WUI substantially increases the risk from wildfire.

The Wildland Urban Interface (WUI) layer reflects housing density depicting where humans and their structures meet or intermix with wildland fuels. In the past, conventional wildland-urban interface data sets, such as USFS SILVIS, have been used to reflect these concerns. However, USFS SILVIS and other existing data sources did not provide the level of detail needed by the Colorado State Forest Service and local fire protection agencies, particularly reflecting encroachment into urban core areas.

For the **Hay Creek Hull Subdivision** project area, it is estimated that **2** people or **100%** percent of the total project area population (2) live within the WUI.

The new WUI data set is derived using advanced modeling techniques based on the Where People Live (housing density) data set and 2021 LandScan USA population count data available from the Department of Homeland Security, HSIP data. WUI is simply a subset of the Where People Live data set. The primary difference is populated areas surrounded by sufficient non-burnable areas (i.e. interior urban areas) are removed from the Where People Live data set, as these areas are not expected to be directly impacted by a wildfire. Fringe urban areas, i.e. those on the edge of urban areas directly adjacent to burnable fuels are included in the WUI. Advanced encroachment algorithms were used to define these fringe areas.

Data is modeled at a 20-meter grid cell resolution, which is consistent with other CO-WRA layers. The WUI classes are based on the number of houses per acre. Class breaks are based on densities well understood and commonly used for fire protection planning.

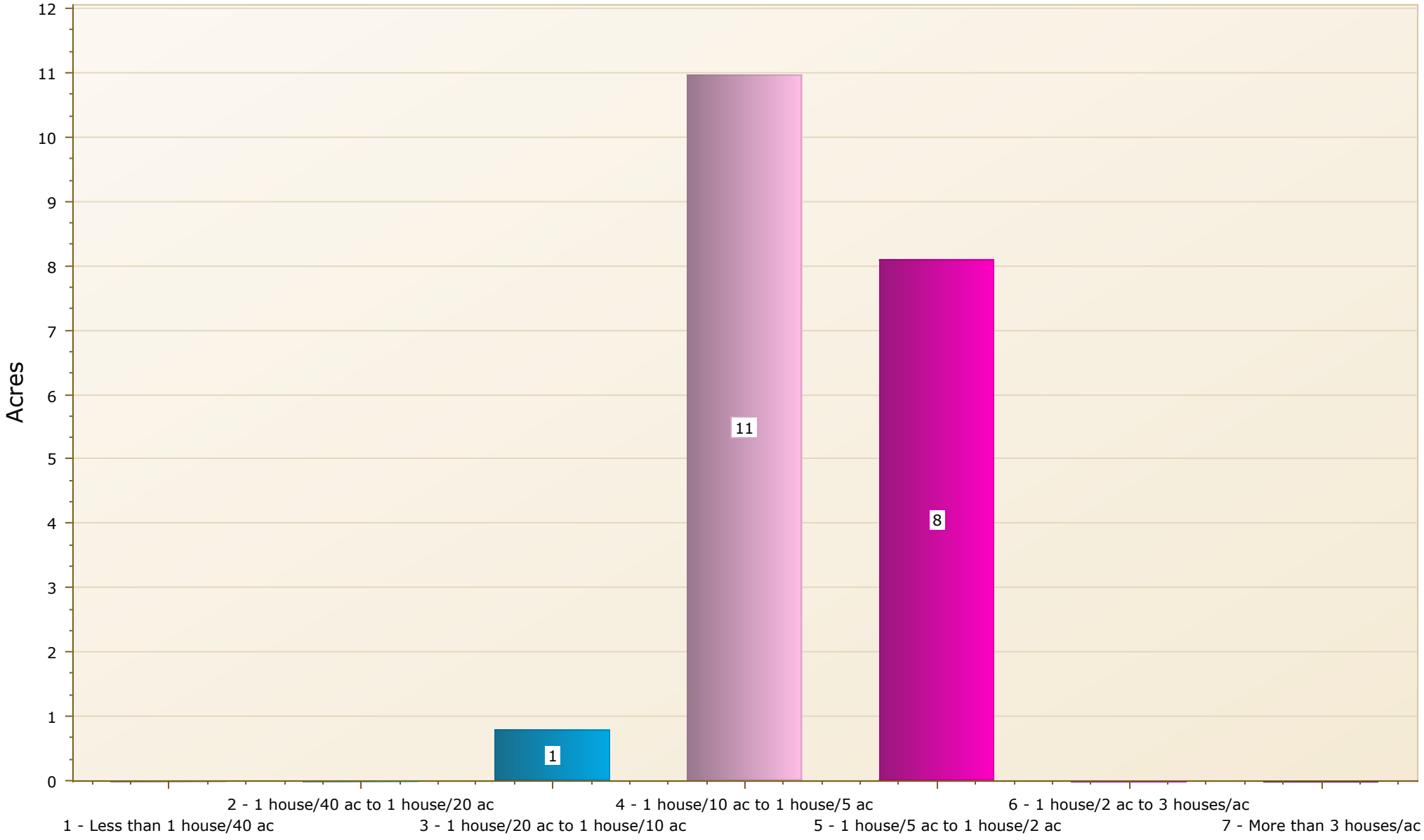
A more detailed description of the risk assessment algorithms is provided in the Colorado Wildfire Risk Assessment (Colorado WRA) Final Report, which can be downloaded from www.ColoradoForestAtlas.com

Housing Density	WUI Population	Percent of WUI Population
1 - Less than 1 house/40 ac	0	0%
2 - 1 house/40 ac to 1 house/20 ac	0	0%
3 - 1 house/20 ac to 1 house/10 ac	0	0%
4 - 1 house/10 ac to 1 house/5 ac	2	100%
5 - 1 house/5 ac to 1 house/2 ac	0	0%
6 - 1 house/2 ac to 3 houses/ac	0	0%
7 - More than 3 houses/ac	0	0%
Total	**2**	**100%**

Housing Density	WUI Acres	Percent of WUI Acres
1 - Less than 1 house/40 ac	0	0%
2 - 1 house/40 ac to 1 house/20 ac	0	0%
3 - 1 house/20 ac to 1 house/10 ac	1	4%
4 - 1 house/10 ac to 1 house/5 ac	11	55.2%
5 - 1 house/5 ac to 1 house/2 ac	8	40.8%
6 - 1 house/2 ac to 3 houses/ac	0	0%
7 - More than 3 houses/ac	0	0%
None	**20**	**100%**

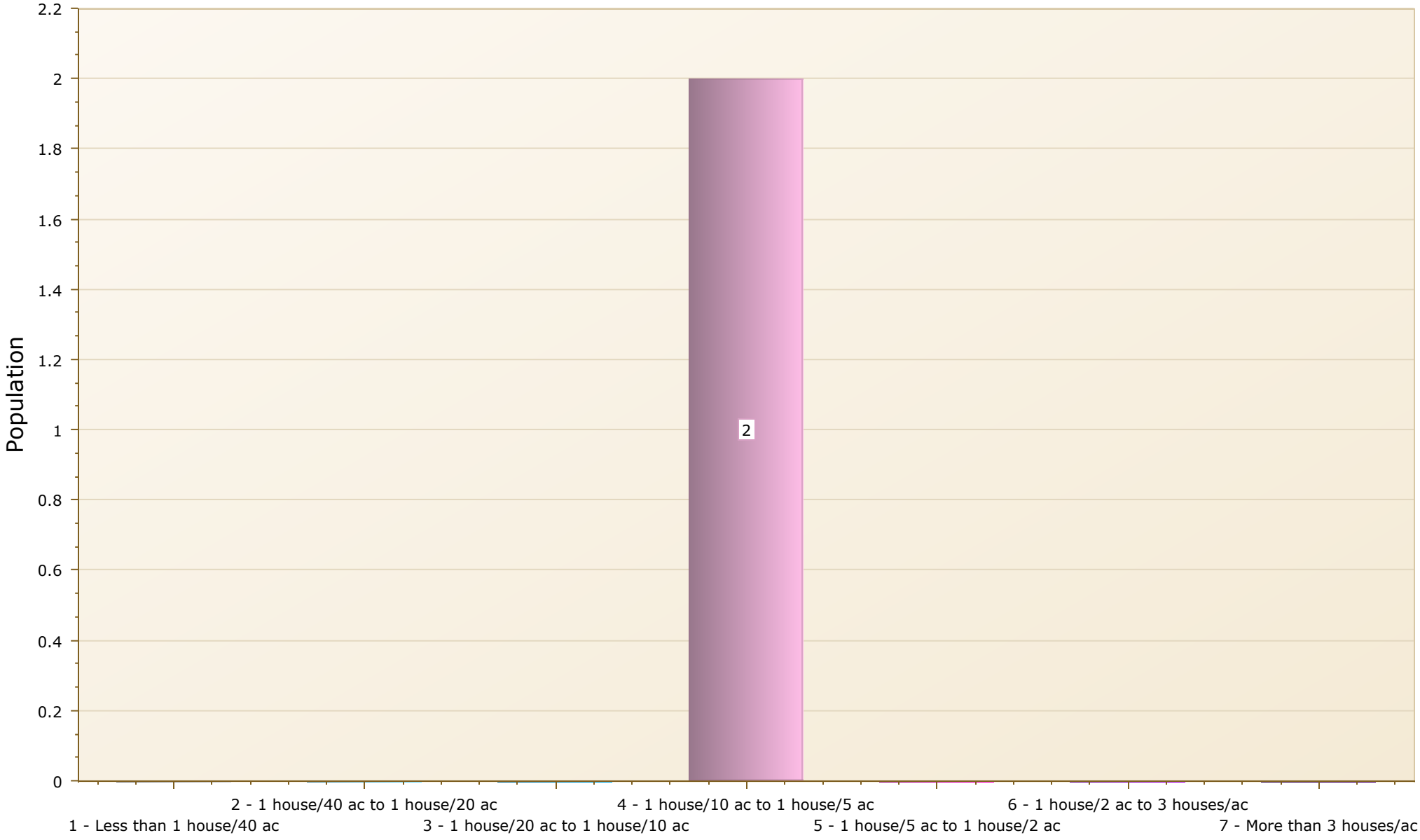
Wildland Urban Interface - Acres

Hay Creek Hull Subdivision



Wildland Urban Interface - Population

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Wildland Urban Interface
1 - Less than 1 house/40 ac
2 - 1 house/40 ac to 1 house/20 ac
3 - 1 house/20 ac to 1 house/10 ac
4 - 1 house/10 ac to 1 house/5 ac
5 - 1 house/5 ac to 1 house/2 ac
6 - 1 house/2 ac to 3 houses/ac
7 - More than 3 houses/ac
COLORADO STATE FOREST SERVICE
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40 m
100 ft

Wildland Urban Interface (WUI) Risk

The Wildland-Urban Interface (WUI) Risk Index layer is a rating of the potential impact of a wildfire on people and their homes.
The key input, WUI, reflects housing density (houses per acre) consistent with Federal Register National standards. The location of people living in the wildland-urban interface and rural areas is essential for defining potential wildfire impacts to people and homes.

The WUI Risk Index is derived using a response function modeling approach. Response functions are a method of assigning a net change in the value to a resource or asset based on susceptibility to fire at different intensity levels, such as flame length.

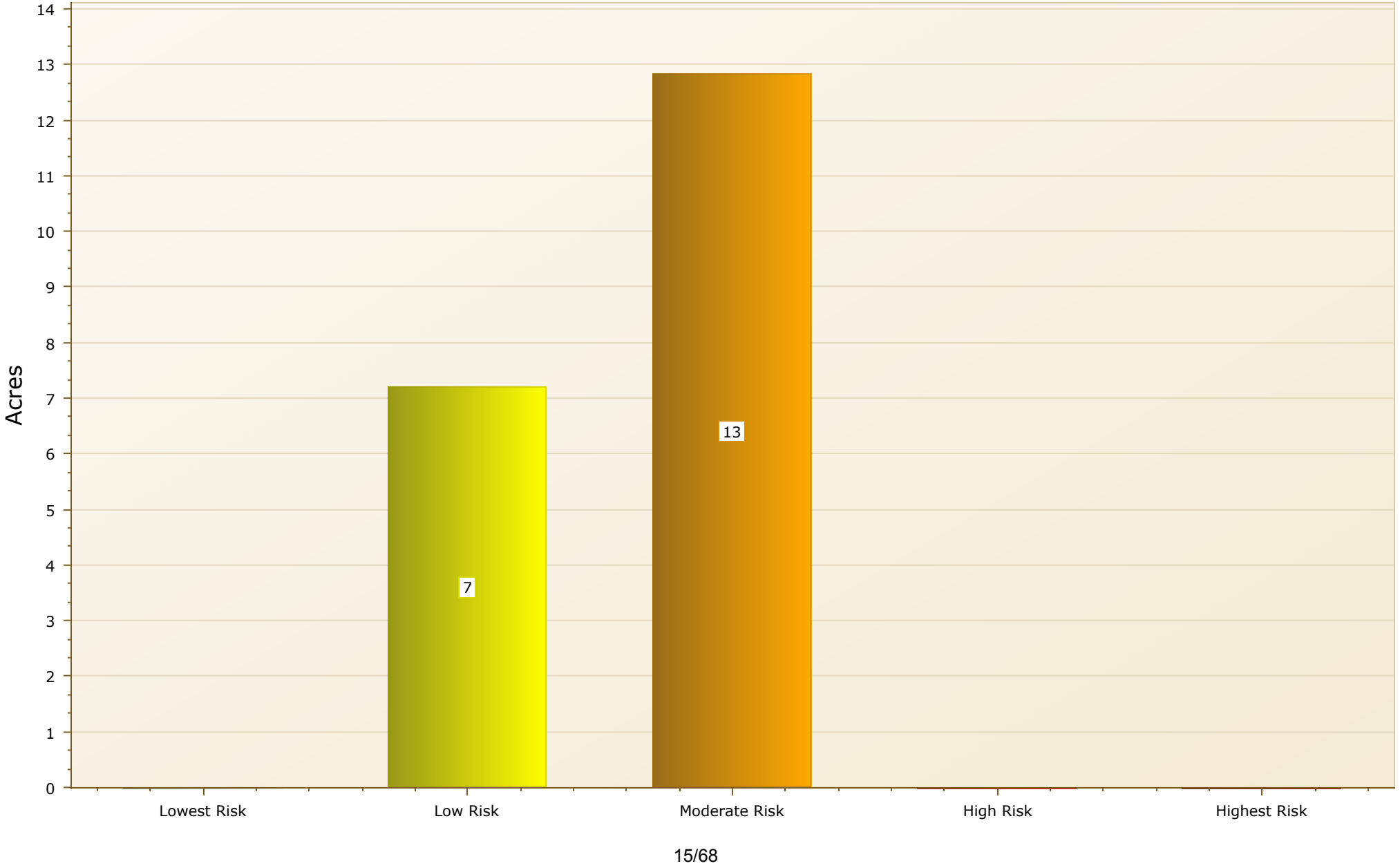
To calculate the WUI Risk Index, the WUI housing density data were combined with flame length data and response functions were defined to represent potential impacts. The response functions were defined by a team of experts led by Colorado State Forest Service mitigation planning staff. By combining flame length with the WUI housing density data, it is possible to determine where the greatest potential impact to homes and people is likely to occur. Customized urban encroachment algorithms were used to ensure those fringe urban areas were included in the WUI Risk outputs. Encroachment distances into urban areas were based on the underlying fuel models and their fuel types and propensity for spotting and spreading.

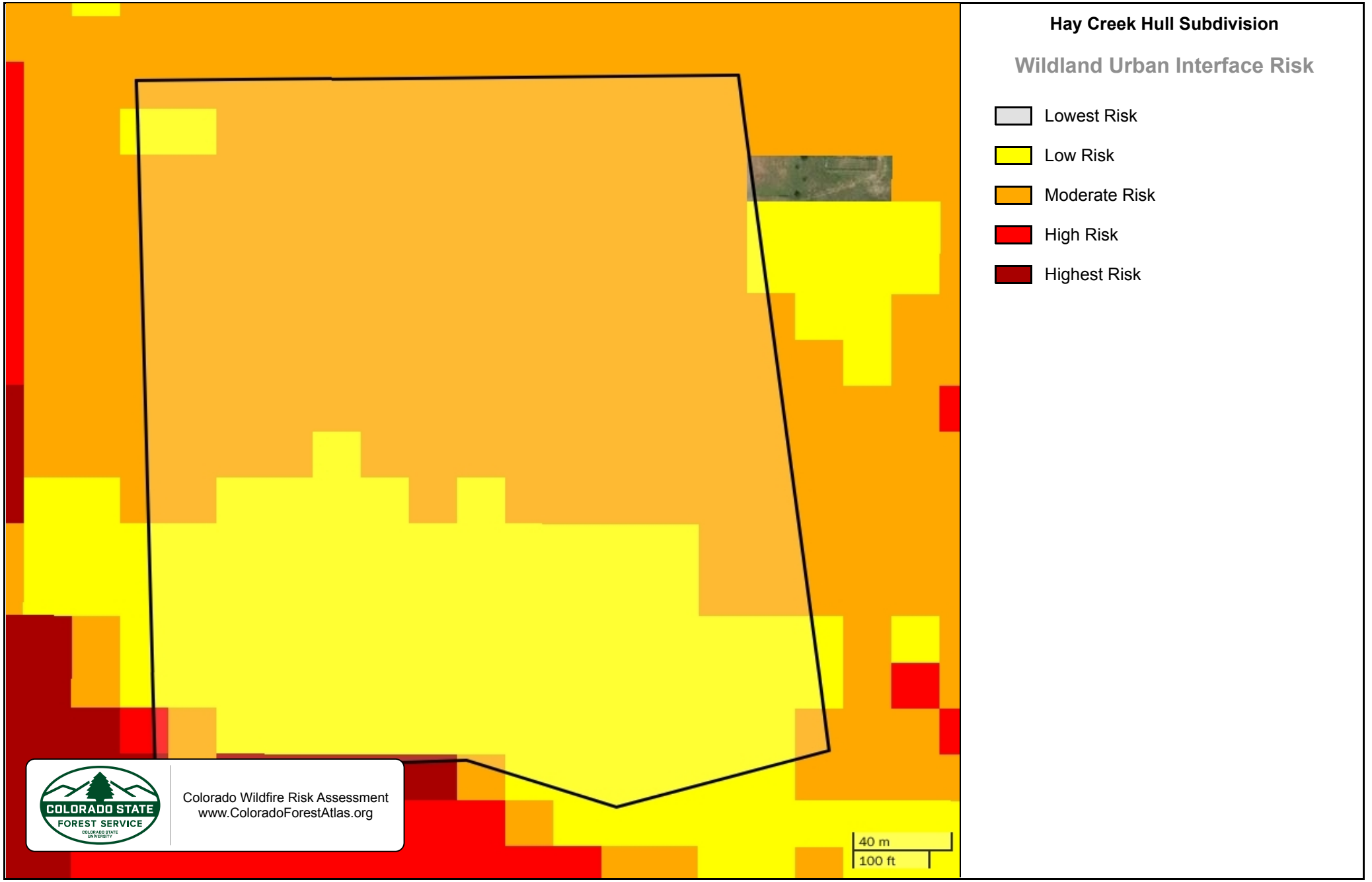
The WUI Risk Index has been calculated consistently for all areas in Colorado, which allows for comparison and ordination of areas across the entire state. Data is modeled at a 20-meter cell resolution, which is consistent with other CO-WRA layers.

WUI Risk Class	Acres	Percent
Lowest Risk		0%
Low Risk	7	36%
Moderate Risk	13	64%
High Risk		0%
Highest Risk		0%
Total	**20**	**100%**

Wildland Urban Interface Risk

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Wildland Urban Interface Risk
Lowest Risk
Low Risk
Moderate Risk
High Risk
Highest Risk
COLORADO STATE
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Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Firewise USA Recognized Sites

Description

Firewise USA® is a national recognition program that provides resources to inform communities how to adapt to living with wildfire and encourages neighbors to take action together to reduce their wildfire risk. Colorado communities that take the following five steps can be recognized as Firewise:

1. Form a Firewise board or committe
2. Obtain a wildfire risk assessment from the CSFS or local fire department, and create an action plan
3. Hold a Firewise event once per year
4. Invest a minimum of $24.14 per dwelling unit in local Firewise actions annually
5. Create a National Fire Prevention Association (NFPA) profile and follow the application directions located at https://portal.firewise.org/user/login

The Firewise USA® dataset defines the boundaries of the recognized communities. Mapping Firewise USA® boundaries will generally be completed by CSFS staff.

Note: These are estimated boundaries using a variety of methods with varying degrees of accuracy. These are not legal boundaries and should not be construed as such. The boundaries may overlap with CWPP areas and are subject to change over time as the communities develop, change, and continue to implement wildfire mitigation efforts.
To learn more about the Firewise USA® recognition program or to fill out an application, visit https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA - OR https://csfs.colostate.edu/wildfire-mitigation/colorado-firewise-communities/

The designated area does not contain data for this section.

Community Wildfire Protection Plans (CWPPs)

Description

A Community Wildfire Protection Plan (CWPP) is a document developed and agreed upon by a community to identify how the community will reduce its wildfire risk. CWPPs identify areas where fuels reduction is needed to reduce wildfire threats to communities and critical infrastructure, address protection of homes and other structures, and plan for wildfire response capability. The Colorado State Forest Service (CSFS) supports the development and implementation of CWPPs and provides resources, educational materials and information to those interested in developing CWPPs.

The CWPP dataset represents the boundaries of those areas that have developed a CWPP. Note that CWPPs can be developed by different groups at varying scales, such as county, Fire Protection District (FPD), community/subdivision, HOA, etc., and as such, can overlap. In addition, the CWPPs can be from different dates. Often a county CWPP is completed first with subsequently more detailed CWPPs done for local communities within that county or FPD. CO-WRAP provides a tool that allows the user to select the CWPP area and retrieve the CWPP document for review (PDF).

At a minimum, a CWPP should include:

- The wildland-urban interface (WUI) boundary, defined on a map, where people, structures and other community values are most likely to be negatively impacted by wildfire
- The CSFS, local fire authority and local government involvement and any additional stakeholders
- A narrative that identifies the community's values and fuel hazards
- The community's plan for when a wildfire occurs
- An implementation plan that identifies areas of high priority for fuels treatments

CWPPs are not shelf documents and should be reviewed, tracked and updated. A plan stays alive when it is periodically updated to address the accomplishments of the community. Community review of progress in meeting plan objectives and determining areas of new concern where actions must be taken to reduce wildfire risk helps the community stay current with changing environment and wildfire mitigation priorities.

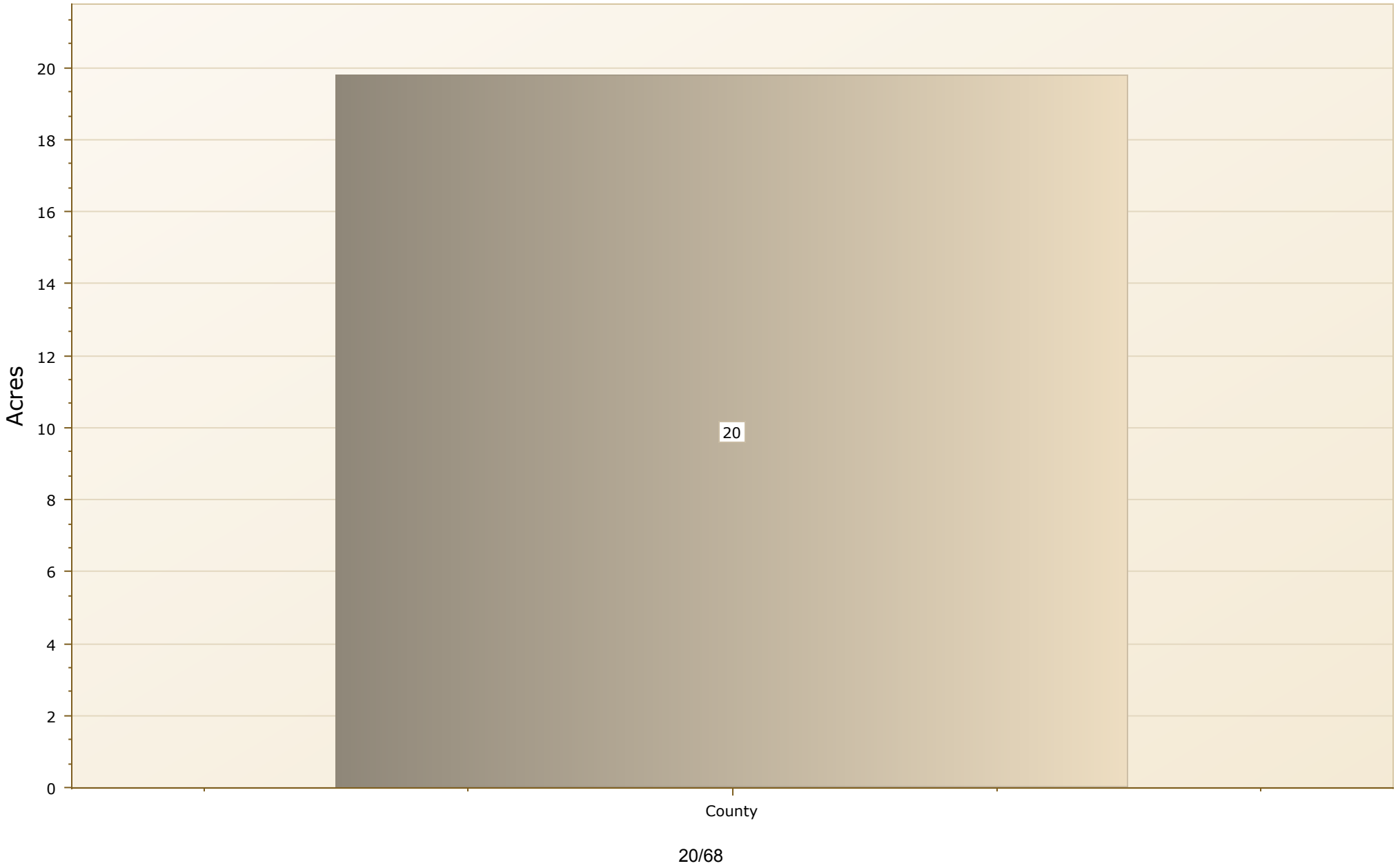
Community input is the foundation of a Community Wildfire Protection Plan that identfies community needs and garners community support.

