Targeting the Community Fire Planning Zone

Mapping Matters

Ecological Risk Analysis

SCIENCE FROM

THE WILDERNESS SOCIETY

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Targeting the Community Fire Planning Zone

Mapping Matters

By
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and
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The Wilderness Society

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This science report is one of a series that stems from conservation research studies conducted by The Wilderness Society's Ecology and Economics Research Department. Other reports in the series that focus on issues relevant to this report include:

- **The Wildland Fire Challenge:** Focus on Reliable Data, Community Protection, and Ecological Restoration
- **The Federal Wildland Fire Budget:** Let's Prepare, Not Just React (Emphasis on Reduced Financial and Ecological Costs)
- **Following the Money:** National Fire Plan Funding and Implementation

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- **Wildland Fire Use:** An Essential Fire Management Tool
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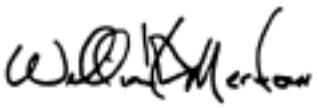
Preface

Year after year intense wildfires traverse landscapes across the West, threatening nearby communities. Smoke billows through the valleys, residents evacuate, and homes burn. In 2000 a new policy framework, the National Fire Plan, was put in place to help solve the wildfire problem. Since then the federal government has allocated billions of dollars toward fire management, with a special emphasis placed on reducing risks in those areas where private property abuts public lands.

While protecting communities at risk lies at the heart of the national fire policy, we have not yet determined exactly how to reduce those communities' vulnerability. Is the best use of scarce federal resources to focus on cutting brush and trees close to homes to create a "defensible space"? Or should federal agencies try to treat larger swaths of forest to reduce a fire's intensity before the flames can reach a community? How much of a "buffer" is actually necessary to protect structures from wildland fire? Even more fundamentally, are the federal and state entities charged with safeguarding our municipalities able to define or identify the location of at-risk communities?

In The Wilderness Society's report, Targeting the Community Fire Planning Zone: Mapping Matters, forest ecologist Dr. Greg Aplet and landscape ecologist Bo Wilmer find these definitions to be both immensely important and extremely elusive. Community Fire Planning Zones (CFPZ) — areas in and around communities where federal, state and local fire managers should focus their efforts to mitigate fire risk — include tens of millions of acres, much of which is private land. In order to successfully tackle such an immense planning challenge, protection strategies must be tightly focused and well-informed. But because each state uses a different method to designate communities at risk, no national-scale definition of the CFPZ exists today. The coordination of local and national fire-safe activities suffers as a result.

The National Fire Plan has rightly placed its emphasis on the importance of reducing wildfire risk within communities and on the public lands nearby. Before our nation can protect the hundreds of western communities currently at risk, however, we must first understand where they are.



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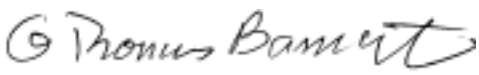

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Report Highlights

Protecting communities threatened by wildland fire is one of the highest priorities of federal fire policy. The National Fire Plan and the 10-Year Comprehensive Strategy have called on federal agencies such the USDA Forest Service and the USDOI Bureau of Land Management to focus their efforts on the "wildland-urban interface," where private homes abut fire-prone public wildlands. Determining where to focus community protection efforts, such as establishing adequate water supplies and cutting trees and brush, requires identifying a Community Fire Planning Zone (CFPZ), the area where special management attention is needed to protect communities and homes. However, exactly where these efforts should be focused — and what land, exactly, the CFPZ includes — has been a subject of debate and confusion.

In order to design the most cost-effective fuels treatments for community protection, it is imperative that fire managers first have an understanding of exactly where communities at risk of wildfire are located across the landscape. Pinpointing the location of critical areas requires sophisticated tools of geographic analysis, including data that describe housing density, land ownership, and vegetation.

Unfortunately, such analyses vary from state to state. Disparate state definitions of the CFPZ mean that communities facing similar threats may be considered to be at risk of wildfire in one state but excluded in another, and thus deprived of essential federal resources to help reduce that risk. These inconsistent definitions not only hamper fire planning in some communities, they also make comparison and use in national policymaking nearly impossible.

In order to learn how various state definitions of communities affect identification of the CFPZ, this report seeks to compare "apples to apples" by applying one consistent, simplified definition of community to three fire-prone landscapes: the Colorado Front Range, the Central Idaho Ecosystem, and the Greater Yosemite area in California. Each landscape displays different land ownership and land cover patterns and thus presents singular community protection challenges. Taken together, these analyses point to some broad conclusions about efforts to define the CFPZ in the West.

1. Definitions matter. Different definitions of community and the Community Fire Planning Zone have a major effect on what is targeted for protection on the ground. If federal policy makers were to rely solely on the states' individual assessments in order to allocate fuel

Towards a Solution

The community, in partnership with adjacent federal land managers, must ultimately assess where local wildfire protection efforts should be focused. At the present time, however, local planners must rely on highly variable and in some cases inaccurate state and federal spatial assessments to manage wildfire threats in their community. Several improvements can be made to assist communities in their wildfire planning efforts:

- Refinements in state and federal community mapping techniques will greatly assist local stakeholders by providing accurate information for site-specific risk reduction recommendations.
- Additional federal resources must be provided to local communities to facilitate collaborative efforts to reduce risk from wildland fire.
- Federal agencies should create new incentives to encourage federal managers to work across ownerships and collaborate locally on community protection efforts.
- As more and more communities begin the process of developing local wildfire protection plans, state-level or sub-regional multi-stakeholder collaborative bodies should ensure that site-specific recommendations fit within a framework of comprehensive fire management.

▼
In order to design the most cost-effective fuels treatments for community protection, fire managers must first understand exactly where communities at risk of wildfire are located across the landscape.
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treatment resources, the inconsistency among states would undermine efforts to direct limited resources to those places where community protection is most needed.

2. The CFPZ is vast. Estimates of the proportion of the landscape in the CFPZ ranged from about 8 percent in central Idaho to over 30 percent along the Front Range. Even if the CFPZ represented only 2-5 percent of western lands, it would still include tens of millions of acres. Substantial resources and effort are needed to achieve community protection over such a vast landscape.

3. The CFPZ is mostly private. Even in federally dominated landscapes such as those examined in this study, private land is still the most common ownership in the CFPZ, dominating Greater Yosemite and the Front Range, and contributing substantially to central Idaho's CFPZ. Addressing community safety within the CFPZ will require resources and policy solutions targeted at private land. Policies that facilitate fuel treatment on federal land without concomitant attention to private land will fail to achieve community safety.

4. The CFPZ is highly variable. The CFPZ of the Greater Yosemite area is very different from the CFPZ of Colorado's Front Range. One is dominated by grasslands, shrublands, and open woodlands, and the other is dominated by dense coniferous forest. In central Idaho, the majority of the CFPZ is federal land. These findings suggest that no single community protection formula will work in every location. Achieving community protection will require the development of local solutions, tailored to local conditions.

PHOTO COURTESY WWW.WILDLANDFIRE.COM

For some communities, nearby wildfires can be an all-too-frequent occurrence. Julian, California was evacuated twice in the same month during the fiery summer of 2002. The second fire destroyed two homes and five outbuildings in the southern California town.

Introduction

Each summer, the network news broadcasts a tragic story that has sadly become familiar across many western states. Battling an extreme forest fire resulting from an unusually dry summer, heroic firefighters risk their lives to defend a rural community threatened by the wind-driven blaze. Images of towering flames and panicked residents captivate national attention as the government responds by unleashing its arsenal of expensive fire suppression equipment. Tragically, despite the best efforts of highly trained firefighters and C-130 aircraft tankers, homes burn and entire communities are displaced. Shocked residents look to the adjacent federal land, where the fire originated, and question whether a more efficient strategy could have been employed ahead of time to protect their communities.

In response, federal agencies, including the USDA Forest Service and the USDOI Bureau of Land Management (BLM), have proposed cutting trees and brush adjacent to communities, in what has come to be called the "wildland-urban interface." However, exactly where and how these "fuels" should be treated has been a subject of debate. Forest Service research suggests that treating areas directly adjacent to individual structures is the most important factor in protecting a house (Cohen 2000). By clearing out fine fuels within this "home ignitability zone," houses can be protected regardless of how the surrounding forests burn. Others argue that the wildland-urban interface should be defined much more broadly. They note that large fires can spread quickly and cover vast distances in a day, and thinning the forest could alter fire behavior, reducing an extreme crown fire to a harmless surface fire before it ever reaches a community.

Mediating these two positions is the issue of cost. Treating fuels is expensive, and sound fiscal management requires a focused prioritization of resources to where they are likely to achieve the most good. Given the cost of thinning trees and the additional cost of prescribed burning or mowing to keep fuels low, treating fuels across wide swaths of forest is not an efficient allocation of scarce resources compared to focusing them around specific communities. In addition, thinning vast landscapes could have harmful ecological costs, if such treatments degrade wildlife habitat or disrupt the historic fire regime to which native species have adapted through time.

In order to design the most cost-effective fuel treatments for community protection, it is imperative that fire managers first have an understanding of exactly where communities at risk of wildfire are located across the landscape and the patterns of ownership within them. A classically defined community consists of mostly private property clustered around a main street, a post office, and perhaps a gas station, for example. Increasingly, however, rural residents across the West are dispersing farther into fire-prone wildlands, resulting in isolated houses built amidst potentially

PHOTO COURTESY WWW.WILDLANDFIRE.COM

There are simple steps homeowners can take to clear fuels from the "home ignitability zone." Mowing tall grasses and raking needles around the house, thinning trees within 60 yards of a house, and building roofs with non-flammable materials can help prevent homes from igniting during wildfires.

dangerous fuels. Pinpointing the location of critical areas that must be considered for community protection requires increasingly sophisticated tools of geographic analysis, including data that describe housing density, land ownership, and land cover.

