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Delineating Firewise Communities/USA® Developing Self-Mapping Techniques for Communities for Wildland Fire Behavior Modeling

Jennifer Muha
University of Denver

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Publication Statement

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Project Definition

The increased density of homes and outbuildings intermingled with forests, shrubs, and grasslands (fuels typically ignited by lightning, not structure fires) has led to an increasing risk of these homes burning during wildland fire. Of the 2.3 billion total land acres[1] of the United States, 600 million acres are classified as the Wildland/Urban Interface, with 393 million acres developed and 220 million acres declared by a state forester to be 'high-risk'. Looking back at development rates from 1990 – 2012, there is an average of 2 million acres per year being converted from wildland to a WUI, a rate of three acres per minute (ICCH 2008, CodeSmart 2013). As of July 2013, there were 46 million homes located in the Wildland/Urban Interface, with 1.2 million of the homes in the highest wildfire risk states (California, Colorado, and Texas) and worth more than $189 billion (Botts, et al. 2013, CodeSmart 2013).

While the number of fires per year has been on a slight downward trend, the size of those fires has increased rapidly in both acreage and duration (NIFC 2014), attributed to an increase of average temperatures (EPA 2013), tree mortality (Man 2012), and drought conditions (USDM 2014), along with the cost of suppression increasing every year (NIFC 2014). The 10-year average number of fires occurring between 1990 and 1999 was 78,587 with an average 2.9 million yearly acres burned. When compared to the 10-year average number of fires between 2000 and 2009, the number decreased very slightly to 78,549 (-0.048%), yet an average of 6.9 million acres were burned per year (+138.6%). The cost to suppress these large fires, recently referred to as 'megafires' (ERI 2012, Hudack, et al. 2011), has

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[1] 1 square mile = 640 acres

also had a marked increase, with a 10-year average cost between 1990 and 1999 of $453 million per year, compared to a 2000 – 2009 10-year average cost of $1.4 billion per year (+213.4%)[2] (NIFC 2014). With only four years into the next decade group completed, the numbers are seemingly following the upward trend (Figure 1,Figure 2).

	1985 - 1989	1990's	2000 - 2009	2010 - 2013
Average cost	$371,308,600	$453,498,600	$1,421,411,400	$1,626,362,000
Median Cost	$335,109,000	$407,328,000	$1,368,970,000	$358,994,000
Total Cost	$1,856,543,000	$4,534,986,000	$14,214,114,000	$6,505,448,000
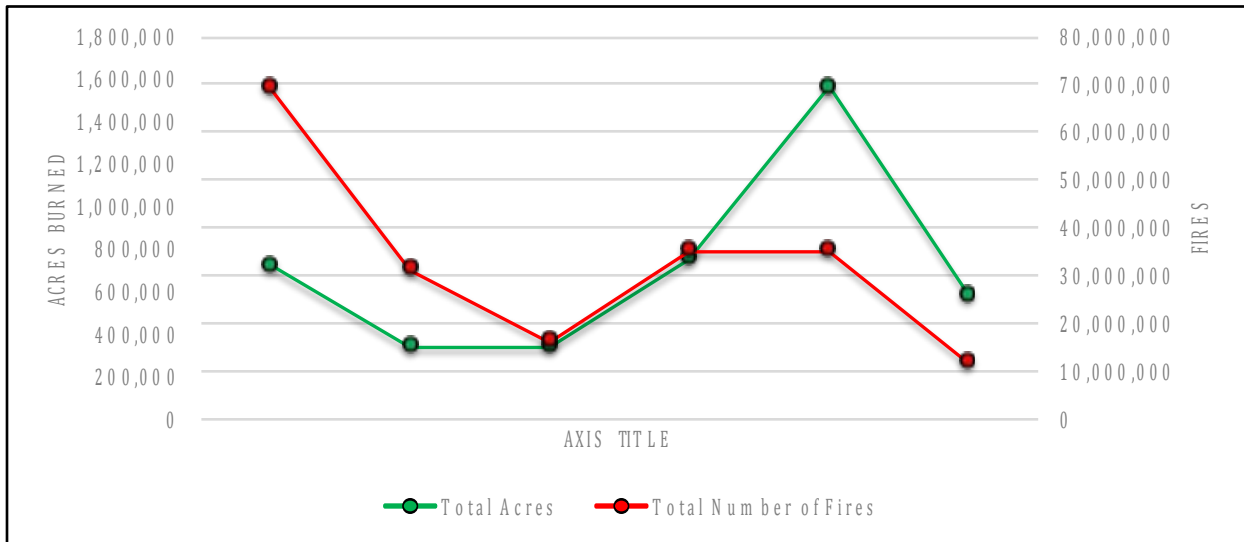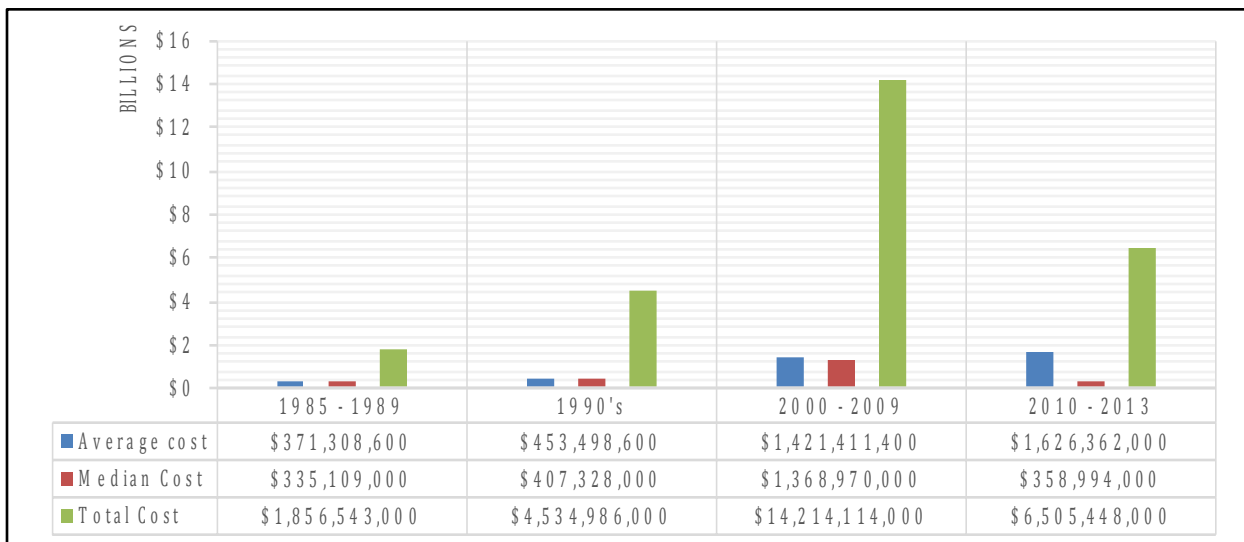
Figure 2: 10-year Cost Summary for FEDERAL fires 1985 - 2013

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[2] Figures based on total yearly number provided by the National Interagency Fire Center

The Wildland/Urban Interface (WUI), is defined as "the area where houses meet or intermingle with undeveloped wildland vegetation", "more specifically as lands with more than one housing unit per 40 acres where wildlands dominate the landscape (referred to as intermix); and land with higher housing densities that are adjacent to natural areas (referred to as interface)" (Radeloff, et al. 2005). Structure[3] loss for the ten-year period between 2000 and 2009 has averaged 2,990 structures per year (CodeSmart 2013), a 220.8% increase from the 1990's (Figure 3).
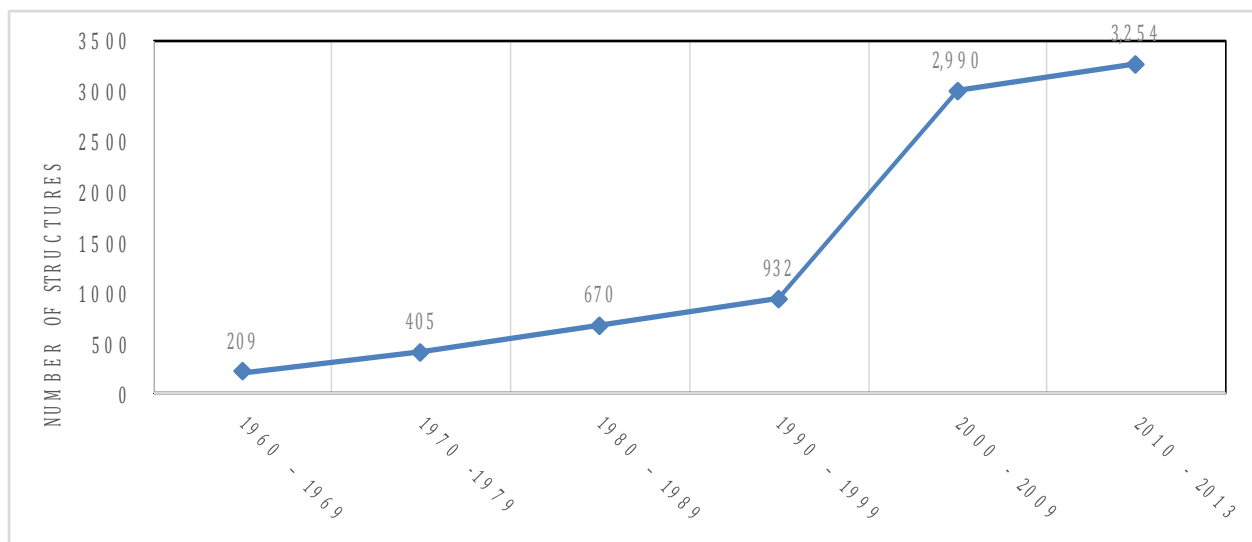
Figure 3: Average Structure Loss 1960 – 2013

Yet, there is light in the dark smoke. The promotion of the 'fire-adapted community', "a knowledgeable and engaged community in which the awareness and actions of residents regarding infrastructure, buildings, landscaping, and the surrounding ecosystem, lessen the need for extensive protection actions" by government agencies "and enables the community to safely accept fire as a part of the surrounding landscape," which can reduce the cost and effort of suppression

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[3] 'Structures' include residences, outbuildings, and commercial buildings.

(Menakis, et al. 2013). Studies suggest that when mitigation occurs only in the WUI, the risk of an Active Crowning fire (a fire with the ability to move through the crowns of trees) is reduced by 6%. In comparison, when mitigation occurs in both the WUI and adjacent public lands, the resulting Active Crown fire risk is reduced by 30% (ERI 2012).

Firewise Communities/USA®

Programs such as the National Fire Protection Association's (NFPA) Firewise Communities/USA® have worked to increase homeowner education regarding living in a fire-adapted landscape, focusing on neighborhood involvement to reduce the risk of property damage and loss when wildfire strikes. Each individual community is required to complete a five-step process to gain recognition as a Firewise community.

1. Obtain a wildfire risk assessment as a written document from their state forestry agency or fire department.
2. Form a board or committee, and create an action plan based on the assessment.
3. Conduct a "Firewise Day" event.
4. Invest a minimum of $2 per capita in local Firewise actions for the year.
5. Submit an application to their state Firewise liaison. (NFPA 2014)

The application requires a representative from the applying community to use a third-party website to find the latitude and longitude of "an address near the center of the community" (Firewise 2014)(Figure 4). This simplified version of community location, in addition to the fact that a community may be only a portion of a larger, administratively defined city, has led to a rather expected confusion of the exact boundaries of many Firewise Communities.
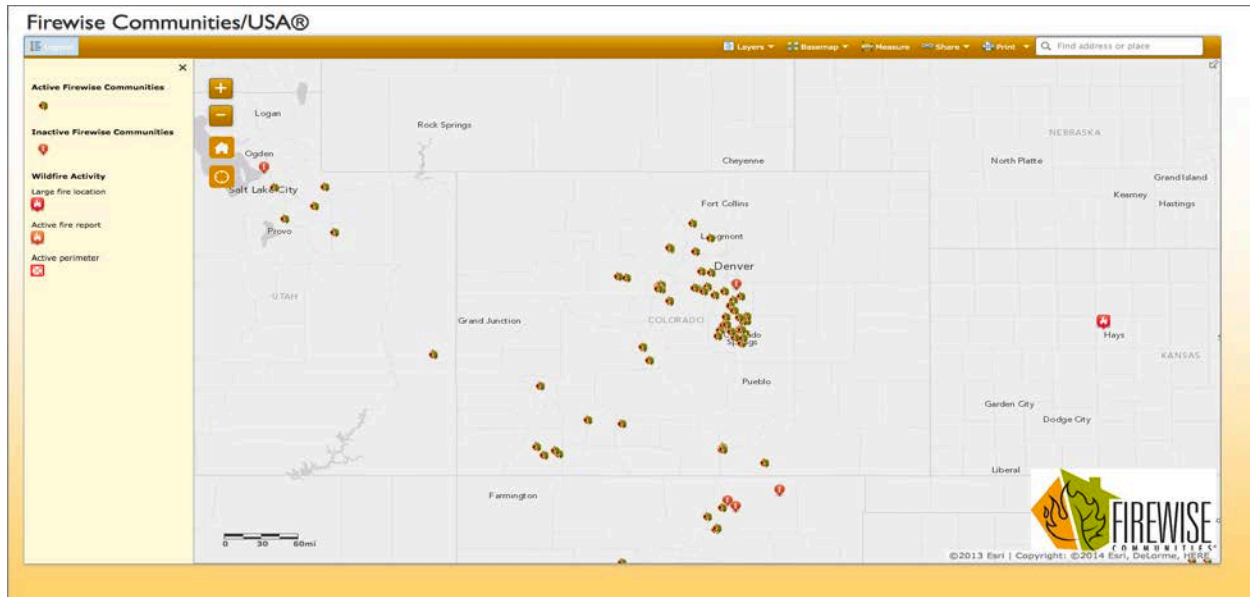
Figure 4: Firewise Community Points

There is no recommended methods of selecting a point to best represent the community. In many cases, the point provided on the Firewise application is simply the latitude/longitude of the representative's home address when the community initially applied for recognition. In some cases, the point is expected to represent a larger area, such as the Genesee Community at 3.5 square miles, and in other cases, the point can represent a very small area, such a Valley Hi Estates at 0.3 square miles (Figure 5).

Understanding the location of the Firewise Communities/USA® within the WUI is vital in order to move forward in the planning of mitigation of both private and public lands. In December 2013, Hylton Haynes, CF, Associate Project Manager of the NFPA Wildland Fire Operations Division, contacted the Colorado State Forest Service regarding the collection of more detailed spatial data of the Firewise Communities within the State of Colorado. The NFPA has several goals regarding the collection of this data:

1. Providing the collected spatial data from Colorado and other states for academic and professional research purposes
2. Providing the data to insurance companies for internal use such as determining active prevention actions on the part of their policy holders as well as for use with internal spatial models
3. Use with NFPA models to explore loss risk analysis as it relates to communities which participate in the Firewise Communities/USA® and those which do not
4. To establish a method of self-defining communities for future participants in the Firewise program.