If your community is in an area at risk from wildfire, now is a good time to start working with neighbors on a CWPP and preparing forfuture wildfires. Contact your local CSFS district to learn how to start this process and create a CWPP for your community: http://csfs.colostate.edu/pages/your-local-forester.html
For the **Hay Creek Hull Subdivision** test project area, there are 1 CWPPs areas that are totally or partially in the defined project area.

CWPP Name	CWPP Type	CSFS District	Acres inside project area	Total Acres
El Paso County	County	Woodland Park	20	1,361,917
Total Acres			**20**	**1,361,917**

Community Wildfire Protection Plans

Hay Creek Hull Subdivision



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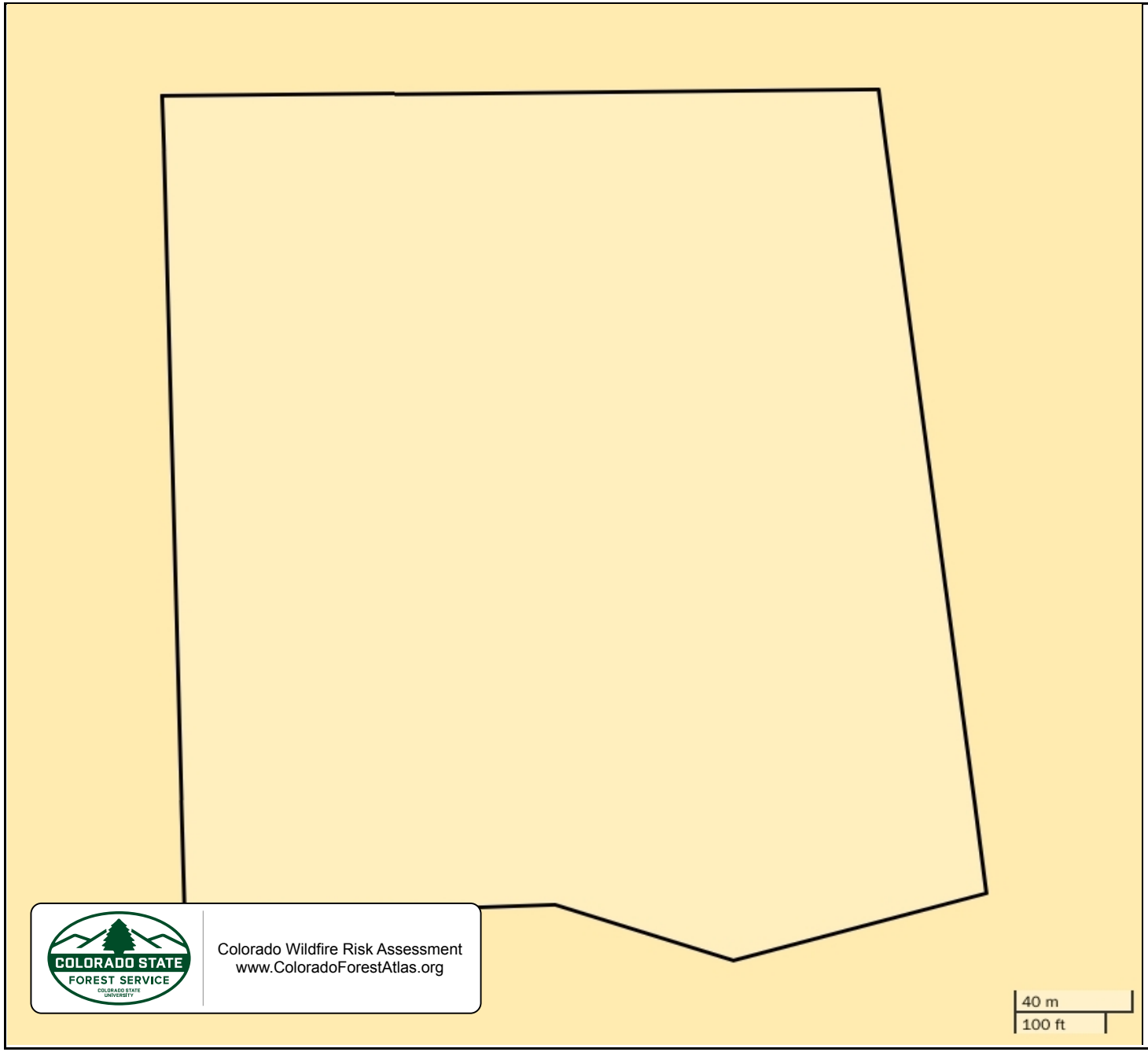
Hay Creek Hull Subdivision
CWPP
Local
FPD
County
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Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Wildfire Risk to Assets

Description

Wildfire Risk is a composite risk map created by combining the Values at Risk Rating and the Burn Probability layers.
It identifies areas with the greatest potential impacts from a wildfire – i.e., those areas most at risk when considering the four values layers.

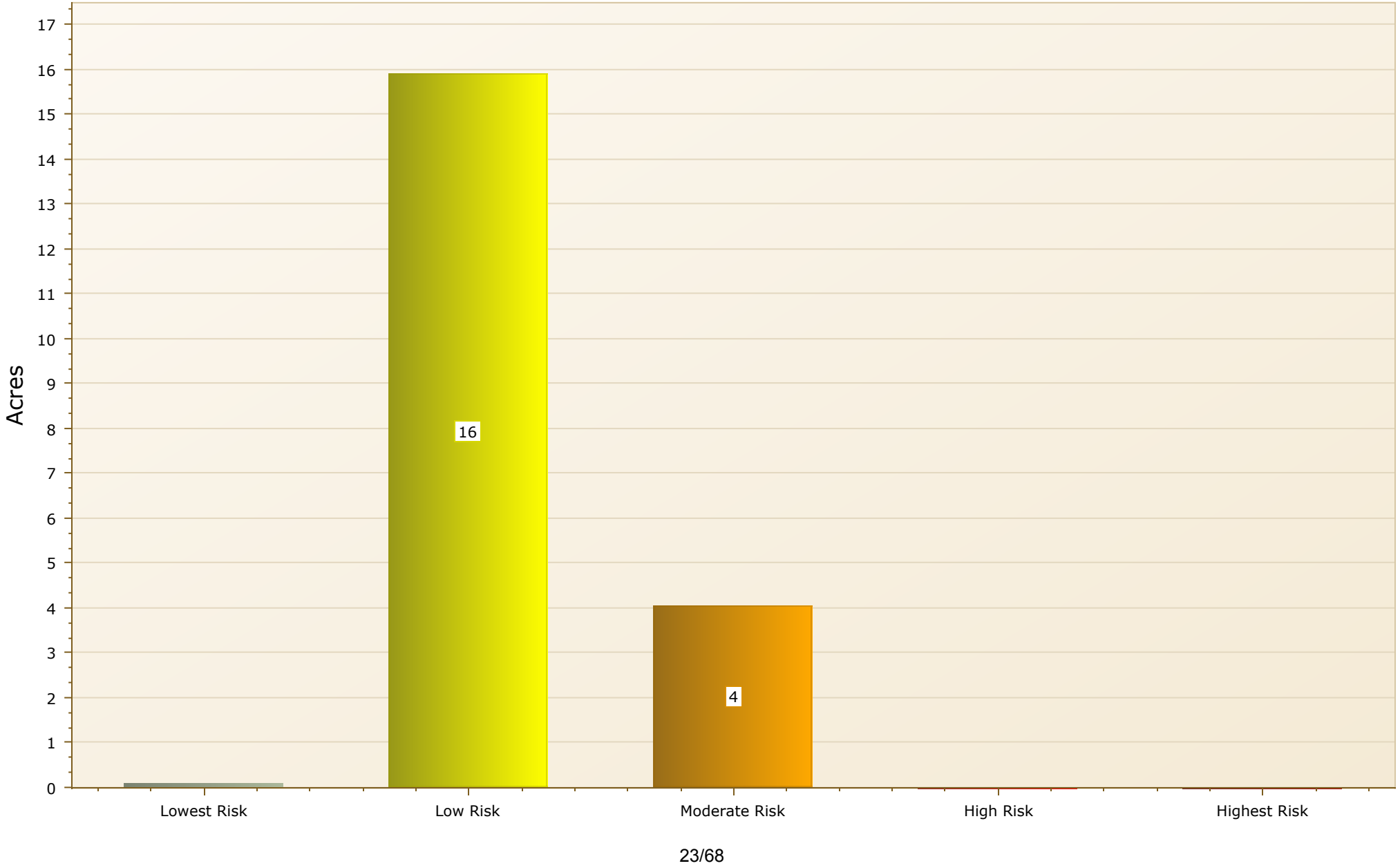
The Values at Risk Rating is a key component of Wildfire Risk. It is comprised of several individual risk layers including Wildland Urban Interface (housing density), Forest Assets, Riparian Assets and Watershed Protection risk outputs. The WUI component is a key element of the composite risk since it represents where people live in the wildland and urban fringe areas that are susceptible to wildfires and damages. The found individual risk layers are weighted to derive the Values at Risk Rating layer.

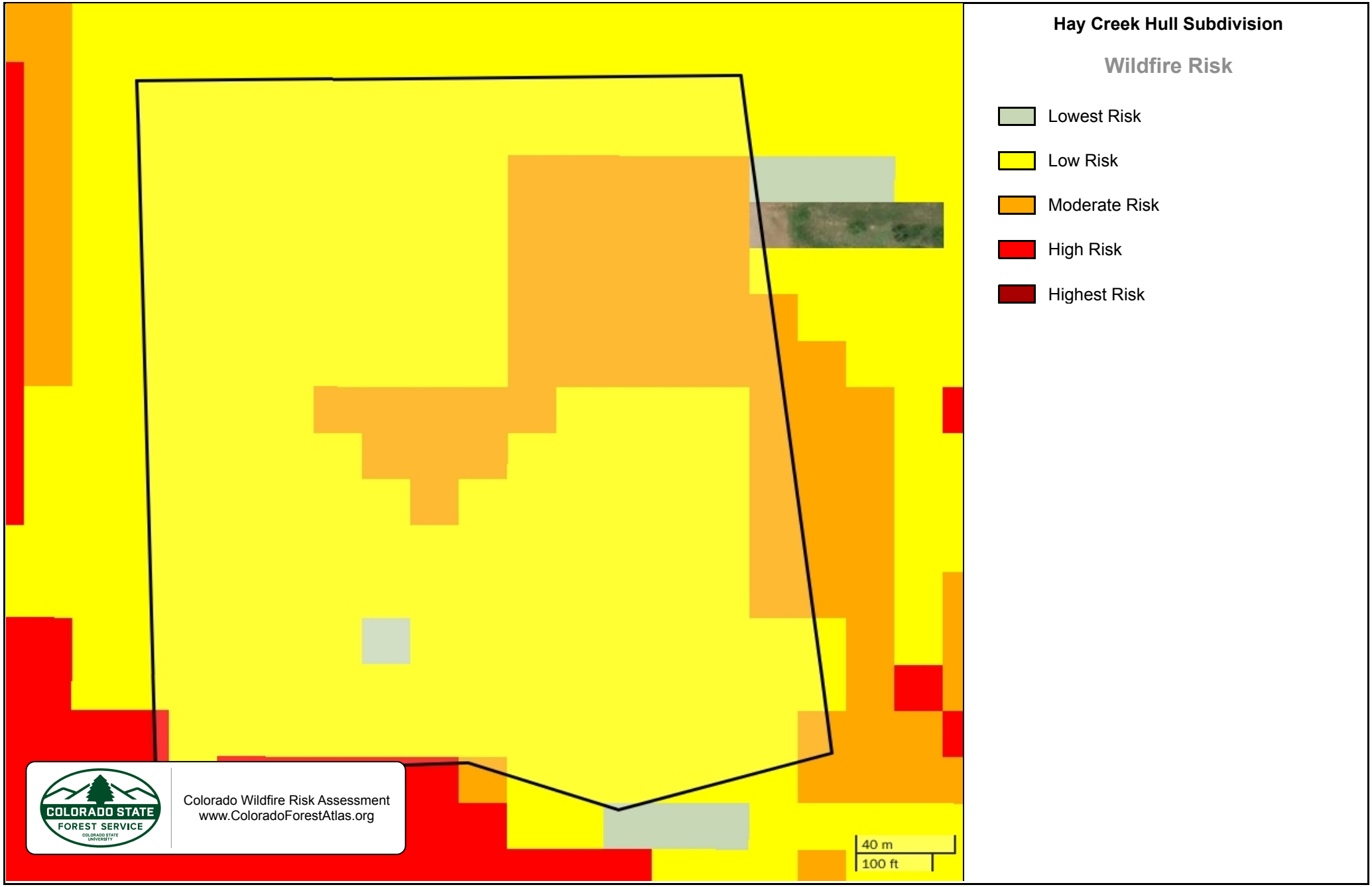
The risk map is derived at a 20-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county, or local planning efforts.

Wildfire Risk	Acres	Percent
Lowest Risk		0.5%
Low Risk	16	79.3%
Moderate Risk	4	20.2%
High Risk		0%
Highest Risk		0%
Total	**20**	**100%**

Wildfire Risk to Assets

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Wildfire Risk
Lowest Risk
Low Risk
Moderate Risk
High Risk
Highest Risk
COLORADO STATE
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Colorado Wildfire Risk Assessment
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40 m
100 ft

Burn Probability

Description

Burn Probability (BP) is the annual probability of any location burning due to a wildfire.

The annual BP was calculated as the number of times that a cell was burned and the number of iterations used to run the models. The annual BP was estimated for Colorado by using a wildfire simulation approach with Technosylva's Wildfire Analyst software (Wildfire Analyst). A total number of 2,342,334 fires were simulated (3,200,000 if we consider those fires outside the Colorado border which were used in a buffer area around the study area to compute BP) with a mean ignition density of 8.68 fires/km2. The ignition points were spatially distributed evenly every 500 meters across the state. Only high and extreme weather conditions were used to run the single fires because they usually burn most of the annual burned area. All fires simulations had a duration of 8 h. After simulating all the fires, some cells were not burned by any simulated fire, resulting in a BP value of zero. Some cells were non-burnable due to the associated fuel type (i.e. water, roads, urban, agricultural areas, barren areas). However, the lowest BP value found in "burnable" cells was assigned to cells where the simulated fires did not reach.

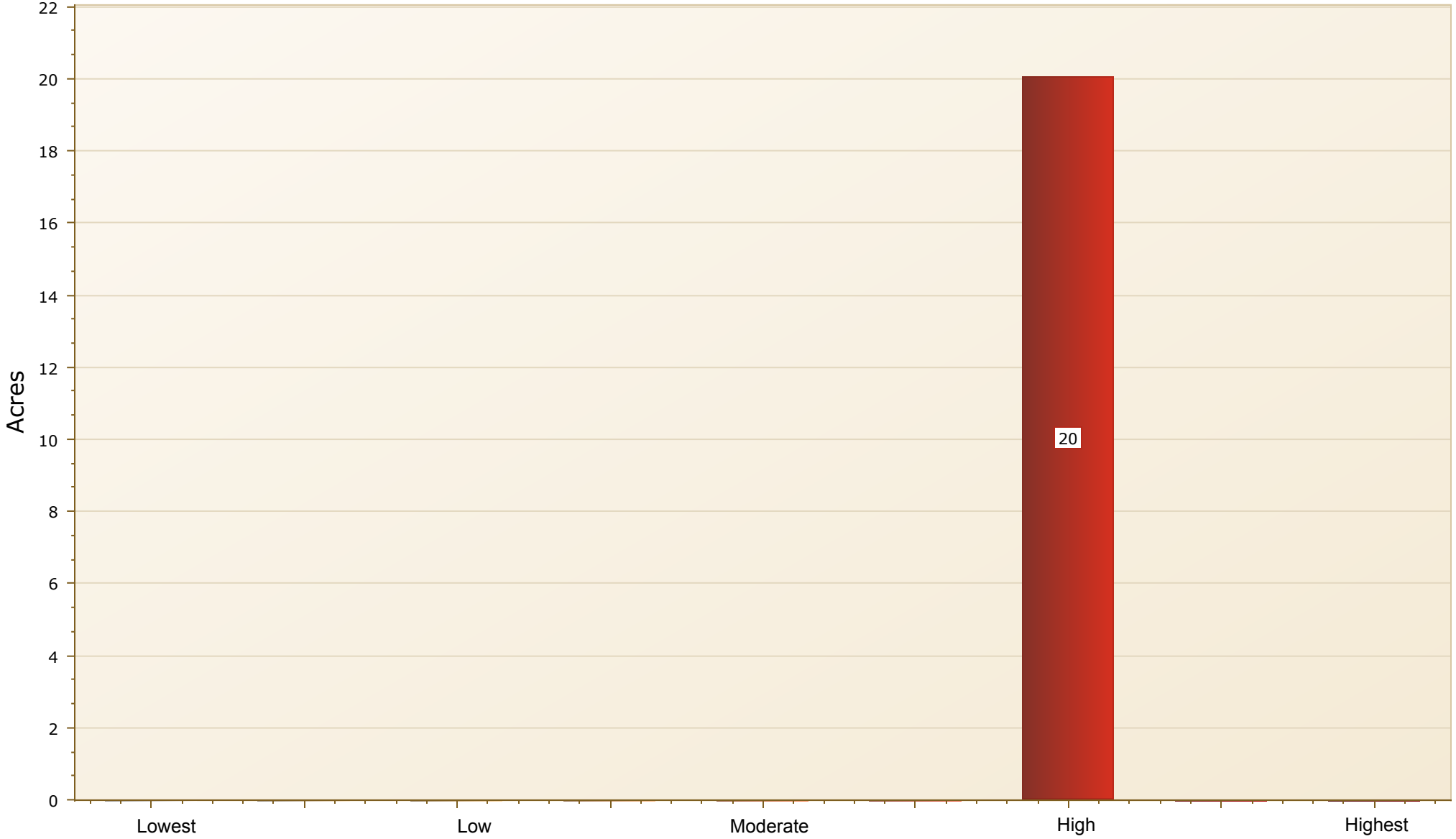
The Wildfire Analyst fire simulator considered the number of times that the simulated fires burned each cell. After that, results were weighted by considering the historical fire occurrence. The weighting was done by assessing the relation between the annual historical fire ignition density in Colorado and the total number of simulated fires with varying input data in high and moderate weather scenarios and the historical spatial distribution of the ignition points.

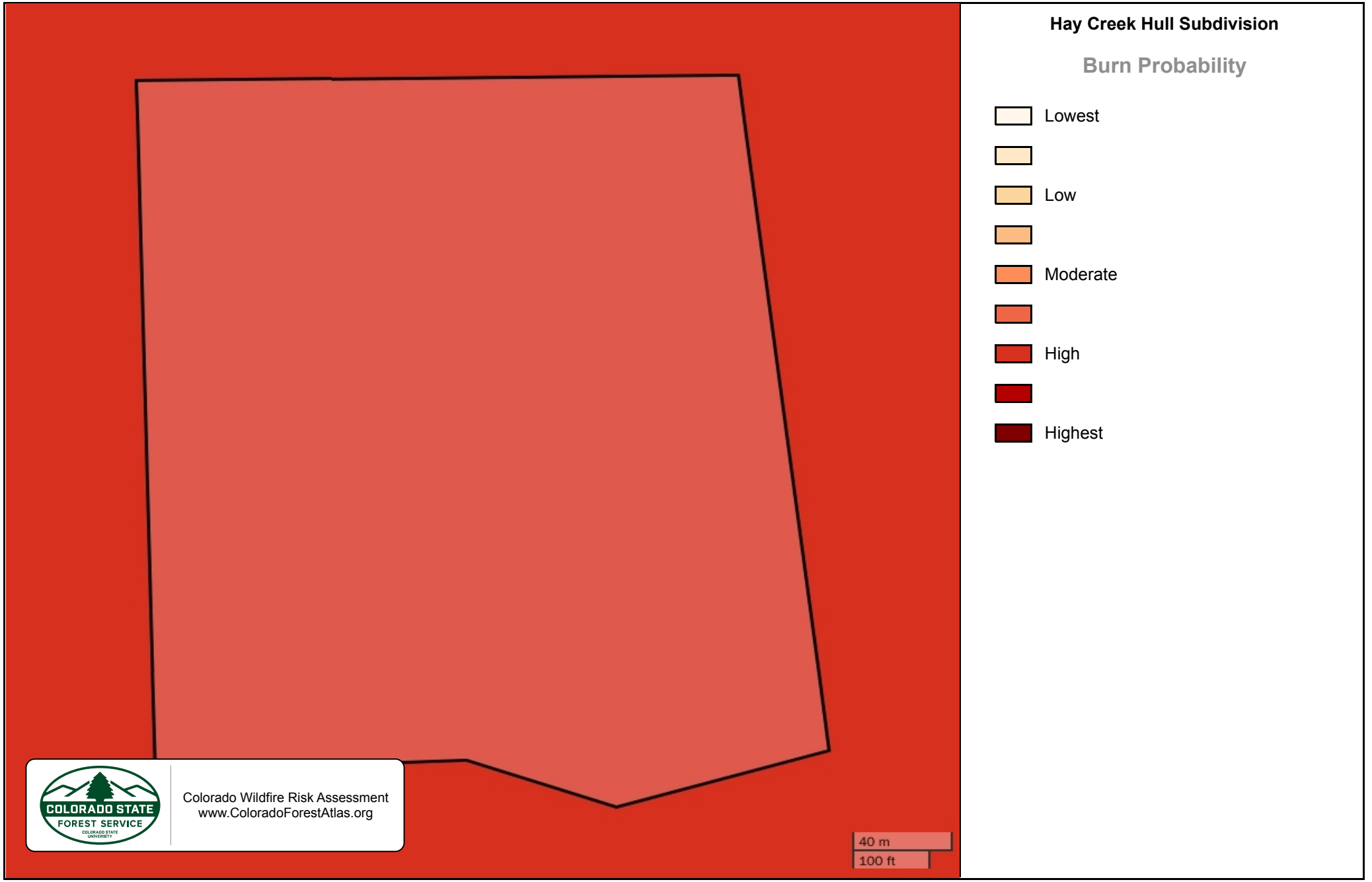
The probability map is derived at a 20-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county or local protection mitigation or prevention.

Burn Probability	Acres	Percent
Lowest		0%
		0%
Low		0%
		0%
Moderate		0%
		0%
High	20	100%
		0%
Highest		0%
Total	**20**	**100%**

Burn Probability

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Burn Probability
Lowest
Low
Moderate
High
Highest
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COLORADO STATE UNIVERSITY
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40 m
100 ft

Terrain Difficulty Index

Description

The 2012 and 2017 CO-WRA included a simple metric that described suppression difficulty based on fireline dozer rates. For 2022 CO-WRA, this standalone metric has been updated to reflect a more enhanced definition of areas where access to fires and suppression from ground resources is difficult. Although not a component of the standard risk assessment outputs, this metric is provided as it helps inform which areas may have limited suppression capabilities, especially for initial attack, across the State.