Mapping analyses conducted so far (Schmidt et al. 2002, Aplet and Wilmer 2003, Stewart et al. 2003) demonstrate that, for the U.S. as a whole, the majority of the wildland-urban interface is non-federal and lies mostly in California and the East. However, most fire-management attention, including the National Fire Plan and the Bush Administration's Healthy Forests Initiative, has focused on the fire-prone, federally-dominated landscapes of the arid West where recent large fires have garnered national media attention. Understanding the nature of the wildland-urban interface and implications of federal spending for community protection in these landscapes requires a more geographically focused analysis that can describe patterns of housing density, ownership, and vegetation using higher resolution data and a clear, consistent definition of community. In this report, we apply this type of rigorous, coherent analysis to the wildland-urban interface in three fire-prone western landscapes to better understand what is needed to protect communities in these nationally treasured wildlands.

Policy History

After massive forest fires burned over 8 million acres of the West in the summer of 2000, President Clinton initiated the National Fire Plan to address the risk of wildland fire across federal lands. This plan clearly identified community protection as a priority and set into motion a series of policies and guidelines to address community protection specifically.

Directed by Congress in the legislation funding the National Fire Plan, the federal agencies involved in managing public land prone to wildland fire began working with governors and other interested stakeholders to craft "a long-term strategy to deal with the wildland fire and hazardous fuels situation, as well as needs for habitat restoration and rehabilitation in the Nation" (Committee report language, FY 2001 Interior Appropriations Act). The resulting "10-Year Comprehensive Strategy," completed in 2002 with the support of the Western Governors' Association, called for the development of "nationally comparable definitions for identifying at risk wildland urban interface communities and a process for prioritizing communities."

In an effort to fill this need, federal and state officials collaborated on a document produced in mid-2003 by the National Association of State Foresters (NASF), entitled *Field Guidance: Identifying and Prioritizing Communities at Risk*, which provides guidance on how to use geographic data both to identify where communities are and to determine risk to them from wildfire. Unfortunately, despite its intent "to establish broad, nationally compatible standards for identifying and prioritizing communities at risk," the *Field Guidance* does not clearly explain how to conduct the analysis, leading to inconsistent designation of communities at risk among the states. Also, while the title suggests an intent to address community identification and risk separately, the text suggests that the two analyses can be combined into a single map of wildfire risk to communities. The resulting state maps are not only built on inconsistent methods, they are also difficult to interpret. Areas identified as high risk due to fuel conditions may or may not be near communities.

The intent of the *Field Guidance* was to implement definitions of "urban wildland interface communities" and preliminary community risk rating criteria that were published by the Secretaries of Agriculture and Interior in the Federal Register in January 2001.[1] According to this notice, three classes of communities

TABLE 1.

Wildland-Urban Interface Community Definitions

Classification	Federal Register Definition
Interface Community	"The Interface Community exists where structures directly abut wildland fuels. There is a clear line of demarcation between residential, business, and public structures and wildland fuels. Wildland fuels do not generally continue into the developed area. The development density for an interface community is usually 3 or more structures per acre, with shared municipal services. Fire protection is generally provided by a local government fire department with the responsibility to protect the structure from both an interior fire and an advancing wildland fire. An alternative definition of the interface community emphasizes a population density of 250 or more people per square mile."
Intermix Community	"The Intermix Community exists where structures are scattered throughout a wildland area. There is no clear line of demarcation; wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to one structure per 40 acres. Fire protection districts funded by various taxing authorities normally provide life and property fire protection and may also have wildland fire protection responsibilities. An alternative definition of intermix community emphasizes a population density of between 28-250 people per square mile."
Occluded Community	"The Occluded Community generally exists in a situation, often within a city, where structures abut an island of wildland fuels (e.g., park or open space). There is a clear line of demarcation between structures and wildland fuels. The development density for an occluded community is usually similar to those found in the interface community, but the occluded area is usually less than 1,000 acres in size. Fire protection is normally provided by local government fire departments."

Source: Federal Register 66(3), January 4, 2001.

at risk from wildland fire can be distinguished: 1) high-density "interface" communities (three or more structures per acre) that abut wildland vegetation; 2) low-density "intermix" communities (one or more houses per 40 acres) that are mixed in with wildland vegetation; and 3) "occluded" communities that surround small (<1000 acre) patches of wildland vegetation (Table 1). Unfortunately, while these definitions of different types of wildland-urban interface communities helped provide additional specificity, the fact that one of these classifications is itself labeled an "interface community" has perpetuated confusion over the definition of the broader wildland-urban interface.

In late 2003, the need to identify communities at risk and to map them became a matter of law. The Healthy Forests Restoration Act (HFRA) authorized special fuel reduction projects within "an area extending 1/2-mile [and in some cases 1.5 miles] from the boundary of an at-risk community." The Act specifically defines an "at-risk community" as "an interface community as defined in the [January 4, 2001] notice." Because of confusion resulting from the use of "interface community" as a subcategory of "urban wildland interface community," ambiguity persists over the appropriate definition. The Senate floor record suggests that the intent of Congress was to limit the definition to the narrow, high-density case. Others no doubt believe the law applies more broadly to intermix and occluded communities. In either case, HFRA created a

[1] "Urban wildland interface communities within the vicinity of Federal lands that are at high risk from wildfire" (Federal Register 66(3): 751-777, January 4, 2001).

PHOTO COURTESY WWW.WILDLANDFIRE.COM

Treating the areas directly around individual structures can save homes even in naturally fire-prone forests, where fire may pass through every few years as part of a normal ecological cycle.

nationwide need to move beyond the inconsistent statewide maps of community wildfire risk to a consistent reckoning of the boundaries of at-risk communities. While we do not specifically endorse the one-house-per-40-acre definition of "community," we use it throughout the rest of this paper to illustrate the extent of the community protection challenge.[3]

Regardless of which density threshold is used, it is clear that some houses will exist at too low a density to be included in a community. Exclusion of these homes from the definition of community does not mean that they should go without protection, however. Individual homeowners have access to a number of programs that provide resources for fire safety, including low interest loans and free consultation. The exclusion of those homes simply means that homeowners are not subject to specific policies, such as the Healthy Forests Restoration Act, aimed at protecting distinct communities.

[3] The definitions used in the January 4, 2001 notice were derived from a little-known publication, "A Report to the Council of Western State Foresters — Fire in the West: the Wildland/Urban Interface Fire Problem," dated September 18, 2000, which received scant critical review in the scientific literature. Despite this lack of review, these definitions have become the standard, and we use them here because of their popularity, not because they reflect a deliberated consensus of fire management professionals.

The Community Fire Planning Zone

It has been demonstrated that the most effective way to protect homes is to focus on appropriate building materials and on reducing fuels immediately adjacent to structures (Cohen 2000). The simple principle behind this conclusion is that homes will not burn if they do not ignite, regardless of what happens to the surrounding forest. A very narrow "home ignitability zone" determines whether a home will burn. Research by the U.S. Forest Service has shown that there are three primary mechanisms for home ignition. First, houses can ignite when shingles and siding are exposed to direct contact with flames from adjacent fuels especially flames carried in fine fuels, such as grasses, needles, leaves, and small branches. The second way homes can catch fire is through radiant heat from nearby flames elevating the temperature of structures themselves above their ignition thresholds. Third, the roofs of houses can ignite when exposed to showers of lofted embers.

These three mechanisms for home ignition can only be disrupted by building structures out of fire resistant materials and by reducing fuels in the area directly around individual structures. By eliminating fine fuels such as grass and pine needles within the home ignitability zone, homeowners can prevent flames from directly contacting the house.

The **Community Fire Planning Zone** is the area surrounding homes at risk of wildland fire within which fire planners must look for **opportunities** to improve public safety through fuel treatment, infrastructure improvement, and public education. The management priority is **community protection**.

PHOTO BY SHERI ASCHERFELD

After a number of difficult fire seasons, residents in communities across the West are becoming more aware of the importance of taking steps to protect themselves from the inevitable wildland fire. In 2002, a coal seam burning underground for nearly a century ignited drought-stressed vegetation just west of Glenwood Springs, Colorado. The fire jumped both the Colorado River and Interstate 70, destroying more than 30 structures before it was suppressed.

Thinning trees within 60 meters of homes can also reduce the potential for radiant heat to ignite a home (Cohen and Butler 1998, Cohen 2000). By building rooftops out of non-flammable materials, fire risk to homes can also be drastically reduced. Other protective steps, such as pruning branches away from homes and moving woodpiles, are well described by fire protection alliances, such as the National Wildland/Urban Interface Fire Program (see www.firewise.org).

While structure protection demands a focus on the immediate vicinity of the home, there are reasons why treatments may be extended beyond 60 meters. Communities may wish to create "defensible space" within which firefighters may work safely, or they may wish to thin trees to reduce the probability of crown fire in order to protect scenic views or watershed quality. Nowicki (2002) applied rules of thumb developed by fire physicists and fire safety personnel to conclude that a zone of 400 meters, if treated to reduce the potential for sustained crown fire, could provide an area that would allow firefighters to work safely to protect structures. The calculations

assumed that an adequate safety zone would be four times the maximum sustained flame length of a crown fire, where the length of a crown fire flame may be twice the height of the forest canopy. Since few communities are surrounded by forests with trees exceeding 50 meters (165 feet) in height, the study arrived at this estimate of 400 meters, or approximately one-quarter mile, as an adequate "buffer" width within which to plan fuel treatments. Aplet and Wilmer (2003) suggested that a distance of a half-mile (800 meters) should provide the latitude needed to adjust the buffer to terrain, taking advantage of natural fuel breaks such as cliffs and rock outcrops. The Healthy Forests Restoration Act generally endorses the half-mile distance but allows that there may be times when the provisions of the law should be extended to 1.5 miles to account for steep slopes, particularly dangerous fuel conditions, or to include natural fuel breaks.

It is important to emphasize here that this logic does not argue for clearing a half-mile swath around every community. Rather, it is within this buffer that community members should look for *opportunities* to improve public safety. Within this "Community Fire Planning Zone" (CFPZ), assessments should be made of infrastructure needs (e.g. fire truck access, hydrants) and strategic fuel reduction (to protect homes and create defensible space). Not every type of vegetation will need to be treated, and there are some vegetation types, such as chaparral and subalpine forest, within which thinning will be ineffective in lowering the probability of crown fire because fuel structure has such a limited effect on fire behavior. The CFPZ represents the area beyond (and including) the intermix zone where special management attention is needed to protect communities and associated homes. Beyond the CFPZ, there may still be a need for fuel treatment, but the management objective there will be ecological restoration, which may require different kinds of treatment.