Figure 5: Point Provided on Application and Recently Collected Boundary

The Colorado State Forest Service and this capstone project are developing a method of community self-definition in order to collect the requested data. The goal of this capstone is to develop a defensible, repeatable, accurate method of

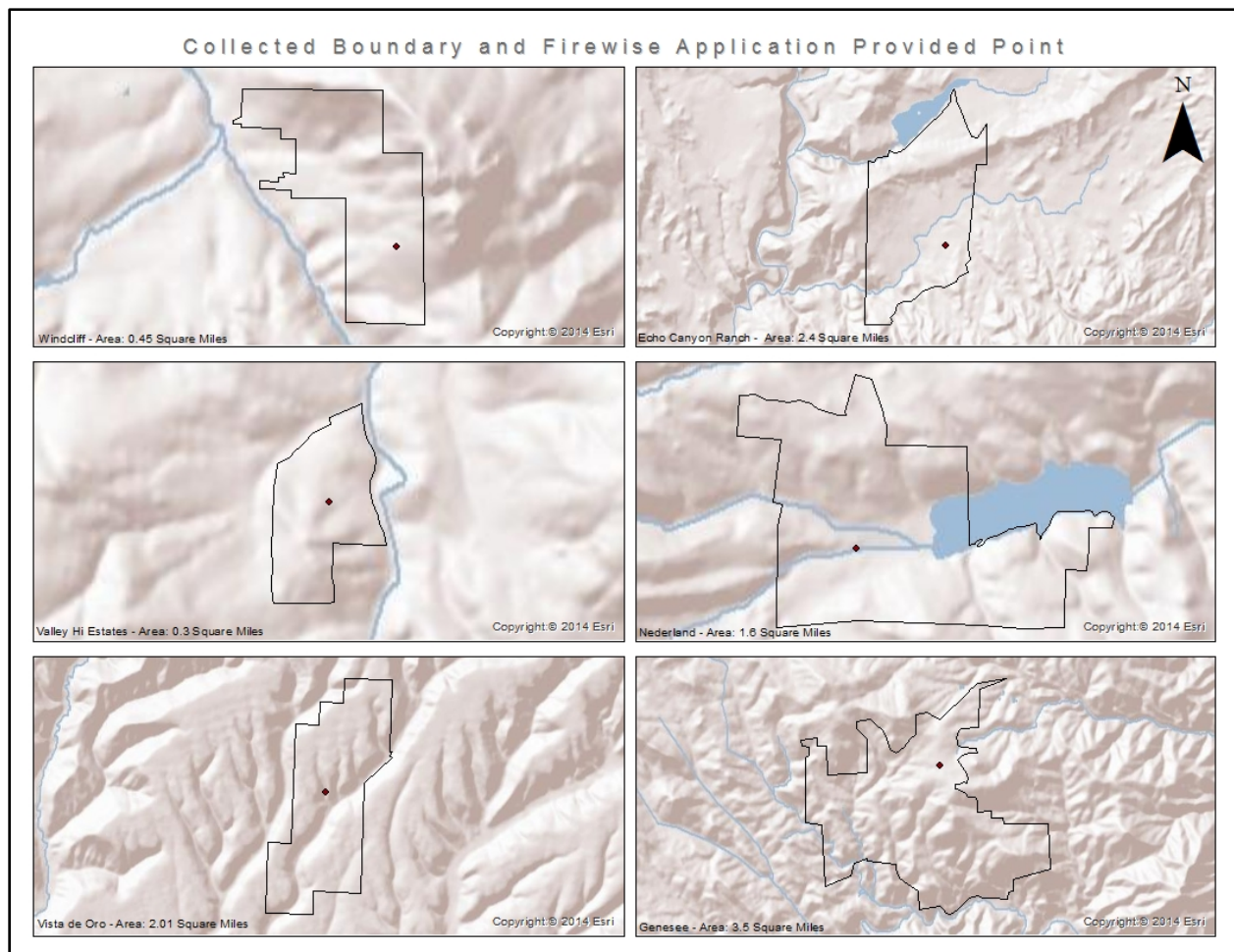community definition for use in modeling wildfire risk with and without adjacent public land mitigation for a select number of communities.

This capstone project is being developed in conjunction with the Colorado State Forest Service and Pete Barry, GIS Coordinator, CSFS.

Project Foundations

"Fire spreads as a continually propagating process, not as a moving mass. Unlike a flash flood or an avalanche where a mass engulfs objects in its path, fire spreads because the locations along the path meet the requirements for combustion."

- Jack P. Cohen, 1999.

Natural Fire Rotation

Understanding the natural fire rotation (the patterned occurrence of fire for a landscape based upon a yearly pattern of weather, fuel moisture, and ignition sources) is key in understanding expected fire behavior and location. Millions of years of fire and plant adaptations have led to 'fire-adapted landscapes', landscapes where fire has become a necessary tool to clear out old plant materials, add nutrients to the soil, and assist some species in the regeneration process. "Fire-adapted ecosystems and species are found in every region of the United States, from the ponderosa pine forests of the Northwest and the Rocky Mountain West, to the Southwest's chaparral, the Midwest's tall grass prairies, the pine barrens of New Jersey, and the South's longleaf pine forests" (Menakis, et al. 2013).

Yet, recent patterns of increased temperatures, increased tree mortality and resulting accumulation of fuels, and long-lasting droughts have created a pattern of increased fire size and duration, recently referred to as 'megafires' (ERI 2012, Hudack, et al. 2011). While the natural fire rotation of the landscape remains approximately the same, the increase of fire contribution factors, in addition to

rapid, continuous development of the WUI, has driven up not only the fire danger rating for the surrounding landscape, but the fire danger rating for individual communities (Hudack, et al. 2011).

National Fire Danger Rating System

Fire danger is defined as "the resultant descriptor of the combination of both constant and variable factors which affect the initiation, spread and difficulty of control of wildfires on an area" (Deeming, et al. 1972). With the constant factor of topography, the daily variable factors are type of fuel, ignition, risk, and weather. Risk is the likelihood of combustion based upon a combination of fuel availability, fuel type and location, difficulty to control fire after ignition (the Burn Index or BI), fire behavior, topography, and weather.

Fire danger is then expressed as a rating, as defined by the National Fire Danger Rating System (Appendix A). The "fire danger rating is a system that integrates the effects of existing and expected states of selected fire danger factors into one or more qualitative or numeric indices that reflect an area's protection needs" (Schlobohm and Brain 2002). Fire danger ratings are used to express the danger across several sizes of landscape, from thousands of acres protected by one agency, to a smaller size, such as a single Firewise community. With a requirement for each community to obtain a wildfire risk assessment, the professional providing the assessment will use a fire danger rating as a part of the report.

The Effect of Drought, Climate Change, Bark Beetles on Forests and Communities

Several factors contribute to determining fuel moisture and availability, or how ready a fuel is to burn. Extended drought, as has been seen in the western United States in the last several years, in addition to rising temperatures, insect

and disease outbreaks, increased wildfire severity, invasive species, and changes in land-use, has dramatically increased the quantity of dead and dying fuel sources available to burn (Williams, et al. 2010). Conifer trees show response to drought stress with an isohydric physiological response by closing the stomates to reduce water loss through transpiration, which in turn leads to a reduction in photosynthesis and carbon assimilation. These reductions cause carbon starvation and finally death (Williams, et al. 2010, Bentz, et al. 2010). A lack of carbon assimilation also reduces the amount of available carbohydrates within the tree, which are necessary for growth, repair, and defense through increased pitch and repellant chemicals. In this condition, the tree is less likely to fend off a bark beetle colonization, which brings with it an array of damage-causing agents (such as fungi, bacteria, nematodes, and mites), thus increasing tree mortality on the stand and landscape level (Bentz, et al. 2010, Williams, et al. 2010).

According to the Congressional Research Service in the 2014 report *Drought in the United States: Causes and Issues for Congress*, "drought conditions are broadly grouped into five categories: (D0) abnormally dry, (D1) moderate, (D2) severe, (D3) extreme, and (D4) exceptional." (Folger and Cody 2014). While drought is a naturally occurring climate phenomenon, since 2000, the United States has seen no less than 6.5% and up to 55% of the land area experiencing at least moderate drought conditions. The weekly average of the land area experiencing at least moderate intensity is 26% (Folger and Cody 2014).

Extreme drought affects a portion of the country every year; since 2000 these extreme conditions have been recorded for 6.4% of the landmass, while exceptional conditions have affected 1.4% of the nation. Between June and

October of 2011 (the general time period of fire season), exceptional drought occurred in greater than 9% of the nation. While some recovery was seen through 2012 in the Southeastern United States, the central continent saw a persistent 6% of exceptional conditions through the winter and into the spring (Figure 1) (Folger and Cody 2014).

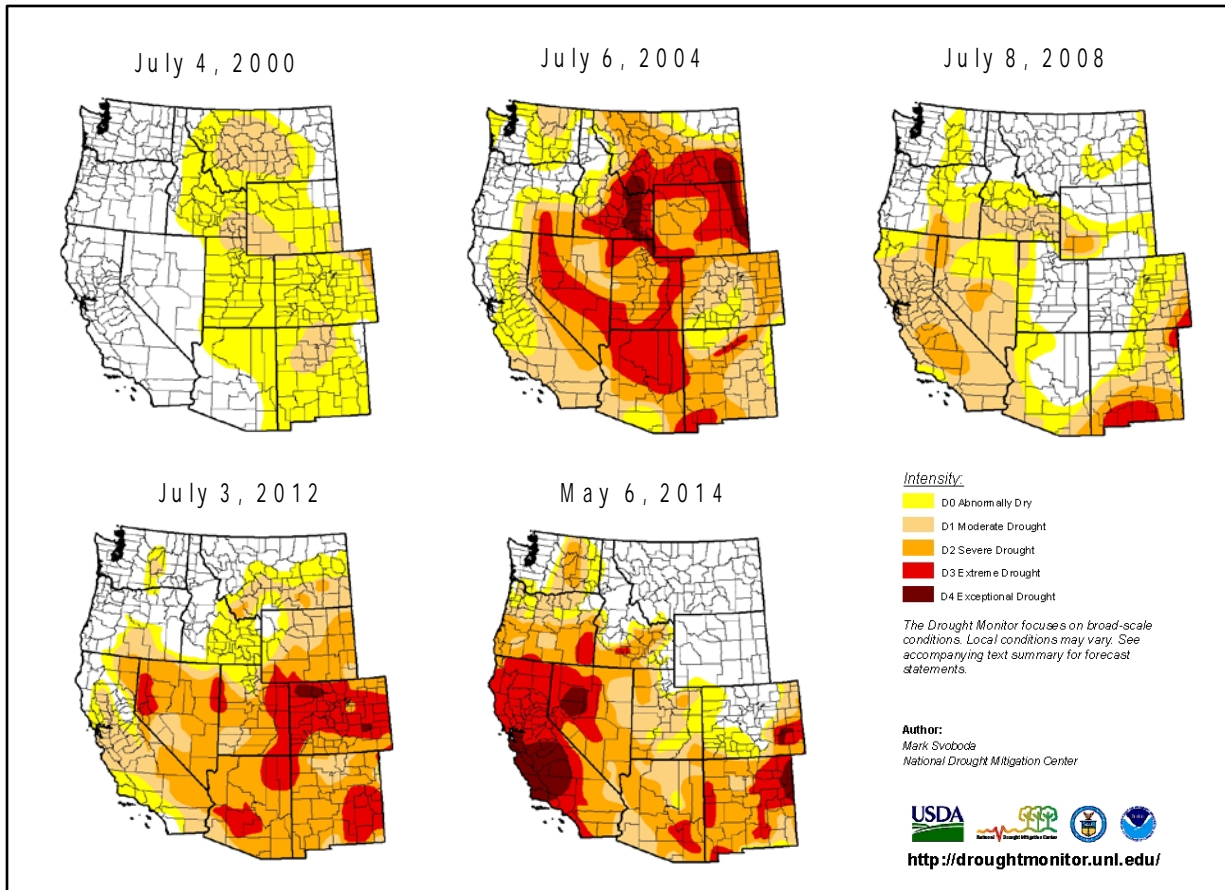Figure 6. Drought Condition Comparison - Western United States

In addition to widespread drought, findings in the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* show statistical certainty in the rise of Global Mean Surface Temperature since the late 19th century, finding each of the last three decades successively warmer and the first decade of the 21st century as the warmest.

Global averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85 [0.65 to 1.06] °C, over the period 1880 and 2012 (Hartmann, et al. 2013).

Native to the western states, insects such as the Mountain Pine Beetle (*Dendroctonus ponderosae*), Spruce Beetle (*Dendroctonus rufipennis*), Western Bark Beetles (various species), and the Western Spruce Budword (*Choristoneura occidentalis*) are an integral part in assisting change and species resilience in coniferous forests. By introducing stress into the environment, plant and tree species are forced to adapt or die, strengthening the existing species or replacing the stand with another. However, studies show a positive correlation between increased temperatures in the western United States and increased population numbers of the bark beetle, thus an overall increase of tree mortality (Bentz, et al. 2010, Man 2012).

Native to southern British Columbia, portions of Alberta, and most of the Western United States, Mountain Pine Beetle (MPB) outbreaks have occurred since 2000 throughout large portions of this region. Affecting 2.4 million acres, 52% of all insect and disease caused tree mortality in the United States, the Mountain Pine Beetle is being found in a broader breadth than historically recorded, including high-elevation white bark pine, *Pinus albicaulis Engelm.*, previously unaffected due to temperatures too low to support the insect (Bentz, et al. 2010, Man 2012).

Crown Fires and Fuel Treatments

Large-scale mortality, drought stress, increased temperature, insect and disease infestation, previous catastrophic fires, and years of aggressive suppression has left an unnatural buildup of fuels historically cleared by frequent, low intensity fires (Hudack, et al. 2011, Man 2012). Extensive beetle kill throughout mature

stands create more easily combustible conditions versus stands with intensive fuel mitigation or younger stands with less mortality (Omi and Kalabokidis 1988).

Crown fires are defined as fires that are propagated by and through the canopies of trees. Initial combustion can be a result of a surface fire moving up ladder fuels into the canopy or through an ignition source within the canopy. This kind of fire can exist independently or in conjunction with surface fire and will burn until continuous fuel sources are exhausted. Large-scale, wind driven crown fires release embers, or firebrands, capable of traveling more than a mile and igniting a new fire and are near impossible to control via traditional suppression techniques and (Keller and DeVecchio 2012, NFPA, USFS, DOI 2008).

A review of fuels treatment types following megafires in Idaho during the 2007 fire season produced several points. First, it was determined that overstory fuels were most affected by mechanical treatments that reduced the amount of fuel in the canopy in conjunction with treatment to remove the amount of surface fuels versus treatments that only removed one or the other fuel type. Second, fuel treatments that were repeated in regular intervals in a landscape were more successful in the long term than areas that were only treated once. Third, collaborative efforts of Firewise Communities/USA® and public agencies through education and fuel treatments created better-prepared lands. Fourth, carefully prioritized locations of treatments in regards to topography yielded less intense fire behavior. Fifth, fuel treatments are designed to change fire behavior in favor of suppression efforts in contrast to a goal of stopping fire all together. Sixth, grazing is a viable method of fuels treatments in areas dominated by flammable grasses and small shrubs (Hudack, et al. 2011).

