System Indicators

Fire Threat

SIERRA NEVADA CONSERVANCY

DRAFT REPORT

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Introduction

This fifth report in the System Indicators series examines fire threat across the entire 25 million acres in the Sierra Nevada Region. The Forest Health and Carbon Storage Indicator report looked at wildfire from a forest health perspective, and only analyzed wildfire relative to the approximately 10.5 million acres of 'productive' forest land in the Region. Some of the information on wildfire included in the Forest Health and Carbon Storage report is also referenced in this report within the broader geographic framework.

As covered in the Forest Health and Carbon Storage Indicators report, overall long-term ecosystem health cannot be discussed without considering both the potential negative and positive impacts from fire. Fire has, and always will be, present in California. It is generally accepted that fire is a natural part of California's ecosystem and for many animal species and vegetation types, fire is necessary in order to maintain those species or the habitats they are dependent on. Fire intensity, size, and location are some of the factors that affect the level of disturbance and potential long term damage, and therefore long term health of natural systems.

However, the characteristics of fire in the Sierra are very different today than prior to European settlement more than 150 years ago, when mostly low-severity fire was a frequent occurrence on the landscape and helped to maintain forest health by thinning out small trees, removing fuel accumulations, and reducing major insect and disease events. A combination of over 100 years of human encroachment into the wildlands and fire suppression led to a drastic reduction in natural fire on the landscape and changed the character of the forest, much of which has filled in with heavy undergrowth which is now much more prone to high severity fire. The past few decades have seen a significant increase in the size of high-severity fires and the acreage subjected to catastrophic burn. Both ecosystems and human infrastructure are at increased risk.

What is "Fire Threat"?

For the reader to understand this report, it is critical that the meaning and implications of "Fire Threat" are clearly understood, and how it is different than risk. Different agencies define and analyze Fire Threat differently. For this report, the definition provided by the California Department of Forestry and Fire Protection (CAL FIRE), Forest Resource Assessment Program (FRAP) will be applied throughout.

According to FRAP, "Fire Threat is a measure of fire hazard that includes components for both probability (chance of burning) and the nature of the fire (fire behavior). Taken collectively, these two features assess the basic threat features of periodic wildfires and their capacity to drive fire effects. It is important to understand that fire threat carries no direct measure of fire effects and associated value change associated with fire risk." This could be simplified as the possibility of a fire occurring based on the history of fire occurrence and the potential damage based on the behavior a fire may exhibit.

This report does not address Fire Risk, which is a measure of expected damage from fire to assets (both natural and economic) that hold value to society. Rather, this Indicator report establishes several measures of Fire Threat that can be tracked accurately and repeatedly over time to assist in policy decisions and actions related to the occurrence, size, and impacts of wildfire in the Sierra and its foothills.

Three Indicators have been selected for this report, two of which utilize already establish data and methodology, and one (burn severity) for which data is not yet available but is in the process of being developed. The three Indicators are:

1) Number of Acres by Fire Threat Class

2) Number of Acres that Burn Annually

3) Acres Burned by Severity

These indicators will be tracked for the entire SNC Region, plus as a subset for the Wildland-Urban Interface (WUI) lands.

Highlights

Fire Threat

- The threat of major fire events is a constant in the Sierra Nevada and its foothills. More than two-thirds of the SNC Region (17.5 million acres) is classified as High and Above fire threat, compared to just less than half of the state as a whole.
- All Subregions have at least two-thirds of the area in the High and Above fire threat, with the exception of the East Subregion which has just under half of the area in that category. The North Subregion has the most amount of land in High and Above fire threat – 4.8 million acres (76 percent of the land area), while the North Central Subregion has the highest percentage in the High and Above category, with 78 percent.
- Sixty-four percent of federal land is in High and Above fire threat, while 78 percent of private land is classified as High and Above.

Fire History

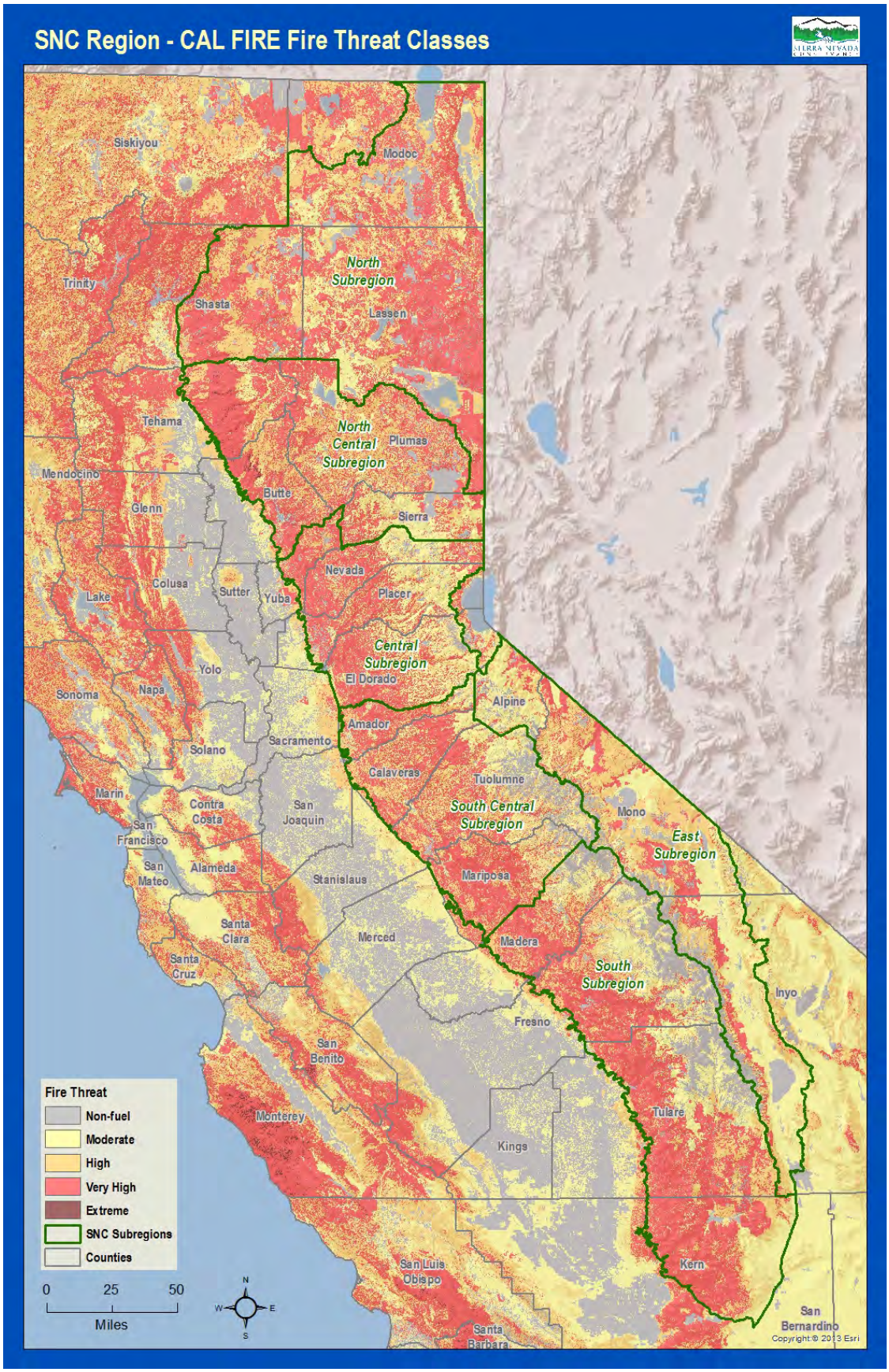
- To meet the tracking criteria of this System Indicators report, fire data only extending back to 1998 was used. This short time frame can't substantiate a clear trend of increasing number acres burned annually, though 2008 and 2012 were two of the biggest fire years in recorded history. Other studies do support increasing high-severity fire size and increasing acres burned annually since 1980.
- While about 60 percent of the SNC Region is in federal ownership, 75 percent of area burned between 1998 and 2012 was on federal land.