PHOTO COURTESY NATIONAL PARK SERVICE

Underburning removes surface fuels, leaving the tree canopy intact. These roadside fuels are being burned so they won't be ignited accidentally by passing vehicles. Native Americans in California historically set fires beneath oaks to enhance the acorn harvest.

Mapping the CFPZ: A Brief History

It should be clear by now that the CFPZ will need to vary in width from place to place, and the treatments within it will need to be matched to conditions. Nevertheless, since land management agencies must set priorities and provide appropriate resources at federal and state levels, it is important to understand the scope of the community protection challenge and, therefore, the extent of the CFPZ. This requires mapping the CFPZ, which, in turn, requires a standard definition in order to derive a map.

The first attempt to quantify the community protection challenge began with the aforementioned Federal Register notice of January 4, 2001. That notice called upon the states to identify communities in the wildland-urban interface that are near federal land and at risk from wildfire. By the summer, states had submitted lists to the federal government that, together, identified over 22,000 communities. Recognizing this list as unwieldy (the January notice had asked the states to "refine and narrow" an original list of less than 5000 communities!), the Secretaries of Agriculture and Interior winnowed the list to 11,376 communities by identifying those that were deemed to be truly "within the vicinity of federal lands" (Federal Register, Vol. 66(160): 43384-43435, August 17, 2001).

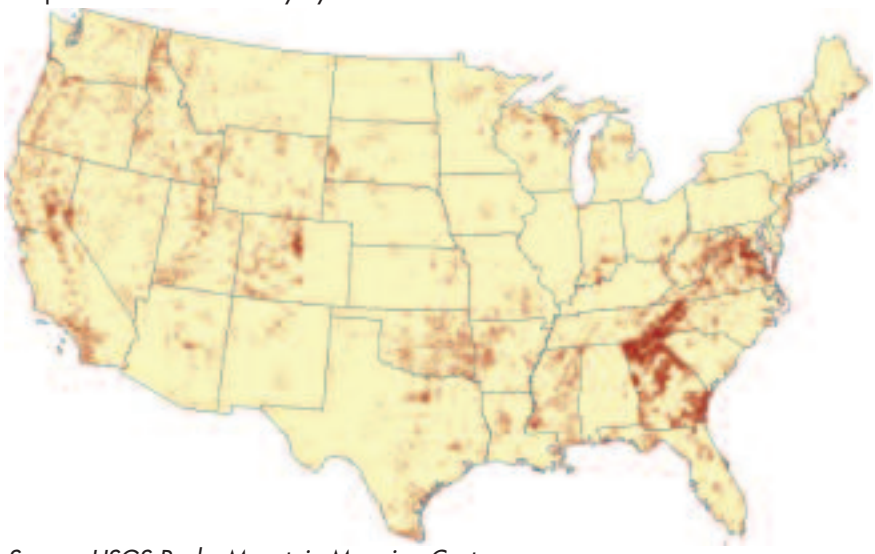
To create a map of these communities, the United States Geological Survey (USGS) Rocky Mountain Mapping Center linked the names of the communities with a spatial database of "placenames" called the Geographic Names Information System (GNIS). The resulting national map (Figure 1) suggests that states used very different methods to identify communities. For example, the boundary between Georgia and Alabama illustrates the contrast between the communities listed in Georgia and an obviously different standard applied in adjacent Alabama. Similar boundaries are apparent across the borders of Idaho and Washington, Colorado and New Mexico, Oklahoma and Kansas, and North Carolina and Tennessee. Kentucky contains hardly any communities at risk, while adjoining states exhibit significant numbers in similar terrain.

In addition to the problems created by different approaches, only 9,371 of the 11,376 communities on the federal list could be matched with the USGS database and consequently mapped. Thus, over two thousand of the communities submitted by the states and determined by the Secretaries to be "in the vicinity of federal land" were too small to appear in the GNIS or were known by an alternative name and therefore were left off the map created by the USGS (Figure 1). Over 75 percent of these unmapped communities came from just six states: Colorado, North Carolina, Texas, Utah, Virginia, and Wyoming (Aplet and Wilmer 2003), further biasing the map.

FIGURE 1.

Federally Identified "Communities at Risk"

Communities at risk as listed in the August 17, 2001 Federal Register and mapped as points across the country by USGS.



Source: USGS Rocky Mountain Mapping Center

TABLE 2.

Chronology of Efforts to Map Communities in the WUI

Year	Authors	Methods	Findings	Comments
2001	Federal Register	State-nominated list of communities-at-risk	Identified over 11,000 communities-at-risk near federal land	No attempt to quantify land area
2002	Schmidt et al.	Modeling of "wildland fire risk to flammable structures"	Identified over 98 million acres of land containing structures at risk, over 92 percent of which are on private land, primarily in California and the East	Coarse-scale estimate using modeled and/or low-resolution data
2003	Aplet and Wilmer	Estimated land area associated with "communities-at-risk" using urban land cover "footprints"	Determined that 85 percent of land associated with federal communities-at-risk is private, mostly in California and the East	Relied on flawed national map of communities-at-risk and did not account for housing density
2003	National Association of State Foresters (*Field Guidance*)	Instructed states to use Census 2000 data to map communities and wildfire risk	Process produced various state maps of wildfire hazard and risk	Resulted in widely divergent methods and representations of communities
2003	Stewart, Radeloff, and Hammer	Used Census 2000 data to render a consistent, nationwide map of the wildland-urban interface	Identified over 175,000,000 acres of wildland-urban interface (WUI) nationwide, overwhelmingly in the East	Used housing density data but identified entire census blocks and did not include buffer zone

In addition to these inconsistent methods, the USGS map was hindered by the inability to represent the actual "footprint" of at-risk communities on the ground. Each community was represented by a point, regardless of its size; Glendevey Post Office in Colorado's remote Laramie River Valley was given the same weight as Los Angeles, California. If the scope of the community protection challenge is to be described accurately, maps need to rely on finer-scaled GIS data to render the physical area that these points are supposed to represent.

In an attempt to provide such an assessment, Aplet and Wilmer (2003) matched as many of the points from the national map as possible with the physical "footprints" of those communities, as derived from satellite imagery (see Appendix A of Aplet and Wilmer (2003) for methods).[4] To estimate the extent of the CFPZ (which they called the CPZ or "Community Protection Zone"), a half-mile buffer was placed around the community and its area calculated. Using these methods, they detected 2,307 distinct areas of community footprints that together contributed 75.5 percent of the nationwide CFPZ; 5,780 of 9,339 communities were too small to be classified as developed areas on the satellite imagery and were therefore treated as points (i.e., the CFPZ was mapped as a half-mile radius circle around a point on the map). Overall, Aplet and Wilmer (2003) estimated that, nationwide, the CFPZ included 11,381,821 acres, most of which were in California and the East. Because of their

[4] A "footprint" consists of the urbanized land-cover classes of "low-density residential," high-density residential," and "commercial/industrial," derived from the National Land Cover Dataset.

low populations, the fire-prone western states of Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico accounted for less than 15 percent of the CFPZ nationwide. While this represented the first national assessment showing the preponderance of private land in the CFPZ, it relied for its underlying information on a flawed national map of communities at risk (Figure 1), and it did not account for housing density as required by the Federal Register definition (Table 1) and therefore was not accurate enough to identify communities subject to the Healthy Forests Restoration Act.

The *Field Guidance* issued by the National Association of State Foresters sought to remedy the failure to account for housing density by directing the states to use readily available population density data to identify communities and classify risk. The *Field Guidance* instructs:

> "Using the 2000 census data (or other suitable means) identify all communities in the state that are in the wildland urban interface and that are at risk from wildland fire, regardless of their proximity to federal lands. Ideally, the results of this effort would be displayed on a map or series of maps."

While the *Field Guidance* helped to identify the types of data that should be used, it did not describe exactly how to use those data and actually seemed to encourage experimentation. Widely varying methods resulted, with some states attempting to identify precise boundaries of communities and others seeking to identify broadly inclusive regions. Inconsistencies make comparison and use in national policymaking impossible.

In an attempt to employ consistent national data to understand the extent of the community protection challenge, the Forest Service (Schmidt et al. 2002) produced an assessment of "Wildland Fire Risk to Flammable Structures," a map based on "an integration of population density, fuels, and weather spatial data" across the country. This analysis had the advantage of including information about fire hazard and risk, but the results were highly sensitive to the distribution of population. The map revealed areas of concern along the Pacific coast and in the East (wherever population density is highest), but was produced at such a small scale and used such crude estimators that it could reveal only the broadest patterns. Overall they found 98.2 million acres (7.86 percent of the lower 48 states) to be at low, moderate, or high risk of wildfire destroying structures, 92 percent of which was private land.

PHOTO COURTESY WWW.NPS.GOV

Fire prevention experts recommend "limbing" on trees near structures to prevent fire from climbing into the treetops. These homeowners limbed nearby cypress trees as part of an effort to remove "ladder fuels" such as the low-lying branches and intermediate sized trees and shrubs that increase wildland fire hazard.

In 2003, a dramatic improvement in community mapping was provided by researchers at the University of Wisconsin and the USDA Forest Service North Central Research Station (Stewart et al. 2003). They used Census 2000 data to determine housing density within census blocks nationwide. Using a GIS, they identified all census blocks[5] in which housing density exceeded one house per 40 acres and either was mostly wildland vegetation (intermix communities) or

According to the January 4, 2001, *Federal Register,* an **interface** community exists where there is a "clear line of demarcation" between structures and wildland vegetation. An **intermix** community exists where structures are "scattered throughout a wildland area."

was within 1.5 miles of wildland vegetation (interface communities). According to their estimates, the wildland-urban interface (interface and intermix communities) contained a whopping 175,121,100 acres, or 9.3 percent of the land area of the lower 48 states, the vast majority of which is found in the heavily populated eastern states. Approximately 82 percent of this area was in intermix communities, and only 18 percent was in interface communities, with each type containing about 18 percent of all U.S. houses.