Fire in the Wildland Urban Interface

An examination of the structure loss and damage statistics during the 2007 Witch and Guejito fires in The Trails development north of San Diego looked at reason of ignition and effectiveness of defense by firefighters. Seventy-four of the 245 structures that fell inside the fire's perimeter were destroyed and 16 were damaged. Results showed 15 of the 16 damaged homes were defended and it was concluded that all 15 would have been categorized as a loss without defense. Uninterrupted fuels between the wildland and structures or between structures resulted in 19 losses, while fuel too close to a structure resulted in 35 losses. The remaining 20 structures were categorized under ember-caused fire. Structures were destroyed during a nine-hour period, with a maximum of 29 burning at the same time (Maranghides and Mell 2009). In contrast, during a severe WUI fire situation resulting from the 1993 Laguna Hills fire in Southern California, nearly all of the 366 lost structures ignited and burned in a five-hour period (Cohen and Butler 1998).

Understanding the connection between wildland fire and structure ignition is important in both the efforts of the homeowner before a fire and the fire manager after ignition. Modeling, observation, and experimentation suggest that structures are not likely to ignite without a flaming front or firebrands falling on fuels within 40 meters (132 feet). Often, firebrands from neighboring structures or direct contact with flames emitted from a structure on fire is the reason for another structure to ignite (J. D. Cohen, Reducing the Wildland Fire Threat to Homes: Where and How Much? 1999).

In his 2000 article, Cohen concluded "the WUI fire loss problem can be defined as a home ignitibility issue largely independent of wildland fuels

management issues" (J. D. Cohen, Preventing Disaster 2000), suggesting protecting one's home from fire is found on the community level, such as recommendations from the National Fire Protection Association (NFPA, USFS, DOI 2008) and participating in programs such as Firewise Communities/USA®.

Following the 2011 Wallow Fire, which burned 538,000 acres in Arizona and New Mexico, existing fuel treatments that were burned over were examined for effectiveness. Burning through Pinyon and Juniper woodlands, Ponderosa Pine, and high elevation mixed conifers, fire behavior was uncharacteristic compared to historic data, with 30% of the fire burning at a high level of severity. There were four conclusions of the study: 1. Fuel reduction treatments were effective at reducing fire behavior, 2. Large-scale treatments would have bigger impacts on reducing crown fire behavior, 3. WUI-only treatments resulted in an unchanged fire behavior in regards to crowning potential, and 4. National assessments, such as fire risk and housing density, can benefit from flexibility in recommendations versus a 'one size fits all' method.

Looking at several studies of home survival and ignition rates, it can be concluded private and public land fuel mitigation are not exchangeable, but in fact complement each other.

Modeling Fire Behavior

In order to understand how fire may behave and where mitigation efforts should be focused in this interface between public and private lands, modeling is key to observing results without putting actual fire on the ground. It is important to note "a model is a simplification or approximation of reality and hence will not reflect all of reality (Burnham and Anderson 2002)" meaning it creates a "decision support tool, not a tool that makes decisions (Stratton 2006)". However, many

plans require or can benefit from spatial modeling, such as wildfire risk situational analysis, hazard and risk assessment, and Community Wildfire Protection Plans (CWPP), a requirement of the Firewise Application.

There are various fire modeling tools, some work inside the ArcGIS suite of software, such as the Wildland Fire Assessment Tool (WFAT (Hamilton 2012)) and ArcFuels (Ager, Vaillant and Finney 2011), some have ArcGRID or internal mapping outputs, such as FlamMap (M. A. Finney 2006) and the Fire Area Simulator (FARSITE (M. Finney 2004)), while others have a strictly numeric output such as FireFamilyPlus (Rocky Mountain Research Station Fire Sciences Laboratory and Systems for Environmental Management 2002) and BehavePlus (Andrews 2007), yet all are based upon established algorithms which predict fire behavior and growth (such as rate of spread or flame length (Rothermel 1972) and possible wind driven distance of firebrands and spot fires (Albini 1979)). Many work in conjunction with each other, such as FlamMap and WindNinja (Forthofer and Butler 2007) or WindWizard (Butler, et al. 2006), using the outputs of one model as the input into their own. This method has created variability and expansion between models without having to completely copy existing programming within.

In order to create a spatial output, fire models utilize input data from several sources to find the weather, existing fuel loading, canopy cover, and canopy bulk density, to name a few. These inputs are collected on a regular basis and are available for free public download from several sites.

For weather, current and historic data can be collected from Remote Automated Weather Stations (RAWS). These stations are located throughout the United States and when selecting one for an input to WindNinja or WindWizard, it is

important to choose a station close to your study site with a similar elevation and topographic features (Stratton 2006).

To acquire landscape level files for analysis, the Landscape Fire and Resource Management Planning Tool (LANDFIRE) project was created to assist in the collection of mapped data for use with strategic resource management intitives, such as the Healthy Forest Act, the National Fire Plan, and Community Wildfire Protection Plans (DOI 2014). The LANDFIRE Data Access Tool (LFDAT) is a plugin for ArcGIS to access the data inside your project.

With careful consideration of inputs and outputs in wildland fire behavior models, these models can provide pointed insight to anticipated behavior and fuel consumption, allowing for informed planning of fire mitigation projects on both the community and public land levels.

The National Fire Plan and 10-year Comprehensive Strategy

Following an extremely severe wildfire season in 2000, then-President Clinton asked the Secretaries of the Interior and Agriculture to write a report reflecting on the nation's ability to respond to future wildfire seasons based on severity. The resulting report, with collaboration on reports on planned agency strategies, created the National Fire Plan. "The plan outlines how the country will develop an integrated response to severe wildfires to ensure sufficient firefighting resources for the future, restore ecosystems damaged by fires, rebuild communities and economies, and reduce the risk of future fire through the treatment of hazardous fuels" (PIC 2002). The report was included in the Administration's 2001 budget request, and was granted $2.9 billion to be shared between the US Department of Agriculture and the US Department of the Interior. Along with the appropriations, Congress included directions for use of the funds, emphasizing the use for wildland

fire emergency management and forest restoration efforts in the Wildland Urban Interface.

> The bill specifically gave the Forest Service and Bureau of Land Management authority to enter into procurement contracts, grants, and cooperative agreements with local non-profits, Youth Conservation Corps, or small disadvantaged businesses in order to carry out hazardous fuels reduction activities on federal lands and provide training and monitoring associated with those activities. (PIC 2002)

The National Fire Plan assisted the US Forest Service with a decided shift away from suppression only to a more comprehensive ecosystems management direction adopted with the 1995 Federal Wildland Fire Management Policy. With this shift and the National Fire Plan, agencies were able to focus on the reduction of hazardous fuels in the WUI in cooperation with communities and private landowners; reduce risk in ecosystems with a high fire danger rating to protect these and nearby low risk areas; and increase the number of contracts available to private sector services to carry out these hazardous fuel reduction projects (PIC 2002).

In efforts to appropriately distribute funds, Congress directed the Secretaries to work with state governors and other stakeholders to create and implement strategies for success. The result was the *10-Year Comprehensive Strategy – A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment*, an initiative with four goals:

1. Reduce risk to communities and the environment from wildland fires for the long-term.
2. Promote a collaborative, community-based approach to address wildland fire issues that recognizes the importance of making key decisions at the local level.
3. Support the primary goals of the National Fire Plan: improve prevention and suppression, reduce hazardous fuels, restore fire-adapted ecosystems, and promote community assistance.
4. Hold the core guiding principles of collaboration, priority setting, and

accountability. (DOI, USDA, Western Govenors' Association 2002)

The first goal of the 10-year Comprehensive Strategy, Improve Prevention and Suppression, focuses on increasing public safety and firefighter readiness as well as prevention through education. The plan outlines goals of increasing community education through the expansion of programs such as the Firewise Community Recognition Program and developing strategies to reduce wildfire danger public lands adjacent to the WUI.

The second goal, Reduce Hazardous Fuels, focuses on the reduction of fuels in high risk areas, with priority for areas in the WUI, incorporating public health considerations when creating mitigation plans, controlling activities on mitigated public lands to retain resilience of treatments, and ensuring local ecosystems are a consideration of fuel mitigation plans.

The third goal, Restore Fire Adapted Systems, includes guidelines for the use of rehabilitation, restoration, using science and information, and monitoring in the decision making process. By using the most recent science available, as well as promoting continued research, areas should be rehabilitated and restored using ecosystem appropriate species and reducing invasives. These methods should be followed up with appropriate monitoring to assure the efforts remain on course.

The fourth and last goal of the Strategy, Promote Community Assistance, promotes mitigation with community involvement through increasing local capacity, using local sources whenever possible to accomplish hazardous fuel accumulations and ecosystems rehabilitation work; incentive programs, promoting better fire prevention in communities using technical assistance and cost-sharing incentives; and proper biomass utilization, ensuring small diameter woody material produced

by fuel mitigation projects is re-used in biomass electrical plants, pulp and paper making processes, and composite structural building materials (DOI, USDA, Western Govenors' Association 2002).

Approach

This project consists of two parts: perimeter collection and fire behavior analysis based upon adjacency of fuels on public lands, each with their own approach.

Firewise Community/USA® Delineation

The community delineation portion of the project will begin with a letter written and approved by the Colorado State Forest Service (Appendix C) and a set of instructions explaining how to use Google Maps Engine GIS software to delineate the boundary of their community. For the scope of this project, ten of the ninety-two communities are being hand selected as 'test communities' in order to refine collection methods before distributing documents to the remaining Firewise Communities/USA® in the state of Colorado. Google Maps Engine was chosen for the ease of use for a non-GIS person and it is a free-to-access website without any download or plugin requirements.

Additional help will be available for Firewise representatives through email and phone with the Colorado State Forest Service, as well as access to a YouTube video consisting of a screen recording walking users through the steps of the instructional document (http://youtu.be/kI3AvwB1QuY).

Following the user-drawn community perimeter, the representative will 'Share' the map with the Colorado State Forest Service, who will have access to the completed maps. This access will allow for working with the representatives to assure the quality and correctness of the resulting map. Maps will then be exported

as a Google Earth KML file, which can be imported into ArcGIS using the Conversion: KML to Layer tool. Once layers are imported into ArcGIS, fuel mitigation and behavior tools can be run to analyze the Firewise community and surrounding areas.

Fire Behavior

Study Area and Data

The study area consists of a 2,395 square mile area in Southern Colorado, near the border of New Mexico. The perimeter of the Vista de Oro community, as defined by the Firewise Community representative, is the focus of the fuels reduction treatments. Points representing four other Firewise Communities/USA®, were collected on the initial application for community recognition.

To determine the area to mitigate the fuels on the landscape for comparison, four layers were created. The first was the
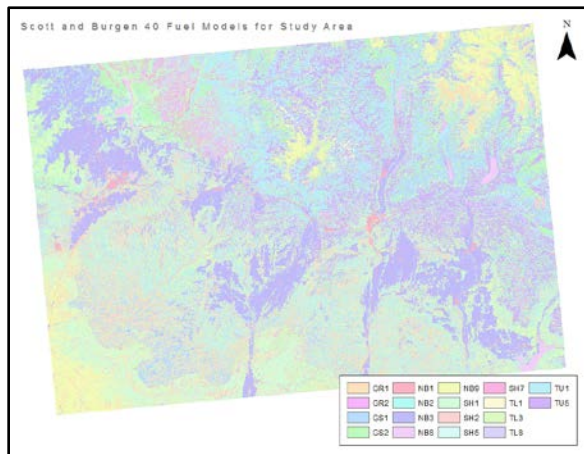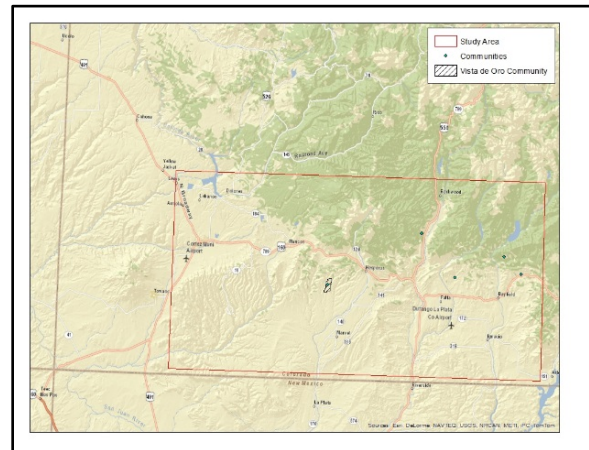

Figure 7: Study Area - Vista de Oro Community Near Durango, CO.

Figure 8: Example of LANDFIRE Data.

polygon of Vista de Oro, as defined by the representative. The second was a five mile buffer of Vista de Oro, clipped to privately owned lands. The third used the current point collection method, and set an arbitrary buffer of five miles around the five points in this layer. The fourth layer was the five mile buffer of Vista de Oro, representing the public and private lands working together to reduce fuels.   Data used in this examination included fire ignition points, the collected Firewise boundary of one community, topographic layers including elevation, slope, and aspect, several layers to determine fire behavior, and August climate layers for average maximum temperature and average precipitation. Fire behavior layers included: Scott and Burgen 40 Fuel Models (Scott and Burgen, 2001), canopy cover, canopy height, canopy base height, canopy bulk density, and fire effects fuel model. Non-spatial data utilized in behavior modeling consisted of average fuel moisture figures for a very dry region, foliar moisture of 100% (noting 'normal' conditions for the season), 20-foot winds set to 25 MPH uphill, interior west region, summer season, and the Scott/Reinhardt (2001) crown ignition model.

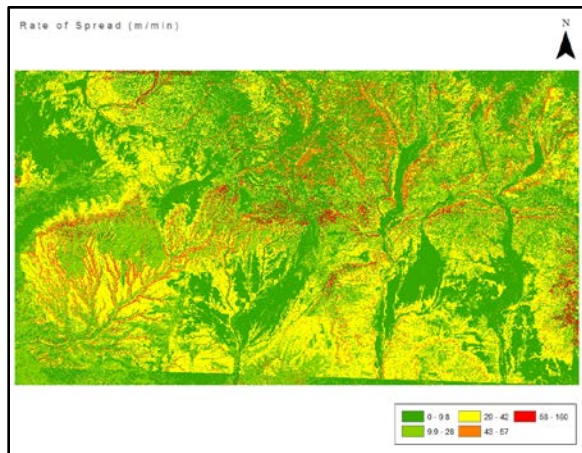To model fire behavior, the Wildland Fire Assessment Tool 2.4 (WFAT), an ArcGIS third-party toolbar, designed and maintained by The National Interagency Fuels Technology Transfer (NIFTT) at the University of Idaho (The National Interagency Fuels Technology Transfer (NIFTT) 2014) was used utilizing layers collected with another third-party ArcGIS toolbar, the LANDFIRE Data Access Tool (LDAT) (Landscape Fire and Resource

Figure 9: Example of WFAT Output Layer.