The Terrain Difficulty Index (TDI) is a metric that describes the characteristics of the landscape which evaluates the difficulty of extinction, especially in initial attack, although it can also be extrapolated to extended attacks. This static index quantifies the availability of access for the arrival of terrestrial means, the ability to penetrate the area where the fire originates, and the difficulty of extinguishing fuels.

Indicators such as the Accessibility Index, Penetrability Index and Fireline Opening Index (construction) have been used for the formulation of TDI. This index is based on other indices such as the Wildfire Suppression Difficulty Index (terrestrial) (SDIt) (Matthew P Thompson et al, 2018. Francisco Rodriguez and Silva et al, 2020.) which is a quantitative rating of the relative difficulty to perform fire control work. However, TDI is dynamic as it incorporates changes in surface fuels over time providing a less static perspective for a planning point of view.

The designated area does not contain data for this section.

Wildfire Behavior Outputs

Description

Fire behavior is the way a fire reacts to the following environmental influences:

1. Fuels
2. Weather
3. Topography

Fire behavior characteristics are attributes of wildland fire that pertain to its spread, intensity, and growth. Fire behavior characteristics utilized in the Colorado WRA include fire type, rate of spread, flame length and fireline intensity (fire intensity scale). These metrics are used to determine the potential fire behavior under different weather scenarios. Areas that exhibit moderate to high fire behavior potential can be identified for mitigation treatments, especially if these areas are in close proximity to homes, business, or other assets.

Fuels

The Colorado WRA includes composition and characteristics for both surface fuels and canopy fuels. Assessing canopy fire potential and surface fire potential allows identification of areas where significant increases in fire behavior affects the potential of a fire to transition from a surface fire to a canopy fire.

Fuel datasets required to compute both surface and canopy fire potential include:

1.Surface Fuels are typically categorized into one of four primary fuel types based on the primary carrier of the surface fire: 1) grass, 2) shrub/brush, 3) timber litter, and 4) slash. They are generally referred to as fire behavior fuel models and provide the input parameters needed to compute surface fire behavior. The 2022 assessment uses the latest 2022 calibrated fuels for Colorado. The following custom fuels were included to improve the fire modeling in timber, WUI and agricultural areas:

- Timber: 2 new categories (171 and 191)

- Urban: 7 new categories (911,912,913,914,915,916 and 919)

- Roads: 5 new categories (941,942,943,944 and 949)

- Agriculture: 4 new categories (931,932,938 and 939)

- Water: 3 new categories (981,982 and 989)

2. Canopy Cover is the horizontal percentage of the ground surface that is covered by tree crowns. It is used to compute wind-reduction factors and shading.

3.Canopy Ceiling Height/Stand Height is the height above the ground of the highest canopy layer where the density of the crown mass within the layer is high enough to support vertical movement of a fire. A good estimate of canopy ceiling height is the average height of the dominant and co-dominant trees in a stand. It is used to compute wind reduction to mid-flame height, and spotting distances from torching trees.

4.Canopy Base Height is the lowest height above the ground above which sufficient canopy fuel exists to vertically propagate fire (Scott & Reinhardt, 2001). Canopy base height is a property of a plot, stand or group of trees, not an individual tree. For fire modeling, canopy base height is an effective value that incorporates ladder fuels, such as tall shrubs and small trees. Canopy base height is used to determine whether a surface fire will transition to a canopy fire.

5. Canopy Bulk Density is the mass of available canopy fuel per unit canopy volume (Scott & Reinhardt, 2001). Canopy bulk density is a bulk property of a stand, plot, or group of trees, not an individual tree. Canopy bulk density is used to predict whether an active crown fire is possible.

Weather

Weather data (1979-2022) from gridMET was used to analyze potential weather scenarios in which assessing fire behavior and spread. gridMET is a dataset of daily high-spatial resolution (~4-km, 1/24th degree) surface meteorological data covering the contiguous US. Air temperature data at 2m, relative humidity at 2m, and wind speed and direction at 10 m were all downloaded and used.

After computing the weather percentiles of the gridMET variables, data was interpolated using IDW algorithms (Inverse Distance Weighting) at 20-meter pixel resolution.

Dead fuel moisture content was estimated using the model of Rothermel and Rinehart (1983). Both temperature and air relative humidity at 2m from gridMET was used to define the fuel moisture model. The model also considered elevation and aspect to take into account the accumulated solar radiation at 14h (local time). 1% and 2% were added to the 1h-dead fuel moisture content to estimate 10h and 100h dead fuel moisture content, respectively.

For the first time in CO-WRA risk assessments, both herbaceous and woody live fuel moisture content was modelled using Technosylva's proprietary models based on optical imagery, drought indices and phenology. The models were trained with the WFAS National live fuel moisture content. Foliar moisture content in the canopies was considered as a constant value (80%) across the entire state.

Wind speed at 10 m was estimated at 20 ft applying a wind adjustment factor to use 20-ft wind speed in the fire spread and behavior equations. Afterward, wind speed percentiles were computed to use these data in the FB analysis at 20-meter pixel resolution. Wind direction for Colorado was analyzed for a 40-year period (1979-2022) considering the calculated wind speed percentiles from gridMET data. Predominant wind direction is from SW to NE, especially when wind speed is high or very high.

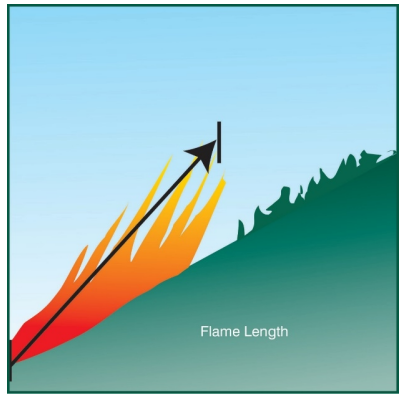
Characteristic Flame Length

The typical or representative flame length of a potential fire based on a weighted average of four percentile weather categories.

Flame Length is defined as the distance between the flame tip and the midpoint of the flame depth at the base of the flame, which is generally the ground surface. It is an indicator of fire intensity and is often used to estimate how much heat the fire is generating.

Flame length is typically measured in feet. Flame length is the measure of fire intensity used to generate the Fire Effects outputs for the CO-WRA and it is influenced by three environmental factors - fuels, weather, and topography. Weather is by far the most dynamic variable as it changes frequently. To account for this variability, four percentile weather categories were created from historical weather observations to represent low, moderate, high, and extreme weather days for each 20-meter grid cell in Colorado.

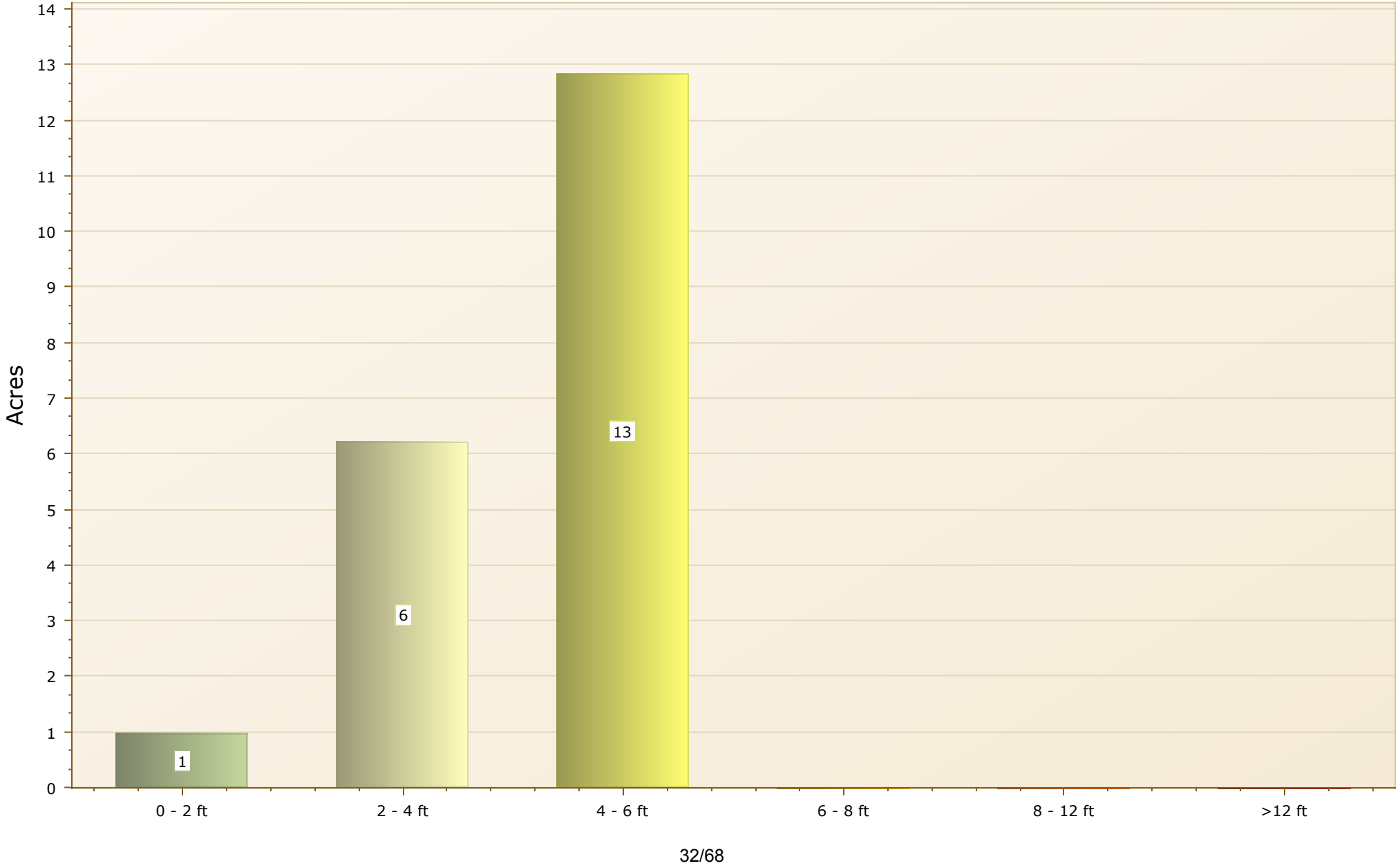
The Characteristic Flame Length represents the weighted average for all four weather percentiles. While not discussed in this report, the individual percentile weather Flame Length outputs are available in the CO-WRA data.

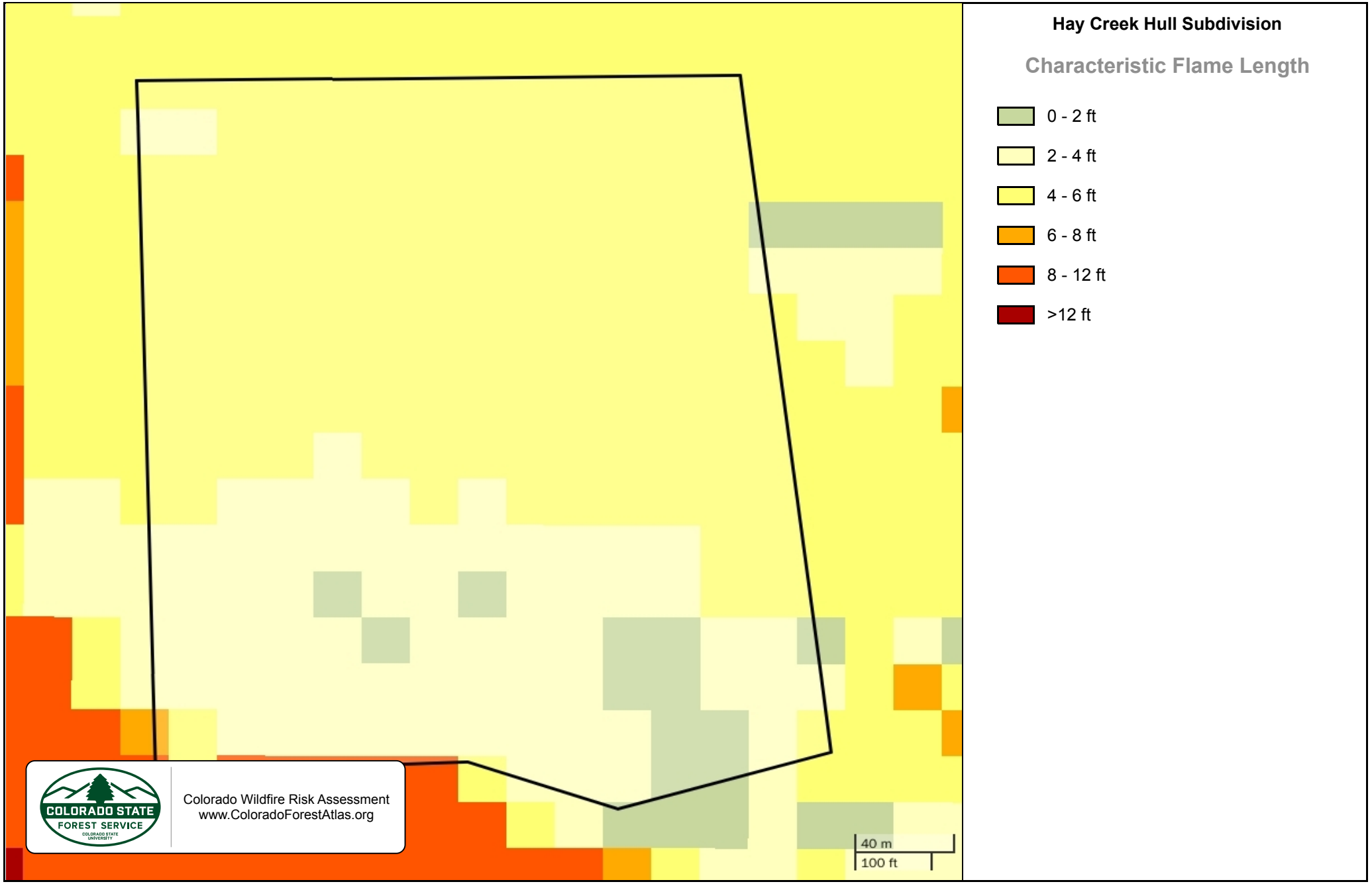


Characteristic Flame Length	Acres	Percent
0 - 2 ft	1	4.3%
2 - 4 ft	6	27.3%
4 - 6 ft	13	56.3%
6 - 8 ft		0%
8 - 12 ft		0%
>12 ft		0%
Total	**20**	**88%**

Characteristic Flame Length

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Characteristic Flame Length
0 - 2 ft
2 - 4 ft
4 - 6 ft
6 - 8 ft
8 - 12 ft
>12 ft
COLORADO STATE FOREST SERVICE
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Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Fire Intensity Scale

Description

Quantifies the potential fire intensity by orders of magnitude.
Fire Intensity Scale (FIS) specifically identifies areas where significant fuel hazards and associated dangerous fire behavior potential exist. Similar to the Richter scale for earthquakes, FIS provides a standard scale to measure potential wildfire intensity. FIS consist of five (5) classes where the order of magnitude between classes is ten-fold. The minimum class, Class 1, represents very low wildfire intensities and the maximum class, Class 5, represents very high wildfire intensities.

1. Class 1, Lowest Intensity:
Very small, discontinuous flames, usually less than 1 foot in length; very low rate of spread; no spotting. Fires are typically easy to suppress by firefighters with basic training and non-specialized equipment.

2. Class 2, Low:
Small flames, usually less than two feet long; small amount of very short-range spotting possible. Fires are easy to suppress by trained firefighters with protective equipment and specialized tools.

3. Class 3, Moderate:
Flames up to 8 feet in length; short-range spotting is possible. Trained firefighters will find these fires difficult to suppress without support from aircraft or engines, but dozer and plows are generally effective. Increasing potential for harm or damage to life and property.

4. Class 4, High:
Large Flames, up to 30 feet in length; short-range spotting common; medium range spotting possible. Direct attack by trained firefighters, engines, and dozers is generally ineffective, indirect attack may be effective. Significant potential for harm or damage to life and property.

5. Class 5, Highest Intensity:
Very large flames up to 150 feet in length; profuse short-range spotting, frequent long-range spotting; strong fire-induced winds. Indirect attack marginally effective at the head of the fire. Great potential for harm or damage to life and property.

Burn Probability and Fire Intensity Scale are designed to complement each other. Unlike Wildfire Threat, the Fire Intensity Scale does not incorporate historical occurrence information. It only evaluates the potential fire behavior for an area, regardless if any fires have occurred there in the past. This additional information allows mitigation planners to quickly identify areas where dangerous fire behavior potential exists in relationship to nearby homes or other valued assets.

Since all areas in Colorado have fire intensity scale calculated consistently, it allows for comparison and ordination of areas across the entire state. For example, a high fire intensity area in Eastern Colorado is equivalent to a high fire intensity area in Western Colorado.

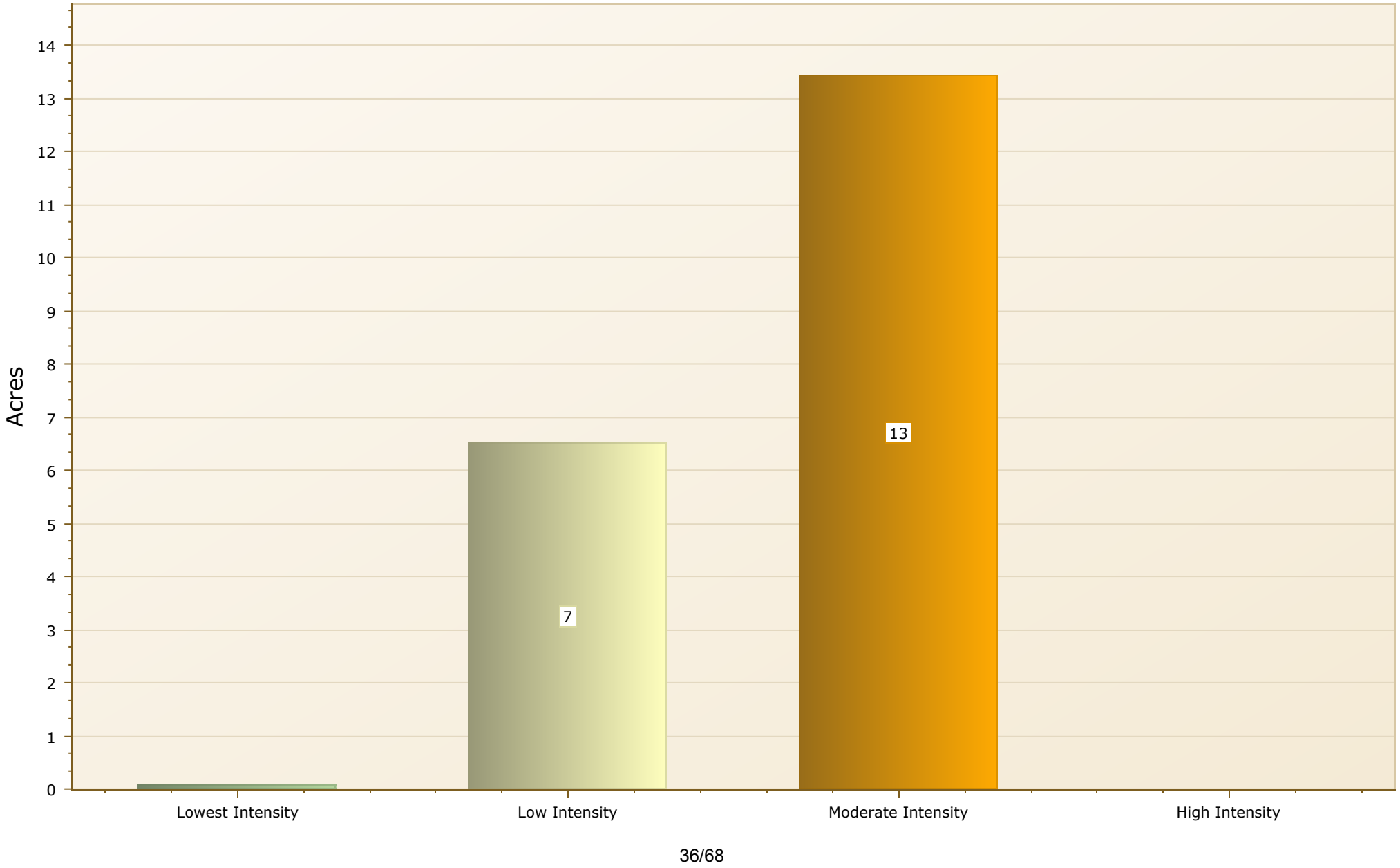
Fire intensity scale is a fire behavior output, which is influenced by three environmental factors - fuels, weather, and topography – and the spread itself (back, flank or head fire influences fire behavior for a given pixel for a specific fire simulation). Weather is by far the most dynamic variable as it changes frequently. Thus, each pixel may burn many times with different fire spread patterns based on the aforementioned factors. The fire intensity scale maps represent an average fire intensity map.

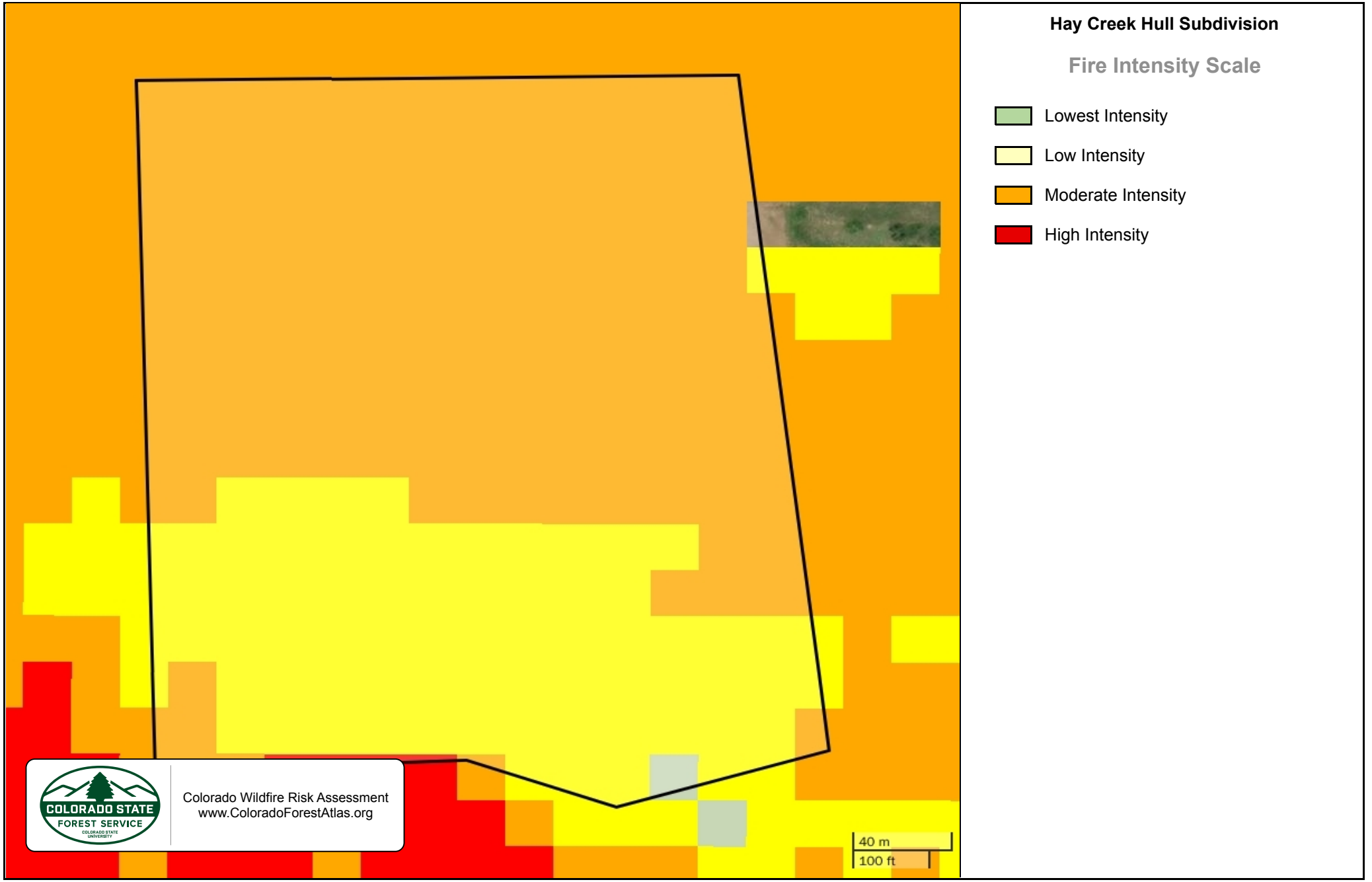
The fire intensity scale map is derived at a 20-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county, or local planning efforts.