Though the work of Stewart et al. (2003) greatly improved our understanding of the distribution of wildland-urban interface communities, it still does not provide an estimate of the size of the CFPZ. Stewart et al. (2003) identified only the communities, not the associated buffer. Also, they based their density estimates on the entire area of a census block, even if that census block included large areas of uninhabited land. This has the effect of both underestimating the number of census blocks that contain areas that meet the density criteria and overestimating the area of the "community."[6] While Stewart et al. (2003) represents a quantum leap in our understanding of the nature and extent of the wildland-urban interface, there remains an unmet need for a simple, consistently applied method for estimating the extent of the CFPZ.

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[5] A census block is the smallest geographic unit for which the Census Bureau tabulates 100-percent data. Many blocks correspond to individual city blocks bounded by streets, but blocks — especially in rural areas — may include many square miles and may have some boundaries that are not streets. The Census Bureau established blocks covering the entire nation for the first time in 1990. Previous censuses back to 1940 established blocks only for part of the nation. Over 8 million blocks are identified for Census 2000. (http://www.bayareacensus.ca.gov/glossary.htm)

[6] When the entire census block, including uninhabited areas, is included, the overall density of the area is "diluted" below the density of the occupied areas. Thus, some census blocks will fall below the one-house-per-40-acre threshold and be missed, despite containing dense communities with them, leading to a local underestimate of community area. Conversely, for census blocks that do meet the density threshold, the entire census block is mapped as "community," even though it may contain considerable unoccupied area, leading to a local overestimate of community area.

Toward a Standard Description of the CFPZ: Why Definitions Matter

By now, it should be apparent that there are about as many definitions of the CFPZ as there are communities. Wildland-urban interface communities have been described as points, points with buffers, buffers around urban "footprints," urban areas near wildland vegetation, and wildland vegetation mixed with houses. Each of these definitions has implications for what gets mapped as the CFPZ and consequently where scarce federal resources are expended to reduce the risk from wildfire.

To illustrate this concept, we explored the effects of various definitions of "community" for an area of northern Idaho that has been proposed for fuel treatment. The communities of Hope, East Hope, and Clark Fork, near Lake Pend Oreille, are considered by the Forest Service and the State of Idaho to be at risk from wildfire and were listed in the August 2001 Federal Register notice. In this area, the varying definitions of "community" and the CFPZ dramatically affect how much land is involved, what ownerships will need to be part of the community protection solution, and what other issues (e.g. roadless area conservation) may be affected by community protection efforts. In an effort to protect these communities, the Forest Service has proposed the Rising Cougar Fuel Reduction Project (shown in purple in Figure 2). We applied three different classifications of "community" to show how these different definitions affect the area that might be the target of community fire planning.

The first panel of Figure 2 represents federally defined "interface communities," exceeding a density of three houses per acre. The second image represents "raw," unmodified census blocks that exceed the federal definition of "intermix community," where housing density exceeds one house per 40 acres. Such census blocks often consist of large areas that are known to be uninhabited, such as public lands. In the third image, we applied methods increasingly used by GIS mapping experts to improve the spatial accuracy of census data (Theobald and Kneeland 2002, Jones et al. 2003, Sapsis 2002). The most logical and simple GIS technique involves simply overlaying and removing public lands from the census blocks to identify only the inhabited parts of each block. Additional efforts to improve the spatial accuracy of the Census 2000 blocks may involve removing steep slopes, known uninhabited private lands, and unroaded areas (Sapsis 2002). Still other efforts involve more complicated modeling of where people are *likely* to reside within census blocks, based on correlations between known residences and various GIS data layers, such as roads, slopes, and vegetation (Holloway, Schumacher, and Redmond 1997, Theobald 2001). To keep calculations simple, we employed the most basic method of removing only public lands from the area of each census block before identifying the intermix community displayed in the third image.

Several key points emerge from this illustration. The area associated with a "community" is highly dependent on the definition being used. A literal definition of an "interface" community, more than three houses per acre, shows little of this landscape as inhabited. By contrast, when a community is defined as "intermix," or one house per 40 acres, several census blocks emerge across the landscape. By referring to high resolution aerial photographs, we were able to spot-check the accuracy of these maps, and we found that "intermix" census blocks provide a more realistic depiction of the community in the vicinity of Clark Fork, Hope, and East Hope than does the "interface" definition alone. The valley extending to the north of Clark Fork, as well as the peninsula extending into Lake Pend

▼

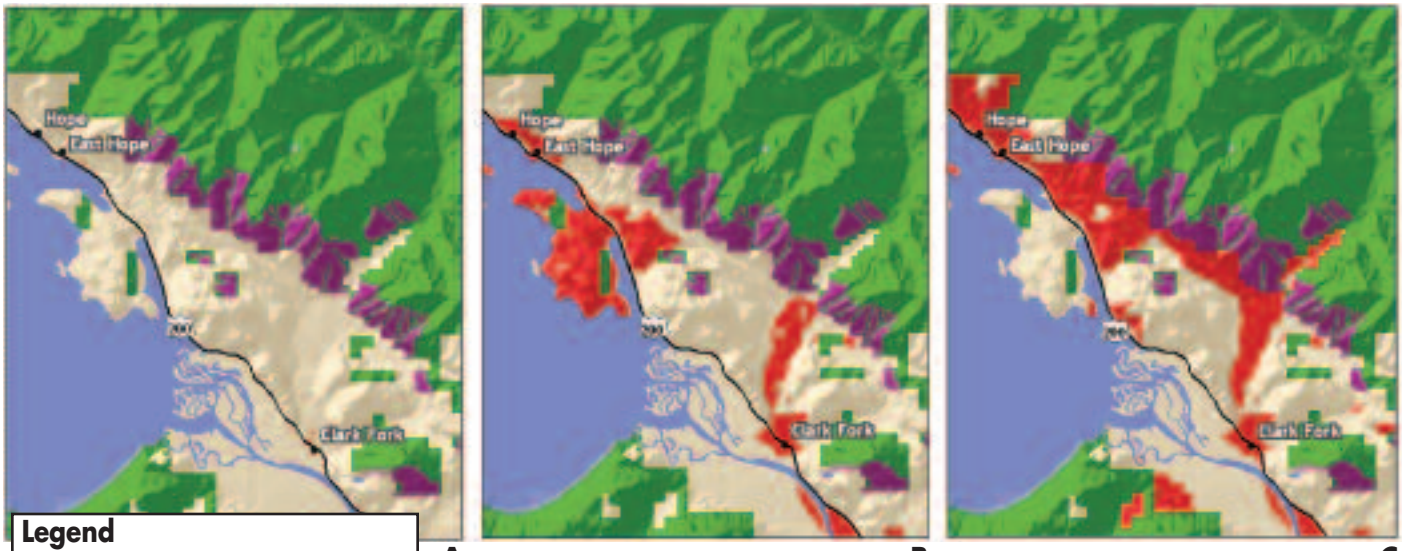
Current inconsistent definitions of the CFPZ undermine efforts to direct limited federal resources to those communities that are most at risk from wildland fire.

▲

FIGURE 2.

Rising Cougar Proposed Fuel Reduction Project

Rising Cougar Proposed Fuel Reduction Project, displaying the variety of potential interpretations of "community." Green represents national forest land, with roadless areas in dark green and the proposed fuel reduction project in purple. Red represents the census blocks that: a) exceed three houses per acre; b) exceed one house per 40 acres in unmodified census blocks; and c) exceed one house per 40 acres in census blocks that have been "smartened" by the removal of public land.



Oreille, are both, in fact, populated, and so should be included in the depiction of the community.

While delineating intermix census blocks is more helpful at resolving the community than delineating interface census blocks alone, accuracy can be improved by accounting for portions of the landscape that are in public ownership and therefore less likely to contain residences. For example, the peninsula identified as intermix in the second panel is actually mostly public wildlife refuge; the community can be more precisely described by the private portion of the census block. Conversely, the unmodified census blocks, depicted in the second panel, do not show the obvious linear valley that extends from the northwest of the map to the southeast to be occupied, yet aerial photographs reveal numerous homes located along this valley. When original census blocks are modified by subtracting public lands, home density on the remaining lands increases above the one-house-per-40-acre threshold, and the valley emerges as within the intermix. While this technique allows the possibility that some structures on public land, such as ranger stations and leased recreational cabins, will be omitted from the analysis, it has the benefit of better representing the majority of stakeholders in community fire plans: private homeowners.

This example of community mapping for the Rising Cougar Fuels Reduction Project demonstrates that different definitions of the community, based on various housing densities, have far-reaching consequences for fire protection across the landscape. By relying on the simple assumption that people do not typically live on public land, the shape of census blocks can be rendered more accurate and new communities adjacent to public land can be identified. Of course, local assessments using the best available data and personal knowledge is always preferable, but we believe that, in the absence of local data, modified census data can provide a practical means to quickly approximate the extent of privately owned communities.

Characterizing the CFPZ: How Do States Compare?

In order to learn how various state definitions of communities affect the CFPZ, we selected the Colorado Front Range, the Central Idaho Ecosystem, and the Greater Yosemite area in California, three fire-prone landscapes mapped using very different methods (Figure 3). We characterized the nature of the CFPZ in each location using the methods by which each state identified communities at risk of wildfire, and then compared those states' data to a simplified rendering of community that we devised in order to gauge how different methods of community identification affect the estimated size of the CFPZ.

In California, we delineated a *Greater Yosemite Area* by relying on a combination of ecological and political boundaries. The Greater Yosemite region of the central Sierra Nevada stretches from the northern boundary of Tuolumne County south across Yosemite National Park to the central portion of Madera County. This region encompasses a broad range of land ownerships and land allocations, including national forests, national parks, and state parks as well as wilderness areas, roadless areas, wild and scenic rivers and old-growth forests. It is also a highly fire-prone landscape. As characterized by the California Department of Forestry, "the combination of vegetation, climate, and topography creates a 'world class' fire environment" (CDF 2000).