Management Planning Tools (LANDFIRE) 2014). "The LDAT tool utilized the spatial coordinates within ArcGIS (via a box drawn by the user) to access the LANDFIRE database and returns layers selected by the use in ZIP form. LDAT can then decompress and prepare the data for use with ArcGIS (LANDFIRE 2011)

> The Wildland Fire Assessment Tool (WFAT) is a custom ArcMap toolbar that provides an interface between ArcGIS desktop software, FlamMap4 algorithms (Finney 2006), First Order Fire Effects Model (FOFEM) algorithms (Reinhardt 2003), and FuelCalc (Reinhardt and others 2006) algorithms to produce predicted fire behavior, fire effects, and post - fire fuels map layers. (Wildland Fire Management R&D 2014)

For the creation of this model, the tool outputs of Fireline Intensity (measured in British Thermal Units/ft^2/sec) and Flame length (measured in feet) were used in conjunction with slope, aspect, and vegetation type to interpolate a risk layer for the study area. Output risk was classified according to the National Fire Danger Rating System.

Climate layers were downloaded from WORLDCLIM, a free source of worldwide average monthly climate data in ArcGRID form (Hijmans, et al. 2005).

Average maximum temperature and average monthly precipitation layers from August for the region (Tile 12) were utilized in this model.

A fire ignition history layer was obtained from the US Forest Service's Research Data Archive. "This data product contains a spatial database of wildfires
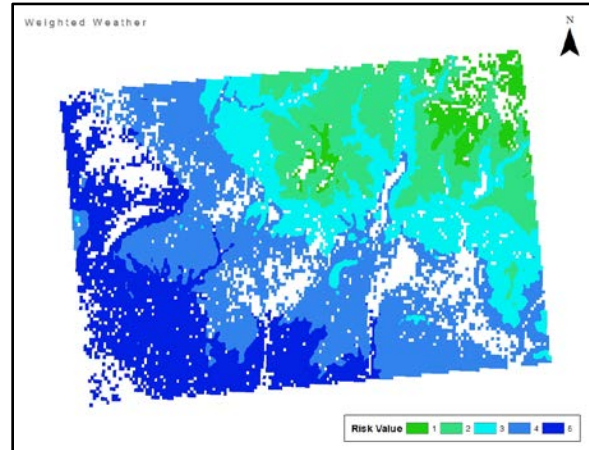

Figure 10: Weighted Weather Layer.

that occurred in the United States from 1992 to 2011, generated for the national Fire Program Analysis (FPA) system" (Short 2013). Ignition points for both human and lightning caused fires between 1992 and 2011 within the study area was derived from this layer.

Additional layers were derived or interpolated through several tools within the ArcGIS suite of software.

Analysis

An initial examination of the basic structure and statistics of the fire ignition data was performed to rule out a statistical possibility of completely random event data, which would have ended the analysis.

Average Nearest Neighbor By Month

The average nearest neighbor tool is an examination of the location of the inputs to determine the likelihood the events are random, clustered, or dispersed. By examining the distance of points in relation to each other as compared to the
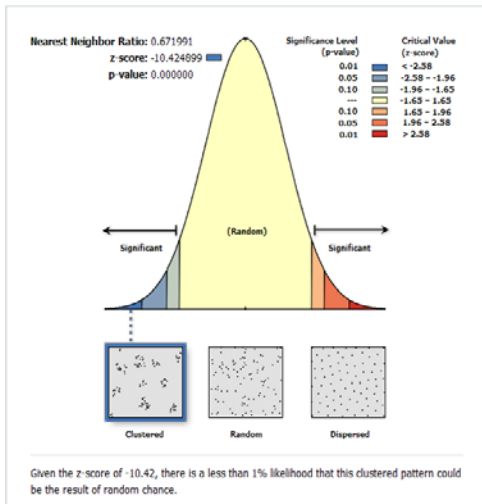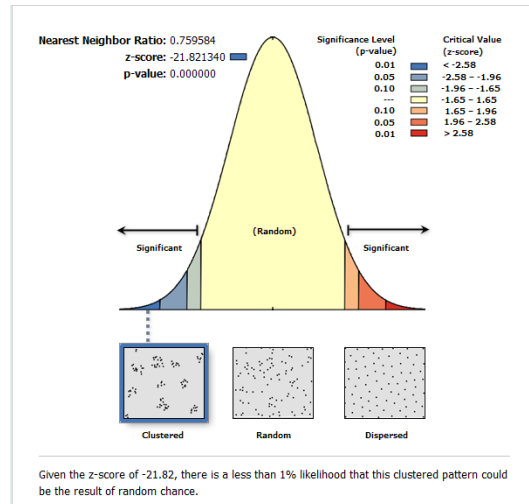

Figure 12: Human Caused Fire Ignitions

Figure 12: Lightning Caused Ignition Points

distance of an arbitrarily assigned event, the location of the score lies on a histogram to determine the likelihood a series of events is the result of complete random chance. The histogram ranges from clustered to random, with the Z-Score ranging from -2.58 to +2.58, respectively. Z-Scores are recorded for the entire data set and for each month of lightning strikes.

Human caused fires resulted in a Z-Score of -10.42 and lightning caused fires, a score of -21.82. With both scores falling well below -2.58, it is extremely unlikely the clustering is a result of random events.

Kernel estimation of spatial density

Kernel density, used to express density distribution of events, was used to examine ignition points of both human and lightning caused fires. When a roads layer was overlaid on top of the kernel density, the spatial pattern shows a favoring of human caused ignitions near roads and lightning caused ignitions in more remote
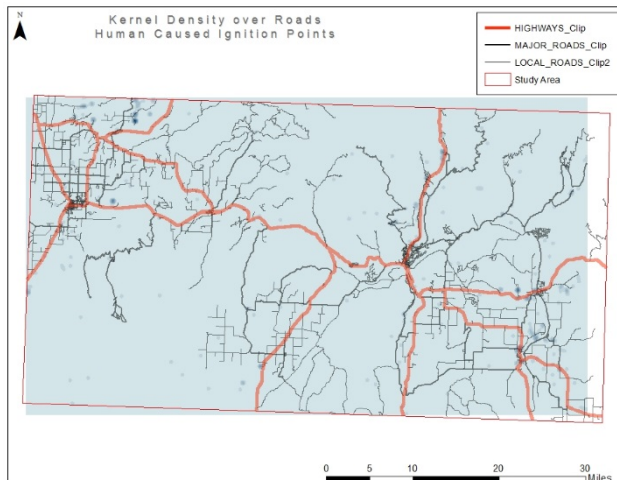

Figure 14: Human Caused Fire Ignition Points
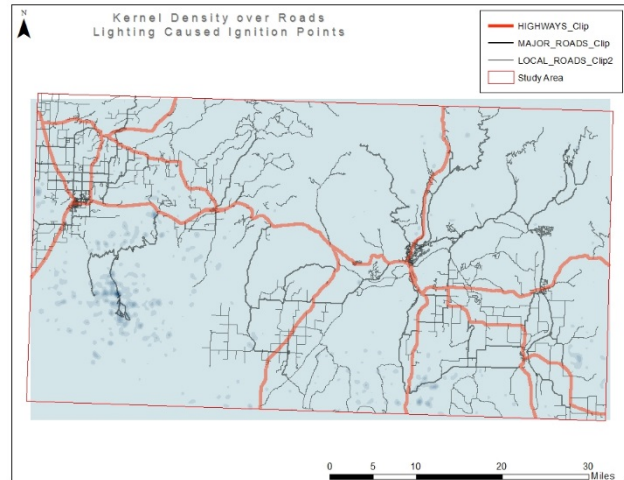
Figure 14: Lightning Caused Fire Ignition Points

areas.

Topography

Slope and aspect layers were created using Spatial Analyst: Slope (in percent) and Aspect from the Digital Elevation Model (DEM) layer collected with the LANDFIRE tool. Both of these layers were utilized by the WFAT tool to determine fireline intensity and flame length by means of established equations (Rothermel Fire Spread Model, 1972).

Fuels Reduction Mitigation

Spatial Analyst: Raster Calculator was utilized to reduce the fuel on the landscape for the four projected areas. Canopy bulk density, canopy height, canopy base height, and canopy density were all 'thinned' back to Firewise standards prior to running fire behavior analysis tools (Appendix D).

Fire Behavior Analysis

Using an adaptation of Deeming et al, 1977, the document "Understanding the National Fire Danger Rating System" (Schlobohm and Brain 2002) created a cross-reference table to equate flame length and fireline intensity as they relate to wildland fire behavior, breaking fire behavior into six categories (Table 1).

Utilizing the raster layers collected with the LANDFIRE Data Collection Tool, the Wildland Fire Assessment Tool (WFAT) was used to create the above outputs. Using the table and the Spatial Analyst: Reclassify tool, the resulting fireline intensity and flame length layers were reclassified to match the table, numbered 1 – 6. Once the layers were reclassified, Spatial Analyst: Weighted Overlay was used with a 50/50 weight spilt to create a new layer titled 'Landscape Risk based upon Deeming Index'.

Climate Layer Analysis

Probability of fire ignition is based upon several factors, heavily weighted upon fuel type, fuel moisture, and duff moisture. Fuel and duff moisture are most affected by precipitation and maximum temperature (Latham and Schliter 1989). While WFAT can sometimes interpolate this data with the given inputs plus information on wind, weather, and known moisture levels, this method is better suited for a small period of time, such as 3 to 5 days, not long-term, generalized landscape analysis. To act as a surrogate for fuel and duff moisture data, a weighted weather layer was

Table 1: Burn Index/Fire Behavior Cross Reference (Deeming et al, 1987)

Burn Index (BI) - 1978 [5]	Potential Flame Length (feet)	Fireline Intensity (BTUs/ft2/sec)	Risk Value (Reclassify) [6]	Narrative Comments
0 – 30	0 – 3	0 – 55	1	Most prescribed burns are conducted in this range
30 – 40	3 – 4	55 – 110	2	Generally represent the limit of control for direct attack methods.
40 – 60	4 – 6	110 – 280	3	Machine methods usually necessary or indirect attack should be used.
60 – 80	6 – 8	280 – 520	4	The prospects for direct control by any means are poor above this intensity
80 – 90	8 – 9	520 – 670	5	The heat load on people within 30 feet of the fire is dangerous.
90 –110+	9+	670 – 1050+	6	Above this intensity, spotting, fire whirls, and crowning should be expected.

created. Both precipitation and average maximum temperature were ramped with 25 classes, followed by Spatial Analyst: Reclassify to assign a rating of 1 – 5 [4]. Weather data was combined using Spatial Analyst: Weighted Overlay for the month of August, assigning 70% to precipitation and 30% to average maximum temperature, reflecting the general constant of temperature for each month from year to year and the variable amount of rainfall (Peninsula Ecosystem Management Class 2012), creating a new layer titled 'Weighted Weather' [7].

Fire Ignition Risk

To examine the relationship between landscape and weather factors, the final layers created were the "Fire Risk – [Treatment Type]. For the initial model, 'Landscape Risk' was assigned 60% weight and 'Weighted Weather' was assigned 40%. This was based upon landscape being an independent factor and

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[4] Precipitation was rated 5 to 1 in Spatial Analyst: Reclassify, showing less precipitation as more hazardous, while average maximum temperature was rated 1 to 5, showing higher temperatures as more hazardous.
[5] Simply put, burn index is a rating describing the difficulty of controlling fire post ignition based upon several inputs. Burn index was not used in this model.
[6] Risk Value based upon Fire Danger Rating System and not part of Deeming et al. 1973
[7] Prior to the creation of the Weighted Weather layer, a Spatial Analyst: Extract by Mask was used to remove the urban and developed areas from the precipitation and average maximum temperature layers. When analysis was done with these areas left in, the model showed the urban and developed areas as a fire risk, throwing the rest of the model off.

temperature/precipitation being the 'feeder factor', meaning fire behavior is highly based upon the landscape and fueled by weather.

Project Solution

Firewise Community/USA® Delineation

Contact was made with ten communities, six of whom were eager to participate in the project. All six representatives accomplished the task without noted trouble in a timely manner. The resulting KML files were imported into ArcGIS as layer files and corrected where inconstancies had occurred such as lines which were too long or did not close the polygon.

Optional feedback was requested from the community representatives; however, none was provided.

Fire Behavior

Fuel mitigation within and surrounding the Firewise Community improved fire behavior, fire effects, National Fire Danger Rating Risk, and fire type. Fire behavior factors examined included flame length, rate of spread, fireline intensity, maximum spotting distance, and pre-burn canopy load. Fire effects factors included post-burn canopy load, total post-burn load (including trees, shrubs, forbs, and grasses), consumed canopy load, and total consumed load. All factors were expressed in percent change from the baseline fire behavior modeling. All factors, either behavior or effects, had no change or a reduction. In no case did fire behavior or effects rise to a more dangerous level for the landscape.