FIS Class	Acres	Percent
Lowest Intensity		0.5%
Low Intensity	7	32.5%
Moderate Intensity	13	67%
High Intensity		0%
Total	**20**	**100%**

Fire Intensity Scale

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Fire Intensity Scale
Lowest Intensity
Low Intensity
Moderate Intensity
High Intensity
COLORADO STATE
FOREST SERVICE
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Fire Type

Represents the potential fire type under the extreme percentile weather category.

Canopy fires are very dangerous, destructive and difficult to control due to their increased fire intensity. From a planning perspective, it is important to identify where these conditions are likely to occur on the landscape so that special preparedness measure can be taken if necessary. The Fire Type layer shows the footprint of where these areas are most likely to occur. However, it is important to note that canopy fires are not restricted to these areas. Under the right conditions, it can occur in other canopied areas.

There are two primary fire types – surface fire and canopy fire. Canopy fire can be further subdivided into passive canopy fire and active canopy fire. A short description of each of these is provided below.

• Surface Fire - A fire that spreads through surface fuel without consuming any overlying canopy fuel. Surface fuels include grass, timber litter, shrub/brush, slash and other dead or live vegetation within about 6 feet of the ground.

• Passive Canopy Fire – A type of crown fire in which the crowns of individual trees or small groups of trees burn, but solid flaming in the canopy cannot be maintained except for short periods (Scott & Reinhardt, 2001).

• Conditional Crown Fire – A type of crown fire in which an active crown fire is possible but one would not be predicted to initiate. Two outcomes are possible in that situation: surface fire if the fire starts in the stand as a surface fire, or active crown fire if fire enters the stand as an active crown fire.

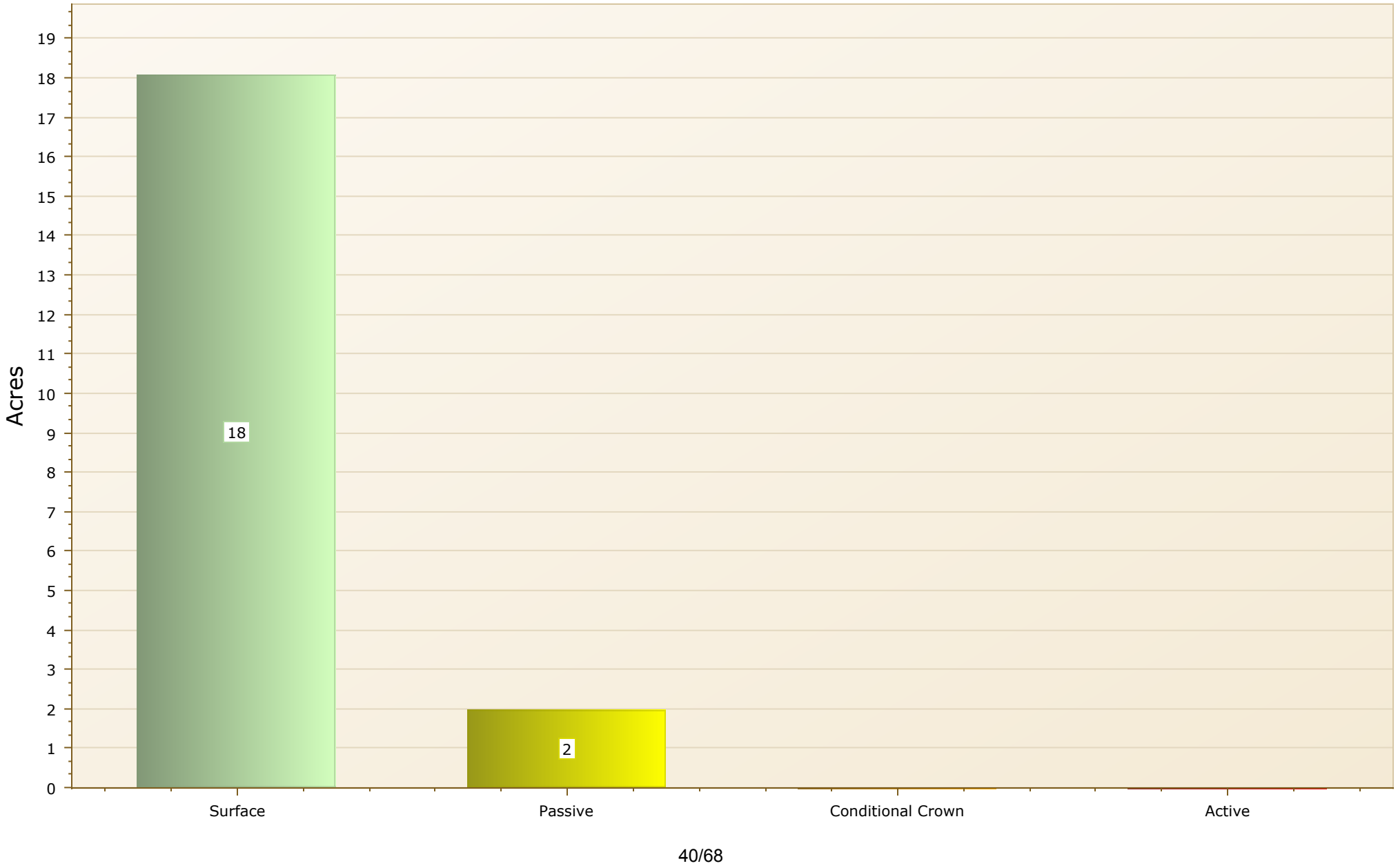
• Active Canopy Fire - A crown fire in which the entire fuel complex (canopy) is involved in flame, but the crowning phase remains dependent on heat released from surface fuel for continued spread (Scott & Reinhardt, 2001).

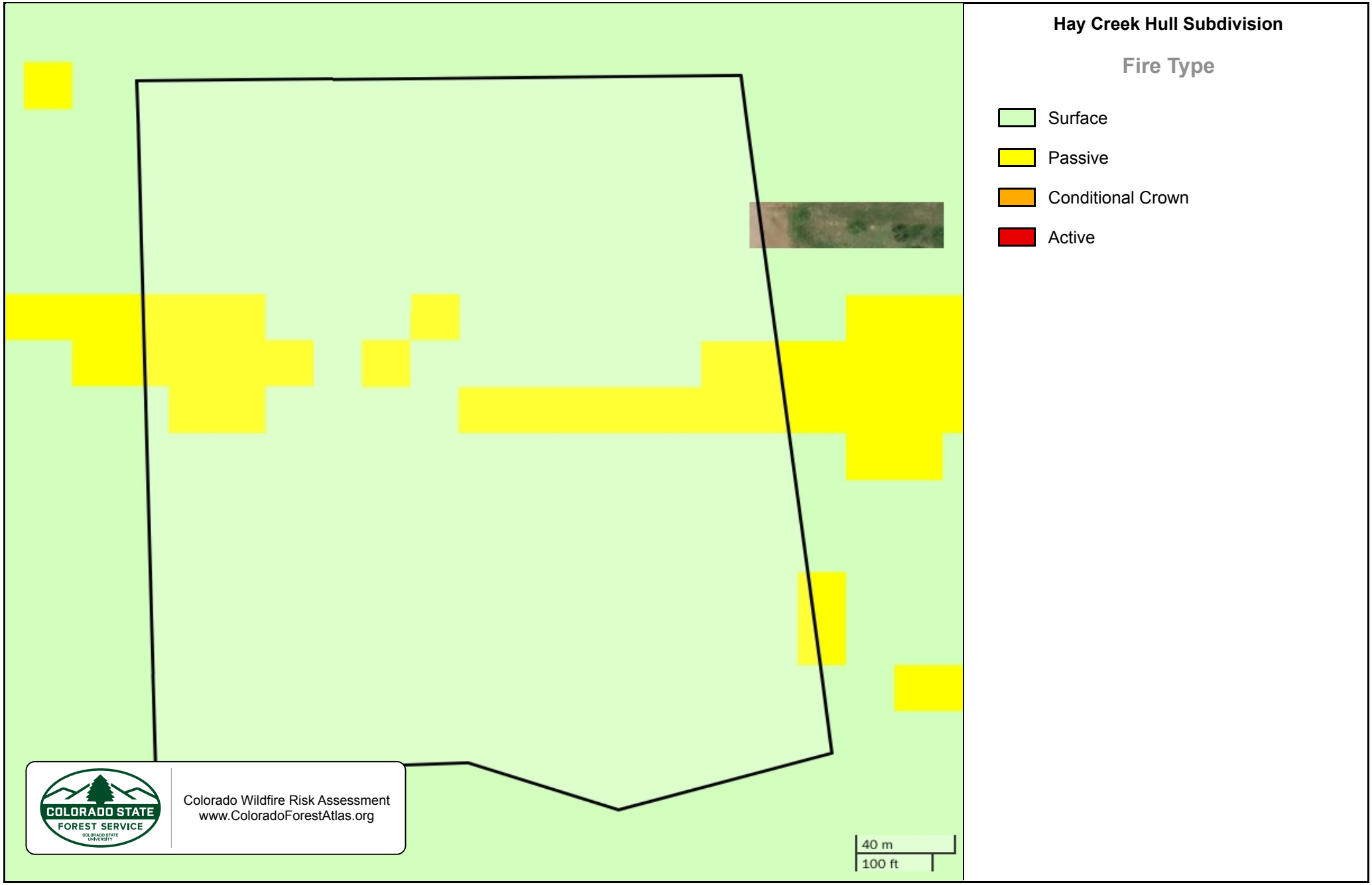
The fire type map is derived at a 20-meter resolution and was estimated based on the extreme weather scenario (percentile 97th). This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county or local planning efforts.

Fire Type	Acres	Percent
Surface	18	90.1%
Passive	2	9.8%
Conditional Crown		0%
Active		0%
Total	**20**	**100%**

Fire Type

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Fire Type
Surface
Passive
Conditional Crown
Active
COLORADO STATE
FOREST SERVICE
COLORADO STATE UNIVERSITY
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Rate of Spread

The typical or representative rate of spread of a potential fire based on a weighted average of four percentile weather categories.

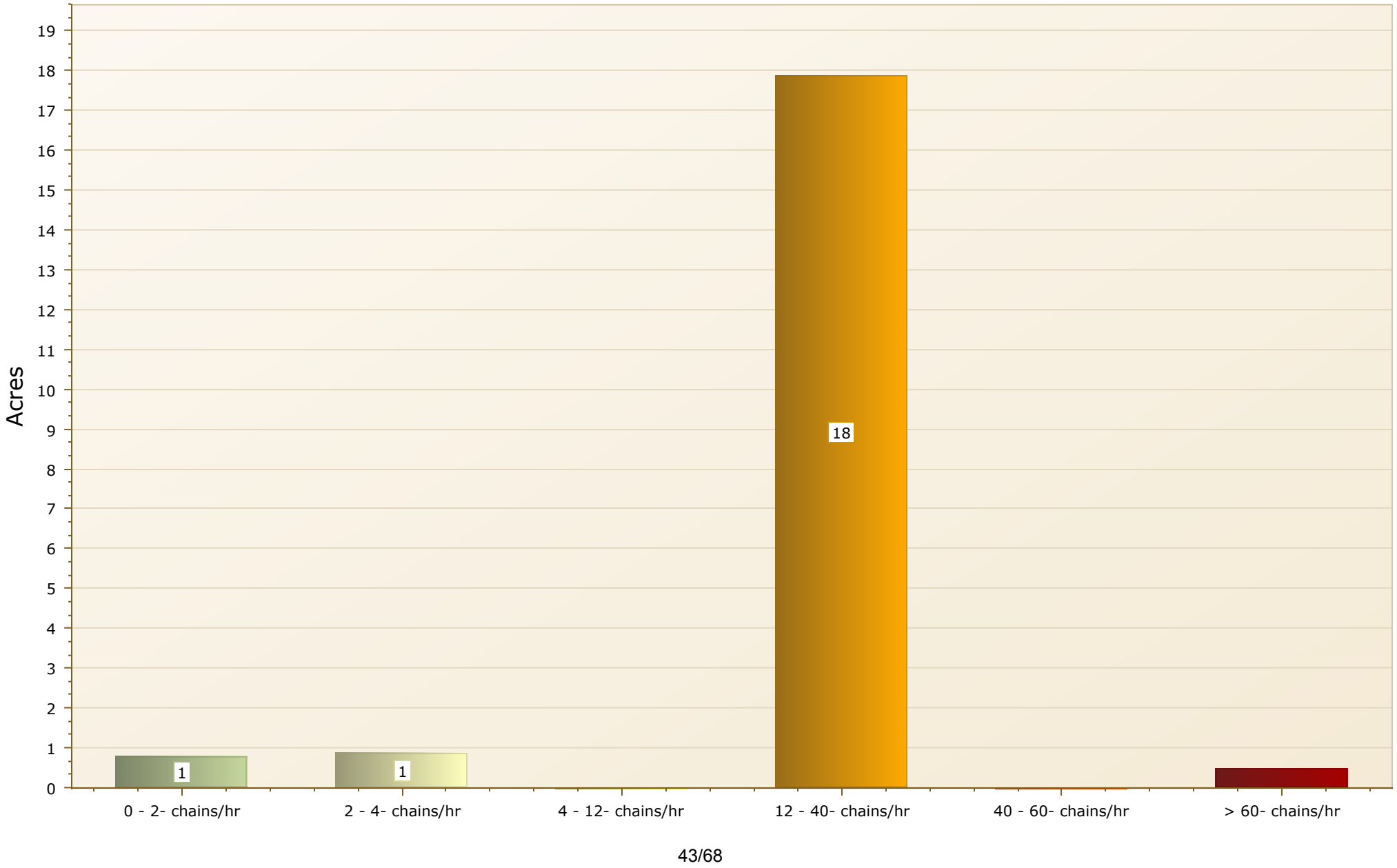
Rate of spread is the speed with which a fire moves in a horizontal direction across the landscape, usually expressed in chains per hour (ch/hr) or feet per minute (ft/min). For purposes of the CO-WRA, this measurement represents the maximum rate of spread of the fire front.

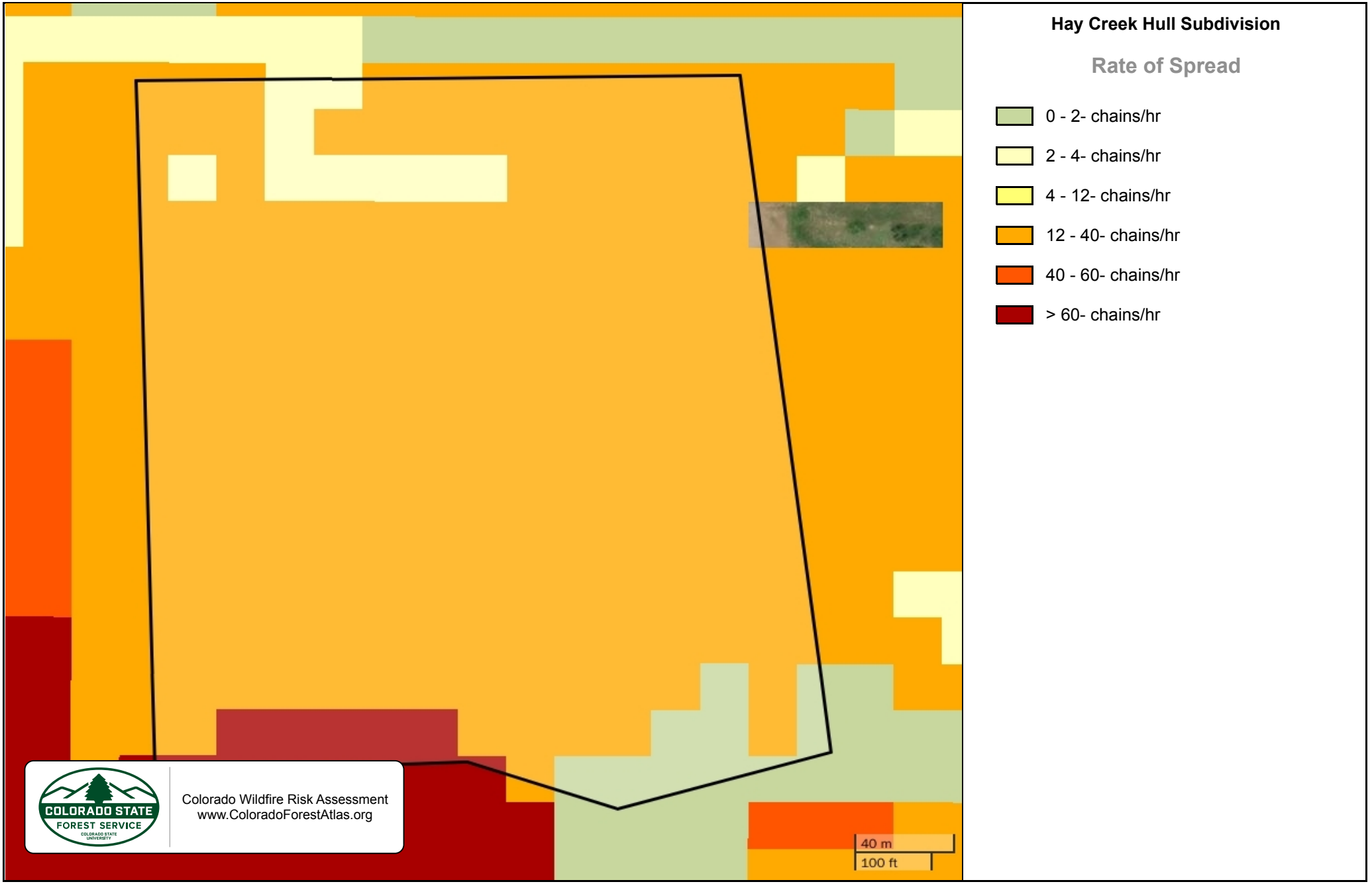
Rate of spread is a fire behavior output, which is influenced by three environmental factors - fuels, weather, and topography. Weather is by far the most dynamic variable as it changes frequently. To account for this variability, four percentile weather categories were created from historical weather observations to represent low, moderate, high, and extreme weather days for a 20-meter grid cell in Colorado.

Rate of Spread	Acres	Percent
0 - 2- chains/hr	1	3.9%
2 - 4- chains/hr	1	4.4%
4 - 12- chains/hr		0%
12 - 40- chains/hr	18	89.2%
40 - 60- chains/hr		0%
> 60- chains/hr		2.5%
Total	**20**	**100%**

Rate of Spread

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Rate of Spread
0 - 2- chains/hr
2 - 4- chains/hr
4 - 12- chains/hr
12 - 40- chains/hr
40 - 60- chains/hr
> 60- chains/hr
COLORADO STATE
FOREST SERVICE
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Surface Fuels

Fire behavior fuel models that contain the parameters required to calculate fire behavior outputs.

Surface fuels, or fire behavior fuel models as they are technically referred to, contain the parameters needed by the Rothermel (1972) surface fire spread model to compute surface fire behavior characteristics, e.g. rate of spread, flame length, fireline intensity, and other fire behavior metrics. As the name might suggest, surface fuels account only for surface fire potential. Canopy fire potential is computed through a separate but linked process. The CO-WRA accounts for both surface and canopy fire potential in the fire behavior outputs.

An up-to-date surface fuel dataset at 20-meter (m) resolution was developed for this project, based on Scott and Burgan (2005) fuel models, enhanced with custom fuels created by Technosylva. The custom fuels distinguish this assessment from previous ones performed in Colorado as they allow a better characterization of fire behavior across the landscape. Additionally, the urban and road custom fuel models included in the assessment are key for better characterizing the exposure, vulnerability and risk of both buildings and population in the Wildland Urban Interface (WUI). This also allows for better modeling of fire encroachment in urban areas considering the building density, community structure and fuels surrounding the buildings and urban areas.

The following custom fuels were included in order to improve the fire modeling in timber, WUI and agricultural areas:

- Timber: 2 new categories (171 and 191)
- Urban: 7 new categories (911,912,913,914,915,916 and 919)
- Roads: 5 new categories (941,942,943,944 and 949)
- Agriculture: 4 new categories (931,932,938a and 939)
- Water: 3 new categories (981,982 and 989)

Additionally, we also considered canopy fuel data to better simulate crown fire behavior. This includes:

- canopy bulk density (CBD),
- canopy base height (CBH),
- canopy cover (CC) and
- canopy height (CH).

Unmanaged forest with dead amd dowmed trees and branches

Slash on the ground indicates that forest management treatments have occurred in this area

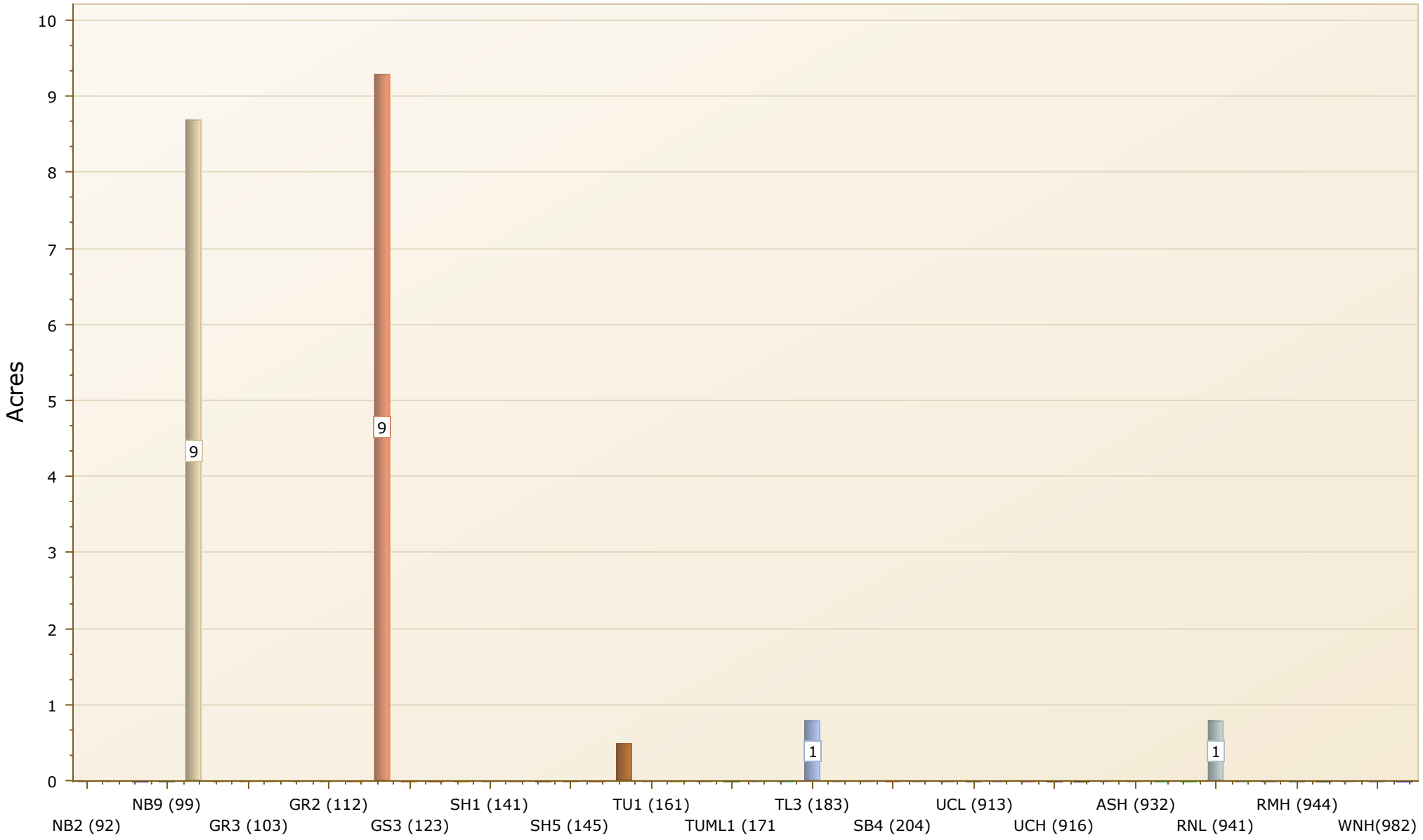
The updated fuel dataset also considered the effects of natural disturbances on vegetation (fires, insect and disease, and harvesting/fuel treatments) that occurred in Colorado from 2013 to 2022. More information about the methods used can be found in the Colorado 2022 Fuels Mapping Final Report.