In Colorado, some low-elevation forests are crowded and fire-prone, and several recent spectacular fires in the heavily populated foothills above Denver have caught the attention of residents and national forest managers. In response, the Forest Service's Regional Forester of Region 2 recently established the Front Range Fuels Treatment Partnership to help land managers (both state and federal) identify, prioritize, and implement hazardous fuel treatment projects throughout the Front Range region, a section of the Rocky Mountain Front that extends from the Wyoming border south to the Arkansas River. Encompassing 14 counties, the Front Range contains four national forests (administered as two units: the Pike/San Isabel and the Arapaho/Roosevelt), lands under the stewardship of the Bureau of Land Management, Rocky Mountain National Park, and over a dozen designated wilderness areas.

In Idaho, we created a focus area by buffering the Boise, Payette and Sawtooth National Forests by 10 miles. All these forests recently completed revisions of their Land Management Plans, and efforts to revise or develop fire management strategies for these forests are at varying stages. While addressing a range of management issues, these plans will also lay out the general parameters more broadly for fire management in national forests across the Rocky Mountain region. The forests of Idaho are among the healthiest in the nation, largely due to relatively unaltered fire regimes, especially within the state's nine million acres of roadless areas and the vast Sel-

FIGURE 3.

Study Areas Selected for CFPZ Analysis

TABLE 3.

Study Area Statistics

Study Area	Total Acreage	Percent Federal	Number of Houses
Greater Yosemite	4,306,223	73%	100,081
Colorado Front Range	8,090,201	51%	756,655
Central Idaho	11,325,538	78%	119,886

way-Bitterroot/Frank Church/River of No Return Wilderness complex (Rollins et al. 2001). With such vast tracts of undeveloped land, Idaho's forests could serve as models for demonstrating how to use wildland fire to prevent fuel buildup and maintain ecosystem integrity.

Within each study area, we compared each state's map of communities at risk from wildland fire with our own consistent, simplified approach to mapping the CFPZ. Our goal for the analysis was to characterize the nature of the CFPZ in three representative landscapes using one consistent definition of community. While we believe that community fire planning should be done at the local level using the best available data, understanding the nature of the CFPZ requires applying a consistent definition to avoid the distorting "definition effect" highlighted in the previous section. Table 3 presents the acreage, percentage of federal land, and number of houses in each study area.

Our method followed three steps. First, we mapped communities exceeding one house per 40 acres based on housing density calculated from modified Census 2000 blocks (Figure 4a). We modified the original census blocks by subtracting public land and recalculated housing density based on the area of non-public land.[7] Second, we buffered these communities by a half-mile to approximate the CFPZ (Figure 4b). Third, we refined our map of the CFPZ by removing non-wildland fuels from the buffered communities (Figure 4c). For this purpose, non-wildland fuels were identified as water, barren, rock, agriculture, and urban land cover classes from the National Land Cover Dataset (USGS, 1992).[8] We removed non-wildland cover types because these are generally not the subject of fire protection planning, and their removal facilitated a more realistic characterization of the CFPZ. Thus, our final map of the CFPZ represents wildland fuels (natural vegetation) within one-half-mile of communities (exceeding one house per 40 acres).

Identifying Communities: Comparison among States

The California Department of Forestry and Fire Protection (CDF) mapped the density of structures across residential and commercial areas of California based on a combination of Census 2000 data, land ownership, and land cover. They modified Census 2000 data by overlaying public lands, as identified in a statewide land ownership dataset. To map residential housing density, the number of housing units within each Census 2000 block was divided by the area of non-public land within that block. In addition to the standard overlay of public lands, CDF also assessed the ratio of public to private land within the block. This procedure allowed CDF to eliminate small slivers that were erroneously created by slight discrepancies between the ownership and census maps.

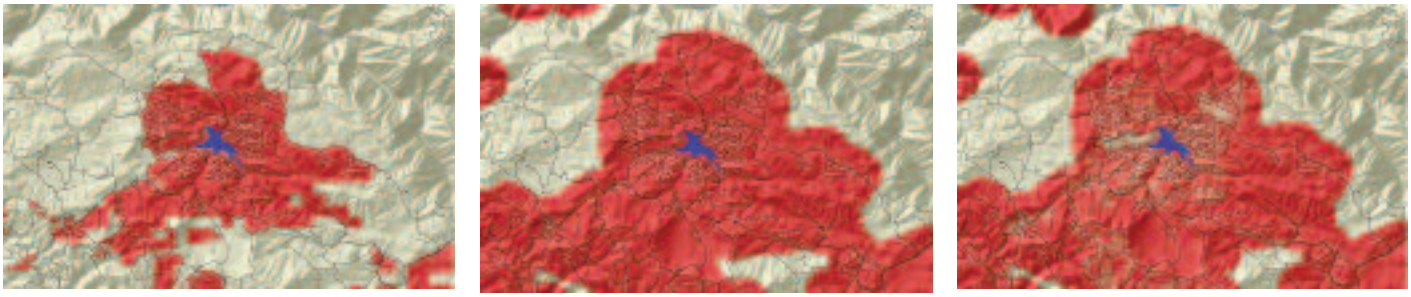
As a further step, CDF distinguished *development* classes from *residential* housing density classes. The development classes were designed to improve upon the census housing density classes by taking advantage of urban land cover

[7] Ownership data are available from each state: California, http://gis.ca.gov/BrowseCatalog.epl; Colorado, http://www.dot.state.co.us/App_DTD_DataAccess/index.cfm; Idaho, http://inside.uidaho.edu

[8] The National Land Cover Dataset is a crude approximation of vegetation types, but it is the best data on land cover that is available consistently across the U.S. It is available at 30-meter resolution.

FIGURE 4.

Mapping the CFPZ



A. Communities. Census blocks exceeding one structure per 40 acres after removal of public lands.

B. Buffered Communities. Communities depicted at left when "buffered" by one-half mile.

C. The Community Fire Planning Zone. Buffered communities after removal of non-wildland-fuel cover types (e.g. urban, agricultural, rock, water).

Source: TWS Analysis of Greater Yosemite Study Area

imagery to represent where additional, non-residential, or commercial development is located. This had the effect of increasing the area in the most urban housing-density class (greater than one house per five acres). Presuming fire mitigation strategies aim to prevent damage to both homes and commercial businesses alike, it appears these augmented development classes represent a more appropriate characterization of the community protection challenge than the housing density data alone.[9] Finally, CDF resampled the resulting dataset to a spatial resolution of 100 meters.

In Colorado, the state modified Census 2000 blocks to remove public lands and water, but they also combined other datasets to take advantage of the best available information on housing density across Colorado. In addition to the modified Census 2000 blocks, county parcel maps were incorporated for various counties, and 240,278 well locations were mapped from the Office of the State Engineer and the Division of Water Resources. Assuming that each parcel and well location represented a single home, these point data were combined with the Census 2000 blocks in a GIS technique that calculates the average number of houses within a half-mile radius. Interestingly, the adoption of this "moving window" analysis further refined the modified census data by removing inconsistent mapping errors associated with merging land ownership with the census blocks.

The statewide assessment by the Idaho Department of Lands relied on two data sources to map communities within the wildland-urban interface: Census 2000 blocks, and the map of points representing official at-risk communities listed in the Federal Register. They modified census blocks to represent smaller, more realistic areas where actual residences are more likely to be found. In this case, rather than simply subtracting public lands and water, their analysis relied on additional information to refine the population density estimates from the census blocks. Using a technique called "dasymetric mapping"

Understanding the nature of the CFPZ requires the application of one consistent definition of a fire-prone "community."

[9] In its original characterization, the California Department of Forestry and Fire Protection defined a community as one unit per 20 acres, different from the federal definition of one unit per 40 acres. Thus, housing densities less than one house per 20 acres were not included in further CDF assessments of the wildland-urban interface. In our analysis, however, we used state data representing one house per 40 acres in order to maintain a consistent analysis, even though it over-represents the area that California considers community.

TABLE 4.

Community Acreage

Study Area	State Method	TWS Method	Percent Difference	Percentage of Study Area Houses in State-Identified Communities	Percentage of Houses in TWS-Identified Communities
Greater Yosemite (4,306,223 acres)	297,812	314,168	+ 5.5 %	51.8	53.8
Colorado Front Range (8,090,201 acres)	1,159,944	1,098,639	- 5.3 %	91.9	92.9
Central Idaho (11,325,538 acres)	1,034,720	235,680	- 77 %	94.7	95.7

(Holloway et al. 1997), they modeled correlations between various GIS data layers and known residences using data from Kootenai, Idaho, and Gallatin counties. These correlations were then extrapolated statewide to refine the Census 2000 blocks such that public land, water, highway and railroad corridors, areas greater than one mile from a road, and slopes steeper than 43 percent were eliminated. Remaining census blocks were then classified into "inhabited" and "uninhabited," and inhabited blocks were buffered by one mile to represent the wildland-urban interface.

In addition to the buffered, modified Census 2000 blocks, the Idaho statewide assessment of the wildland-urban interface applied the USGS map of points representing the official list of "communities at risk" from the *Federal Register*. However, because only three of these points in our study area fell outside of the buffered, inhabited census blocks, we omitted these points and represented the State of Idaho's communities simply as the inhabited census blocks from the state analysis. Also, because we were interested in comparing "apples to apples," we substituted a half-mile buffer for Idaho's one-mile buffer when comparing Idaho's map to ours. Thus, our map of the State of Idaho's representation of the Community Fire Planning Zone consisted of "inhabited" census blocks buffered by one-half mile.

Next, we compared the results of our simple, consistent method with estimates derived using each state's community data. Initially, we compared the community acreage derived from each method. Next, we buffered the communities by one-half mile and repeated the comparison. To assess the accuracy of our approach, we then compared the number of homes within the buffered communities produced by each method. Finally, we examined the fuel and ownership patterns within the CFPZ by overlaying maps of vegetation and land ownership with our maps of the CFPZ.

Table 4 shows the acreage identified as "community" using each state's method compared to the simplified method employed by The Wilderness Society. In the 4,306,223-acre Greater Yosemite region, the California Department of Forestry's method (using one house per 40 acre data) yielded 297,812 acres that meet the definition of community. Our method identified 314,168 acres in the same landscape. The CDF-defined method included 51.8 percent of the 100,081 houses in the study area, while our method included 2 percent more houses on 5.5 percent more land. The remaining houses are found outside of areas identified as communities.