Fire in the Wildland-Urban Interface

- Six and one-half percent of the SNC Region land area (1.65 million acres) is classified as Wildland-Urban Interface (WUI). The Central Subregion accounts for 39 percent of the WUI, and 25 percent of the Central Subregion land area is WUI.
- Eight-four percent of the WUI is in High and Above fire threat, ranging in a north-to-south trend from 66 percent in the North Subregion to 94 percent in the South Subregion. Only 49 percent of East Subregion WUI is in High and Above fire threat.
- Wildfire in the WUI accounts for a small proportion of total fire in the Region; about one to three percent of total area burned in most years since 1998. In most years, 90 to 99 percent of WUI fire is on land classified as High and Above fire threat. Particularly in years where the WUI experiences a large amount of fire, much of that fire is in oak woodland.

Fire Severity

- It would be hugely useful to comprehensively document the severity of fire in the Sierra and foothills. Methodology is being developed to be able to characterize and track fire severity in the future.


SNC Region - CAL FIRE Fire Threat Classes
Siskiyou
Modoc
Trinity
Shasta
Lassen
North Subregion
Tehama
Plumas
North Central Subregion
Mendocino
Butte
Glenn
Sierra
Nevada
Colusa
Sutter
Yuba
Placer
Lake
Central Subregion
El Dorado
Yolo
Napa
Sonoma
Alpine
Amador
Sacramento
Solano
Calaveras
Tuolumne
Marin
Contra Costa
San Joaquin
South Central Subregion
Mono
San Francisco
East Subregion
San Mateo
Alameda
Stanislaus
Mariposa
Santa Clara
Merced
Madera
Santa Cruz
South Subregion
Inyo
Fresno
San Benito
Fire Threat
Non-fuel
Moderate
High
Very High
Extreme
SNC Subregions
Counties
Monterey
Tulare
Kings
0
25
50
Miles
N
W
E
S
San Luis Obispo
Kern
San Bernardino
Santa Barbara
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Number of Acres by Fire Threat Class

It is important to track changes in fire threat class over times as the higher the threat class, the higher the potential for large fires that burn with higher intensities creating more significant short term and long term impacts on watersheds and the natural and economic assets they provide.

CAL FIRE identifies and tracks changes in five fire threat classes: Extreme, Very High, High, Moderate, and Low or No threat. The preceding map highlights the five threat classes for the SNC Region. For this report, we have grouped the Extreme, Very High, and High classes together into a 'High and Above' class and left the Moderate and Low classes separate. Combining the higher threat classes together simplifies the discussion of fire threat without losing any pertinent considerations. The distinctions between High, Very High, and Extreme have little bearing on how SNC sees its role in trying to understand and reduce fire threat in the Sierra Nevada. Any threat above moderate is a dire condition. (For a more detailed reference, Table 2 in the appendix provides data for all five threat classes.)

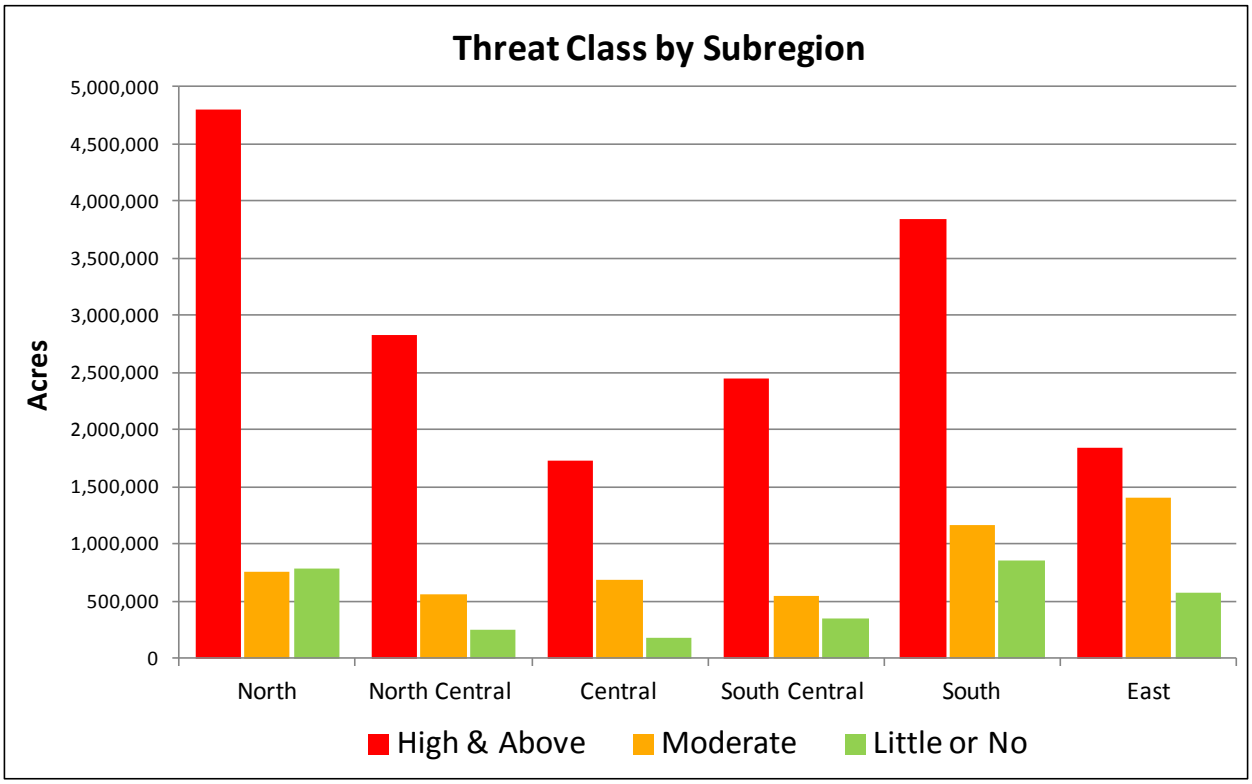
The SNC Region, both forest and non-forest, is dominated by the higher fire threats – 17.5 million acres, 68 percent of the Region, is classified as High and Above as compared to 48 percent for California as a whole. Twenty percent of the Region is classified as Moderate, and only 12 percent is classified as Little or No threat. Most of the Little/No threat area is in the high alpine elevations. Of the 17.5 million acres in the High and Above threat class, 63 percent is Very High; there is very little that is actually classified as Extreme.

Fire Threat by Subregion

As shown in the table and chart below, fire threat is uniformly high across the Subregions within the Sierra, with the exception of the East Subregion. The North, North Central, and South Central Subregions average about 75 percent in the High and Above fire threat classes, while about two-thirds of the Central and South Subregions is in that threat range. There are likely a number of factors that lead to a bit lower threat class for the latter Subregions. The landscape the Central Subregion, which contains the bulk of the Region's population, has been much more modified than other Subregions. The South Subregion is likely at slightly lower overall threat because it has the highest elevations and contains the most area at Little or No fire threat, which is primarily high alpine terrain with little vegetation. The large area of National Park land is the South may also play into the figures. Only 48 percent of the East Subregion is in the High and Above threat range, due mostly to lack of heavy vegetation to carry large fires due to dry conditions on the east slope of the Sierra and in the Owens Valley.