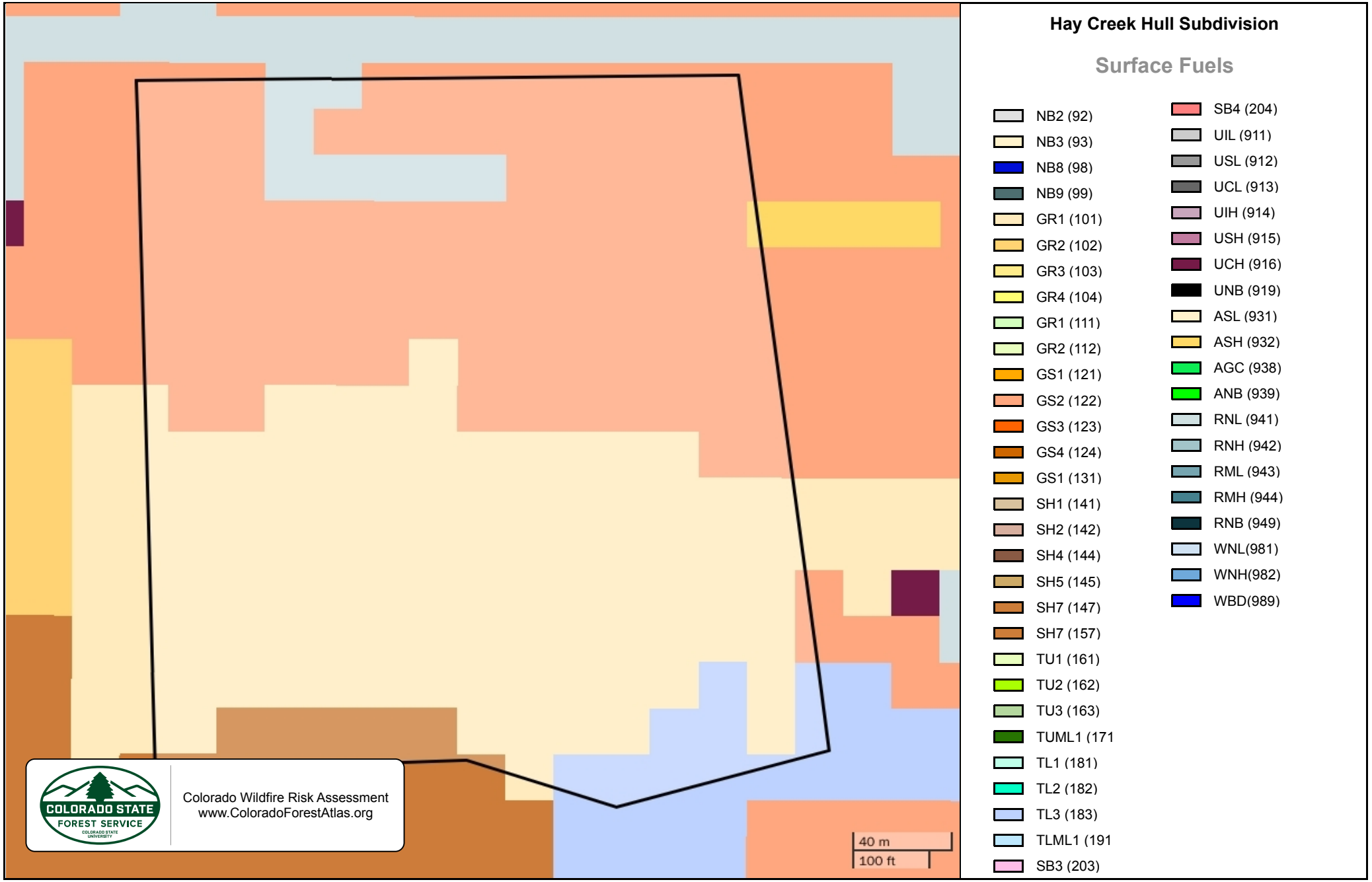
Surface Fuels	Description	Acres	Percent
NB2 (92)	Snow/Ice		0%
NB3 (93)	Agricultural		0%
NB8 (98)	Open Water		0%
NB9 (99)	Bare Ground		0%
GR1 (101)	Short, Sparse Dry Climate Grass	9	43.3%
GR2 (102)	Low Load, Dry Climate Grass		0%
GR3 (103)	Low Load, Very Coarse, Humid Climate Grass		0%
GR4 (104)	Moderate Load, Dry Climate Grass		0%
GR1 (111)	Short, Sparse Dry Climate Grass - ALPINE		0%
GR2 (112)	Low Load, Dry Climate Grass - ALPINE		0%
GS1 (121)	Low Load, Dry Climate Grass-Shrub		0%
GS2 (122)	Moderate Load, Dry Climate Grass-Shrub	9	46.3%
GS3 (123)	Moderate Load, Humid Climate Grass-Shrub		0%
GS4 (124)	High Load, Humid Climate Grass-Shrub		0%
GS1 (131)	Low Load, Dry Climate Grass-Shrub - ALPINE		0%
SH1 (141)	Low Load Dry Climate Shrub		0%
SH2 (142)	Moderate Load Dry Climate Shrub		0%
SH4 (144)	Low Load, Humid Climate Timber-Shrub		0%
SH5 (145)	High Load, Dry Climate Shrub		0%
SH7 (147)	Very High Load, Dry Climate Shrub		0%
SH7 (157)	Very High Load, Dry Climate Shrub		2.5%
TU1 (161)	Low Load Dry Climate Timber-Grass-Shrub		0%
TU2 (162)	Moderate Load, Humid Climate Timber-Shrub		0%
TU3 (163)	Moderate Load, Humid Climate Timber-Grass-Shrub		0%
TUML1 (171	Timber Understory Dynamic ML (TSYL 2022)		0%
TL1 (181)	Low Load Compact Conifer Litter		0%
TL2 (182)	Low Load Broadleaf Litter		0%
TL3 (183)	Moderate Load Conifer Litter	1	3.9%
TLML1 (191	Timber Litter ML (TSYL 2022)		0%

Surface Fuels	Description	Acres	Percent
SB3 (203)	High Load Activity Fuel or Moderate Load Blowdown		0%
SB4 (204)	High Load Blowdown		0%
UIL (911)	Isolated urban surrounded by Low FB fuel		0%
USL (912)	Scattered urban surrounded by Low FB fuel		0%
UCL (913)	Urban core surrounded by Low FB fuel		0%
UIH (914)	Isolated urban surrounded by High FB fuel		0%
USH (915)	Scattered urban surrounded by High FB fuel		0%
UCH (916)	Urban core surrounded by High FB fuel		0%
UNB (919)	Unburnable urban areas		0%
ASL (931)	Agricultural Low Load Fuels, with seasonal changes of its Burnable condition		0%
ASH (932)	Agricultural High Load Fuels, with seasonal changes of its Burnable condition		0%
AGC (938)	Golf courses - Non-Burnable (no encroachment)		0%
ANB (939)	Agricultural Fields, maintained in a Non-Burnable condition		0%
RNL (941)	Minor roads Low FB	1	3.9%
RNH (942)	Minor roads High FB		0%
RML (943)	Major roads Low FB		0%
RMH (944)	Major roads High FB		0%
RNB (949)	Roads surrounded by non-burnable fuels		0%
WNL(981)	Minor Water streams surrounded by Low Load Fuel (moderate encroachment)		0%
WNH(982)	Minor Water streams surrounded by High Load Fuel (high encroachment)		0%
WBD(989)	Water Bodies		0%
Total		**20**	**100%**

Surface Fuels

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Surface Fuels
NB2 (92)
NB3 (93)
NB8 (98)
NB9 (99)
GR1 (101)
GR2 (102)
GR3 (103)
GR4 (104)
GR1 (111)
GR2 (112)
GS1 (121)
GS2 (122)
GS3 (123)
GS4 (124)
GS1 (131)
SH1 (141)
SH2 (142)
SH4 (144)
SH5 (145)
SH7 (147)
SH7 (157)
TU1 (161)
TU2 (162)
TU3 (163)
TUML1 (171
TL1 (181)
TL2 (182)
TL3 (183)
TLML1 (191
SB3 (203)
SB4 (204)
UIL (911)
USL (912)
UCL (913)
UIH (914)
USH (915)
UCH (916)
UNB (919)
ASL (931)
ASH (932)
AGC (938)
ANB (939)
RNL (941)
RNH (942)
RML (943)
RMH (944)
RNB (949)
WNL(981)
WNH(982)
WBD(989)
COLORADO STATE FOREST SERVICE
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Vegetation

The Vegetation map describes the general vegetation and landcover types across the state of Colorado.

In the CO-WRA, the Vegetation dataset is used to support the development of the Surface Fuels, Canopy Cover, Canopy Stand Height, Canopy Base Height, and Canopy Bulk Density datasets.
The 2020 LANDFIRE program data product (Existing Vegetation Type) was used to compile the Vegetation data for the CO-WRA. This reflects data current to 2020. The LANDFIRE EVT data were classified to reflect general vegetation cover types for representation with CFA.

Oak shrublands are commonly found añlong dry foothills and lower mountain slopes, and are often situates above Piñyon-juniper.

Piñyon-juniper woodlands are common in southern and southwestern Colorado

Douglas-fir understory in a ponderosa pine forest

Grasslands occur both on Colorado's Eastern Plains and on the Western Slope.

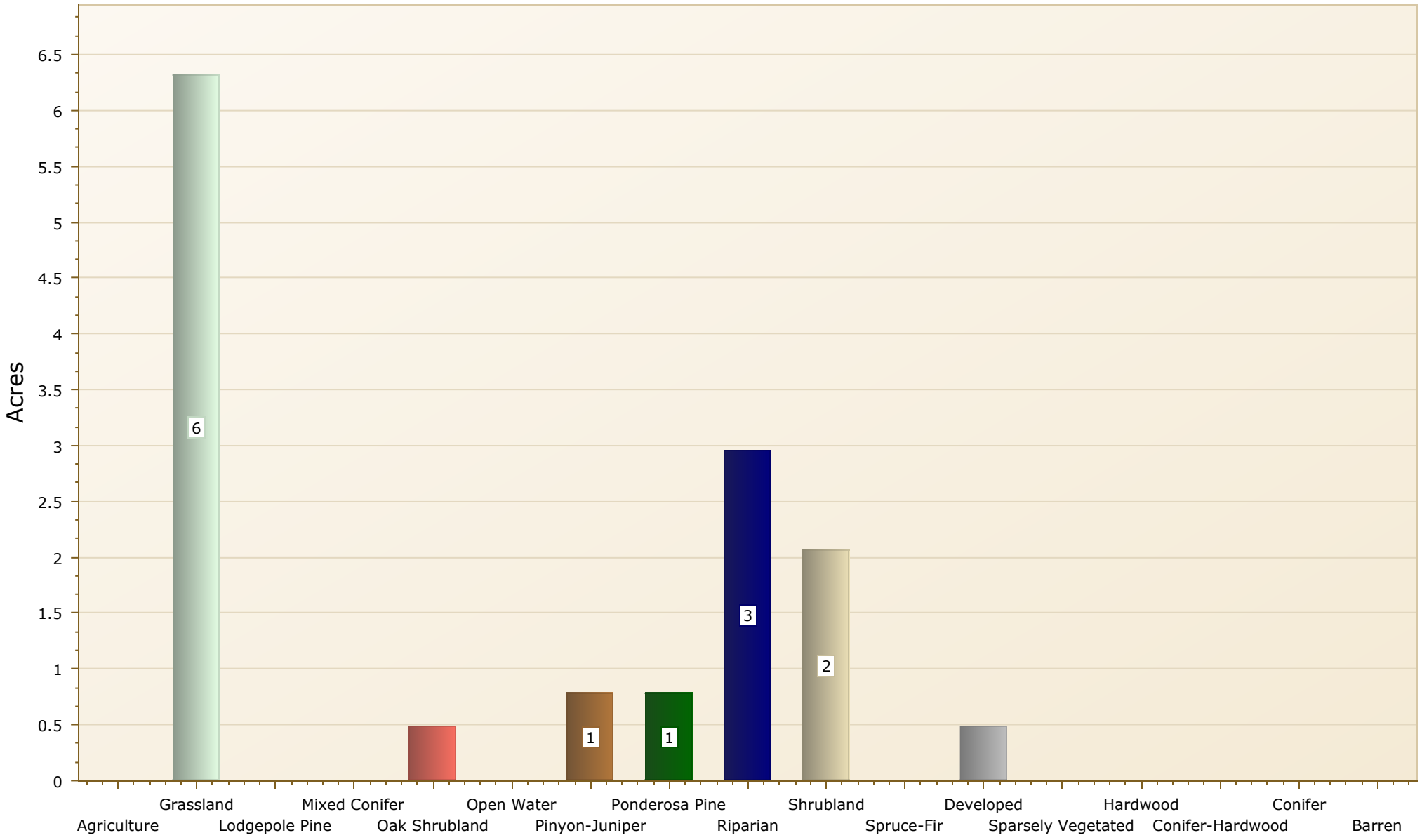
Wildland fire threat increases in lodgepole pine as the dense forest grow old

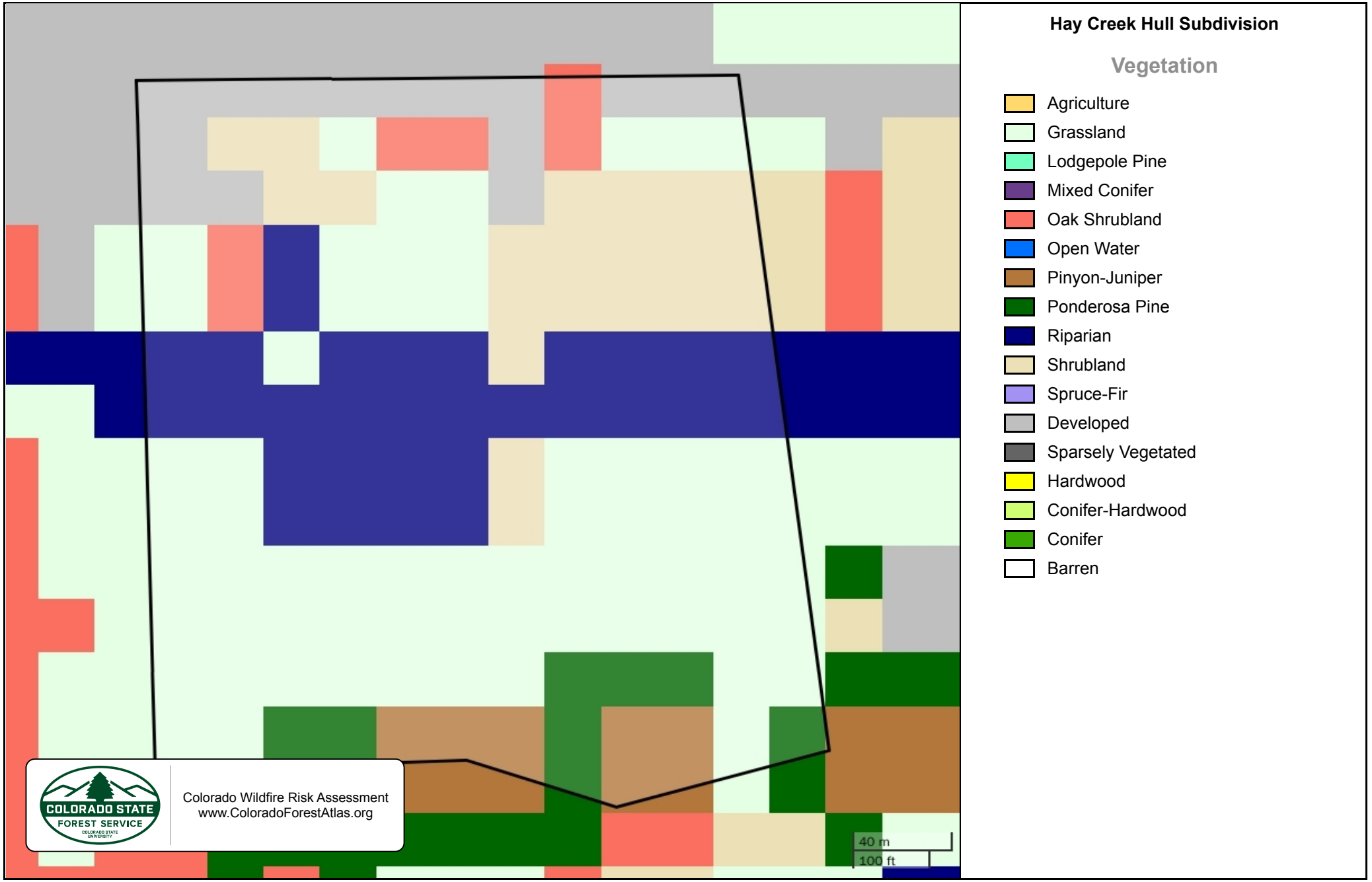
Overly dense ponderosa pine, a dominant species of the montane zone

Vegetation Class	Acres	Percent
Agriculture		0%
Grassland	6	45.4%
Lodgepole Pine		0%
Mixed Conifer		0%
Oak Shrubland		3.5%
Open Water		0%
Pinyon-Juniper	1	5.7%
Ponderosa Pine	1	5.7%
Riparian	3	21.3%
Shrubland	2	14.9%
Spruce-Fir		0%
Developed		3.5%
Sparsely Vegetated		0%
Hardwood		0%
Conifer-Hardwood		0%
Conifer		0%
Barren		0%
Total	**14**	**100%**

Vegetation

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Vegetation
Agriculture
Grassland
Lodgepole Pine
Mixed Conifer
Oak Shrubland
Open Water
Pinyon-Juniper
Ponderosa Pine
Riparian
Shrubland
Spruce-Fir
Developed
Sparsely Vegetated
Hardwood
Conifer-Hardwood
Conifer
Barren
COLORADO STATE FOREST SERVICE
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Watershed Protection Risk

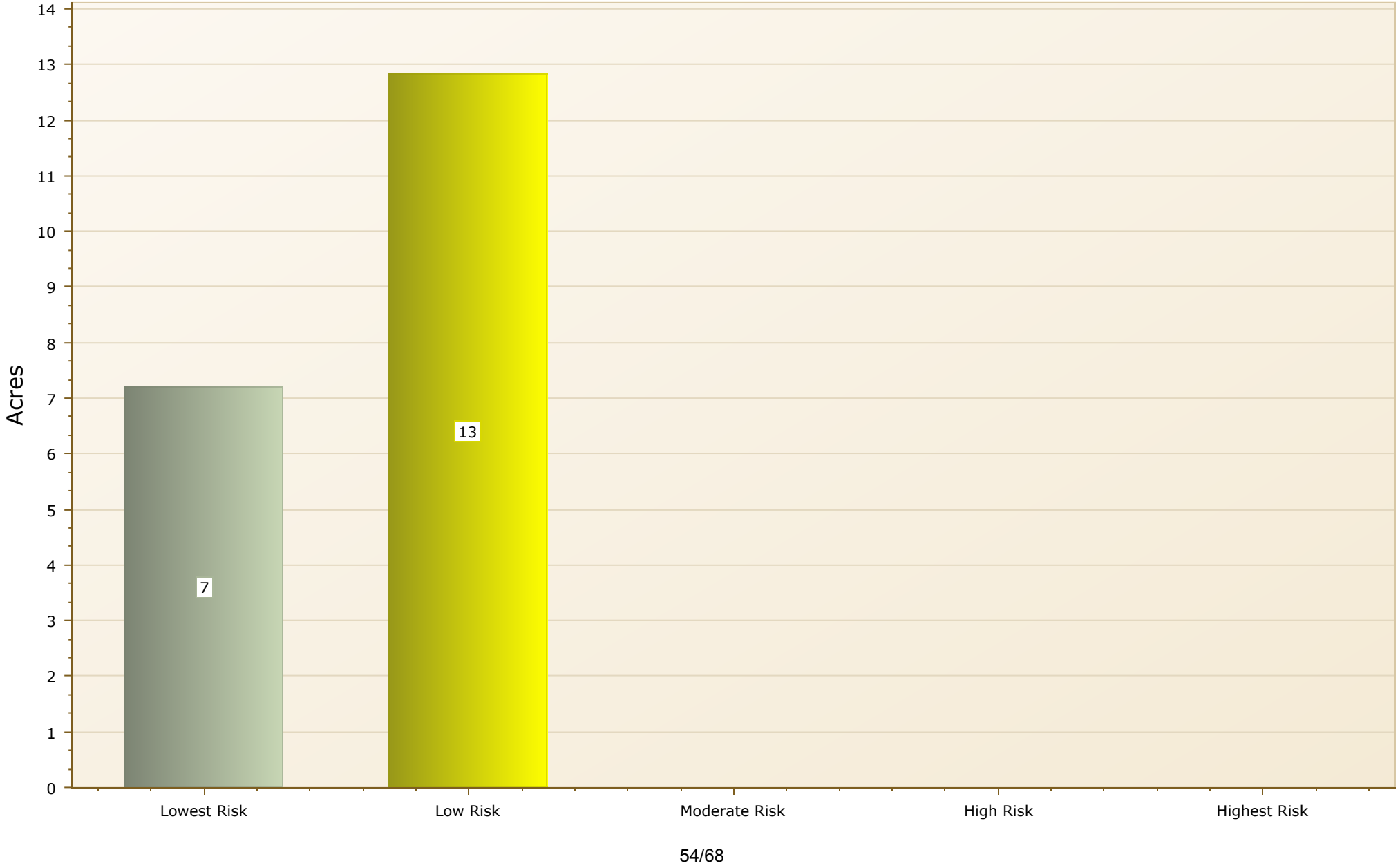
A measure of the risk to Watershed Protection Areas based on the potential negative impacts from wildfire.