Comparing specific numbers, when mitigation occurred only inside the boundaries of the Firewise Community, the behavior changed none to very little across all behavior and effect factors, while the treatment area when the surrounding private and public lands worked together with Firewise community had

the greatest improvement over the entire area. Figure 15 and 16 show the average
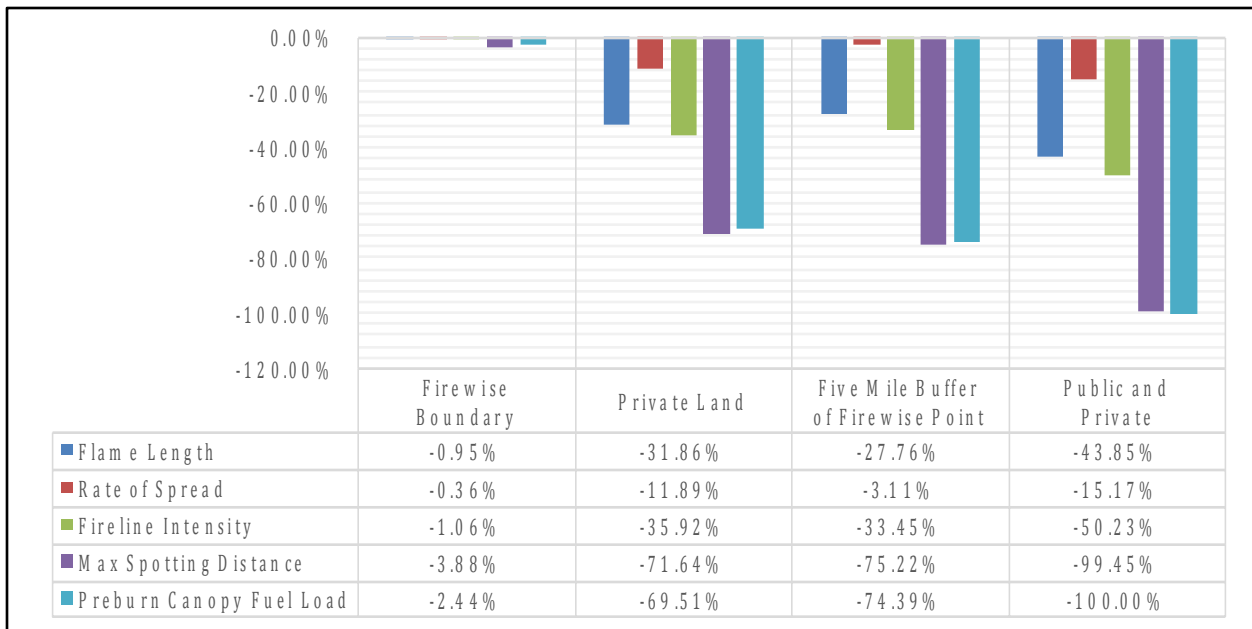

	Firewise Boundary	Private Land	Five Mile Buffer of Firewise Point	Public and Private
■ Flame Length	-0.95%	-31.86%	-27.76%	-43.85%
■ Rate of Spread	-0.36%	-11.89%	-3.11%	-15.17%
■ Fireline Intensity	-1.06%	-35.92%	-33.45%	-50.23%
■ Max Spotting Distance	-3.88%	-71.64%	-75.22%	-99.45%
■ Preburn Canopy Fuel Load	-2.44%	-69.51%	-74.39%	-100.00%

Figure 16: AVERAGE Fire Behavior Percent Change from Baseline Values

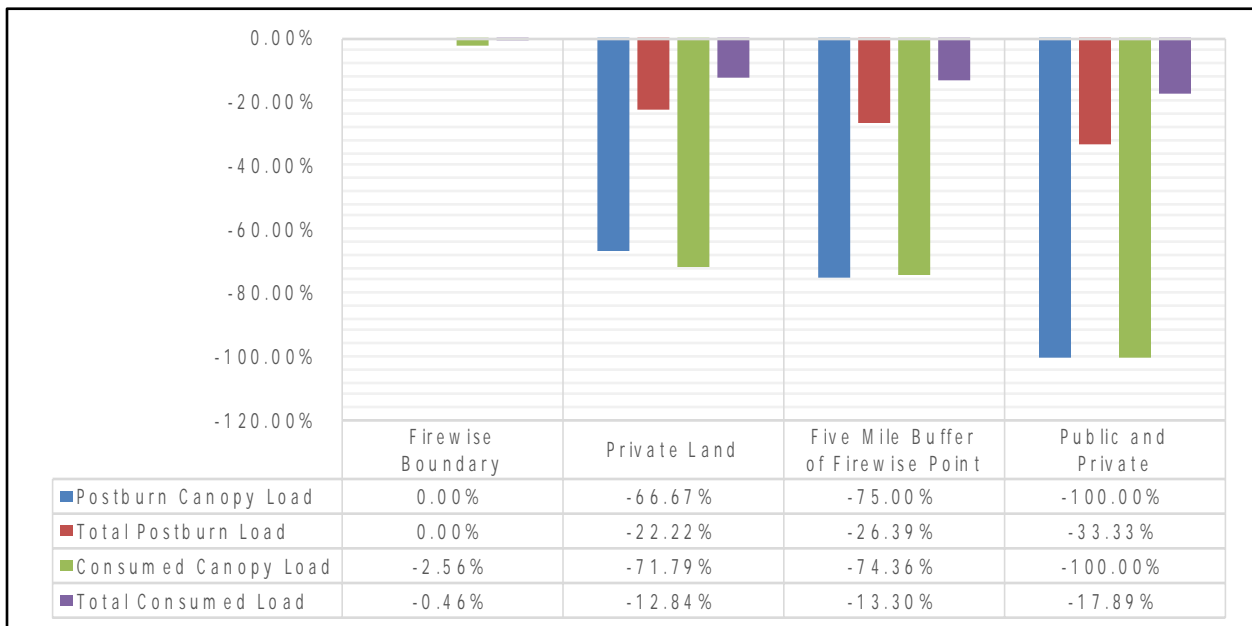|	Firewise Boundary	Private Land	Five Mile Buffer of Firewise Point	Public and Private
■ Postburn Canopy Load	0.00%	-66.67%	-75.00%	-100.00%
■ Total Postburn Load	0.00%	-22.22%	-26.39%	-33.33%
■ Consumed Canopy Load	-2.56%	-71.79%	-74.36%	-100.00%
■ Total Consumed Load	-0.46%	-12.84%	-13.30%	-17.89%

Figure 15: AVERAGE Fire Effects Percent Change from Baseline Values

percent change in each factor.

Each treatment area shows a reduction in active crown fire (23.25% baseline

to 2.95% for public and private lands combined) and an increase in passive crown

fire (12.89% baseline to 34.47% for public/private lands) from the baseline values.
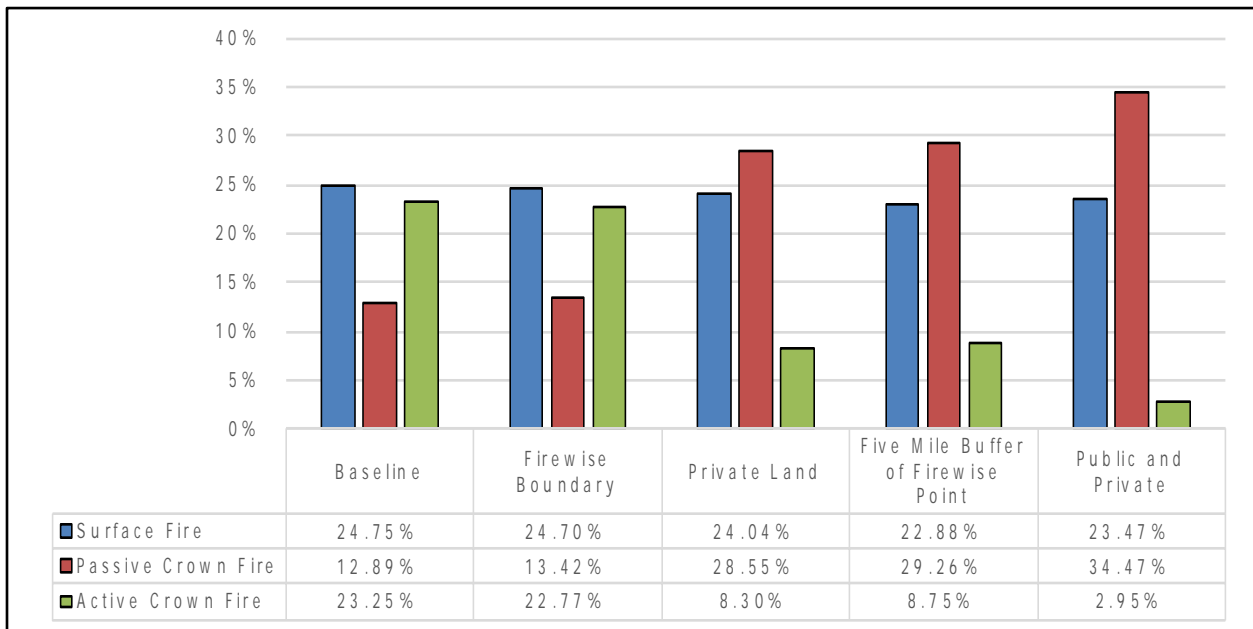
	Baseline	Firewise Boundary	Private Land	Five Mile Buffer of Firewise Point	Public and Private
Surface Fire	24.75%	24.70%	24.04%	22.88%	23.47%
Passive Crown Fire	12.89%	13.42%	28.55%	29.26%	34.47%
Active Crown Fire	23.25%	22.77%	8.30%	8.75%	2.95%

Figure 17: Fire Type

Surface fire held more or less constant at approximately 24% through each treatment area.

National Fire Danger within the study area on the baseline map shows a large amount of Very High Risk (44.55%, Orange), which reduces across all treatment areas. There is little change in the Low Risk (Green) and a trend of Moderate (Blue) and High (Yellow) risk increasing when Very High reduces (Schlobohm and

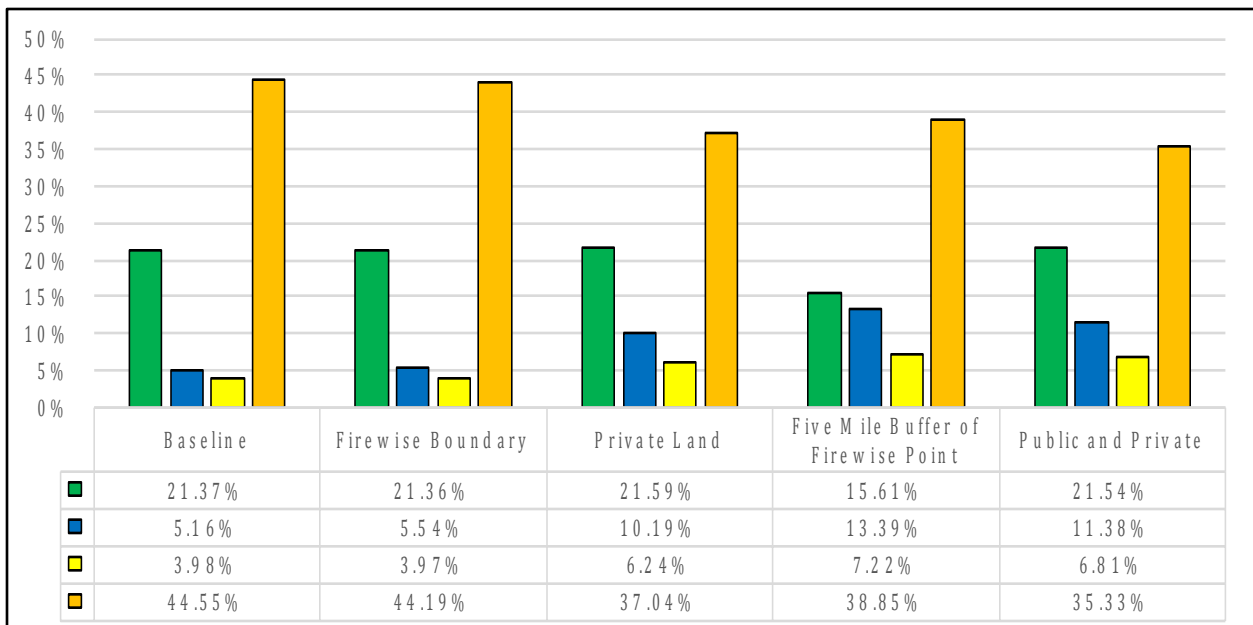|	Baseline	Firewise Boundary	Private Land	Five Mile Buffer of Firewise Point	Public and Private
	21.37%	21.36%	21.59%	15.61%	21.54%
	5.16%	5.54%	10.19%	13.39%	11.38%
	3.98%	3.97%	6.24%	7.22%	6.81%
	44.55%	44.19%	37.04%	38.85%	35.33%

Figure 18: National Fire Danger Rating

Brain 2002). A constant of 24.94% exists across the study area of non-burnable land - classified as urban, snow/ice, agricultural fields in unburnable condition, open water, and bare ground (Scott and Burgan June 2005).

Discussion and Recommendations

Firewise Community/USA® Delineation

The six participants completed and 'Shared' their maps in a very timely manner with no stated problems. With no feedback or questions about the document, it can be surmised that the instructional document was sufficient in its content to accomplish the task being asked. Widespread distribution of the instructional document in order to collect boundaries from the remaining eighty-six Firewise Communities in Colorado will result in a more definitive answer on the quality of the instructional document.

According to the Colorado State Forest Service head office, some districts have inquired about a method of self-definition for landowners (separate from Firewise Communities) for the purpose of forestry planning as it pertains to wildfire, tree planting and removal, and wildlife habitat. The instructional document produced by this capstone could potentially transfer over, with minor alterations, to other purposes.

The NFAP has requested the success and setbacks of the boundary collection method in Colorado with possible intent of adopting it into the Firewise application process. Following the assessment of widespread collection, the results and instructional document will be provided to the NFPA. If the larger collection efforts mirror the success of the test group, both with 60% response utilizing the Google

Maps Engine method and response enthusiasm and time, it is setting up to be a very successful method of data collection.

Fire Behavior

For this examination, the randomly selected five mile buffer of the point provided by a Firewise representative on the initial application worked well with the mitigation efforts. However, when the point is expected to represent all Firewise communities, which can vary greatly in size, the random choice for a five mile buffer may be much too small and not encompass the entire community or the other extreme, where a five mile buffer is an area much too large for the community or may overlap areas not suitable for mitigation. Using the exact perimeter of the Firewise community when modeling fire behavior versus simply buffering the points provided allow for a more accurate representation of mitigation across the landscape, especially when executing large scale mitigation for several communities across a very large landscape.

Treatment within the study area reduced risk to a level of fire type more acceptable for areas within a WUI environment. All treatments areas had a reduction in active crown fire to passive crown fire. Within the context of the WFAT fire behavior modeling tool, passive crown fire is defined as "low wind speed, low canopy bulk density and cover, high canopy base height" and active crown fire is defined as "higher wind speed, high canopy bulk density and cover, low canopy base height" (Wildland Fire Management R&D 2014).

The change of fire type across the landscape is a reflection of the changes in fire behavior combined with fuels mitigation. The reduction of active crown fire is desirable across the entire landscape, but specifically near structures and cultural

sites. Active crown fire is extremely difficult to impossible for firefighters to control or extinguish, thus bringing the fire out of the canopy and increasing the amount of surface fire and passive crown fire types allow for methods of control to be effective.

Overall, treatment led to the reduction of danger in regards to fire behavior factors and fire type when the Firewise Community extended the mitigation into surrounding private land. However, a greater reduction of risk occurred when these privately owned land worked with the public lands which not only surround, but are intermixed in the private lands. While this was only a model of a possible combination of mitigation areas, Firewise communities could benefit from the results when requesting funding for use within their community and surrounding privately owned areas to coincide with existing fuels mitigation plans on public lands.