In the 8,090,201-acre Colorado Front Range, the method employed by the Colorado State Forest Service identified

TABLE 5.

Buffered Community Acreage

Study Area	State Method	TWS Method	Percent Difference	Percentage of Study Area Houses in State-Identified Communities	Percentage of Houses in TWS-Identified Communities
Greater Yosemite	740,152	811,871	+ 9.7 %	55.4	55.5
Colorado Front Range	2,237,005	3,031,193	+ 36.0 %	97.1	98.9
Central Idaho	2,476,772	1,096,576	- 56.0 %	99.6	97.8

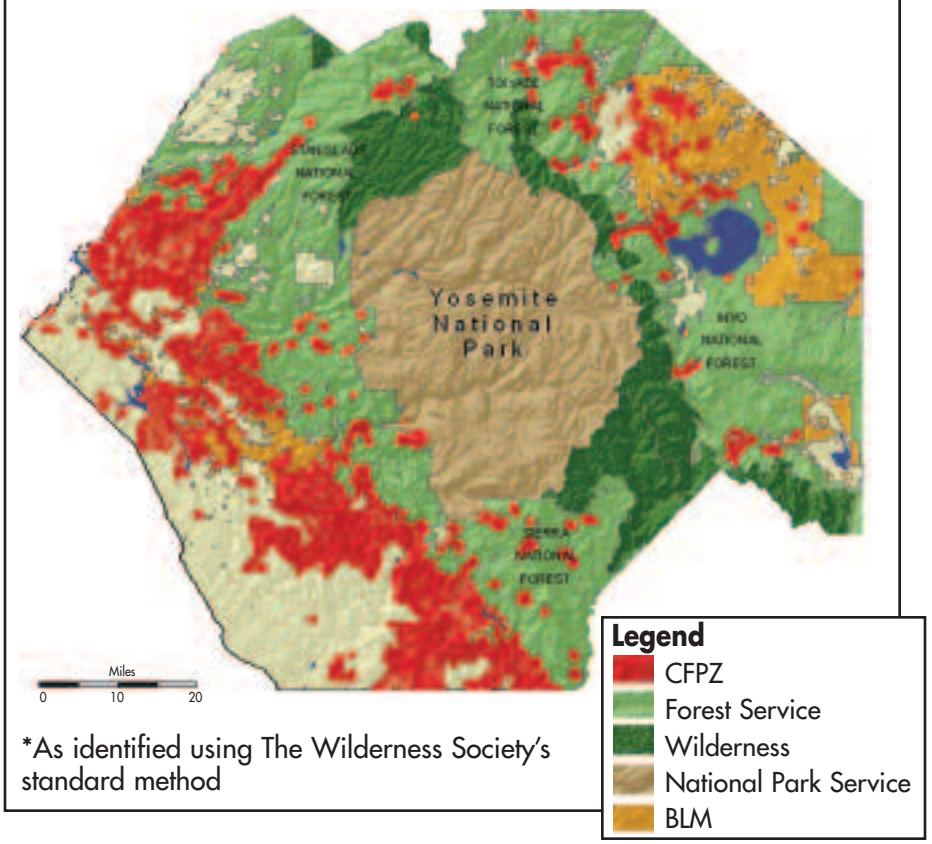
1,159,944 acres that qualify as community, representing 91.9 percent of the 756,655 houses in the study area. Our method identified slightly more houses on somewhat less land. The method employed by the Idaho Department of Lands identified 1,034,720 acres of community within the 11,325,538 Boise-Payette-Sawtooth National Forests landscape, which includes 94.7 percent of the 119,886 houses in the study area. In contrast, our method incorporated 77 percent less land inside of the communities than did the state's method, but those communities we identified included slightly more houses than the communities identified by the state.

In general, our simplified method compared favorably to the method developed by the states in terms of its ability to capture houses within communities. In each case, our method captured slightly more houses than the states'. In California and Colorado, we identified a comparable community land area, and in Idaho, we identified a comparable number of homes in less than one-quarter of the area.

The story changes somewhat when communities are buffered by one-half mile (Table 5). Buffered community acreage in the Greater Yosemite area is 811,871 acres using our method, almost 10 percent larger than the state estimate, without capturing a significantly larger number of the houses. In the Colorado Front Range, application of our method yielded a buffered community area of over 3 million acres, 36 percent higher than the state method, again without a significant increase in the number of houses represented. In Idaho, buffering communities yielded an area of 1,096,576 acres, less than half the area identified using the state's method, though it did not capture quite as many houses as did the state method (Table 5). While the purpose of adding the half-mile buffer was to approximate the CFPZ, not to expand community area, the buffer did include some homes beyond the limits of density-defined

FIGURE 5.

Greater Yosemite CFPZ*



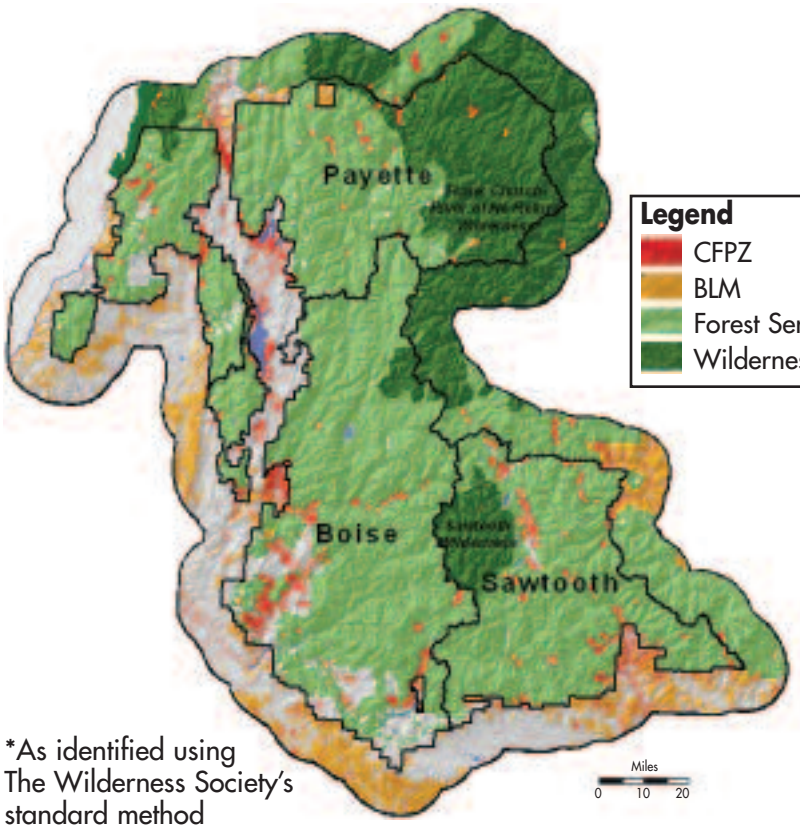
*As identified using The Wilderness Society's standard method

communities, thereby increasing the size of the "community."

In each study area, community buffers derived using our simplified method yielded larger percentage increases in area than buffering state-derived communities, indicating that TWS-identified communities are more dispersed across the landscape than are state-identified communities. This phenomenon is an artifact of our method, which identifies all private property within a census block that meets the density threshold as "community," whether it is occupied or not. In a landscape like the Colorado Front Range, which includes hundreds, if not thousands, of old, unoccupied mining claims deep in the backcountry, buffering private land by one-half mile can dramatically increase the amount of land in the buffered "community" without capturing any additional homes. We recognize this as a shortcoming of our simplified method.

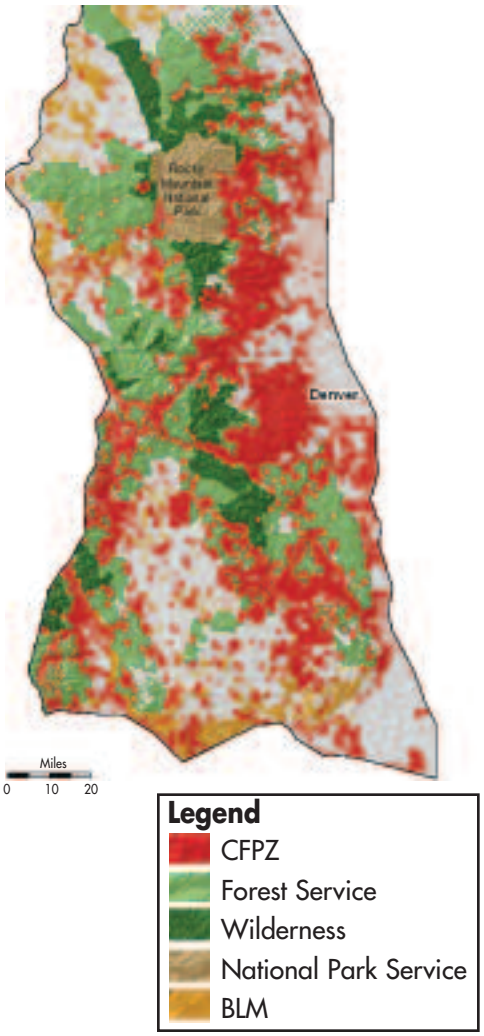
Still, the ability of our method to capture as many homes within a comparable (or lower) area of communities (see Table 4) suggests that our method is reasonably accurate for identifying communities. The fact that our method performs comparably to state-derived methods in terms of the number of houses included within the community buffer suggests that our approach sufficiently

FIGURE 6.
Central Idaho CFPZ*



*As identified using The Wilderness Society's standard method

FIGURE 7.
Colorado Front Range CFPZ*



*As identified using The Wilderness Society's standard method

represents, using one simple method, communities identified using local data and customized analyses. Where local data produce better results than ours (as appears to be the case in Colorado), we recommend the use of local data in local analyses. However, because we want to be able to make comparisons among states using a single method, in the remainder of this section, we report findings based only on the simple, standard "TWS" method described above.

TABLE 6.