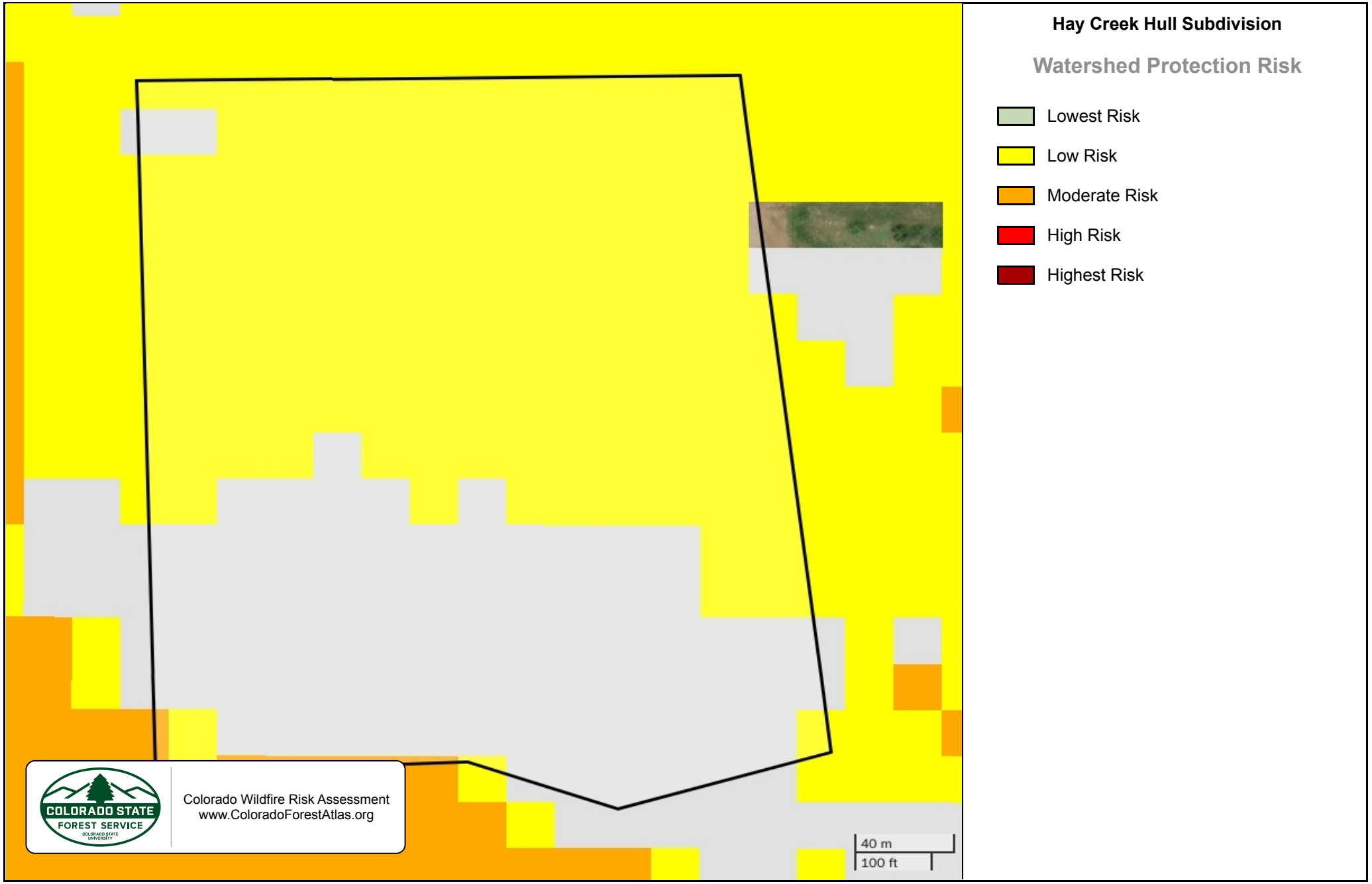
In areas that experience low-severity burns, fire events can serve to eliminate competition, rejuvenate growth and improve watershed conditions. But in landscapes subjected to high, or even moderate-burn severity, the post-fire threats to public safety and natural resources can be extreme.
High-severity wildfires remove virtually all forest vegetation – from trees, shrubs and grasses down to discarded needles, decomposed roots and other elements of ground cover or duff that protect forest soils. A severe wildfire also can cause certain types of soil to become hydrophobic by forming a waxy, water-repellent layer that keeps water from penetrating the soil, dramatically amplifying the rate of runoff.
The loss of critical surface vegetation leaves forested slopes extremely vulnerable to large-scale soil erosion and flooding during subsequent storm events. In turn, these threats can impact the health, safety and integrity of communities and natural resources downstream. The likelihood that such a post-fire event will occur in Colorado is increased by the prevalence of highly erodible soils in several parts of the state, and weather patterns that frequently bring heavy rains on the heels of fire season.
In the aftermath of the 2002 fire season, the Colorado Department of Health estimated that 26 municipal water storage facilities were shut down due to fire and post-fire impacts. The potential for severe soil erosion is a consequence of wildfire because as a fire burns, it destroys plant material and the litter layer. Shrubs, forbs, grasses, trees and the litter layer disperse water during severe rainstorms. Plant roots stabilize the soil, and stems and leaves slow the water to give it time to percolate into the soil profile. Fire can destroy this soil protection.
The risk index has been calculated by combining the Watershed Protection data with a measure of fire intensity using a Response Function approach. Those areas with the highest negative impact (-9) represent areas with high potential fire intensity and high importance for ecosystem services. Those areas with the lowest negative impact (-1) represent those areas with low potential fire intensity and a low importance for ecosystem services. The response function outputs were combined into 5 qualitative classes.

Watershed Protection Risk	Acres	Percent
Lowest Risk	7	36%
Low Risk	13	64%
Moderate Risk		0%
High Risk		0%
Highest Risk		0%
Total	**20**	**100%**

Watershed Protection Risk

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Watershed Protection Risk
Lowest Risk
Low Risk
Moderate Risk
High Risk
Highest Risk
COLORADO STATE
FOREST SERVICE
COLORADO STATE UNIVERSITY
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Riparian Assets Risk

A measure of the risk to riparian areas based on the potential negative impacts from wildfire.

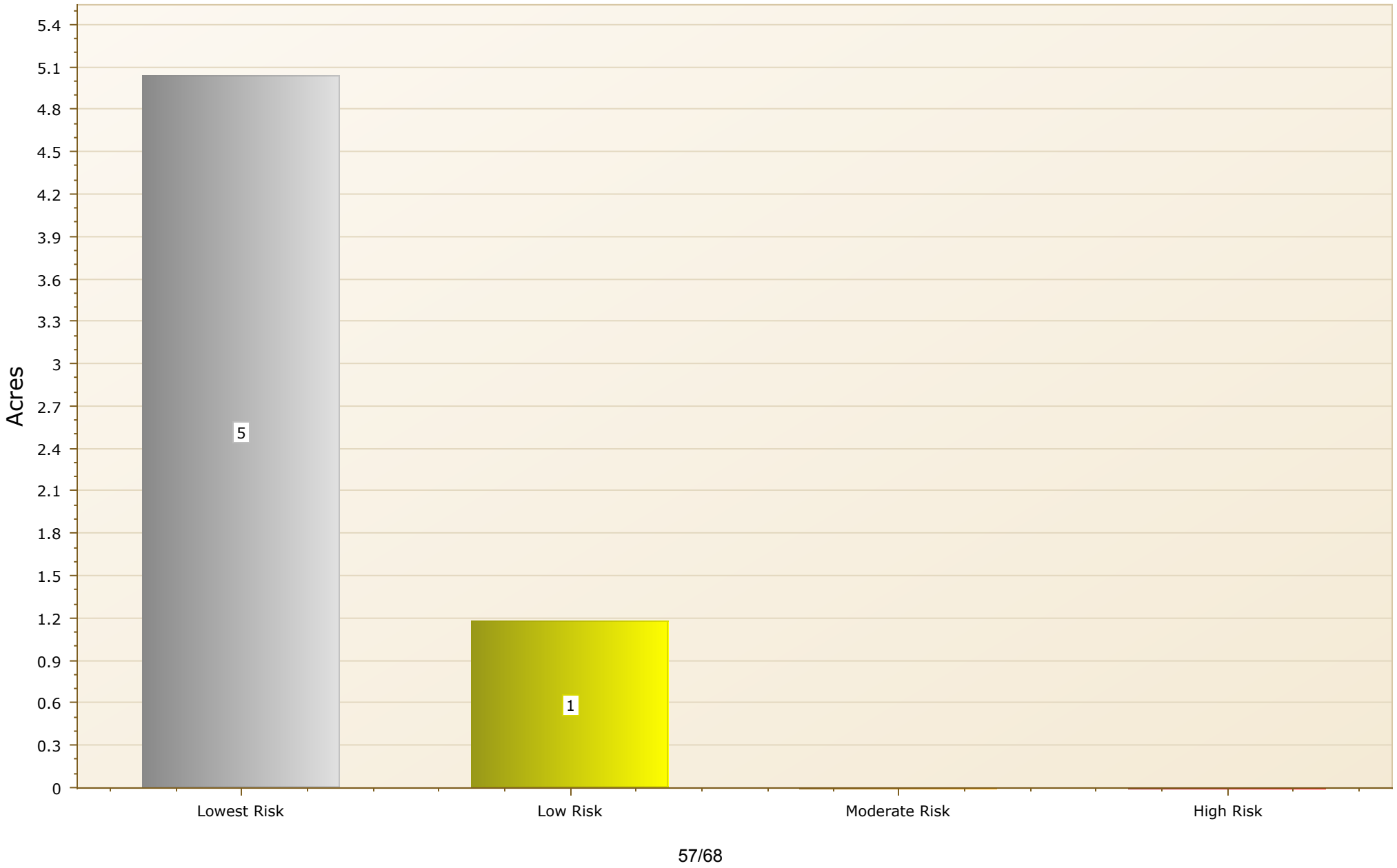
The risk index has been calculated by combining the Riparian Assets data with a measure of fire intensity using a Response Function approach. Those areas with the highest negative impact (-9) represent areas with high potential fire intensity and high importance for ecosystem services. Those areas with the lowest negative impact (-1) represent those areas with low potential fire intensity and a low importance for ecosystem services. The response function outputs were combined into 5 qualitative classes.

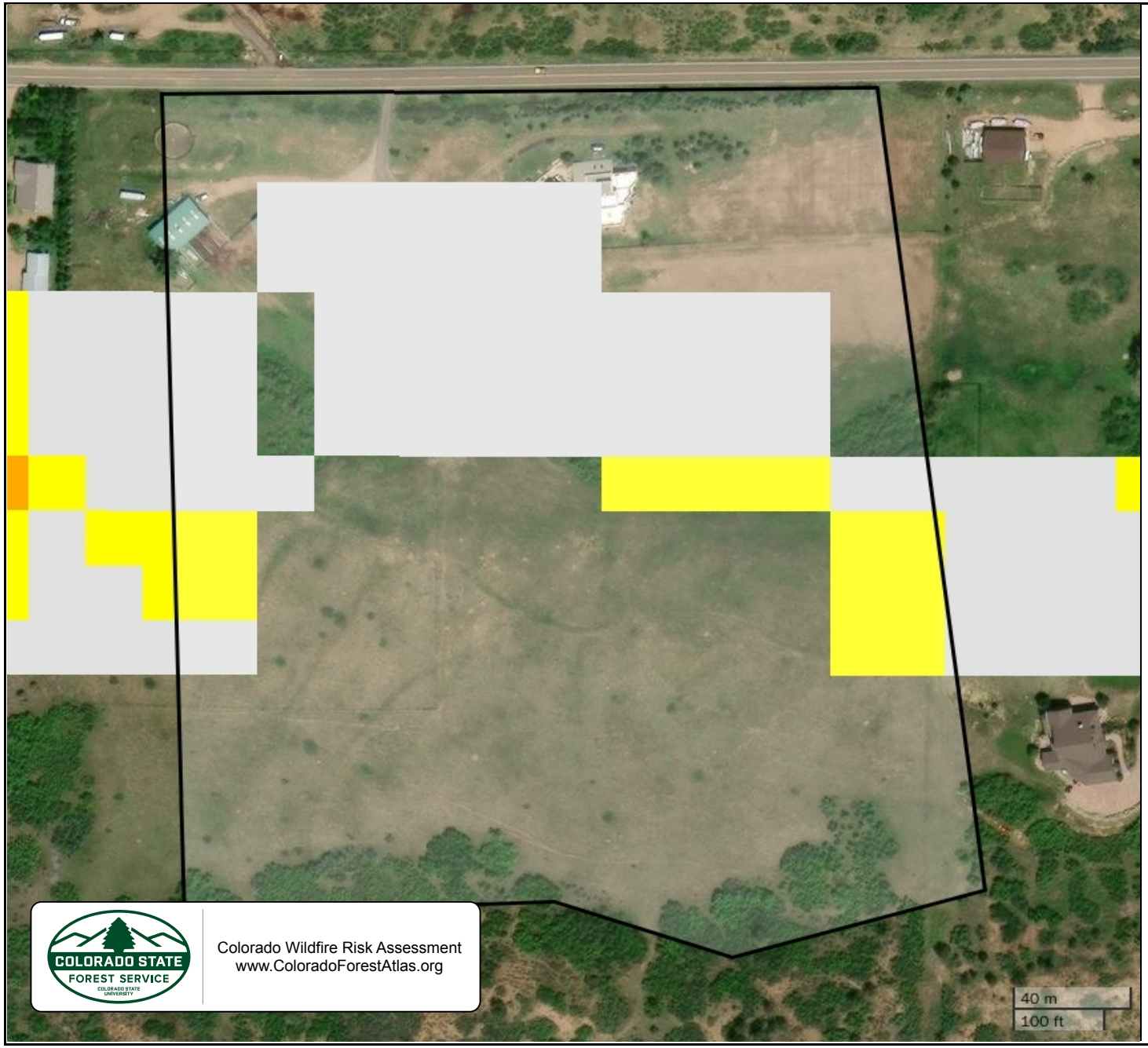
This risk output is intended to supplement the Watershed Protection Risk Index by identifying wildfire risk within the more detailed riparian areas.

Riparian Assets Risk		Acres	Percent
	Lowest Risk	5	81%
	Low Risk	1	19%
	Moderate Risk		0%
	High Risk		0%
Total		**6**	**100%**

Riparian Assets Risk

Hay Creek Hull Subdivision





Hay Creek Hull Subdivision

Riparian Assets Risk

- Lowest Risk
- Low Risk
- Moderate Risk
- High Risk

Forest Assets Risk

A measure of the risk to forested areas based on the potential negative impacts from wildfire.
This layer identifies those forested areas with the greatest potential for adverse effects from wildfire.This layer identifies those forested areas with the greatest potential for adverse effects from wildfire.

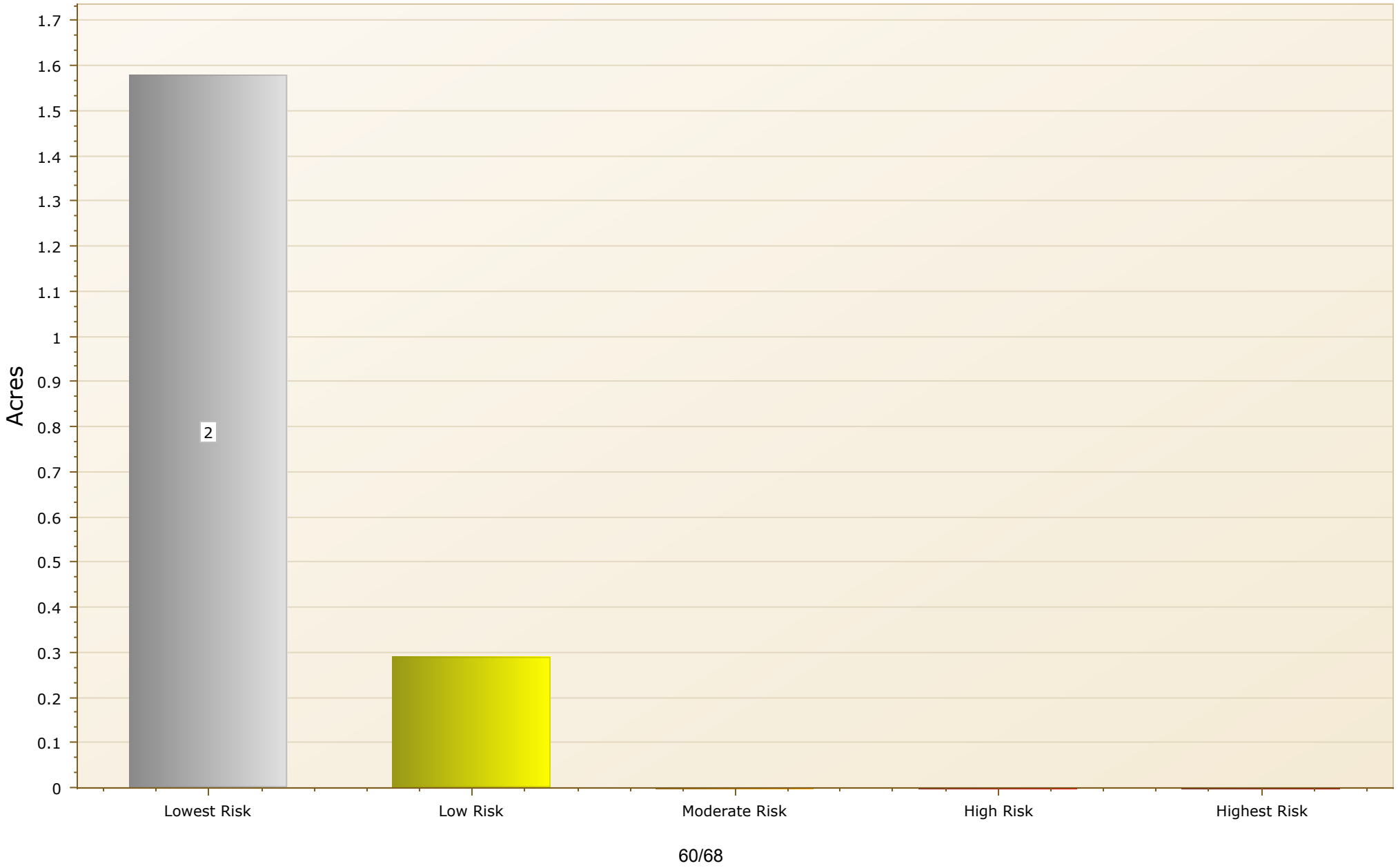
The risk index has been calculated by combining the Forest Assets data with a measure of fire intensity using a Response Function approach. Those areas with the highest negative impact (-9) represent areas with high potential fire intensity and low resilience or adaptability to fire. Those areas with the lowest negative impact (-1) represent those areas with low potential fire intensity and high resilience or adaptability to fire. The response function outputs were combined into 5 qualitative classes.

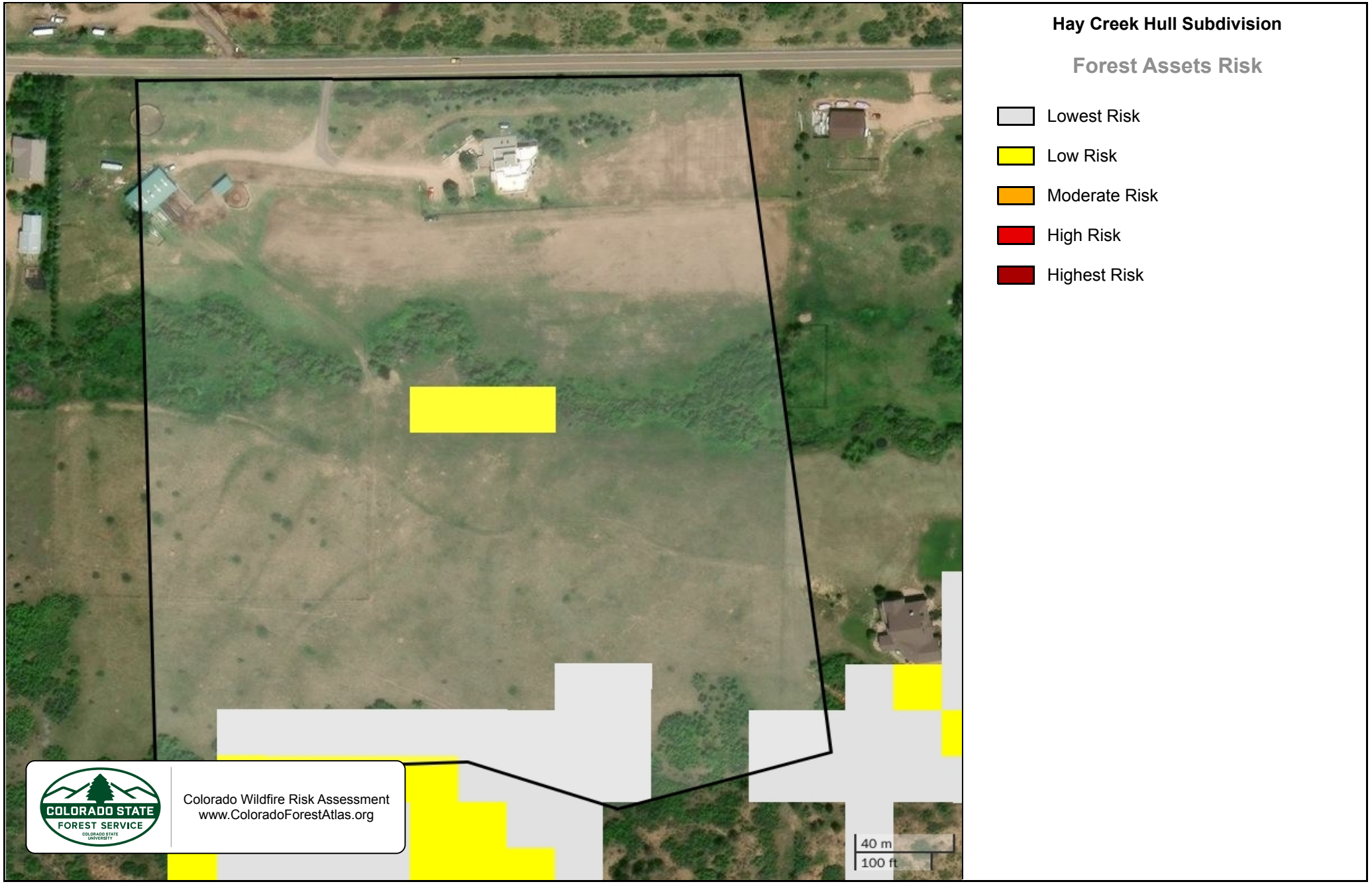
This risk output is intended to provide an overall forest index for potential impact from wildfire. This can be applied to consider aesthetic values, ecosystem services, or economic values of forested lands.

Forest Assets Risk	Acres	Percent
Lowest Risk	2	84.2%
Low Risk		15.8%
Moderate Risk		0%
High Risk		0%
Highest Risk		0%
Total	**2**	**100%**

Forest Assets Risk

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Forest Assets Risk
Lowest Risk
Low Risk
Moderate Risk
High Risk
Highest Risk
COLORADO STATE
FOREST SERVICE
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Building Damage Potential

This metric estimates the potential for building loss and was derived using proprietary data from Technosylva Inc. on building damages that was created by analyzing 13 years of building damage data from state agency inspections after large fires.

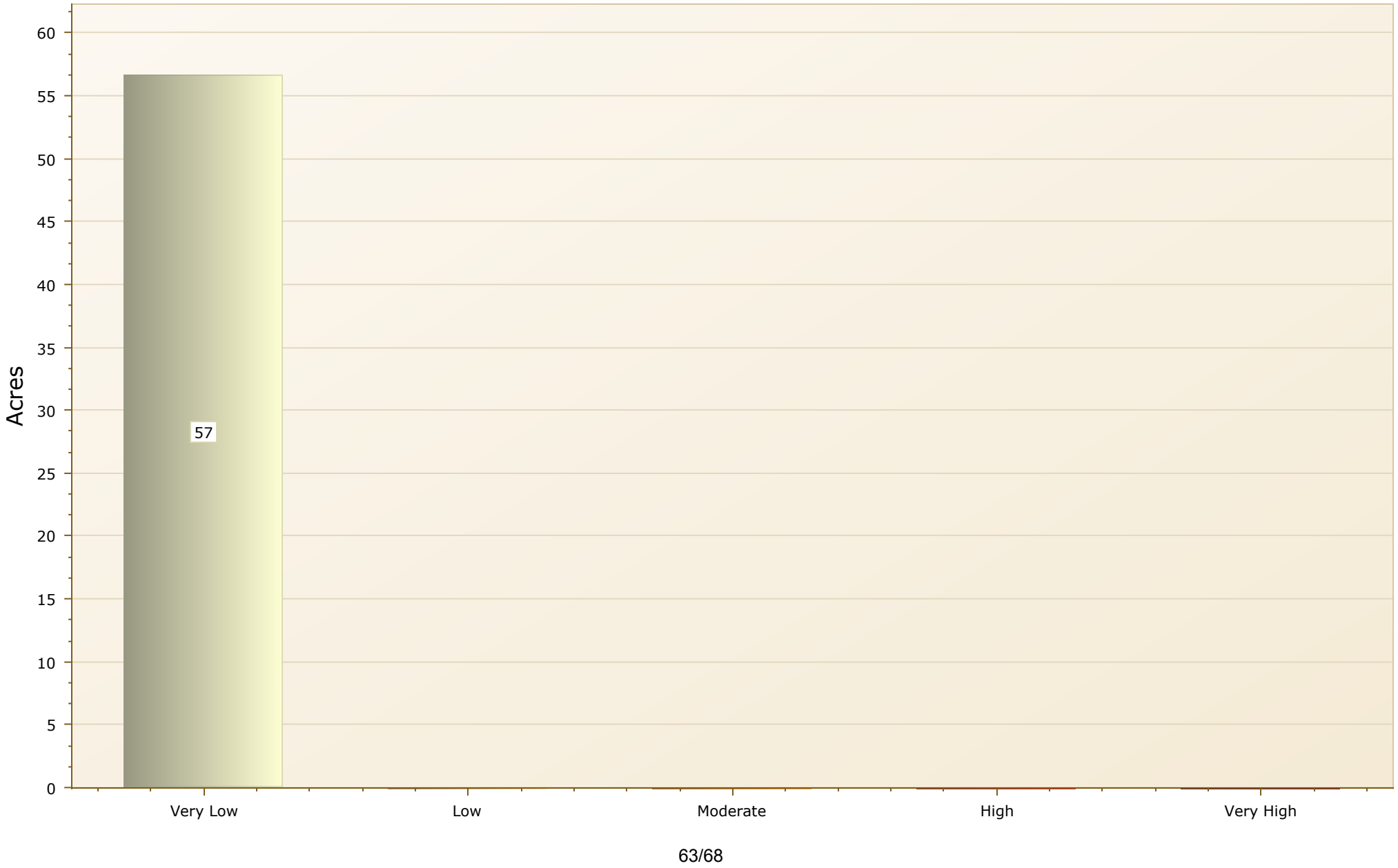
BDP is a spatially variable metric that is calculated on a building-by-building basis and aggregated to Uber H3 hexagons, providing a measure of the number of potential buildings lost based on the number of buildings threatened by fires in the specific area. BDP was calibrated using Machine Learning algorithms that identified the key factors that influenced building loss from historical damage inspection databases. The model has been calibrated using 13 years of damage inspection data and validated across multiple Western States with current wildfire data.