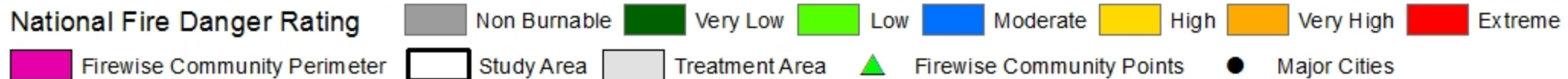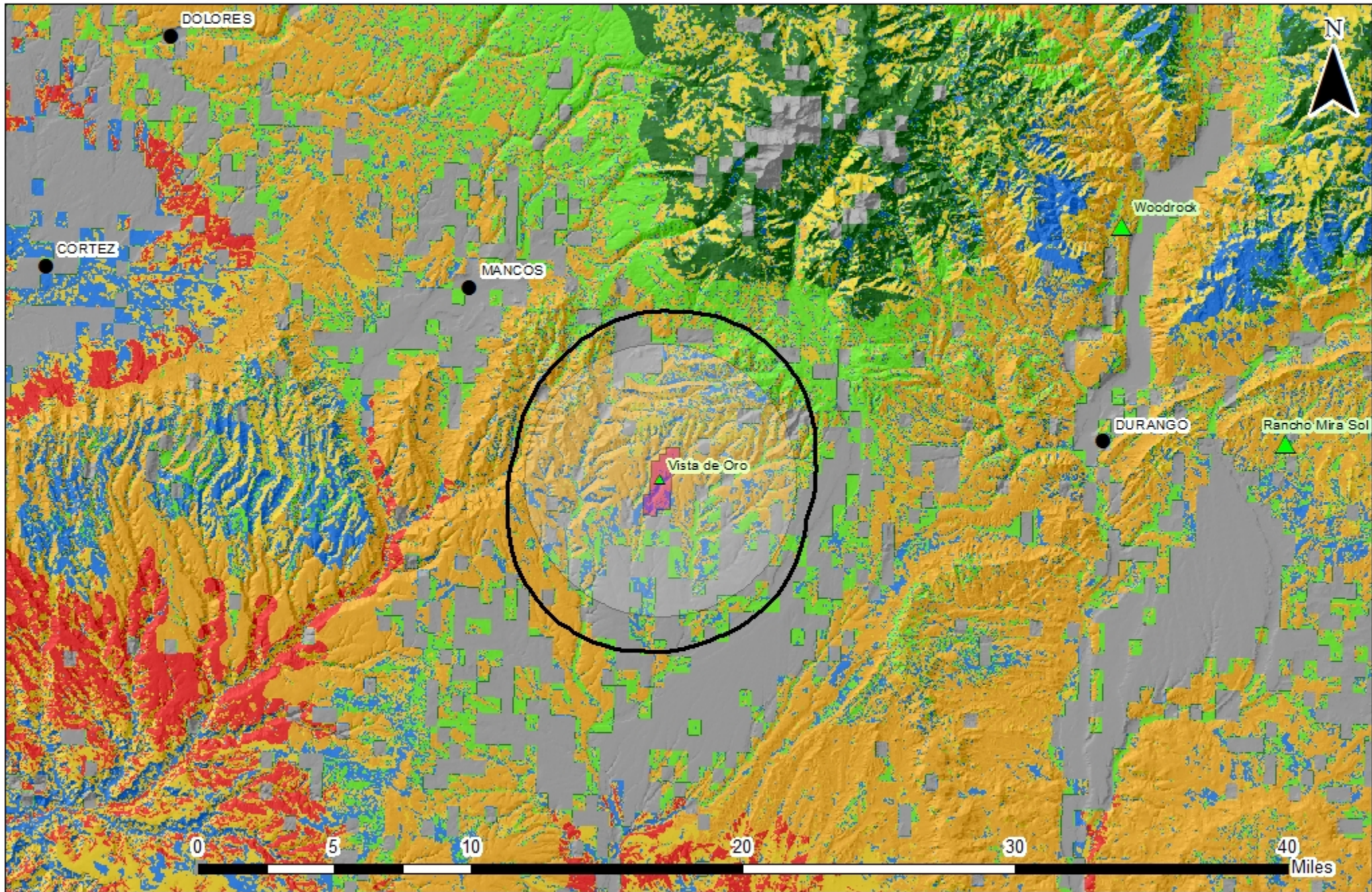National Fire Danger Rating

No Fuels Treatment - Baseline Values
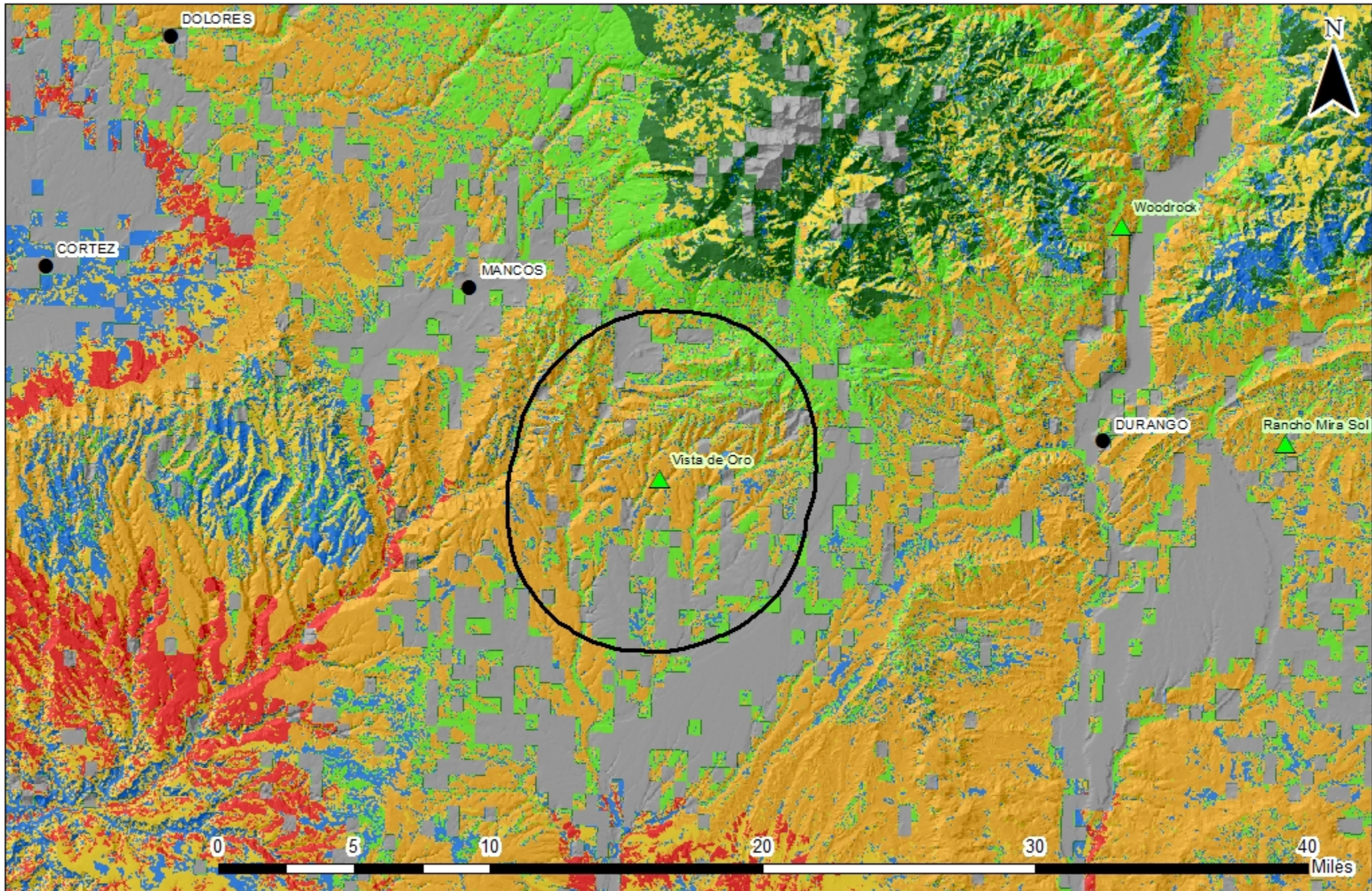
National Fire Danger Rating

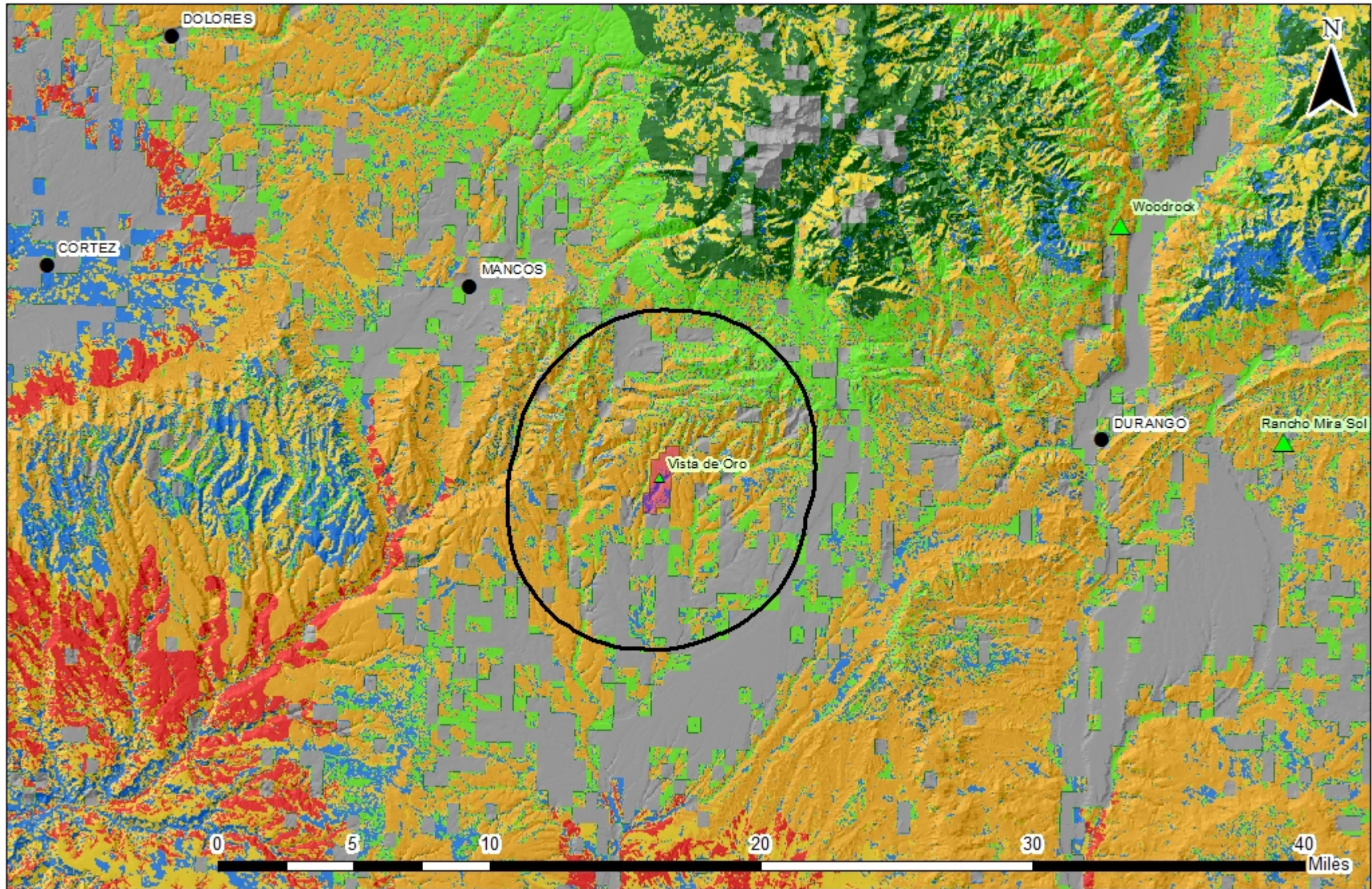|		
Non Burnable	Very Low	Low
Moderate	High	Very High
Extreme		

Study Area

Firewise Community Points

Major Cities

National Fire Danger Rating

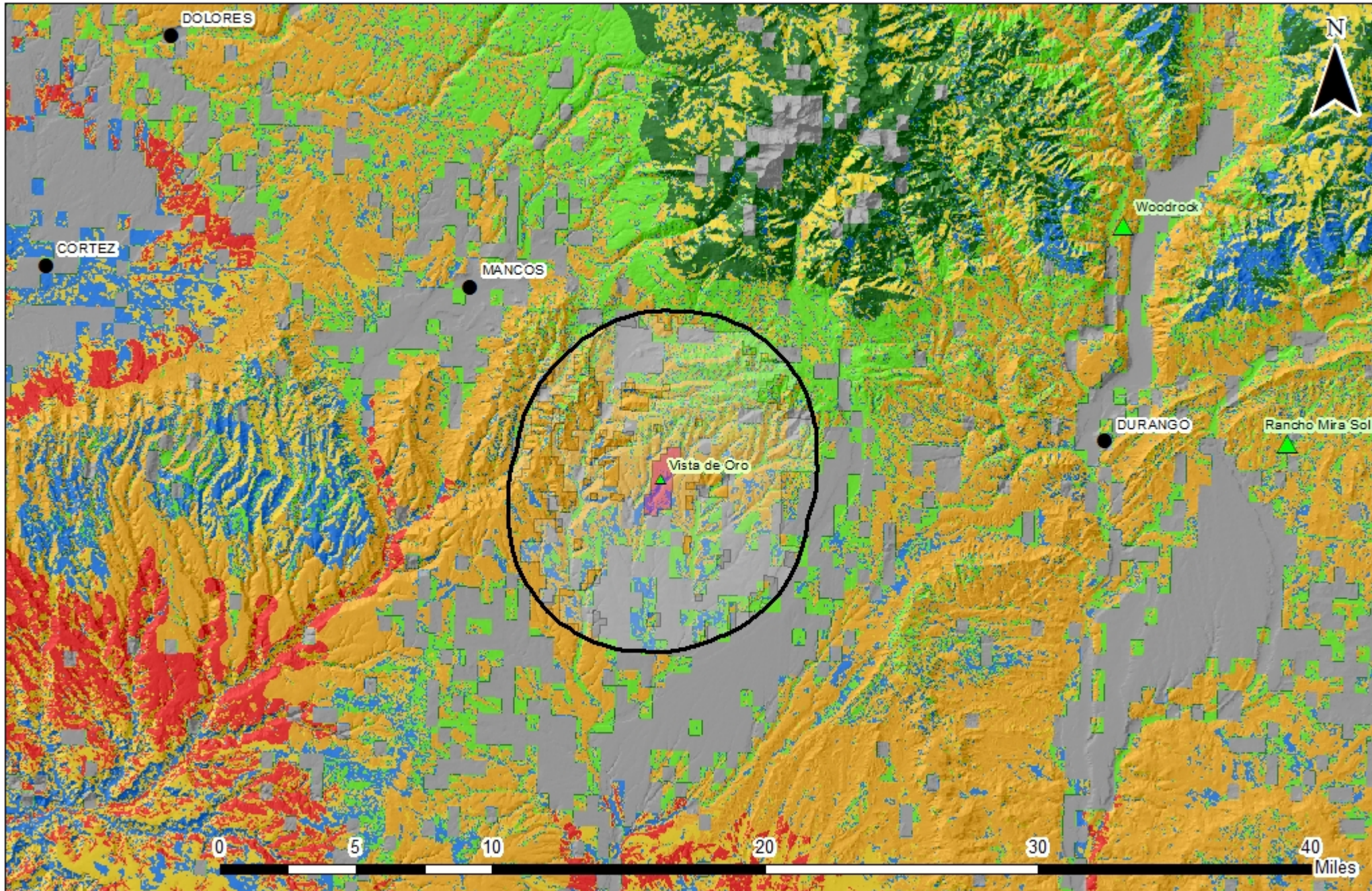Fuels Treatment Area: Simple Five Mile Buffer of Provided Firewise Community Point

National Fire Danger Rating — Non Burnable — Very Low — Low — Moderate — High — Very High — Extreme

Firewise Community Perimeter — Study Area — Treatment Area — Firewise Community Points — Major Cities