Threat Class by Subregion (Acres and Percent)

	High & Above		Moderate		Little or No		
	Acres	%	Acres	%	Acres	%	Total Acres
North	4,799,843	76%	751,306	12%	785,844	12%	6,336,993
North Central	2,825,785	78%	562,998	16%	241,467	7%	3,630,250
Central	1,721,863	67%	683,069	27%	170,315	7%	2,575,247
South Central	2,447,832	73%	549,627	16%	344,960	10%	3,342,419
South	3,845,603	66%	1,161,359	20%	850,240	15%	5,857,202
East	1,838,179	48%	1,402,414	37%	578,728	15%	3,819,321
Total	17,479,105	68%	5,110,773	20%	2,971,554	12%	25,561,432



Fire Threat by Ownership

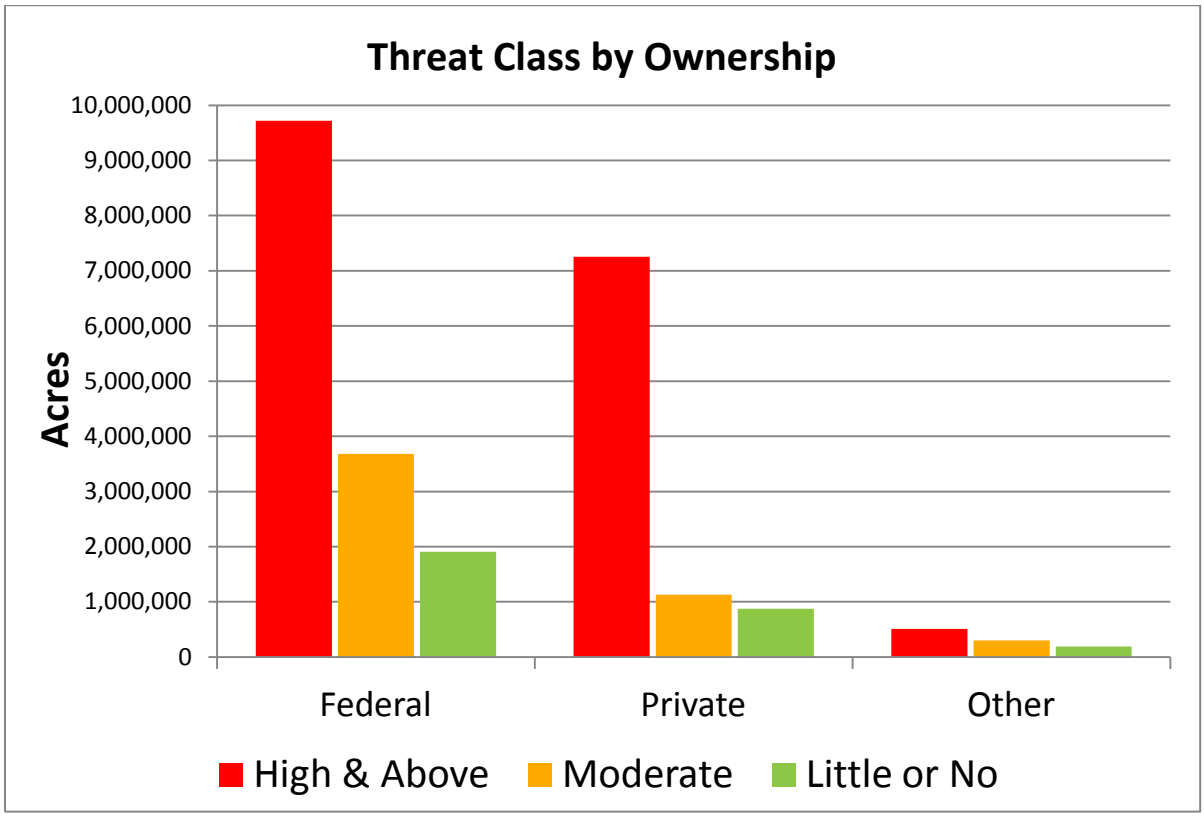
Just about 60 percent of the SNC Region – 15.3 million acres – is under federal management (primarily US Forest Service (USFS), Bureau of Land Management (BLM), and National Park Service (NPS)). Almost 10 million acres – nearly two-thirds of the federal land – is in a fire threat class of High and Above.

Land in private ownership totals 9.25 million acres (36 percent of the Region) and has an even higher proportion – 78 percent – in High and Above fire threat classes. Part of the explanation for this difference is that most of the lands with high alpine terrain with little vegetation occur on federal land (for example wilderness lands). This fact results in a lower proportion of federal lands being classified at High and Above.

'Other' land summarized below consists of land under state or local municipality ownership, tribal lands, and protected private land held in public trust. It totals just under one million acres, about 4 percent of the Region. About half of these lands are in the High and Above fire threat classes. A possible explanation for this lesser amount in High and Above may be the nature of lands held by these entities, much of which has been converted to a less natural state (developed lands, improved parks, etc.).

Threat Class by Ownership (Acres and Percent)

	High & Above		Moderate		Little or No		
	Acres	%	Acres	%	Acres	%	Total Acres
Federal	9,718,960	64%	3,683,786	24%	1,906,677	12%	15,309,423
Private	7,252,000	78%	1,127,721	12%	873,425	9%	9,253,146
Other	508,144	51%	299,268	30%	191,451	19%	998,863
Total	17,479,105	68%	5,110,773	20%	2,971,554	12%	25,561,432



Impacts of Fuel Treatments on Threat Class

As part of their 2010 Strategic Plan, CAL FIRE is developing programs to track fuel reduction and fuel modification treatments throughout the state. Some tracking is being done now, but not comprehensively and across all landowners in all areas. The CAL FIRE effort will collect data on area treated and type of treatment (whether prescribed fire or mechanical) for a comprehensive GIS database.

Over time, CAL FIRE threat class mapping is adjusted as relevant factors, including forest conditions, change. The hope is that strategically implemented forest treatments will improve forest conditions such that significant land will be reclassified from higher threat classes to lower threat classes over time. Tracking the extent of fuel treatment projects, and comparing the treatment areas to existing and future threat class maps, will indicate the effectiveness of the treatments in making forest and other lands safer and healthier.

Having this information will help landowners and funders understand landscape scale conditions and coordinate on where to strategically implement projects to maximize benefits. Tracking fuel reduction and installation of other fire suppression structures, like fuel breaks, can also be used in fire suppression actions during active fire situations.

There are complicating factors to lowering fire threat beyond fuels treatments. Threat levels may change in areas that convert from wildland to expanding WUI. People play a part in the threat level due to higher fire frequency from human caused fires, both accidental and intentional, especially in the WUI. But WUI areas also have expanded access for responding to fire.

Potential Future Impact of Climate Change on Fire Threat

Weather conditions have a major effect on the occurrence of fire and its behavior. The likelihood of hotter, drier summers, and perhaps higher winds, in a warming climate is of great concern. These kinds of conditions would certainly increase fire threat in the Sierra Nevada, as well as making already difficult fire-fighting efforts even more challenging.

Large fires are controlled when either weather conditions change to be more favorable for fire fighters, or the fire runs out of fuel to burn. Warmer high elevation temperatures are leading to earlier snow melt and earlier drying of the landscape, potentially allowing for a longer fire season. If late winter and spring precipitation continues to shift from snow to rain, this trend would only be strengthened. Warmer spring temperatures and available liquid water may also lead to an increase in the lighter fuels that tend to lead to more severe fire seasons, as well as faster growth rates for all the vegetation. All these factors to could lead to higher fuel loading and the need for more frequent maintenance on fuel reduction projects than we have seen in the past.