Acreage in Three Land-Use Zones

Study Area	Within Community Buffer		Outside Community Buffer	
	Non-wildland Fuels	**Wildland Fuels (CFPZ)**		
Yosemite	48,048 (1.12%)	**763,823 (17.7%)**	3,494,352	(81.1%)
Front Range	544,408 (6.72%)	**2,486,785 (30.7%)**	5,059,008	(62.5%)
Central Idaho	197,404 (1.74%)	**899,172 (7.94%)**	10,228,962	(96.8%)

TABLE 7.

Percentage of Houses in Three Land-Use Zones

Study Area	Within Community Buffer		Outside Community Buffer
	Non-wildland Fuels	**Wildland Fuels (CFPZ)**	
Yosemite	10.3	**45.5**	44.4
Front Range	76.6	**22.3**	1.1
Central Idaho	70.0	**27.8**	2.2

Extent of the Community Fire Planning Zone

The final step of our assessment of the CFPZ involved the removal of non-wildland cover types (urban, agricultural, water, barren, and rock) from the buffered communities to identify only the portion composed of wildland fuels (i.e., the CFPZ). This analysis allowed us to discriminate within each landscape the developed lands associated with communities, the wildlands associated with communities, and the zone beyond one-half mile of communities (Table 6). This method does not represent high-density developed areas adjacent to wildlands (i.e. inter*face* communities), but it keeps the focus on adjacent wildland fuels and on houses mixed among wildland fuels (i.e., intermix communities), rather than on urban or suburban areas that are not subject to wildland fire.

Table 6 shows that the proportion of the landscape in the CFPZ varies depending on the area studied. In the Greater Yosemite area, 17.7 percent of the study area is in the CFPZ. Along the Colorado Front Range, over 30 percent, or almost 2.5 million acres, is in the CFPZ, while in Central Idaho, less than 8 percent is CFPZ.

In the Front Range and Idaho, most houses (over 70 percent) are found in developed areas within the community buffer, and very few houses are found beyond the CFPZ (Table 7). If we remove developed areas from the analysis and only look at homes built among wildland fuels, we find that 95.3 percent of homes in the Front Range and 92.7 percent of homes in Central Idaho are in the CFPZ. In the Yosemite area, by contrast, only 10.3 percent of houses occur in developed areas, and the CFPZ encompasses only about half of the remainder. Almost as many homes (44.4 percent) are scattered at very low densities beyond the limits of the CFPZ (Table 7). Obviously, land use patterns, and therefore the fire protection challenge, are very different in the Yosemite region compared to the other two.

Fuel Types within the CFPZ

In addition to the extent of the CFPZ in each region, we assessed the composition of wildland vegetation within the CFPZ to understand the nature of fuels

TABLE 8.
Acreage and Percentage of Fuel Types within the CFPZ of the Three Study Areas

	Greater Yosemite		Colorado Front Range		Central Idaho	
Non-wildland cover	23,433	(3.07 %)	154,905	(6.23 %)	47,505	(5.28 %)
Coniferous forest	157,358	(20.6 %)	1,432,177	(57.6 %)	328,972	(36.6 %)
Other forest	336,221	(44.0 %)	87,304	(3.51 %)	14,487	(1.61 %)
Shrubland	161,138	(21.1 %)	241,142	(9.70 %)	332,898	(37.0 %)
Grassland/other cover	85,671	(11.2 %)	571,253	(23.0 %)	175,318	(19.5 %)

PHOTO COURTESY WWW.WILDLANDFIRE.COM

It is impossible to completely fireproof our forests. Even if the costs were not prohibitively expensive, many forests require periodic fires to regenerate. In order to protect homes and allow healthy forests to burn naturally, resources must be targeted effectively to protect communities located in fire-prone landscapes.

and the kinds of fuel treatments that might be necessary. To do this, we used the best available GIS vegetation data from each state[10] and overlaid it with the CFPZ derived from our simple methods. Despite the fact that non-wildland cover types from the National Land Cover Database had been removed from the community buffer, local vegetation data revealed that portions of our mapped CFPZ still contained non-wildland cover – as much as 6.23 percent of the CFPZ in the Colorado Front Range (Table 8). These areas do not require treatment and should not be considered part of the CFPZ.

Comparison of the three regions demonstrates substantial variation in vegetation composition from region to region. Around Yosemite, three quarters of the CFPZ consists of grassland, chaparral, and open hardwood forest, such as blue oak woodland; relatively little (20.6 percent) of the CFPZ is classified as coniferous forest (see Appendix A). In the Greater Yosemite area, thinning of coniferous forest will have little effect on community protection. Vegetation is instead dominated by grasses that can carry fire quickly but will do little damage to ecosystems or to "Firewise" homes. Fire protection efforts can be very effective if focused on the area immediately adjacent to homes, both within and outside the CFPZ.

In Colorado, however, vegetation within the CFPZ is dominated by over 1.5 million acres of coniferous forest, including ponderosa pine (26 percent of CFPZ), lodgepole pine (11 percent), and mixed conifer (10 percent). Little of the vegetation is hardwood forest (3.51 percent) or shrubland (9.7 percent). In central Idaho, very little of the vegetation consists of hardwood forest, and the landscape is dominated by coniferous forest, such as ponderosa pine (13 percent) and Douglas-fir (7 percent), and shrub-

[10] California: FRAP Multi-Source Vegetation Data, http://frap.cdf.ca.gov/projects/frap_veg/index.asp; Colorado: Digital Landcover Dataset for the Southwestern United States, RS/GIS Laboratory, College of Natural Resources, Utah State University, Sept. 15, 2004. USGS GAP Analysis Program, "Southwest Regional GAP Analysis Project Final Report." http://earth.gis.usu.edu/swgap/landcover.html; Idaho: ID-GAP, Idaho Current Land Cover, http://www.wildlife.uidaho.edu/idgap/idgap_landcover.asp

TABLE 9.

Acreage and Percentage of Land Ownership Classes within the CFPZ of the Three Study Areas

	Greater Yosemite		Colorado Front Range		Central Idaho	
Private	457,611	(59.9 %)	1,422,105	(57.2 %)	388,242	(43.2 %)
USDA Forest Service	201,890	(26.4 %)	786,055	(31.6 %)	290,360	(32.3 %)
BLM	96,082	(12.6 %)	162,399	(6.53 %)	145,972	(16.2 %)
National Park Service	2,177	(0.29 %)	12,095	(0.49 %)	n/a	
Other Federal land	2,485	(0.33 %)	9,953	(0.40 %)	804	(0.09 %)
State land	2,832	(0.37 %)	93,422	(3.76 %)	70,540	(7.84 %)
City/County	351	(0.05 %)	757	(0.03 %)	n/a	
Tribal	494	(0.07 %)	n/a		n/a	
Other	n/a		n/a		3,254	(0.36 %)

land, such as sagebrush (20 percent) and bitterbrush (7 percent). The CFPZ in both landscapes is almost 20 percent grassland. (See Appendix A for a full accounting of vegetation types within the CFPZ of each study area.) In both landscapes, attention must be paid first to reducing hazards in the area immediately adjacent to homes, but there also may be opportunities to improve community safety by thinning coniferous forests.

Ownership within the CFPZ

Private land is the most common component of the CFPZ, composing about 60 percent of the CFPZ around Yosemite and along the Front Range, and over 43 percent in central Idaho (Table 9). Next most common in all three landscapes is national forest land, which accounts for a quarter to a third of the CFPZ, followed by BLM land. Together, these three land classes made up nearly all of the CFPZ.

Conclusions

In order to allocate scarce federal resources to protect communities in the wildland-urban interface, fire planners must have a better understanding of exactly where those communities are located across the landscape. This analysis provides the means to characterize those communities by comparing "apples to apples" without the confounding effects of the disparate methods developed by individual states. Our examination of the three study areas chosen for the analysis makes it clear that each landscape presents unique challenges: community protection from wildfire does not have a single, simple solution. Nevertheless, several conclusions can be drawn.

1. Definitions matter. Different definitions of community and the CFPZ have a major effect on what is targeted for protection on the ground. The use of unique data and methods in each state produced vastly different estimates of the size of the CFPZ. Using locally "best available data" can result in improved estimates of the location and extent of the CFPZ, but it comes at the expense of comparability across state lines. The application of our simple, consistent method across regions produced estimates of buffered community area 36 percent higher than Colorado's along the Front Range and 77 percent lower than Idaho's in central Idaho. If federal policy makers were to rely solely on the states' individual assessments in order to allocate fuel treatment resources, the inconsistency among states would undermine efforts to direct limited resources to those places where community protection is most needed.

2. The CFPZ is vast. Estimates of the proportion of the landscape in the CFPZ ranged from about 8 percent in central Idaho to over 30 percent along the Front Range. These three landscapes are all "lived-in wildlands," and so may over-represent the extent of the CFPZ relative to less occupied or more developed parts of the West. This analysis assumed a half-mile buffer; actual buffer widths will be determined at the local level and will affect the size of the CFPZ. But even if the CFPZ represented only 2-5 percent of western lands, it would still include tens of millions of acres. Substantial resources and effort are needed to achieve community protection over such a vast landscape.

3. The CFPZ is mostly private. Aplet and Wilmer (2003) estimated that, nationwide (lower 48 only), the CFPZ was 85 percent private, heavily influenced by the distribution of people and private land in the East. Here, we looked more closely at three western landscapes that are predominantly federal land (see Table 3). Our results show that even in these federal-land-dominated landscapes, private land is still the most common ownership in the CFPZ, dominating Greater Yosemite and the Front Range, and contributing substantially to central Idaho's CFPZ. Locally determined buffer distances will change the ratio of private to public land in the CFPZ, but it is clear that addressing community safety within the CFPZ will require resources and policy solutions targeted at private land. Policies that facilitate fuel treatment on federal land without concomitant attention to private land will fail to achieve community safety.

4. The CFPZ is highly variable. Our analysis shows that the CFPZ of the Greater Yosemite area is very different from the CFPZ of Colorado's Front Range. One is dominated by grasslands, shrublands, and open woodlands, and the other is dominated by dense coniferous forest. In central Idaho, the majority of the CFPZ is federal land. These findings suggest that no single community protection formula will work in every location. Different strategies will be needed to address different conditions, and treatment options will vary. Achieving community protection will require the development of local solutions, tailored to local conditions.