National Fire Danger Rating

Fuels Treatment Area: Firewise Community Only

DOLORES

Woodrock

CORTEZ

MANCOS

Vista de Oro

DURANGO

Rancho Mira Sol
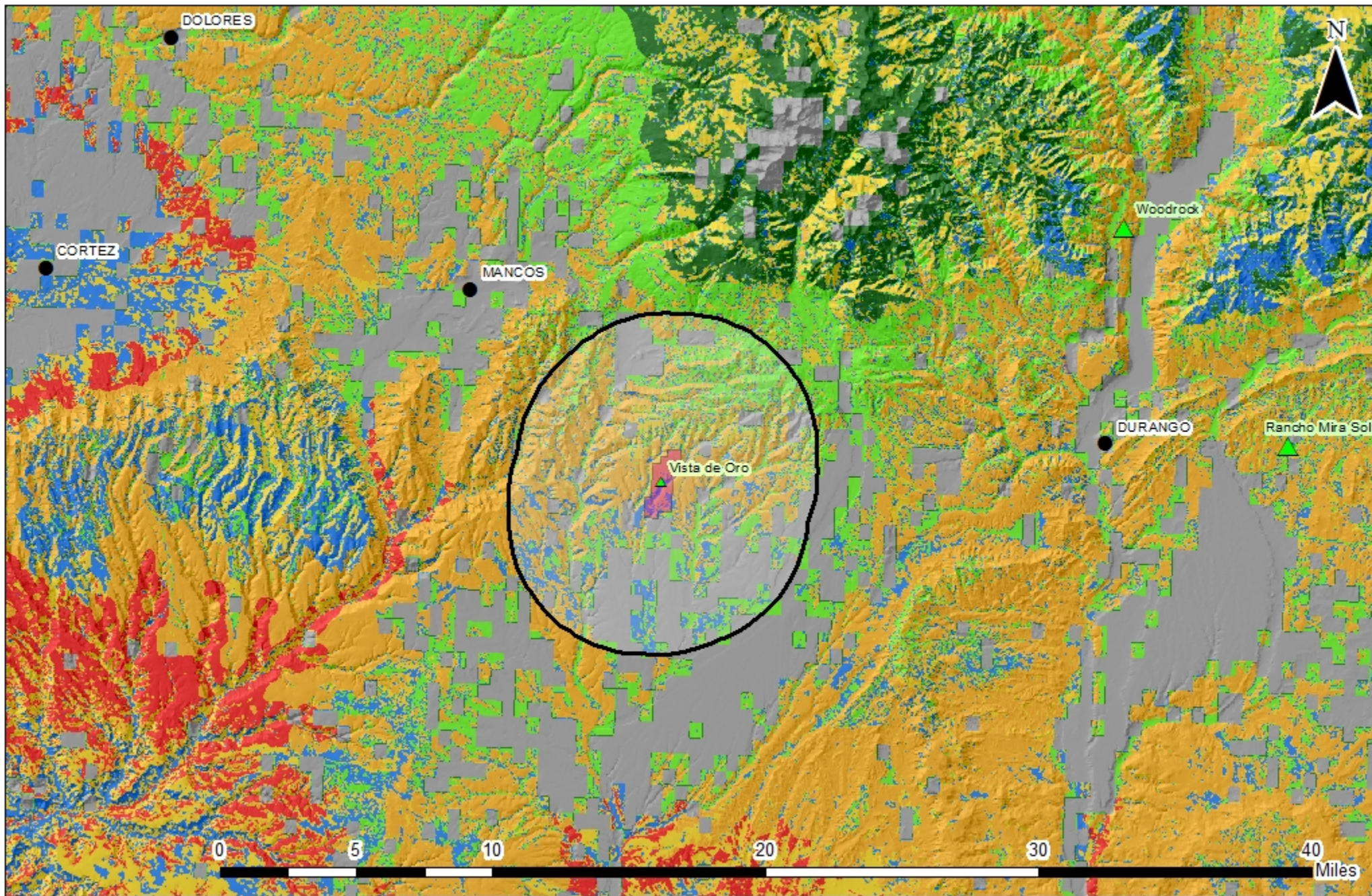
N

| 0 | 5 | 10 | 20 | 30 | 40 |

Miles

National Fire Danger Rating

Non Burnable   Very Low   Low   Moderate   High   Very High   Extreme

Firewise Community Perimeter   Study Area   Firewise Community Points   Major Cities

National Fire Danger Rating
Fuels Treatment Area: Public Lands Surrounding Firewise Community

DOLORES

CORTEZ

MANCOS

Woodrock

DURANGO

Rancho Mira Sol

Vista de Oro

N

| 0 | 5 | 10 | 20 | 30 | 40 |

Miles

National Fire Danger Rating — Non Burnable — Very Low — Low — Moderate — High — Very High — Extreme

Firewise Community Perimeter — Study Area — Major Cities — Firewise Community Points

National Fire Danger Rating

Fuels Treatment Area: Combination of Public and Private Lands - Five Miles Around Firewise Community

DOLORES

CORTEZ

MANCOS

Woodrock

DURANGO

Rancho Mira Sol

Vista de Oro

N

| 0 | 5 | 10 | 20 | 30 | 40 |
Miles

National Fire Danger Rating   ▢ Non Burnable   ▢ Very Low   ▢ Low   ▢ Moderate   ▢ High   ▢ Very High   ▢ Extreme

▢ Firewise Community Perimeter   ▢ Study Area   ▢ Treatment Area   ● Major Cities   ▲ Firewise Community Points

Appendix A

National Fire Danger Rating System

Fire Danger Rating and Color Code	Description
Low (L) – Green	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
Moderate (M) – Blue	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (H) – Yellow	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Very High (VH) - Orange	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high intensity characteristics such as long distance spotting and fire whirlwinds when they burn into heavier fuels.
Extreme (E) - Red	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Appendix B
Largest loss wildland fires[8]

Rank	Name	Loss in Year Fire Occurred	Adjusted Loss in 2012 Dollars
1	Oakland Fire Storm (wildland/urban interface) Oakland, California October 1991	$1.5 billion	$2.5 billion
2	The Southern California Firestorm * San Diego County, California October 2007	$1.8 billion	$2.0 billion
3	"Cerro Grande" Wildland Fire (wildland/urban interface) Los Alamos, New Mexico May 2000	$1.0 billion	$1.3 billion
4	"Cedar" Wildland Fire Julian, California October 2003	$1.1 billion	$1.3 billion
5	"Old" Wildland Fire San Bernardino, California October 2003	$975 million	$1.2 billion
6	Southern California Wildfires of November* Sacramento, CA November 2008	$800 million	$853 million
7	"Laguna Beach Fire" (wildland/urban interface) Orange County, California October 1993	$528 million	$838 million
8	Wildland Fire* Florida May–June, 1998	$395 million	$555 million
9	Forest Fire Cloquet, Minnesota October 1918	$35 million	$532 million
10	"Paint Fire" Goletta Wildland/Urban Interface Santa Barbara, California June 1990	$237 million	$416 million

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[8] As reported by the National Fire Protection Association (NFPA 2013)

Appendix C

Letter to Firewise Communities/USA®

May 8, 2014

Colorado State FOREST SERVICE

Colorado State University
5060 Campus Delivery
Fort Collins, CO 80523-5060
(970) 491-6303
FAX: (970) 491-8645

Name
Address
City, State, Zip

Dear <<NAME>>,

I am writing to ask for your help in mapping the boundary of your Firewise Community. The CSFS is working in partnership with the National Fire Protection Association's (NFPA) Firewise Communities/USA® program to build a database with the boundaries of all the Firewise Communities in Colorado.

The boundary information will help communities improve communication and safety among residents. It can help communities:

- provide a map to residents of the Firewise Community;
- inform local fire departments;
- assist in planning future wildfire mitigation projects; and
- provide information for grant applications.

We need your help to provide the boundary information to the CSFS. Enclosed is a set of instructions on how to create a map of your community. Please follow the steps and email the map to the address provided in the tutorial. The process should take 10-15 minutes. If you have questions or need assistance in working through this process, do not hesitate to contact Pete Barry at (970) 491-8408 or CSFS_Firewise@colostate.edu. If possible, please complete the map by May 23, 2014.

The data you provide is not a legal data and will be used for education and information purposes. The data will be used by the CSFS, NFPA and other entities who request the information, which can include insurance companies.

The Colorado State Forest Service (CSFS) is excited that your community has maintained the national Firewise Community/USA designation! The hard work your community has contributed is helping to reduce wildfire risk and improve safety in your area.

Thank you for your help with this project. This is another step forward to improving safety and reducing wildfire risk in communities across Colorado.

Michael B. Lester
State Forester/Director
Colorado State Forest Service

Appendix D

Raster Calculator Inputs for Fuel Mitigation

Canopy Bulk Density Treatment

Step 1: (Arbitrary_CBD_Step_1) =
OutRas = Con(("Landfire\us_100cbd_1" >= 11) & ("Existing Treatment\Rate of Spread (m/min)" >= 35) & ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),5,"Landfire\us_100cbd_1")

Step 2: (Arbitrary_CBD_Step_2) =
OutRas = Con(("Arbitrary 5 Mile Buffer\Arbitrary_CBD_Step_1" >= 21) & ("Existing Treatment\Rate of Spread (m/min)" >= 15) & ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),10,"Arbitrary 5 Mile Buffer\Arbitrary_CBD_Step_1")

Step 3: (Arbitrary_CBD_Step_3) =
OutRas = Con(("Arbitrary 5 Mile Buffer\Arbitrary_CBD_Step_2" >= 31) & ("Existing Treatment\Rate of Spread (m/min)" >= 10) & ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),21,"Arbitrary 5 Mile Buffer\Arbitrary_CBD_Step_2")

Step 4: (Arbitrary_CBD_Step_4) =
OutRas = Con(("Arbitrary 5 Mile Buffer\Arbitrary_CBD_Step_3" >= 41) & ("Existing Treatment\Rate of Spread (m/min)" >= 5) & ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),31,"Arbitrary 5 Mile Buffer\Arbitrary_CBD_Step_3")

Canopy Cover Treatment
Con(("Landfire\us_100cc_1">= 36) & ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),35,"Landfire\us_100cc_1")

Canopy Base Height Treatment
Con(("Landfire\us_100cbh_1" < 3) & ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),3,"Landfire\us_100cbh_1")

Canopy Height Treatment
OutRas= Con(("Landfire\us_100ch_1" > 25) & ("Arbitrary 5 Mile Buffer\Arbitrary_CC"<= 35)& ("Arbitrary 5 Mile Buffer\Buffer_And_Study_Raster" == 2),25,"Landfire\us_100ch_1")

Fuel Behavior Model Inputs
Wind Speed
        25 MPH Uphill
Scott/Reinhardt (2001) Crown Model
Foliar Moisture
        100%
Fuel Moisture
        Default Very Dry Conditions
Region
        Interior West
Season
        Summer

June |**2014**

Delineating Firewise Communities/USA®

Colorado State Forest Service

Using Google Maps Engine, each Firewise Community will be able to self-define the boundaries of their own community

A Colorado State Forest Service project in partnership with Firewise Communities/USA®

The mission of the Colorado State Forest Service is to achieve stewardship of Colorado's diverse forest environments for the benefit of present and future generations.

Contact Information:

Pete Barry
(970) 491-8408
CSFS.Firewise@Gmail.com

Please note: the last few pages of this tutorial is a Troubleshooting Section.

In order to define the boundaries of your community, you will need a Google (or Gmail) account. It is necessary to create and save your community map. If you do not have a Google account, we suggest using '*yourtown*.Firewise@gmail.com'.

1. Sign in or create an account.

2. Point your browser to the Google Maps Engine https://mapsengine.google.com/map/

3. Click on 'Create a new map'

4. Find your town by searching or panning and zooming

   a. Pan using the Pan Tool

      • Hold left mouse button and drag map

   b. Zoom with the Plus/Minus Zoom tool

      • Hint: The mouse wheel will zoom in and out as well

   c. Change the Base map by single clicking on the triangle facing down at the bottom right corner of the Table of Contents and selecting a background from the resulting menu
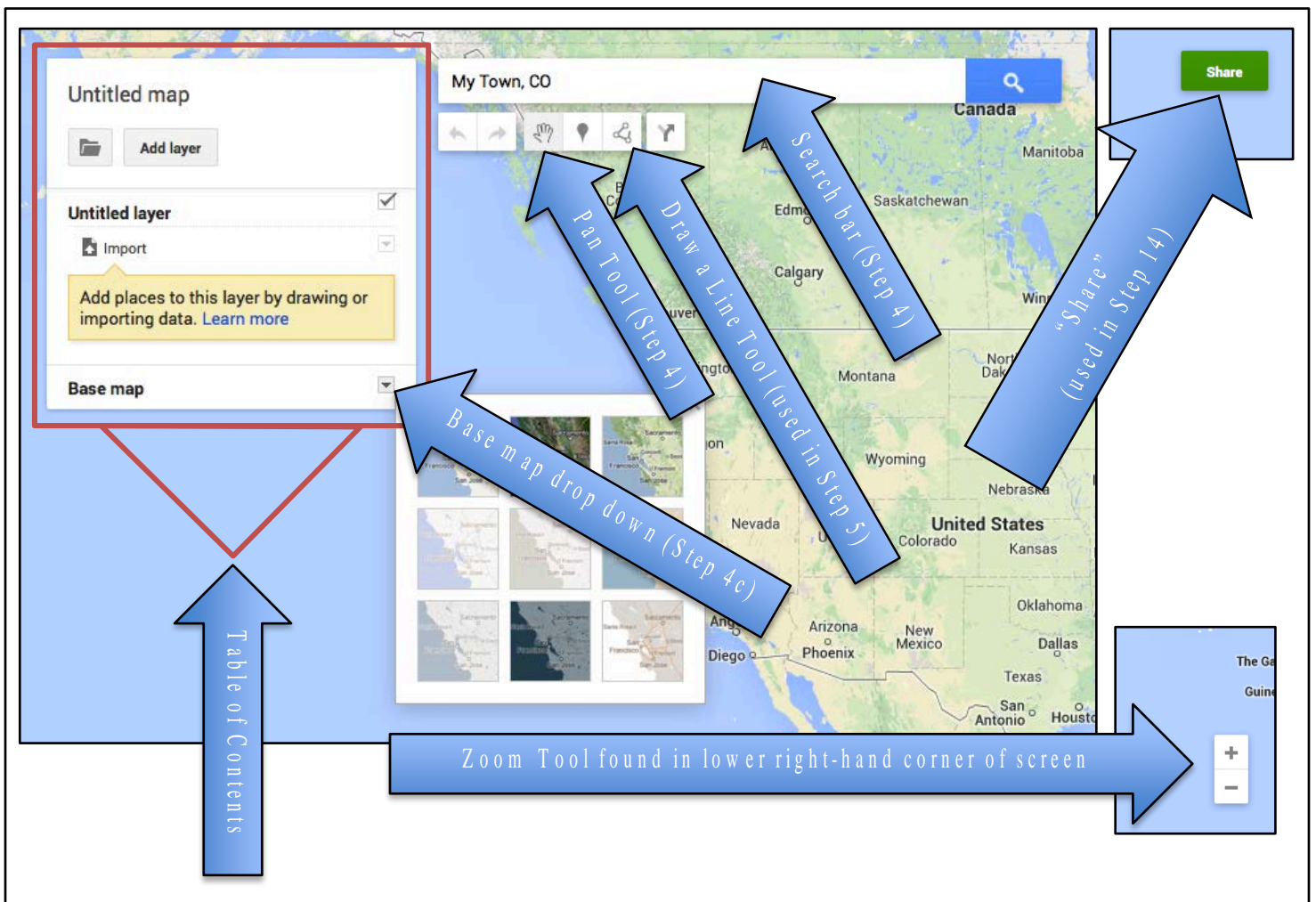
Figure 19. Location of Tools Needed in Google Maps Engine

You, as the Firewise Committee Representative, know the perimeter of your community better then a non-resident. To help us have the most accurate maps, when possible, draw along defined objects, such as streets, railroad tracks, and bodies of water. We understand that sometimes communities are not defined by these existing boundaries. In this situation, please mark the boundary as precisely as possible, as you know it. If you need help with any portion of this tutorial do not hesitate to contact us and we will be happy to assist you.