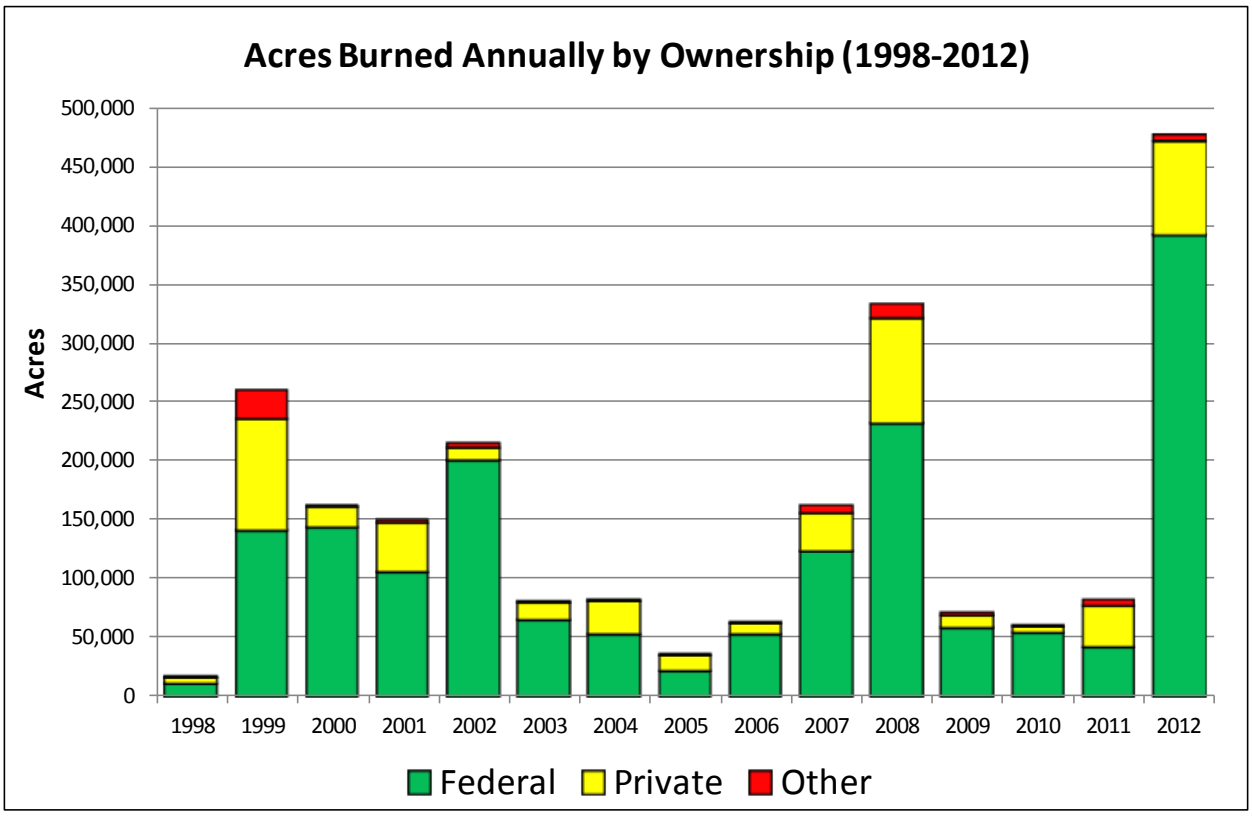
The concern is not only the potential for more 'bad' fire years, but also the potential for changes in the timing of fires within each year and the pattern of fires over time. Many of the ecosystems in California are fire dependent and require some kind of fire to either regenerate or rejuvenate the landscape. Timing of seed production or offspring has evolved over the

centuries to align with traditional timing of more historic natural fire occurrence. Significant shifts in average fire timing could disrupt these processes significantly and threaten the survival of some species. Creating an environment where fire can be used more widely as a management tool is a longer term goal for many.

Number of Acres that Burn Annually

The number of large fires, and the acreage burned, varies greatly from year to year, primarily due to specific weather conditions. Studies indicate that large fires are increasing in frequency in recent years. One study, (Miller, Stafford), analyzed California fire history data from 1908 to 2006. While there were large numbers of fires in the Sierra and total amounts of acreage that burned annually up to about 1940 was comparable to today, average fire size was smaller. With more robust fire suppression after World War II, the number of fires and acreage burned decreased. However, starting in the 1980's, total acreage burned annually started rising. Also, average fire size increased substantially. More dramatically, the largest fires in many of the years since 1960 have been substantially larger than almost any year in the previous era.

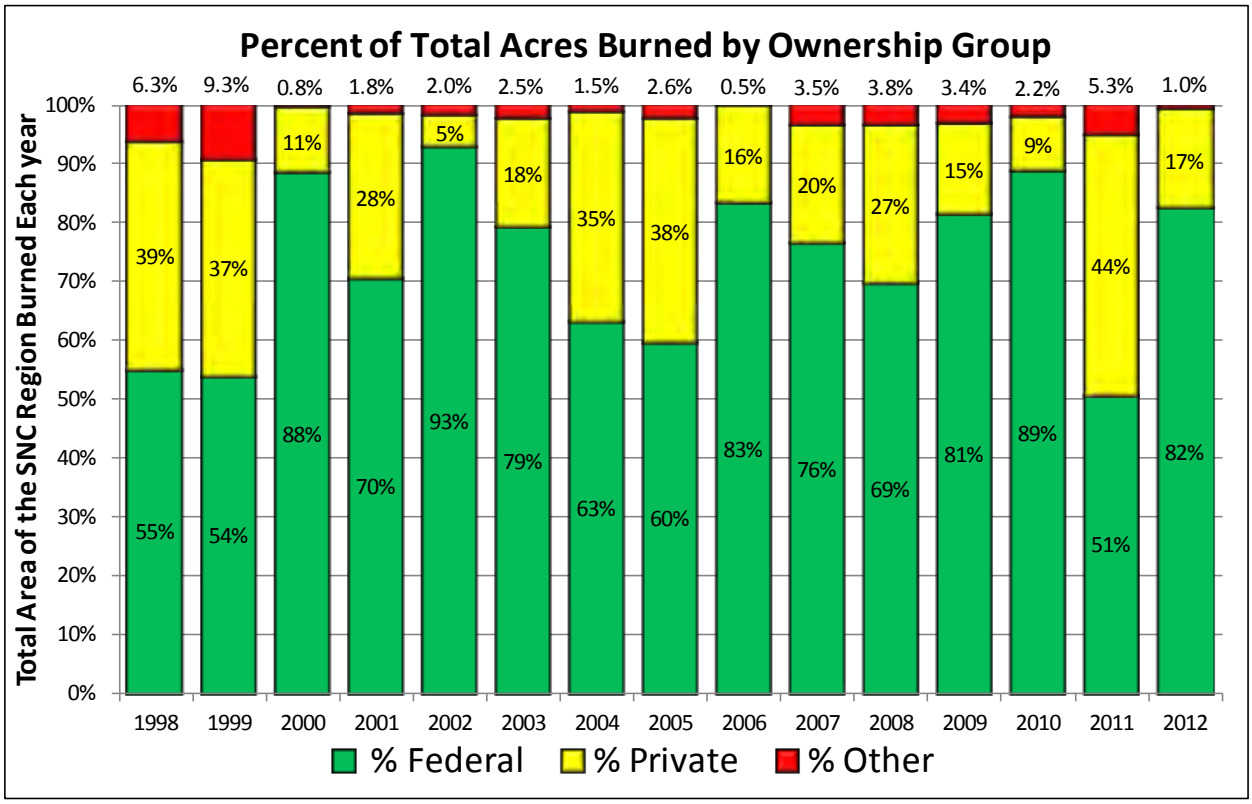
The chart below shows the number of acres that have burned in the SNC Region each year since 1998. (Data provided in Table 4 of the Appendix.) Although, as described above, there is data that extends back much earlier, data that we can tie specifically to the SNC Region, land ownership, and vegetation classifications is only available from 1998 onward. This framework will allow us to track future fire trends and patterns with more detail than the past.