BDP is available as a static risk layer, although a key factor involved in the metric is conditional fire behavior. Conditional Flame Length derived in the fire behavior analysis conducted for the 2022 CO-WRA was used. However, the metric can also be used as a dynamic layer when modulated by the fire intensity of an active wildfire through conventional fire behavior analysis. Although applied as a static layer for the 2022 CO-WRA, the metric is used operationally in California by state agencies and private industry for risk forecasting

Building Damage Potential	Acres	Percent
Very Low	57	100%
Low		0%
Moderate		0%
High		0%
Very High		0%
Total	**57**	**100%**

Building Damage Potential

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Building Damage Potential
Very Low
Low
Moderate
High
Very High
COLORADO STATE
FOREST SERVICE
COLORADO STATE UNIVERSITY
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

Defensible Space Index

The defensible space in a Wildfire Urban Interface (WUI) analysis context refers to the space that surrounds a specific building and can be used to define the hazard, or the exposure, to a wildfire occurrence. In this area, natural and manmade fuels are treated, cleared or reduced to slow the spread of wildfire near structures.

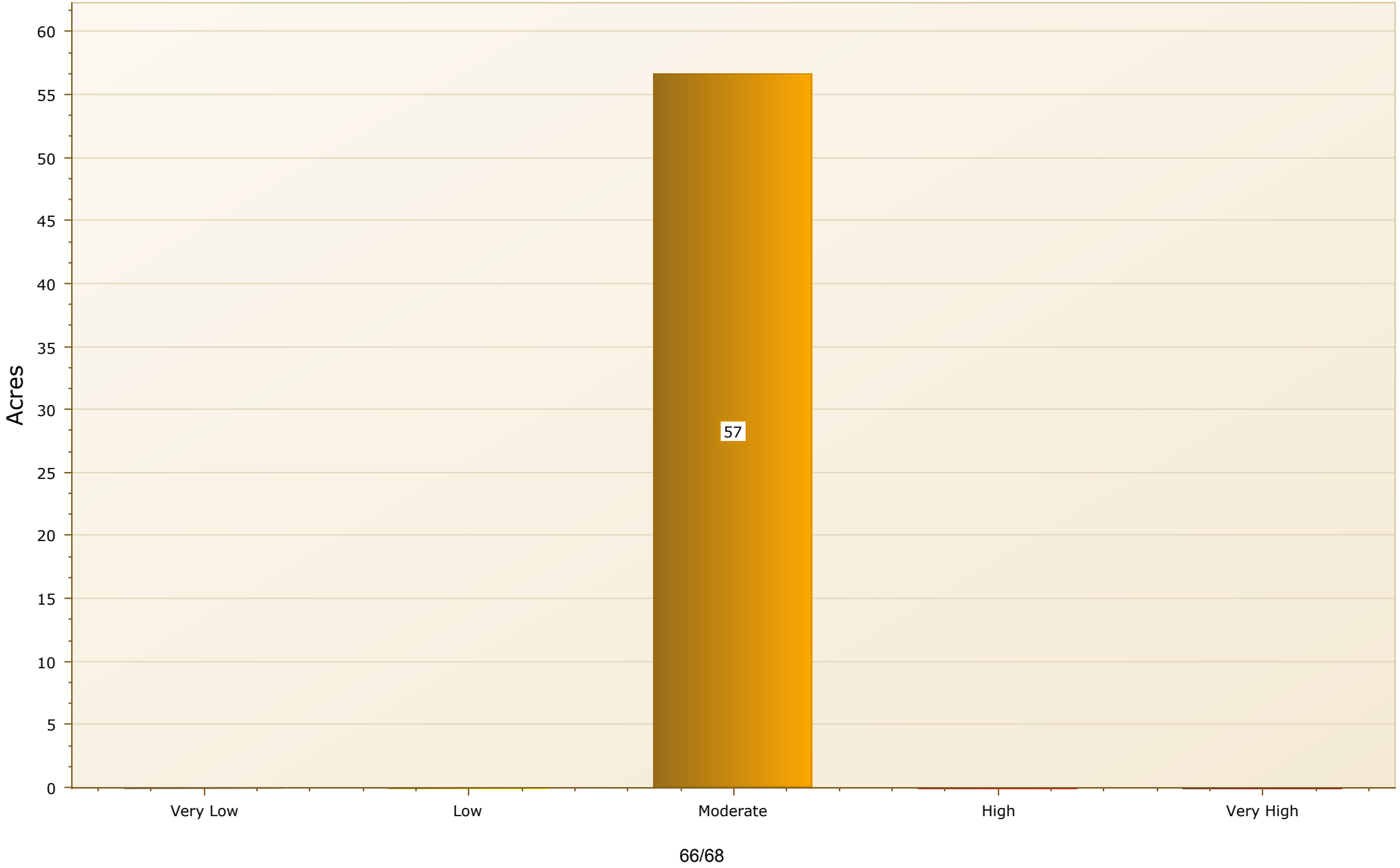
Individual building footprints were used to identify structure locations. Buildings were then grouped using Uber's hexagonal hierarchical spatial index. Within each hexagon, the building values were averaged and applied to the hexagon to remove building specific metrics. This provides a detailed measure of defensible space characteristics for small areas consistent with the accuracy of the structure locations and wildfire fuels and risk analysis data.

Each hexagon in the defensible space risk has a relative value from 0 to 1 that represents the average building hazard in that hexagon. This defensible space value is based on three spatial components/variables: 1) canopy cover, 2) slope, and 3) fuel models present within the buffer around the buildings analyzed.

Defensible Space Index	Acres	Percent
Very Low		0%
Low		0%
Moderate	57	100%
High		0%
Very High		0%
Total	**57**	**100%**

Defensible Space Index

Hay Creek Hull Subdivision




Hay Creek Hull Subdivision
Defensible Space Index
Very Low
Low
Moderate
High
Very High
COLORADO STATE
FOREST SERVICE
COLORADO STATE UNIVERSITY
Colorado Wildfire Risk Assessment
www.ColoradoForestAtlas.org
40 m
100 ft

References

Anderson, H. E. (1982). Aids to determining fuel models for estimating fire behavior. USDA For. Serv. Gen. Tech. Rep. INT-122.

Colorado State Forest Service (August 2023). Colorado Wildfire Risk Assessment Final Report. A final report developed by CSFS and Technosylva Inc. (La Jolla, CA) documenting the technical methods and results for the Colorado wildfire risk assessment update project.

Colorado State Forest Service (June 2023). Fuels Calibration Final Report. A final report developed by CSFS and Technosylva Inc. (La Jolla, CA) documenting the technical methods and results for the Colorado fuels calibration project.

National Wildfire Coordinating Group (NWCG). (2008). Glossary of Wildland Fire Terminology. Publication Management System document PMS-205.

National Wildfire Coordinating Group (2004). Fireline Handbook. NWCG Handbook 3. PMS 410-1. NFES 0065. National Interagency Fire Center. Boise, Idaho 83705.

Scott, J. H., & Burgan, R. E. (2005). Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model. Ft. Collins, CO, Rocky Mountain Research Station: USDA Forest Service, Gen. Tech. Rpt. RMRS-GTR-153.

Scott, J. H., & Reinhardt, E. D. (2001). Assessing the Crown Fire Potential by Linking Models of Surface and Crown Fire Behavior. Ft. Collins, CO, Rocky Mountain Research Station: USDA Forest Service, Research Paper RMRS-RP-29.

THE HOME IGNITION ZONE

COLORADO STATE FOREST SERVICE
EST. 1955

A guide to preparing your home for wildfire and creating defensible space

Formerly Quick Guide FIRE 2012-1: Protecting Your Home From Wildfire

Reducing Your Home's Wildfire Risk Begins With You

WHY?

Homeowners have the ultimate responsibility to proactively prepare their property for wildfire. By creating and maintaining the home ignition zone, residents can improve the likelihood of their home surviving a wildfire and reduce the negative impacts wildfires can have on their property.

In Colorado, if you live in the wildland-urban interface, it is not a matter of *if* a wildfire will impact your home and property, but *when*.

If your home is located in or near the natural vegetation of Colorado's grasslands, shrublands, foothills or mountains, you live in the wildland-urban interface — also known as the WUI — and are inherently at risk from a wildfire. This includes any areas where structures and other human developments meet or intermingle with wildland vegetative fuels.

Wildfires are a natural part of Colorado's varied ecosystems. Planning ahead and taking actions to reduce the risk of wildfires can increase the likelihood your home survives when wildfires occur.

As more people choose to live in wildfire-prone areas, additional homes and lives are potentially threatened every year. Firefighters always do their best to protect residents, but **ultimately, it is your responsibility to protect your property and investments from wildfire**.

This guide focuses on actions that are effective in reducing wildfire hazards on your property. It is important to recognize that these efforts should always begin with the home or structure itself and progress outwards.

Also, remember that taking wildfire risk reduction steps is not a one-time effort — it requires ongoing maintenance. It may be necessary to perform some actions, such as removing pine needles from gutters and mowing grasses and weeds, several times a year. Other actions may just need to be addressed annually or only once.

While you may not be able to accomplish all of these actions at once to prepare your home and property for wildfire, each completed activity will improve the safety of your home during a wildfire. However, it is important to remember there are no guarantees when it comes to wildfire. Implementing risk reduction actions does not guarantee your home will survive a wildfire, but it does improve the odds.

Knowing that wildfire impacts are inevitable, it is not only important for individuals to work on their own homes, but also for residents to work together to increase their community's resilience to wildfire. To become fire adapted, actions must not only be taken before a wildfire

As the 416 Fire burned near Durango in 2018, firefighters conducted burnouts near homes in the fire's path to eliminate fuel for the main fire and provide a secure control line. The work done by homeowners to create the defensible space buffer visible here gave firefighters the option to safely conduct the operation. Photo: Jerry McBride, Durango Herald

arrives but during and after a fire.

The National Cohesive Wildland Fire Management Strategy defines a fire-adapted community as "a human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire."

In order to increase the likelihood homes and infrastructure survive a wildfire, all landowners must work together to reduce fire hazards within and adjacent to communities. This includes work on individual home sites and common areas within communities. Every community member has a role in fire adaptation, from civic leaders, to developers, to first responders, to homeowners and land management agencies.

MORE THAN

HALF

of Colorado residents live in the wildland-urban interface and are at some risk of being affected by wildfire.

Source: CSFS WUI Risk Assessment 2017

Access WUI risk information coloradoforestatlas.org

Reduce your wildfire risk csfs.colostate.edu

Protect your community fireadaptednetwork.org

What Is the Home Ignition Zone?

HOME IGNITION ZONE (HIZ)

is the home and the area around the home (or structure). The HIZ takes into account both the potential of the structure to ignite and the quality of defensible space surrounding it.

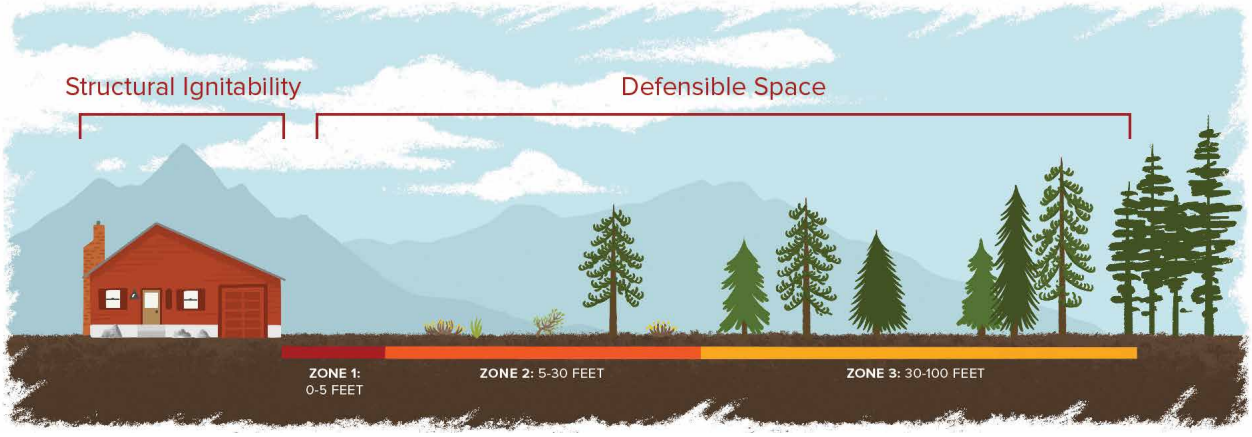


Illustration: Bonnie Palmatory, Colorado State University

The two primary determinants of a home's ability to survive a wildfire include the structure's ignitability and the quality of the surrounding defensible space. Together, these two factors create a concept called the home ignition zone, or HIZ. It includes the structure and the space immediately surrounding it.

The space around the home is divided into three distinct spaces of management, zones 1, 2 and 3. Pages 8-9 outline specific goals and critical steps to manage your property within each of these zones.

To reduce wildfire hazards to your home and property, the most effective proactive steps to take are to minimize the ability of the home to ignite and to reduce or eliminate nearby fuel.

METHODS OF HOME IGNITION

1. EMBER IGNITION

Embers (firebrands) are small pieces of burning material that can be transported by wind more than a mile ahead of a wildfire's flaming front. Embers can vary greatly in size, but even the smallest can start new fires (known as spot fires) on any ignitable surface they encounter, inside or outside a home. This is the most common source of home ignition during wildfires.

Flammable horizontal or nearly horizontal surfaces, such as wooden decks or shake-shingle roofs, are at greater risk for ignition from burning embers.

Many homes in the wildland-urban interface have burned because of airborne embers, so addressing structural ignitability is critical even if it appears difficult for fire to spread in the area surrounding a home.

2. SURFACE FIRE/ DIRECT FLAME CONTACT

If fuels are adjacent to a home, direct flame contact can ignite the house. Ensuring no such fuels exist within 5 feet of a home, particularly near windows or under decks, greatly minimizes this possibility.

3. RADIANT HEAT

Radiant heat is what you feel on your hands while warming them next to a campfire. This same type of heat transfer can ignite a home, whether the source of the heat is a crown fire in treetops or an adjacent home that has caught fire.

Flying embers are the most common source of home ignition during wildfires. Preparing homes for their impact is critical. Embers can ignite leaf litter in gutters and on roofs, as well as shrubs and mulch at the base of the house, as seen in this controlled ember shower experiment. Photo: Insurance Institute for Business & Home Safety

What Is Defensible Space?

DEFENSIBLE SPACE
is the area around a home (or structure) that has been modified to reduce fire hazard by creating space between potential fuel sources.

Firefighters may not be present at your home during a wildfire — they are trained to protect structures only when the situation is safe for them. You should prepare your home and property to withstand wildfire without firefighter intervention. Having an effective defensible space combined with reducing structural ignitability is the best way to improve your home's chance of survival.

Defensible space is the area around a home or other structure that has been modified to reduce fire hazard by creating a disconnected fuel load both vertically and horizontally. In this area, natural and manmade fuels are treated, removed or reduced to slow the spread of wildfire and alter fire behavior.

ATTENTION
These guidelines are adapted for ponderosa pine, Douglas-fir and mixed-conifer forest types below 9,500 feet.

SEE PAGE 14 *for guidelines adapted to other forest types.*

Establishing defensible space reduces the likelihood of a home igniting by direct flame contact or by radiant heat exposure. It also helps limit local production of embers and reduces the chance a structure fire will spread to neighboring homes or surrounding vegetation.

BEFORE

AFTER

A Colorado State Forest Service forest management project near Evergreen cleared dense trees in a residential area to reduce wildfire risk. The same tree with a crooked trunk in the center of these photos shows how tree thinning can be a useful tool to protect property, decrease fire intensity and boost forest health. Photo: Emma Brokl, CSFS

CREATING AN EFFECTIVE DEFENSIBLE SPACE involves establishing a series of management zones. Develop these zones around each building on your property, including detached garages, storage buildings, barns and other structures.

Recognize that fuel continuity and density play a critical role in wildfire behavior.

As you plan defensible space for your property, you can contact your nearest Colorado State Forest Service field office for guidance, or consult a forester, fire department staff or community organization appropriately trained in wildfire mitigation practices.

3

Factors Determine Wildfire Behavior

1. FUELS
2. WEATHER
3. TOPOGRAPHY

Of the three things wildfires need to start and spread, humans cannot change weather or topography, so we must concentrate on altering fuels in order to have any control over a disturbance as dynamic as wildfire.

Fuels can include vegetation like trees, brush and grass; but when near homes, fuels also include propane tanks, woodpiles, sheds and even homes themselves.

East Troublesome Fire. Photo: Zach Wehr, CSFS

Top left: *Hardening your home can include choosing noncombustible building materials like stucco paired with a stone facade. This house near Salida shows you don't have to sacrifice curb appeal to reduce the ignitability of your house. Photo: CSFS*

Top right: *Preparing your home for wildfire can be accomplished as weekend projects, such as clearing vegetation from around your home's perimeter and adding noncombustible material near the foundation that won't ignite if embers land there. Photo: Wildfire Partners*

Bottom: *A metal roof and noncombustible exterior window coverings add layers of protection against wildfire, in addition to the well-maintained defensible space that surrounds this home. Photo: Wildfire Partners*

MORE ONLINE

This guide provides only basic information about structural ignitability.

The National Fire Protection Association (NFPA) and the Insurance Institute for Business & Home Safety (IBHS) together produce Wildfire Research Fact Sheets that provide additional valuable information.

Visit the "Protect Your Home" section at the CSFS website, csfs.colostate.edu/wildfire-mitigation, for links to these and other structural ignitability resources.

Harden Your Home Against the Threat of Wildfire

STRUCTURAL IGNITABILITY

is the likelihood the materials in and on your home will ignite during a wildfire. The practice of reducing structural ignitability is commonly called "home hardening."

The ideal time to address home ignition risk is when the structure is in the design phase. For existing homes, steps must be taken to reduce the structural ignitability in order to improve the likelihood of the home surviving a wildfire. The practice of reducing structural ignitability is commonly called home hardening.

BEST PRACTICES TO REDUCE STRUCTURAL IGNITABILITY

- ☐ Ensure the roof has a Class A fire rating
- ☐ Remove all leaves, needles and other debris from all decks, roofs and gutters
- ☐ Screen attic, roof, eaves and foundation vents with 1/8-inch metal mesh
- ☐ Screen or wall-in stilt foundations and decks with 1/8-inch metal mesh
- ☐ Use tempered glass for windows; two or more panes are recommended
- ☐ Create 6 inches of vertical clearance between the ground and home siding
- ☐ Replace combustible fencing or gates, at least within 5 feet of the home

STRUCTURAL COMPONENTS TO CONSIDER

WINDOWS

Windows can fail either from glass breaking or frames melting before a building ignites, providing a direct path for airborne embers to reach the building's interior. Metal screens should be installed. Windows with multiple panes provide greater protection than single-paned windows.

VENTS

Vents that are not screened or are screened with a gap that exceeds 1/8 of an inch can be a direct entry point for embers to infiltrate a home and ignite it from the inside. Metal mesh screen that is 1/8-inch is small enough that most embers will be extinguished before making it inside.

SOURCE *NFPA/IBHS Wildfire Research Fact Sheet — Attic and Crawl Space Vents*

EXTERIOR WALLS

The exterior walls of a home or other structure are affected most by radiant heat from a fire and, if defensible space is not adequate, by direct contact with flames. Fiber cement board, brick, stucco or other fire resistant materials are recommended.

ROOF

The roof has a significant impact on a structure's ignitability because of its extensive surface area. When your roof needs significant repairs or replacement, choose only fire-resistant roofing materials. Wood and shake-shingle roofs are strongly discouraged because they are highly flammable and are prohibited in some areas of the state. Metal sheets, concrete or shingles made from asphalt, tile, clay, stone or metal are all recommended roofing materials. It is critical to keep the roof and gutters clear of flammable debris.

SOURCE *NFPA/IBHS Wildfire Research Fact Sheet — Roofing Materials*

ROOF EXTENSION

The extension of the roof beyond the exterior structure wall is called the eave. This architectural feature is particularly prone to ignition. As fire approaches a building, the exterior wall deflects hot air and gases up into the eave. If the exterior wall isn't ignition-resistant, the effect of the excess heat is amplified.

SOURCE *NFPA/IBHS Wildfire Research Fact Sheet — Under-Eave Construction*

DECKS/FENCES

Some decks and fences are readily combustible, whether made of synthetic (plastic/composite) or natural materials (wood). Many deck designs allow embers to accumulate between board gaps and at joists below deck boards. Embers can also fall through decks and may easily ignite flammable materials beneath, making it critical to remove all materials from underneath the deck. Regardless of how fuels below decks may ignite, these burning materials can readily ignite the deck and threaten the home.

Fencing material that attaches to the home must be considered a direct extension of the structure and should be made of a noncombustible material, at least where it is immediately adjacent to a home.

SOURCE *NFPA/IBHS Wildfire Research Fact Sheets — Fencing | Decks*

TO MANAGE YOUR HOME, LEARN THE

THREE ZONES

ZONE 1

0-5 FEET FROM THE HOME

The area nearest the home. This zone requires the most vigilant work in order to reduce or eliminate ember ignition and direct flame contact with your home.

ZONE 2

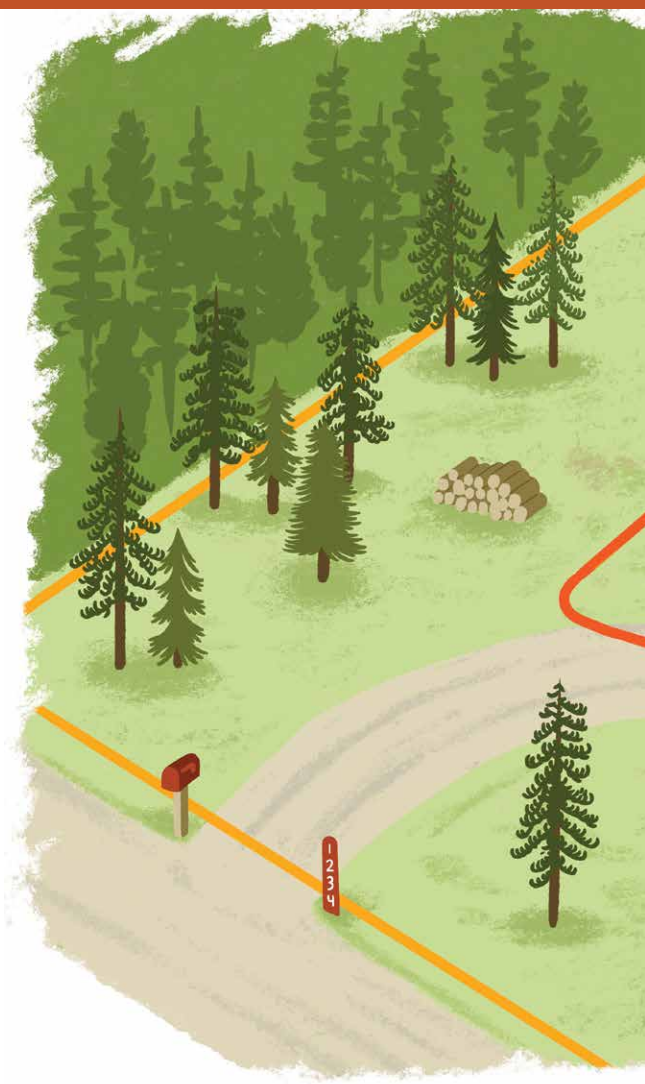
5-30 FEET FROM THE HOME

The area transitioning away from the home where fuels should be reduced. This zone is designed to minimize a fire's intensity and its ability to spread while significantly reducing the likelihood a structure ignites because of radiant heat.