Here are some hints to read before you begin drawing your perimeter.

• Experiment with different backgrounds. They may tell a different story and help you draw the line with more ease. (See Step 4-c and Figure 1)

• If you make a mistake, keep clicking to draw. You can edit individual points after you have completed your polygon (See the Troubleshooting sections of this tutorial for details)

• If you accidentally double-click at any time and you cannot keep drawing, go ahead and save the line (as shown below in Step 6), then right-click on the last point you put down, and select "Extend Line" from the resulting menu. This will allow you to keep drawing. When you reach the end of your perimeter, you will need to double-click again to end, as the single-click to end will no longer work.
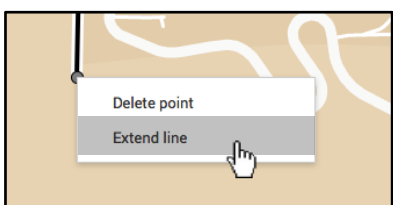

5. Use the 'Draw a Line' Tool to draw a line around your community

    a. Select the tool by single clicking on it. Your cursor will change to a crosshair ⊞.

    b. Single-click on any edge of your community. This will leave one dot (point).

    c. Continue single-clicking, drawing a line around your community

d.   When you reach the end of the perimeter (polygon), move your cursor over the first point you put down. You will see the cursor 'snap' to the first point and your cursor will change from the crosshair [+] to a single finger [✋].

e.   Single-click on the first point to close the polygon.

f.   Fill out the perimeter details in the resulting pop-up box (See Step 6 for more detail)

6.   When you click to close the polygon (Step 5-e of this tutorial), a box will automatically pop up, allowing you to name and provide a description of your polygon. It will also appear in your map's Table of Contents.
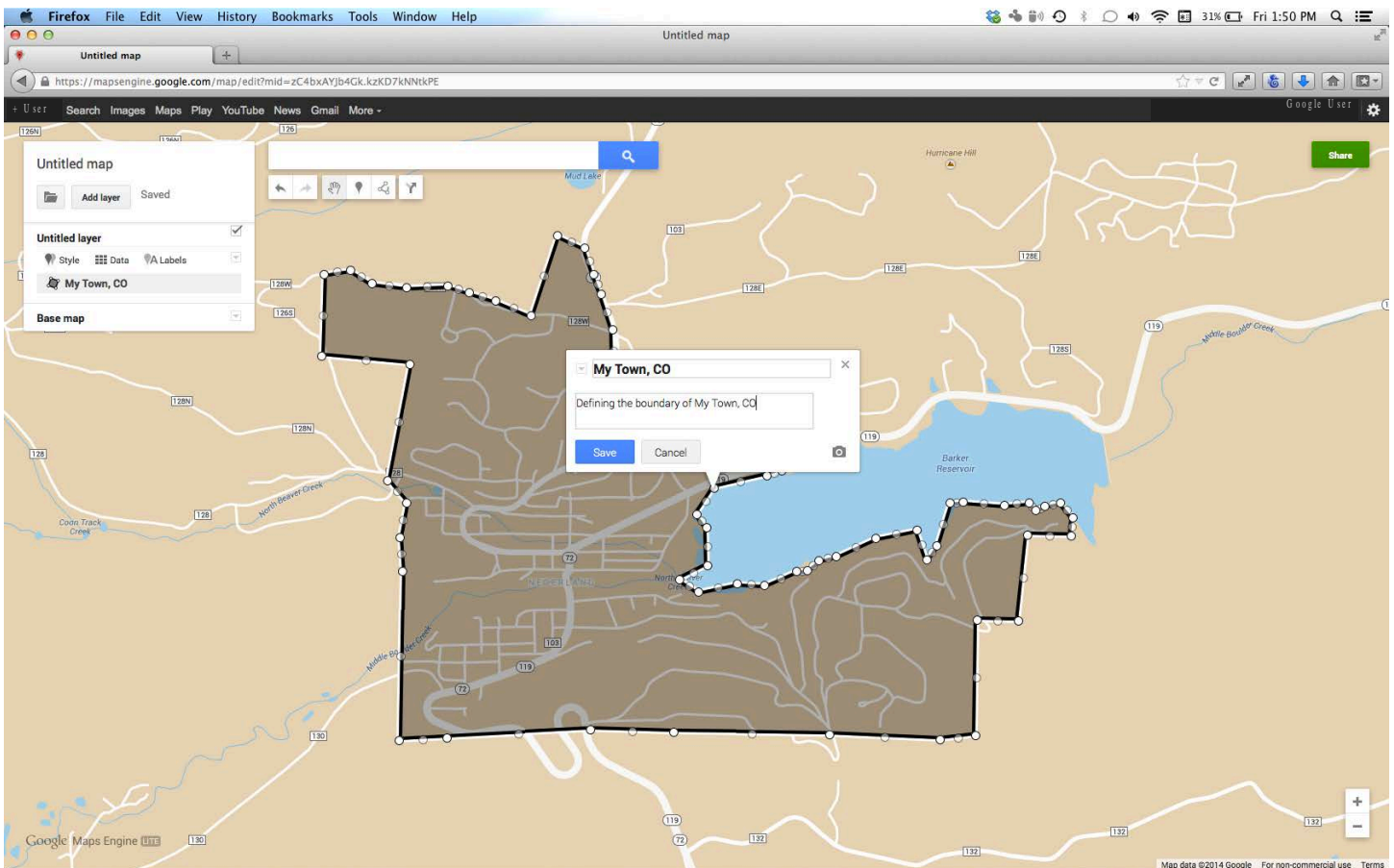
7.   Click 'Save' on the pop up.

- If you have made a mistake or otherwise like to adjust the boundary, see Troubleshooting for details on how to fix errors.

- If your community has more then one part, you can draw the second (or third or fourth...) part by returning to Step 5 and completing the steps again.

8.   Name your map with your Firewise Community name by single-clicking on 'Untitled Map' in the Table of Contents.

• You may give your map any details you think may help someone better know the location.
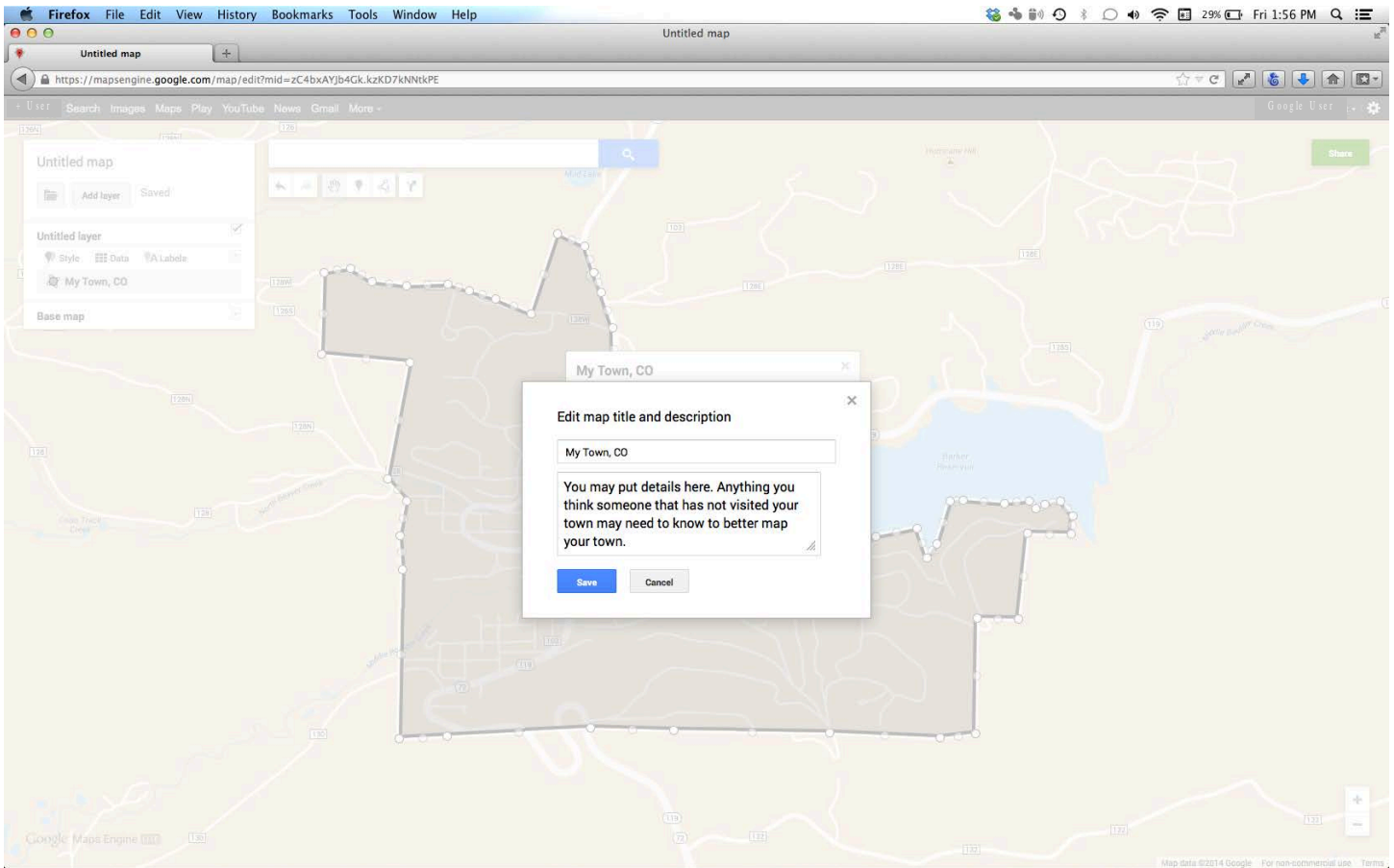
9. When you are all done with your map, click 'Share' in the upper-right hand corner.

10. Share your map with CSFS.Firewise@gmail.com. This will allow the Colorado State Forest Service to access your map. This access allows us to download the map into our software, as well as help you make corrections or assist you in the map-making process.

- Use the 'Invite People:' box to send your map

- Feel free to 'Add Message', as it adds to the body of the email sent to the Colorado State Forest Service

- Make sure 'Can edit' is selected to the right of Invite people. Dropdown the options with the upside down triangle and select 'Can edit' from the two options

- You privacy is our highest concern. Your map and email will not be used for any purpose other than this project. If you are uncomfortable using your personal email for this project, please consider creating a new account using the format at *yourtown*.Firewise@gmail.com.

- Email or call with any questions, concerns, or problems!

Thank you so much for your help and cooperation!

Common Problems When Making a Map with Google Maps Engine

Moving a Point to the Correct Location

Drag a point put in the wrong place by holding the left mouse button and dragging it into the correct place.

- Hint: As you drag points into the correct spot, Google Maps Engine will automatically add more points to help 'round out' your lines.

- Hint: You can see which point you are editing by noting it turns grey and your mouse changes from an open hand [🖐] to a single finger icon [👆] when you hold your cursor over the point.
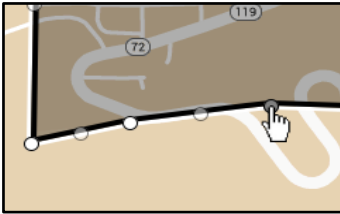
Deleting Unwanted Points

Delete unwanted points by right-clicking on each one and selecting Delete Point from the resulting menu
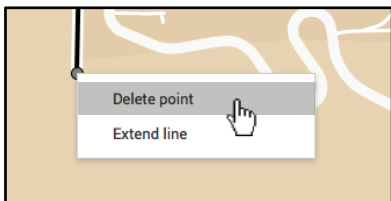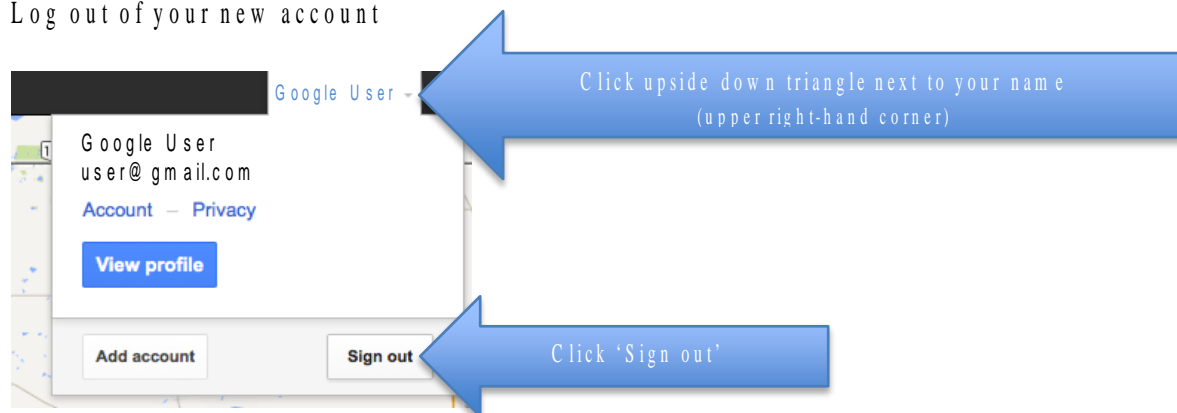

I moved the whole perimeter! Do I have to start over?

If you accidentally click and drag your entire polygon out of place, immediately press Control + Z (Command + Z on a Macintosh) to replace your polygon where it was.

Google Maps Engine: "You have exceeded your sharing quota."

But it's a brand new account!! This is simply a cache error.

1. Log out of your new account

2. Clear your browser's cache

   - Since there are so many browsers out there, here is a link for the US Department of Energy on how to clear all the major browsers (Instead of listing all the directions here!).

     http://www.bnl.gov/itd/webapps/browsercache.asp

3. Point your browser to the Google Maps Engine https://mapsengine.google.com/map/

4. Click on 'Open a map'

5. Sign into your account

6. Try sharing again

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