Toward a Solution: Community Wildfire Protection Planning

Protecting communities, to the degree possible, from the inevitable wildland fire is at the core of all successful fire management. The National Fire Plan and the 10-Year Comprehensive Strategy identify community protection as one of the highest priorities of fire management. However, as important as this goal is in federal policy, community protection cannot be achieved solely by the federal agencies; it requires partnership with the communities themselves.

Indeed, the Disaster Mitigation Act of 2000 and the Healthy Forests Restoration Act of 2003 both emphasize the importance of collaboration by establishing processes that encourage states and local communities to develop Mitigation Plans and Community Wildfire Protection Plans, and directing federal land management agencies to consider local priorities outlined there when implementing projects on federal land. While national policymaking and priority-setting still require a consistent, reliable assessment of the scope of the community protection challenge, the identification of areas within which to focus risk reduction activities must be a function of local planning.

Despite the need for local assessment of conditions, lack of access to good, local data ensures that too often, planning efforts must rely on the very state and federal spatial assessments that we have demonstrated to be both highly variable and, in some cases, inaccurate. Refinements in state and federal community mapping efforts will greatly assist local stakeholders to develop their own wildfire protection plans with site-specific risk reduction recommendations; ultimately, it is the community, in partnership with adjacent federal land managers, that must assess where community protection efforts should be focused. Local community wildfire protection planning also allows plans to reflect not simply hazardous fuel reduction needs but also evacuation, development, and emergency response challenges, issues that cannot be addressed without community input.

PHOTO COURTESY WWW.NPS.GOV

Representatives from the National Park Service and California's Bolinas Fire Protection District meet with fuels treatment project managers to discuss upcoming work. Community partnerships are an important element of any fuels management strategy in the wildland-urban interface.

While local wildfire protection plans provide communities with a ready mechanism to plan for local risk reduction challenges across jurisdictional boundaries, additional resources are needed to assist communities in moving from planning to on-the-ground action to reduce fuel hazards. The more local a planning effort becomes, the greater the reliance on volunteer efforts, from homeowners to rural and volunteer fire chiefs, to produce and implement a plan. These efforts demand resources. Also needed are new incentives to encourage federal managers to work across ownerships and collaborate locally on community protection efforts.

Comprehensive fire management requires the protection of communities, the restoration of fire as an ecological process, and the modification of altered vegetation to accommodate natural fire.

The Community Fire Planning Zone is the area within which community protection should be the dominant management objective. Beyond the CFPZ are other zones in which restoration or the management of natural fire should predominate. By managing these zones together, fire can be restored to fire-dependent ecosystems while also protecting homes and lives. Accordingly, there is a need to ensure that the local planning efforts of citizens, fire chiefs, and local governments are integrated into this comprehensive framework. As more and more communities begin the process of developing local wildfire protection plans, state-level or sub-regional multi-stakeholder collaborative bodies are needed now more than ever to ensure that site-specific recommendations fit within a framework of comprehensive fire management.

Recommendations

1) Governments at all levels should refine and improve mapping techniques to produce accurate information for use in local community fire planning efforts.
2) Resources must be made available to local communities to facilitate collaborative fire planning efforts.
3) Incentives should be instituted to encourage federal and non-federal managers and stakeholders to work together in the development of local community fire protection plans.
4) State or sub-regional collaborative bodies should be established to facilitate landscape-scale fire planning to achieve community protection and the restoration of fire-adapted ecosystems.

Appendix A. Vegetation Types Within the CFPZ in the Three Study Areas

TABLE A1.

Vegetation Within the CFPZ of the Greater Yosemite Region

Vegetation Type	Acres	Percentage of CFPZ
Montane Hardwood	173,148	23
Annual Grassland	72,563	10
Montane Hardwood-Conifer	64,997	9
Blue Oak Woodland	60,497	8
Ponderosa Pine	57,315	8
Mixed Chaparral	52,054	7
Sierran Mixed Conifer	49,190	6
Sagebrush	43,855	6
Blue Oak-Foothill Pine	35,894	5
Chamise-Redshank Chaparral	22,993	3
Undetermined Shrub Type	22,108	3
Pinyon-Juniper	15,674	2
Urban	11,984	2
Barren	10,993	1
Alkali Desert Scrub	10,316	1
Red Fir	9,432	1
Water	7,495	<1
Jeffrey Pine	7,282	<1
Undetermined Conifer Type	6,884	<1
Montane Chaparral	5,698	<1
Lodgepole Pine	4,144	<1
Irrigated Agriculture	3,954	<1
Douglas-Fir	3,620	<1
Subalpine Conifer	2,382	<1
Bitterbrush	2,234	<1
Wet Meadow	2,051	<1
Alpine-Dwarf Shrub	1,880	<1
Aspen	1,685	<1
Juniper	1,238	<1
Closed-Cone Pine-Cypress	148	<1
Montane Riparian	62	<1
White Fir	49	<1
Lacustrine	2	<1
Total	**763,823**	**100**

Source: California Department of Forestry FRAP Multi-Source Vegetation Data.

TABLE A2.

Vegetation Types Within the CFPZ of the Colorado Front Range

Description	Acres	Percentage of CFPZ
Rocky Mountain Ponderosa Pine Woodland	636,749	26
Rocky Mountain Lodgepole Pine Forest	285,230	11

TABLE CONTINUED ON NEXT PAGE

TABLE A2. (CONTINUED FROM PREVIOUS PAGE)

Vegetation Types Within the CFPZ of the Colorado Front Range

Description	Acres	Percentage of CFPZ
Southern Rocky Mountain Montane-Subalpine Grassland	255,162	10
Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	159,162	6
Rocky Mountain Lower Montane-Foothill Shrubland	100,579	4
Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland	99,500	4
Southern Rocky Mountain Pinyon-Juniper Woodland	95,929	4
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	84,790	3
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	80,867	3
Western Great Plains Foothill and Piedmont Grassland	64,992	3
Agriculture	63,872	3
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	59,085	2
Rocky Mountain Aspen Forest and Woodland	59,079	2
Inter-Mountain Basins Montane Sagebrush Steppe	57,421	2
Rocky Mountain Subalpine-Montane Riparian Shrubland	51,595	2
Invasive Perennial Grassland	51,096	2
Western Great Plains Shortgrass Prairie	37,890	2
Rocky Mountain Alpine Bedrock and Scree	34,364	1
Rocky Mountain Dry Tundra	31,294	1
Developed, Open Space - Low Intensity	31,021	1
Inter-Mountain Basins Big Sagebrush Shrubland	18,394	<1
Developed, Medium - High Intensity	15,794	<1
Western Great Plains Riparian Woodland and Shrubland	14,179	<1
Rocky Mountain Alpine-Montane Wet Meadow	12,048	<1
Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland	11,154	<1
Inter-Mountain Basins Mixed Salt Desert Scrub	10,923	<1
Rocky Mountain Subalpine-Montane Riparian Woodland	10,439	<1
Open Water	9,251	<1
Rocky Mountain Cliff and Canyon	8,584	<1
Rocky Mountain Subalpine Mesic Meadow	7,953	<1
Rocky Mountain Alpine Fell-Field	6,073	<1
Inter-Mountain West Aspen-Mixed Conifer Forest and Woodland Complex	4,331	<1
Western Great Plains Floodplain Herbaceous Wetland	3,348	<1
Recently Logged Areas	3,258	<1
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	2,950	<1
Recently Burned	2,646	<1
Inter-Mountain Basins Semi-Desert Shrub Steppe	1,671	<1
Invasive Annual Grassland	1,598	<1
Invasive Southwest Riparian Woodland and Shrubland	657	<1
Barren Lands, Non-specific	599	<1
Western Great Plains Sandhill Shrubland	468	<1
Western Great Plains Cliff and Outcrop	354	<1
Inter-Mountain Basins Active and Stabilized Dune	143	<1
Colorado Plateau Pinyon-Juniper Woodland	115	<1
Inter-Mountain Basins Greasewood Flat	91	<1
Southern Rocky Mountain Juniper Woodland and Savanna	55	<1
Inter-Mountain Basins Wash	22	<1
North American Alpine Ice Field	4	<1
North American Arid West Emergent Marsh	2	<1
Recently Mined or Quarried	0	<1
Invasive Annual and Biennial Forbland	0	<1
Total	**2,486,785**	**100**

Source: USGS GAP Analysis Program, "Southwest Regional GAP Analysis Project Final Report"

TABLE A3.

Vegetation Types Within the CFPZ of the Central Idaho Study Area

Vegetation Type	Acres	Percentage of CFPZ
Ponderosa Pine	116,011	13
Basin & Wyoming Big Sagebrush	113,421	13
Mountain Big Sagebrush	66,030	7
Warm Mesic Shrubs	65,815	7
Douglas-fir	65,615	7
Mixed Xeric Forest	61,955	7
Bitterbrush	59,415	7
Perennial Grassland	47,053	5
Perennial Grass Slope	43,670	5
Lodgepole Pine	29,746	3
Shrub Dominated Riparian	28,711	3
Agricultural Land	21,102	2
High Intensity Urban	17,433	2
Mixed Subalpine Forest	15,765	2
Shrub/Steppe Annual Grass-Forb	15,256	2
Low Sagebrush	15,199	2
Herbaceous Burn	14,347	2
Douglas-fir/Lodgepole Pine	12,876	1
Foothills Grassland	9,353	1
Mountain Low Sagebrush	8,154	<1
Subalpine Fir	7,959	<1
Subalpine Pine	7,808	<1
Broadleaf Dominated Riparian	5,799	<1
Grand Fir	4,631	<1
Total	**899,172**	**100**

Source: ID-GAP, Idaho Current Land Cover

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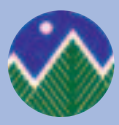
COVER PHOTOS:
When natural fire strikes communities that have not been able to plan strategically and reduce nearby fuels, wildland firefighters must often defend individual homes in dangerous conditions. Pre-fire treatments near homes can save enormous effort, expense and risk.
Horizontal photo by Tim M.;
Photos courtesy www.wildlandfire.com



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