The past 15 years of data don't cover a long enough timeframe to clearly support the case that the extent of wildfire is increasing. The hot, dry years of 2008 and 2012 resulted in total acreage burned far above average, but most of the years since 2002 have had modest fire impacts compared to some previous years.

The chart above also indicates acreage burned by major ownership category. In the past 15 years there have been consistently more acres burned from wildfires on federal lands than private or other ownerships. On the one hand, this might be expected since there is more federal than private land area in the Sierra Nevada. On the other hand, as discussed above, private land has a higher proportion in the High and Above threat classes. However, while about 60 percent of the SNC Region is in federal ownership, about 75 percent of the total acreage burned over the past 15 years has been on federal lands. There are certainly a number of factors that likely contribute to this outcome. Federal land is generally more remote than private land, making it more difficult to access in order to contain fire size; and fires on federal land often don't pose the same imminent risk to humans and communities. These facts lead can lead to a different approach from fighting fire on private lands. For example, wildfires on federal lands (of all federal ownerships) are frequently 'managed' in order to remove understory vegetation, leading to larger burn areas.

The chart below more clearly shows the relative acreage burned each year by ownership.



In addition to a larger proportion of acres being burned on federal lands, the Miller Stafford report also documented that there is an increasing trend of larger fires and higher fire severity over larger areas within the fires' perimeters, causing more damage to the watersheds on federal lands. Many of those watersheds are the headwaters of our major rivers in the state.

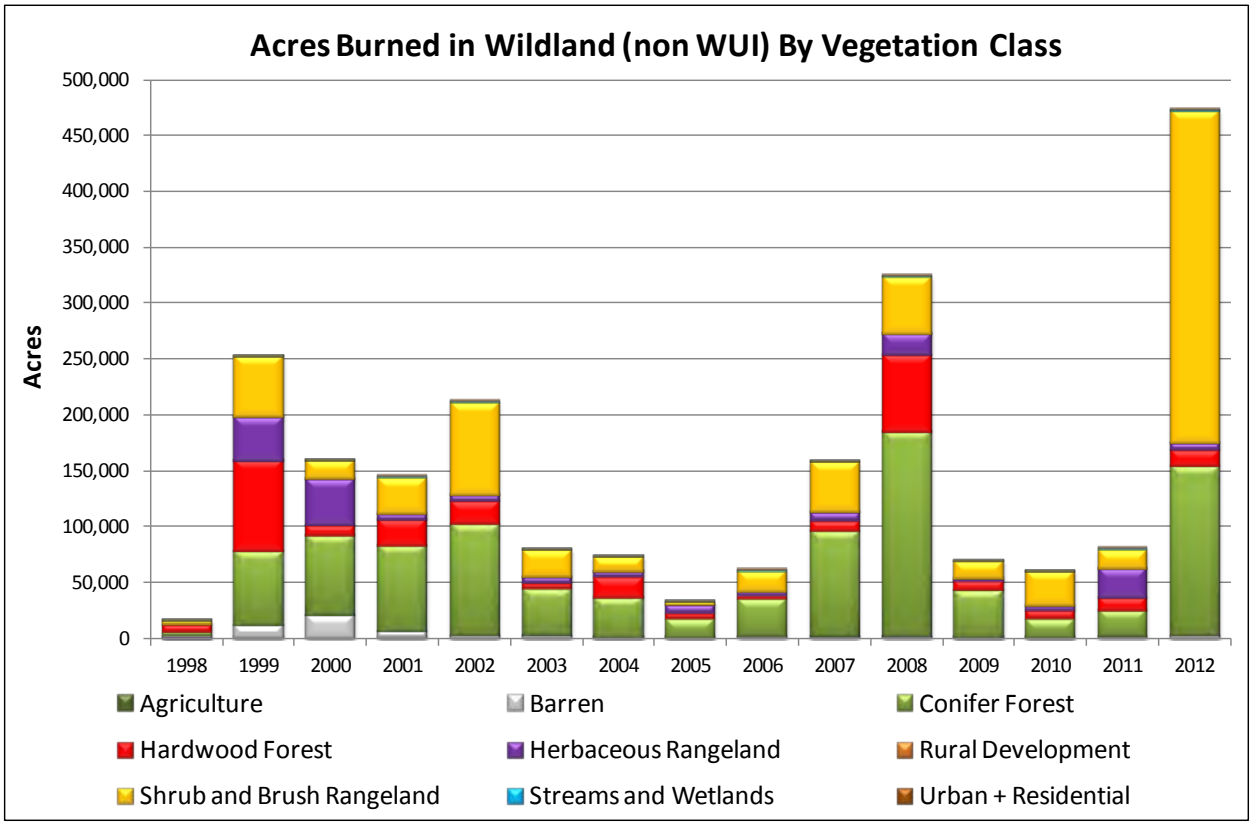
As expected, because most of the Region is in the High and Above fire threat classes, most of the acreage burned in any year is in that threat category. In both of the big fire years of 2008

and 2012, 88 percent of the total acreage burned was in High and Above fire threat classes. Fire distribution across the Region is particularly variable, owing to the erratic nature of where large fires might occur. The North, North Central, and South Subregions generally experience more fire than the other Subregions. As examples, due to particularly large fires, 71 percent of total acreage burned in 2012 was in the North Subregion. In the big fire year of 2008, 48 percent of acreage burned was in the North Central Subregion, while in 2011 only 88 acres burned in the North Central (1/10th of one percent of the total). Detailed tables for annual acres burned by Subregion and threat class are included in the Appendix (Tables 5 and 6).

Acres burned by vegetation type

The chart below shows annual wildland (non-WUI)* acreage burned by major vegetation classes. (Data provided in Table 7 of the Appendix.) The majority of total acreage burned in any given year is dominated by three vegetation types: conifer forest, hardwood forest, and shrub and brush rangeland. In most years, conifer forest accounts for the largest amount of land burned. However, in 2012, a huge shrub land fire in northeastern California dominated the total acreage burned, even though there were several huge conifer fires that same year.

* As fire in the WUI accounts for a very small amount of total fire overall in any year (see next discussion), this chart can be taken to represent fire history in the Region by vegetation classification generally.