ZONE 3

30-100 FEET FROM THE HOME

The area farthest from the home. It extends 100 feet from the home on relatively flat ground. Efforts in this zone are focused on ways to keep fire on the ground and to get fire that may be active in tree crowns (crown fire) to move to the ground (surface fire), where it will be less intense.



ZONE 1

GOAL: This zone is designed to prevent flames from coming in direct contact with the structure. Use nonflammable, hard surface materials in this zone, such as rock, gravel, sand, cement, bare earth or stone/concrete pavers.

CRITICAL STEPS

- ☐ Remove all flammable vegetation, including shrubs, slash, mulch and other woody debris.
- ☐ Do not store firewood or other combustible materials inside this zone.
- ☐ Prune tree branches hanging over the roof and remove all fuels within 10 feet of the chimney.
- ☐ Regularly remove all pine needles and other debris from the roof, deck and gutters.
- ☐ Rake and dispose of pine needles, dead leaves, mulch and other organic debris within 5 feet of all decks and structures. Farther than 5 feet from structures, raking material will not significantly reduce the likelihood of ignition and can negatively affect other trees.
- ☐ Do not use space under decks for storage.

ZONE 2

GOAL: This zone is designed to give an approaching fire less fuel, which will help reduce its intensity as it gets nearer to your home or any structures.

CRITICAL STEPS

- ☐ Mow grasses to 4 inches tall or less.
- ☐ Avoid large accumulations of surface fuels such as logs, branches, slash and mulch.
- ☐ Remove enough trees to create at least 10 feet* of space between crowns. Measure from the outermost branch of one tree to the nearest branch on the next tree.
- ☐ Small groups of two or three trees may be left in some areas of Zone 2. Spacing of 30 feet* should be maintained between remaining tree groups to ensure fire doesn't jump from one group to another.
- ☐ Remove ladder fuels under remaining trees. This is any vegetation that can bring fire from the ground up into taller fuels.
- ☐ Prune tree branches to a height of 6-10 feet from the ground or a third of the total height of the tree, whichever is less.
- ☐ Remove stressed, diseased, dead or dying trees and shrubs.

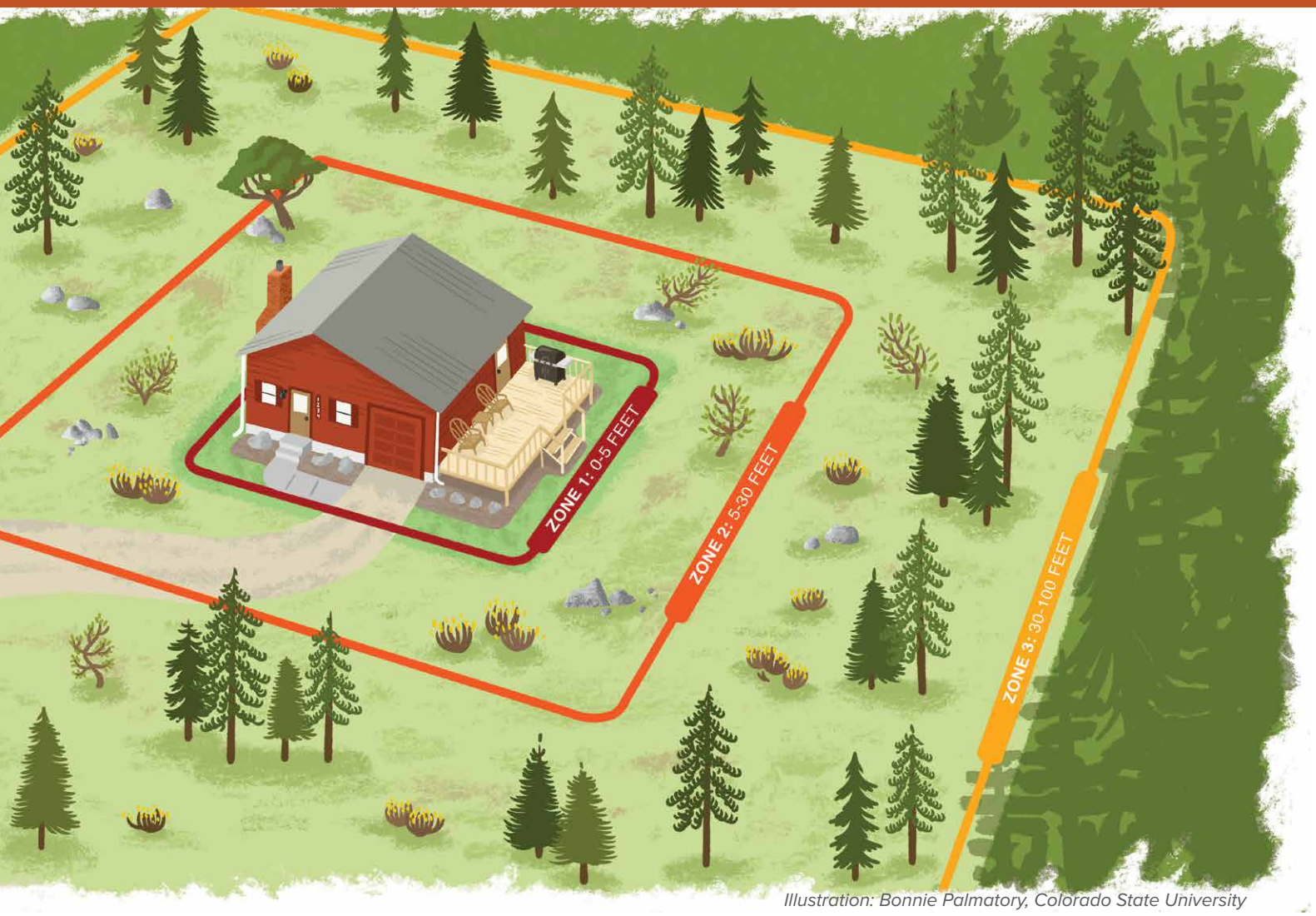


Illustration: Bonnie Palmatory, Colorado State University

This reduces the amount of vegetation available to burn and improves forest health.

- ☐ Common ground junipers should be removed whenever possible because they are highly flammable and tend to hold a layer of flammable material beneath them.
- ☐ You can keep isolated shrubs in Zone 2, as long as they are not growing under trees. Keep shrubs at least 10 feet* away from the edge of tree branches.
- ☐ Periodically prune and maintain shrubs to prevent excessive growth. Remove dead stems annually.
- ☐ Spacing between clumps of shrubs should be at least 2 ½ times* their mature height. Each clump should have a diameter no more than twice the mature height of the vegetation. Example: For shrubs that grow 6 feet tall, space clumps 15 feet apart or more (measured from the edge of the crowns of vegetation clumps). Each clump of these shrubs should not exceed 12 feet in diameter.

** Horizontal spacing recommendations are minimums and can be increased to reduce potential fire behavior, particularly on slopes. Consult a forestry, fire or natural resource professional for guidance with spacing on slopes.*

ZONE 3

GOAL: This zone focuses on mitigation that keeps fire on the ground, but it's also a space to make choices that can improve forest health. Healthy forests include trees of multiple ages, sizes and species, where adequate growing room is maintained over time.

If the distance of 100 feet to the edge of Zone 3 stretches beyond your property lines, it's encouraged to work with adjoining property owners to complete an appropriate defensible space. If your house is on steep slopes or has certain topographic considerations, this zone may be larger.

STEPS TO CONSIDER

- ☐ Mowing grasses is not necessary in Zone 3.
- ☐ Watch for hazards associated with ladder fuels. The chance of a surface fire climbing into the trees is reduced in a forest where surface fuels are widely separated and low tree branches are removed.
- ☐ Tree crown spacing of 6-10 feet is suggested. Consider creating openings or meadows between small clumps of trees so fire must transition to the ground to keep moving.
- ☐ Any approved method of slash treatment is acceptable in this zone, including removal, piling and burning, lop and scatter, or mulching. Lop-and-scatter or mulching treatments should be minimized in favor of treatments that reduce the amount of woody material in the zone. The farther this material is from the home, the better.

Make Home Ignition Zone Maintenance a Priority

WHY?

The home ignition zone requires regular, ongoing maintenance to be effective. Your home is located in a dynamic environment — trees, grasses and shrubs continue to grow, die and drop leaves each season, and there are ongoing maintenance needs on any structures on your property.

HOME IGNITION ZONE CHECKLIST

PREPARE YOUR HOME FOR WILDFIRE WITH THESE STEPS

TOP PRIORITIES

- ☐ **CLEAR** roof, deck and gutters of pine needles and other debris.*
- ☐ **MOW** grass and weeds to a height of 4 inches or less.*
- ☐ **RAKE AND REMOVE** all pine needles and other flammable debris from 5 feet around the foundation of your home and deck.*
- ☐ **TREAT** or mow shrubs that re-sprout aggressively (such as Gambel oak) every 3-5 years or more depending on growth rates.
- ☐ **REMOVE** branches that hang over the roof and chimney.
- ☐ **DISPOSE** of slash from thinning trees and shrubs by chipping, hauling to a disposal site or piling in open areas for burning later. *Any accumulation of slash that's chipped or otherwise should be 30 feet or more from the home.**
- ☐ **AVOID** creating continuous areas of wood chips on the ground when chipping logs and/or slash. Break up the layer of wood chips by adding nonflammable material, or allow for wide gaps of at least 3 feet between chip accumulations.

** Address as needed, more than once a year.*

FIREWOOD

- ☐ Keep firewood stacked uphill from (or at the same elevation as) any structures, and keep the woodpile at least 30 feet away from the home.
- ☐ Do not stack firewood between remaining trees, underneath the deck or on the deck.
- ☐ Remove flammable vegetation within 10 feet of woodpiles.

PROPANE TANKS

- ☐ Keep aboveground tanks at least 30 feet from the home, preferably on the same elevation as the house.
- ☐ Remove flammable vegetation within 10 feet of all propane tanks and gas meters.

DRIVEWAYS

- ☐ Maintain at least 10 feet between tree crowns, thinning them a minimum of 30 feet back from each side of the driveway from the house to the main access road.
- ☐ Remove ladder fuels beneath trees after thinning.
- ☐ Remove any shrubs that are within 10 feet of the outer edge of tree crowns.
- ☐ Space shrubs apart at least 2 ½ times their mature height, as measured from the edge of the shrubs.
- ☐ Post signs at the end of the driveway with your house number that are noncombustible, reflective and easily visible to emergency responders.

SOLUTIONS FOR MANAGING SLASH

1. Spread slash and wood chips over a large area to avoid heavy accumulations and large piles. Being close to the ground will help speed decomposition.
2. Burn slash piles, but before doing so, always contact your county sheriff's office or local fire department for current information or possible restrictions.
3. Lop and scatter slash by cutting it into small pieces (less than 24 inches long) and spreading it over a wide area, to a depth not exceeding 18 inches. Don't scatter material over 4 inches in diameter.

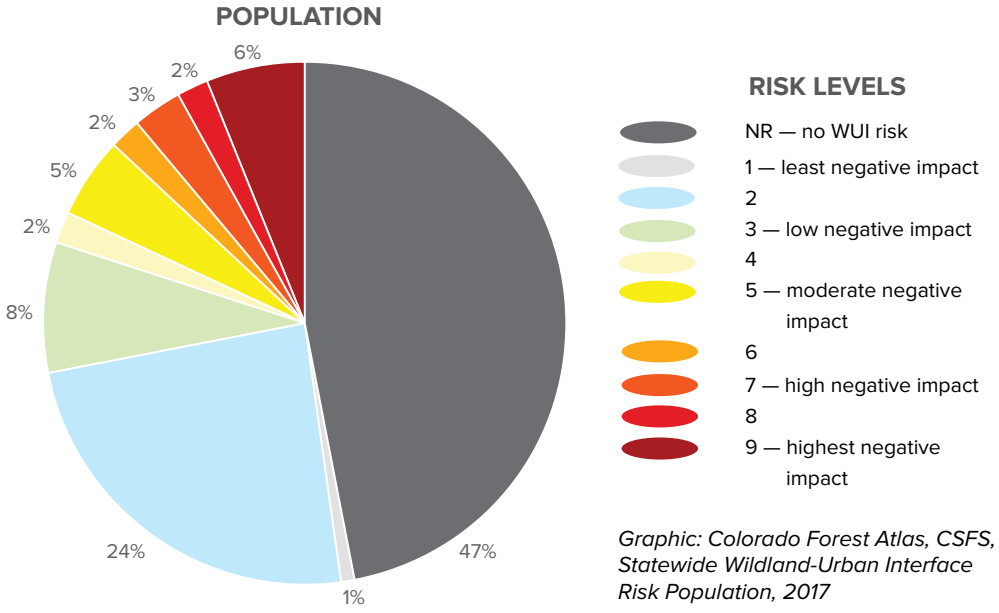
The Colorado State Forest Service works with communities to reduce wildfire risk and become recognized Firewise USA® sites, an accomplishment Piñon Ridge Estates in Chaffee County earned in 2021. CSFS forester Josh Kuehn, right, presents Craig Sommers of Piñon Ridge, with a sign for the community after residents completed the steps required for program recognition. In 2019, the Decker Fire came within a mile and a half of the neighborhood. Photo: Chaffee Chips

More Than Half of Colorado Residents Live With Some Wildfire Risk

The wildland-urban interface (WUI) includes the portions of Colorado where human development meets wildland vegetation.

The majority of Coloradans live in the WUI, in places with at least some risk of wildfire. And that number continues to increase as more residents build homes in the WUI.

As of 2017, the WUI covered about 3.2 million acres in Colorado. By 2040, the WUI area could encompass over 9 million acres in the state, according to projections from Colorado government models.



Graphic: Colorado Forest Atlas, CSFS, Statewide Wildland-Urban Interface Risk Population, 2017

Additional Wildfire Mitigation Resources Online

- Colorado State Forest Service wildfire mitigation information and publications
  csfs.colostate.edu/wildfire-mitigation
- Colorado Wildfire Risk Viewer and Risk Reduction Planner
  coloradoforestatlas.org
- Community Wildfire Protection Planning
  csfs.colostate.edu/wildfire-mitigation/community-wildfire-protection-plans
- National Fire Protection Association: Firewise USA®
  nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA
- Insurance Institute for Business & Home Safety
  ibhs.org/risk-research/wildfire
- Fire Adapted Communities Learning Network
  fireadaptednetwork.org

Fuel Types and Arrangements

FUEL
is any material that will burn.

Whether in a wildland or urban location, when fuels are abundant and there's no space between them, a fire can quickly become uncontrollable and destructive. But when fuels are scarce and separated, a fire cannot build momentum and intensity, which makes it more manageable.

The closer together the fuels are near your home, the bigger the threat they pose.

Fuel hazard measures look at both horizontal and vertical fuels, factoring in the type, amount and arrangement of fuels (called continuity and uniformity). Horizontal continuity is how the fuels are arranged laterally across the ground or among plant canopies. Vertical continuity refers to fuels extending from the ground into the crowns of trees and shrubs.

Fuels with a high degree of both vertical and horizontal continuity are the most hazardous, particularly when they occur on slopes.

Mitigating wildfire hazards in the home ignition zone disrupts this fuel continuity, which helps reduce a fire's intensity and potential sources of home ignition.

SURFACE FUELS

Colorado State Forest Service

GRASSES

Grasses are perhaps the most pervasive and abundant surface fuel in Colorado. When available to burn, grasses can catch fire easily, and grass fires often spread rapidly. They also burn out quickly and do not release as much energy as fires in larger fuel types, like trees. Nonetheless, grass fuels can readily ignite structures that are directly adjacent to them.

Colorado State Forest Service

NEEDLES/LEAVES

Needles and leaf litter accumulate naturally in forests across the state. Long needles from pines like ponderosa and broadleaf litter from trees like aspen, cottonwood and maple do not compact as readily as other leaf types. Fire in these fuels can spread rapidly, particularly during windy conditions.

Shorter needle litter from spruce, fir and lodgepole pines compacts more readily and does not generally spread as fast.

Needles and leaves that ignite anywhere on or adjacent to a structure can cause damage and loss.

Colorado State Forest Service

LOGS/BRANCHES/SLASH/ WOOD CHIPS (MULCH)

Naturally occurring woody material on the ground and debris left from cutting down trees and shrubs (slash) are an important part of the fuel complex near structures.

This larger and denser material generates more heat than smaller fuels do, and it can be problematic when it is burning near structures.

Ultimately, the farther away from a structure that large amounts of these materials can be moved, the better.

MORE: *A guide to mulched materials is available on the Colorado Forest Restoration Institute website,* cfri.colostate.edu.

A firefighter monitors a burnout on the 416 Fire in southwest Colorado in 2018. This effort to manage the wildfire by eliminating fuels left of the train tracks illustrates how fire can transition through different fuel types and arrangements. Photo: Kyle Miller, Wyoming Interagency Hotshot Crew

VERTICAL/LADDER FUELS

Kari Greer

LADDER FUELS

Ladder fuels are burnable materials such as smaller trees and brush that provide a means for fire to climb vertically and continue into aerial fuel sources. Ladder fuels allow a fire to leave the ground level and burn up into the branches and crowns of larger vegetation. Lower branches on large trees also can act as ladder fuels.

These fuels are potentially very hazardous but are generally easy to mitigate. Pay close attention to ladder fuels near homes, as they are extremely hazardous and especially important to address.

InciWeb

BRUSH/SHRUBS

Examples of common brush fuels in Colorado are sagebrush, bitterbrush and mountain mahogany.

As with any type of fuel, brush that is close together and adjacent to homes is hazardous.

In dry climates like Colorado, brush fuels are generally dense and contain more material in a given space than grasses. Brush also usually grows larger and burns longer and more intensely than grass when it ignites.

This makes brush fires more complex, particularly when the brush grows under trees or in large, uniform stands.

CROWN (AERIAL) FUELS

Kari Greer

CROWN FUELS

An intense fire burning in surface fuels can transition into the upper portion of the tree canopies and become a crown fire. Crown fires are dangerous because they are intense, often move rapidly, can burn large areas, and produce embers that can travel great distances and start spot fires well ahead of the main fire.

Crown fire hazard can be reduced by thinning trees to decrease crown fuels, reducing surface fuels under the remaining trees and eliminating vertical fuel continuity from the ground into the crowns.

See recommendations on pages 8-9 of this guide.

Forest Types

Recommendations in this guide refer primarily to ponderosa pine, Douglas fir and mixed-conifer ecosystems below 9,500 feet in elevation.

Those who live in or near other forest types can follow these additional recommendations.

PIÑON-JUNIPER

Fires in piñon-juniper forests tend to burn intensely in the crowns of trees under windy conditions.

When thinning these trees on a property, create a mosaic pattern that is a mixture of individuals and clumps of three to five trees. The size of each clump will depend on the size, health and location of the trees. The minimum spacing between the crowns of individual trees is 10 feet, increasing for larger trees, clumps and stands on steeper slopes.

Pruning trees for defensible space is not as critical in piñon-juniper forests as it is in pine or fir forests. Instead, it is more important to space the trees so it is difficult for a fire to move from one tree clump to the next. These trees should only be pruned to remove branches that are dead or are touching the ground. Live branches can be pruned up to 3 feet above the ground, or a third the height of the tree, whichever is less. Removing shrubs growing beneath piñon and juniper canopies is recommended.

Pruning live branches or removing and processing these trees is not recommended between April and October, when the piñon Ips beetle is active in Colorado. Thinning activity that stimulates sap flow in summer months can attract these beetles to healthy trees. It is acceptable to remove dead trees and dead branches during the summer.

LODGEPOLE PINE

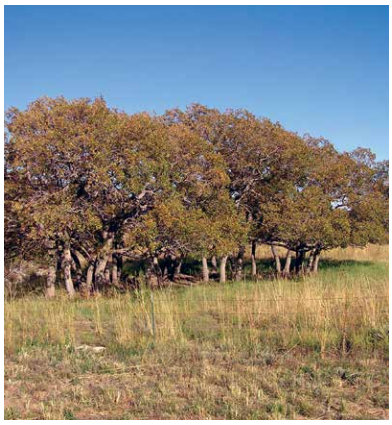
Older lodgepole pine stands generally do not respond well to selective thinning, but instead respond better to removing all trees over a defined area to allow healthy forest regeneration.

Selectively thinning lodgepole can open the stand to severe windthrow and stem breakage. However, if your home is located within a lodgepole pine forest, you may prefer selective thinning instead of removing all the standing trees.

Thinning older stands of lodgepole pine to the extent recommended for defensible space may require several attempts spaced over a decade or more. No more than 30 percent of the trees in a mature stand should be removed in each thinning operation. Focus on removing trees that are obviously lower in height or suppressed in the forest canopy. Leaving the tallest trees will make the remaining trees less susceptible to windthrow.

Another option is leaving clumps of 30-50 trees. Clumps are less susceptible to windthrow than solitary trees. Allow a minimum of 30-50 feet between tree crowns on the clump's perimeter and any adjacent trees or clumps of trees.

To ensure a positive response to thinning throughout the life of a lodgepole pine stand, trees must be thinned early. Begin when trees are small saplings and maintain low densities within the stand as the trees mature.



GAMBEL OAK

Maintaining Gambel oak forests that remain resistant to the spread of wildfire can be a challenge because of their vigorous growing habits. Gambel oak trees grow in clumps or groves, and the stems in each clump originate from the same root system. Most reproduction occurs through sprouts from this deep, extensive root system.

Treat Gambel oak near your home every three to five years, or more often depending on growing conditions. Sprouts should be mowed at least once a year. Herbicides can be used to supplement mowing and control regrowth when treating whole clumps.

This species can be "trained" to grow more like a tree than a shrub in some locations. Remove small diameter oak within clumps and any sprouts growing parallel to the ground.

SPRUCE-FIR

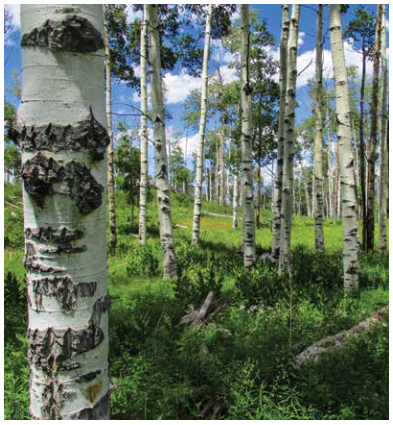
Spruce and fir trees tend to grow in association with each other.

Mature spruce and fir are prone to windthrow when heavily thinned. Light thinnings or leaving groups of trees will help mitigate this problem.

Their hardiness against the wind may not be a problem if a tree has grown to maturity in the open and isn't surrounded by other trees.

Spruce and fir tend to have crowns that extend to the ground. Eliminating lower branches that act as ladder fuels is recommended.

The spruce and Ips bark beetles are native to Colorado and infest Engelmann spruce and Colorado blue spruce. They are particularly attracted to recently fallen green trees and limbs, so it is important to remove any cut branches in a timely manner so surrounding healthy trees are not infested.



Photos: Colorado State Forest Service

ASPEN

Tree spacing and ladder fuel guidelines do not apply to mature stands of aspen trees.

Generally, no thinning is recommended in aspen forests, regardless of tree size, because the thin bark is easily damaged, which can make the tree highly susceptible to fungal infections.

However, in older stands, numerous dead trees on the ground do require removal. Conifer trees often start growing in older aspen stands and can grow up through these old, downed aspens. A buildup of these trees eventually will increase the fire hazard of the stand, so young conifers should be removed from these areas.

Brush also can increase fire hazard in aspen stands and should be thinned to reduce flammability.

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Cover Photography

FRONT
Top left: *Cleaning debris from gutters is a critical step to prevent home ignition. Photo: Wildfire Partners.* ***Top right:*** *Firefighters from Colorado's Platte Canyon Fire Protection District defend a home during a wildfire. As the population expands into the WUI, homeowners must take responsibility to prepare their homes for wildfire. Photo: Kari Greer.* ***Bottom:*** *Of 1,000 homes threatened in the 2016 Cold Springs Fire near Nederland, only 8 burned, due in part to homeowners who readied their properties and followed home ignition zone recommendations. Photo: Wildfire Partners*

BACK *Mitigation work helped spare this Boulder County home near Nederland during the Cold Springs Fire of 2016. Photo: Wildfire Partners*

ADAPT TO WILDFIRE

It's never too early to start protecting your home.
The Colorado State Forest Service can help.

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OUR MISSION

To achieve stewardship of Colorado's diverse forest environments for the benefit of present and future generations