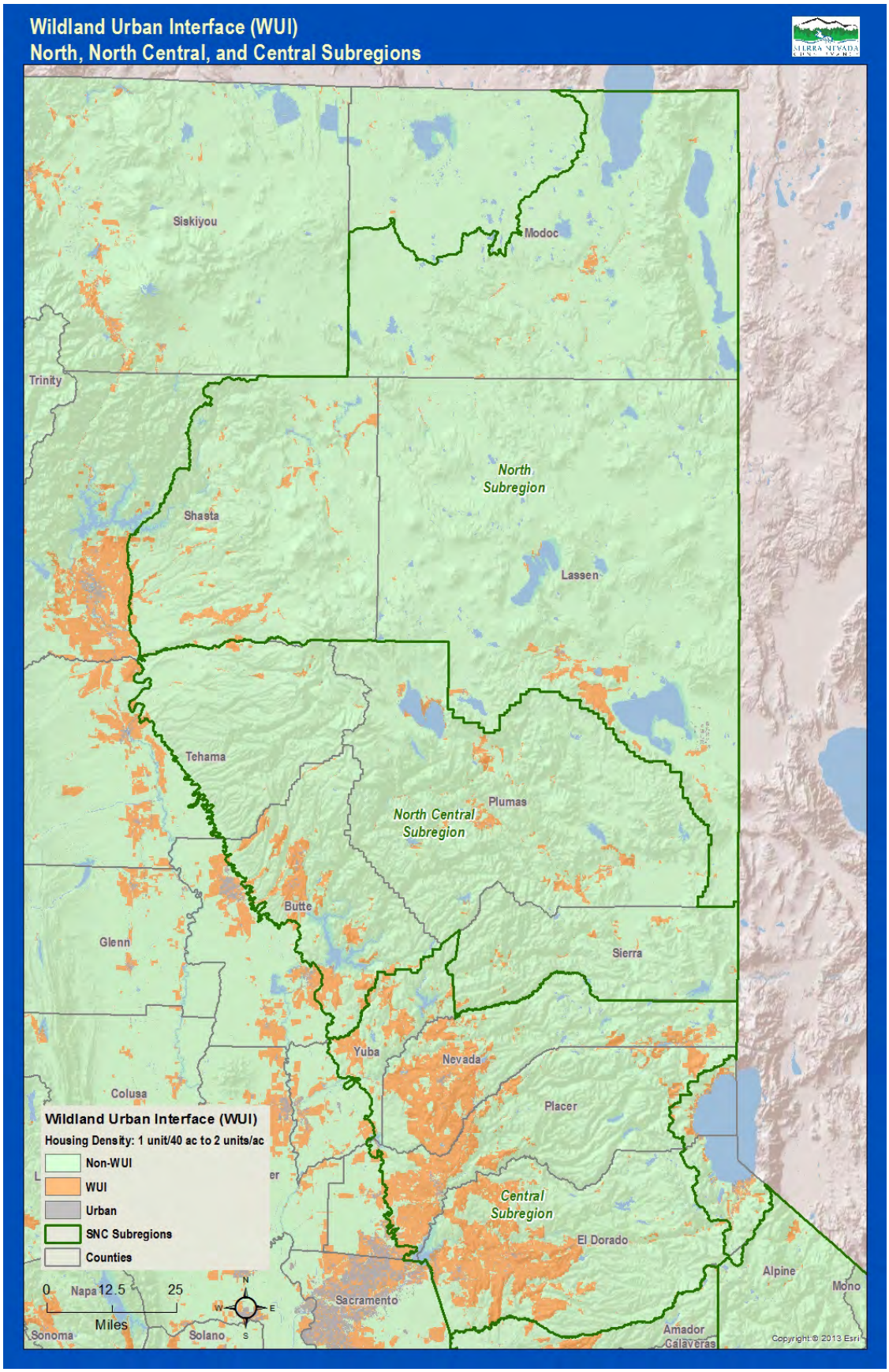
Number of Acres by Fire Threat Class and Number of Acres that Burn Annually Within the Wildland-Urban Interface (WUI)

The majority of human occupation and development within the SNC Region is classified as Wildland-Urban Interface (WUI). For this report the definition of WUI comes from FRAP. WUI is based on housing density where there are no more than 2 homes (units) per acre and no less than 1 house per 40-acres. There is very little urban land in the Sierra, which is defined as more than 2 homes per acre. WUI is characterized by much more vegetation and fire risk than urban land, being more integrated into the wild landscape. The WUI is a particular complication to fire management in the Sierra. As people have moved into what were traditionally more wildland environments, fire suppression tactics have been focused first on protecting life and property, and then on the wildland fire suppression activities.

In any fire suppression action, the initial attack period - generally the first 1-2 hours of the fire - is critical in suppressing the fire while it is still small, therefore minimizing its impact or damage. Control structures associated with the WUI such as roads and fuel breaks, greatly aid the quick attack on a fire. Most areas that contain WUI have additional firefighting resources through local paid or volunteer fire protection districts paid for by local residents. However there may not be enough resources in the early stages of a significant fire to aggressively attack both the structure assets and the wildland portions of a fire at the same time. Where there is wildland involved in the incident and firefighting resources are limited in number initially, the wildland fire portion of these events have tended to grow larger as suppression and protection is targeted first at life and property. As suppression activities move from those life and property assets to the wildland, the fire may have grown to a size and intensity that makes it more difficult to contain or even manage, therefore adding to acres burned and potentially negative impacts to the environment. Along with the physical difficulty in suppressing larger fires, the increase in costs of fire suppression, and post fire restoration and mitigation costs puts an additional strain on federal, state, and local budgets.

Development of historically wildland or agricultural lands is expected to continue as population pressures grow, which will increase the amount of WUI and continue to influence priorities in firefighting. Some recent changes in regulations such wider road widths and turn-around to provide greater access and egress, as well as water source requirements and building codes changes to “harden” the structures being constructed may help mitigate those impacts.

Six-and-a-half percent of the SNC Region land area is classified as WUI. The maps on the following two pages show the distribution of the 1.65 million acres of WUI within the Region. WUI land is represented by the orange areas.


Wildland Urban Interface (WUI)
North, North Central, and Central Subregions
Siskiyou
Modoc
Trinity
Shasta
North Subregion
Lassen
Tehama
Plumas
North Central Subregion
Butte
Glenn
Sierra
Yuba
Nevada
Colusa
Placer
Central Subregion
El Dorado
Alpine
Mono
Napa
Sacramento
Sonoma
Solano
Amador
Calaveras
Wildland Urban Interface (WUI)
Housing Density: 1 unit/40 ac to 2 units/ac
Non-WUI
WUI
Urban
SNC Subregions
Counties
0 12.5 25
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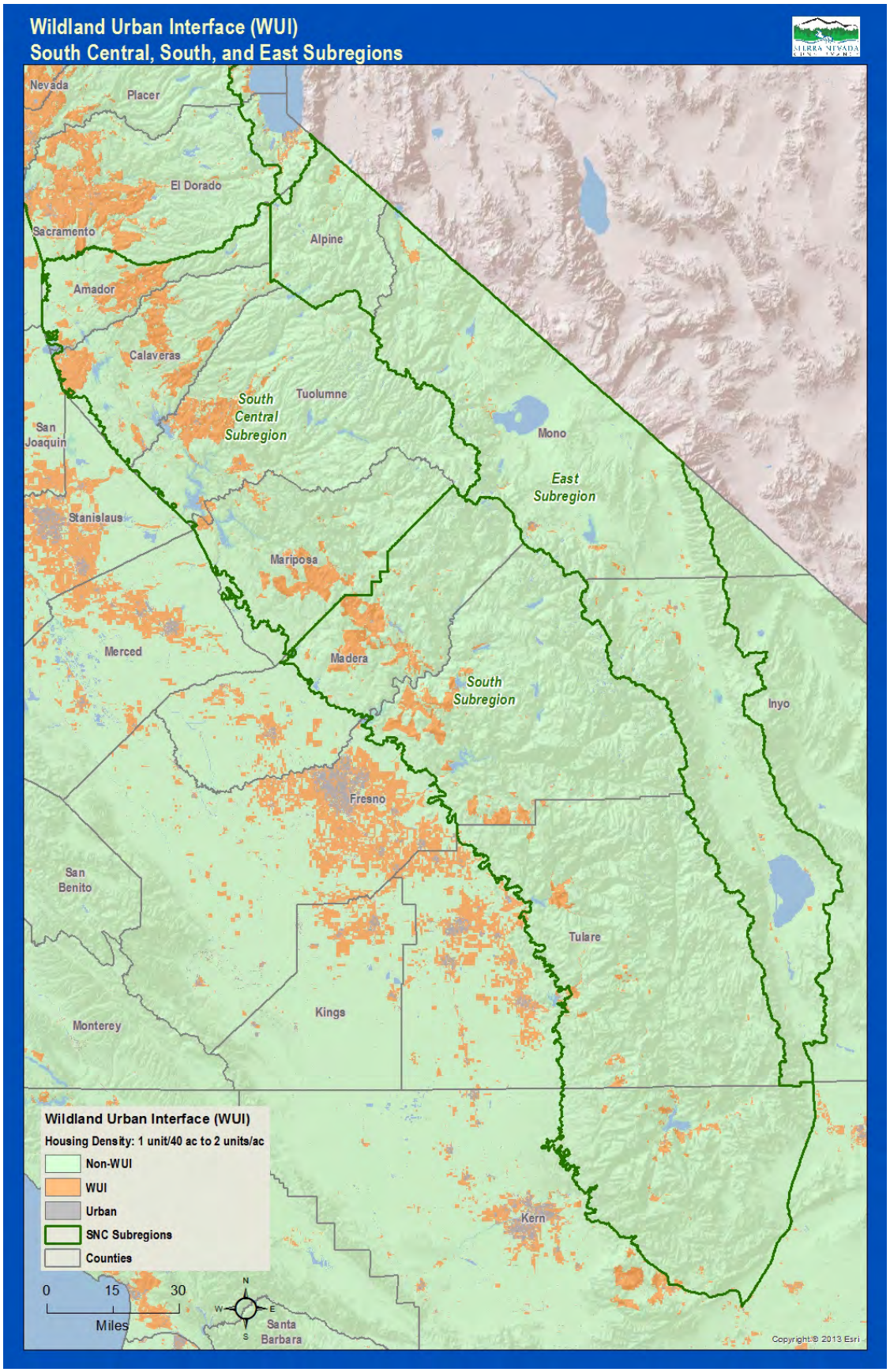
Wildland Urban Interface (WUI)
South Central, South, and East Subregions
Nevada
Placer
El Dorado
Sacramento
Alpine
Amador
Calaveras
Tuolumne
South Central Subregion
San Joaquin
Mono
East Subregion
Stanislaus
Mariposa
Merced
Madera
South Subregion
Inyo
Fresno
San Benito
Tulare
Kings
Monterey
Kern
Santa Barbara
Wildland Urban Interface (WUI)
Housing Density: 1 unit/40 ac to 2 units/ac
Non-WUI
WUI
Urban
SNC Subregions
Counties
0
15
30
Miles
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Acres in WUI by Threat Class and Percent of Subregion in WUI					
Subregion	**WUI in No/Moderate**	**WUI in High and Above**	**Total WUI**	**Total Acres in Subregion**	**WUI as Percent of Subregion**
North	45,887	87,137	**133,025**	6,336,993	**2.1%**
North Central	34,151	136,917	**171,069**	3,630,250	**4.7%**
Central	98,570	541,503	**640,073**	2,575,247	**24.9%**
South Central	41,919	363,687	**405,606**	3,342,419	**12.1%**
South	16,352	244,654	**261,006**	5,857,203	**4.5%**
East	20,335	19,881	**40,215**	3,819,322	**1.1%**
Total Region	**257,214**	**1,393,779**	**1,650,994**	**25,561,434**	**6.5%**

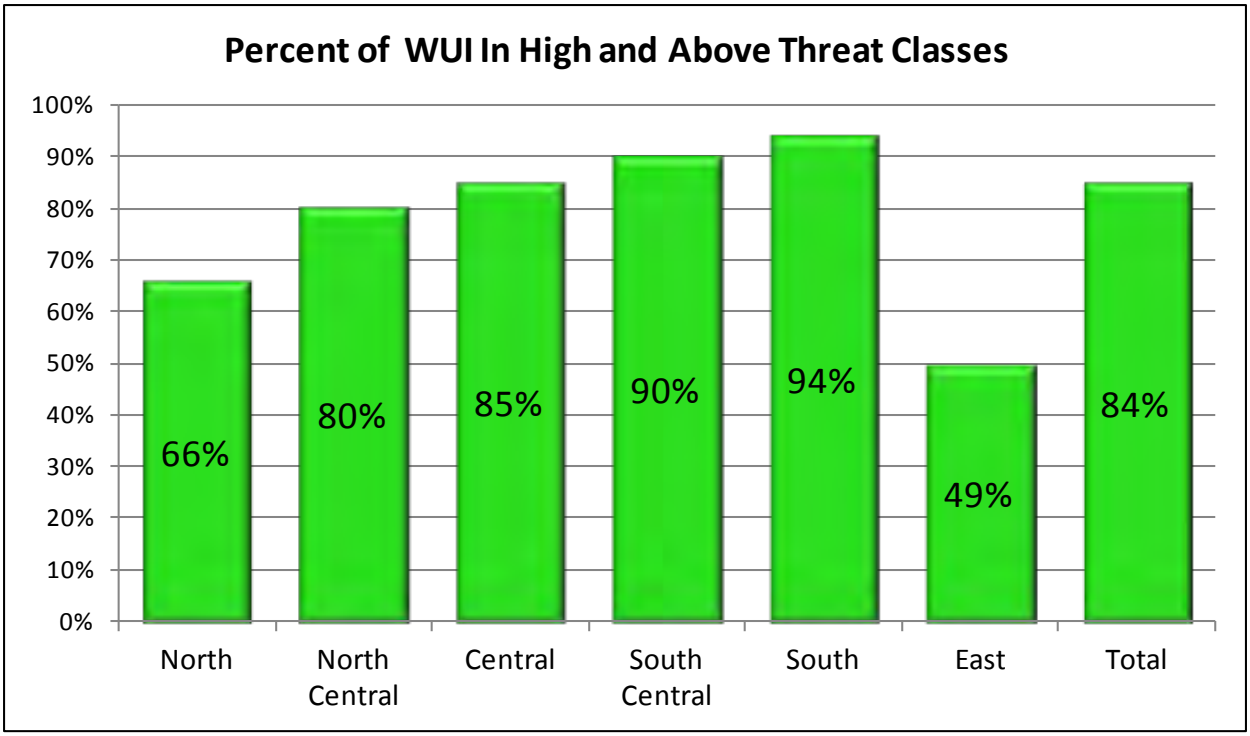
The Central Subregion contains the greatest area of WUI with over 640,000 acres, followed by the South Central with over 405,000 acres. Between them, the two Subregions account for over 63 percent of the WUI lands in the SNC Region.

The counties in the Central Subregion – particularly Placer and El Dorado – have the highest population, major transportation corridors of highways 80 and 50 that transect the Sierra, and are also within commuting distance of Sacramento. Nevada County also has a particularly large amount of WUI land.

Not only does the Central Subregion alone account for almost 39 percent of all the WUI in the Region, but WUI lands constitute nearly 25 percent of the land area of the Central Subregion. About 12 percent of the South Central Subregion is WUI. In contrast, all of the other Subregions are less than 5 percent WUI by land area, and only 1.1 percent of the East Subregion is WUI.

Acres in the WUI by Threat Class

Eighty-four percent of WUI land area is in the High and Above threat classes. As shown in the chart below, there is an interesting trend from north to south with an increasing percentage of WUI in the high threat categories. Only 66 percent of the North Subregion WUI is classified as High and Above fire threat, while 94 percent of the South Subregion WUI is within the higher fire threat classes. The Central and South Central Subregions, comprising the lion's share of WUI land area, is over 85 percent in the High and Above threat classes. The East Subregion, with very different topography, climate and vegetation than the other Subregions has only 49 percent of its WUI in the High and Above threat classes.



Number of Acres that Burn Annually In the WUI

The portion of Sierra wildfire that occurs each year that is in the WUI is generally fairly small. As indicated in the table on the following page, in a typical year since 1998, one to three percent of total land burned in the Sierra is in the WUI. The one major exception in the past 15 years was 2004, when nearly ten percent of the burned acreage was in WUI, though this was overall a modest fire year.

In terms of threat class, generally well over 90 percent of the WUI acreage burned is on land classified as High and Above. Only in three of the past 15 years was it less than 90 percent, and most years 95 – 99 percent of WUI fire was on land classified as High and Above fire threat. (Note: Because of the small amount of WUI acreage that is classified below High threat, the Little & No and Moderate threat classes have been combined for simplification.)

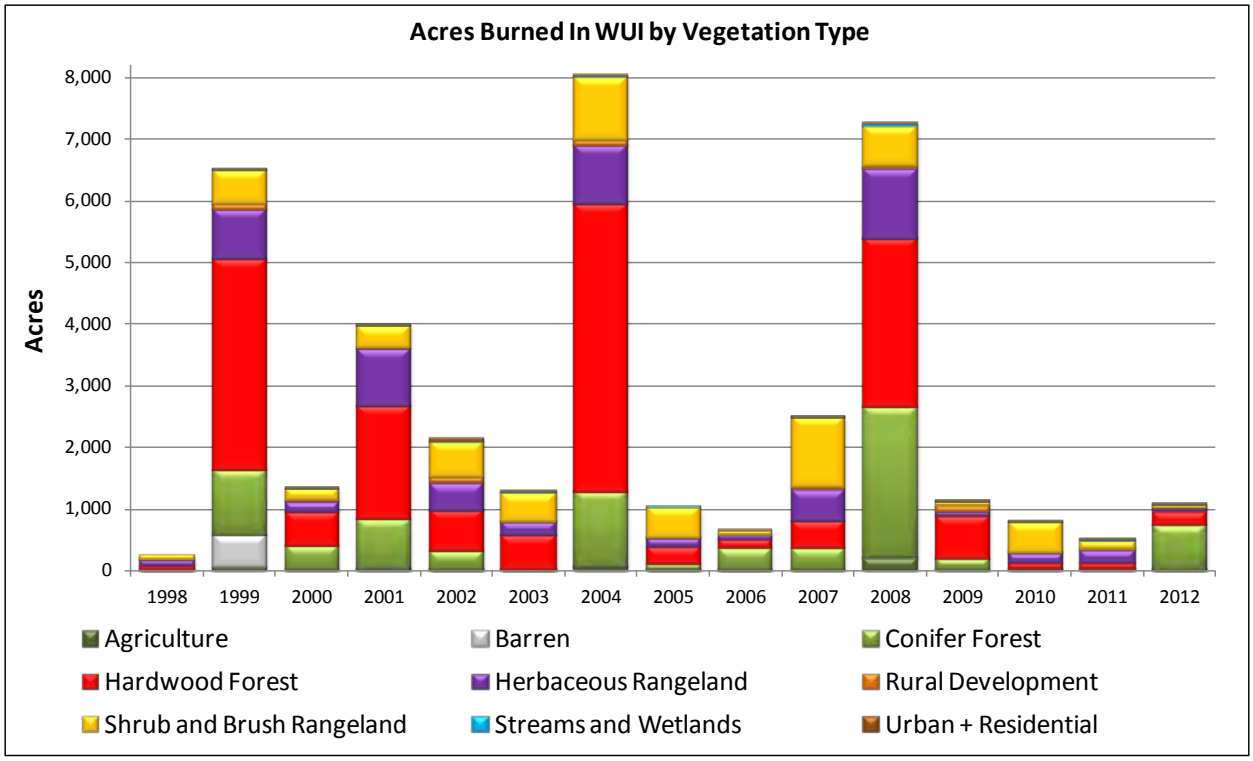
Acres Burned in WUI Annually by Threat Class (1998-2012)							
Year	No & Moderate		High & Above		Total WUI Acres Burned	Total Acres Burned in Region	Percent of Total Land Burned that was in the WUI
	Acres	Percent of total WUI fire area	Acres	Percent of total WUI fire area			
1998	2	1%	254	99%	256	16,508	1.55
1999	315	5%	6,207	95%	6,522	258,735	2.52
2000	61	5%	1,285	95%	1,346	160,953	0.84
2001	78	2%	3,908	98%	3,986	148,927	2.68
2002	526	24%	1,643	76%	2,169	214,493	1.01
2003	60	5%	1,222	95%	1,282	80,453	1.59
2004	506	6%	7,520	94%	8,026	80,817	9.93
2005	51	5%	981	95%	1,032	34,199	3.02
2006	73	11%	577	89%	650	61,353	1.06
2007	177	7%	2,325	93%	2,502	160,467	1.56
2008	522	7%	6,753	93%	7,275	332,213	2.19
2009	112	10%	1,030	90%	1,142	70,663	1.62
2010	20	3%	762	97%	782	60,202	1.30
2011	112	22%	399	78%	511	80,652	0.63
2012	396	37%	679	63%	1,075	474,482	0.23

As shown in the table on the following page, the year-to-year distribution of wildfire in the WUI across Subregions has varied drastically over the past 15 years, likely driven by the happenstance of one or more larger fires in a particular Subregion. However, a cumulative total of the 15 year history for each Subregion indicates that they each “get their share’ of WUI fires over time.

As described previously, the Central Subregion has much more land in WUI than the other Subregions (and also a larger population), yet the table shows that the cumulative amount of WUI burned over the past 15 years has actually been less than some of the other Subregions, and certainly a much smaller percentage of the WUI than any other Subregion.

Acres Burned in WUI Annually by Subregion (1998-2012)								
	North	North Central	Central	South Central	South	East		Year Total
1998	0	56	0	14	186	0		256
1999	3,211	708	2,015	359	230	0		6,522
2000	6	734	15	233	306	51		1,345
2001	62	1,105	284	2,084	450	0		3,985
2002	0	259	838	44	386	642		2,169
2003	381	91	97	221	437	56		1,283
2004	2,701	197	902	3,897	156	174		8,026
2005	403	368	59	115	88	0		1,032
2006	73	57	418	90	13	0		651
2007	582	540	145	207	174	853		2,501
2008	211	4,218	903	1,942	1	0		7,275
2009	2		1,044	31	66	0		1,143
2010	11	1	71	0	700	0		783
2011	1	0	17	290	172	31		511
2012	202	465	104	248	55	0		1,074
1998-2012	7,846	8,799	6,912	9,775	3,420	1,807		

The type of vegetation involved in wildfire in the WUI provides additional insight into where WUI fire occurs. Although conifer forest is still a significant component of WUI fires, hardwood forest has been the dominant vegetation class involved in recent years when a large amount of WUI lands is burned. This is mostly west side oak woodland where there is a lot of relatively low elevation development. There is, however, a vulnerable component of conifer forest within the WUI at a little higher elevation amid the wildland forest. Herbaceous rangeland, as well as shrub and brush, are also a significant components of these high WUI fire years. This is all presented in the chart below (Data provided in Table 8 of the Appendix.).


Acres Burned In WUI by Vegetation Type
Acres
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Agriculture
Barren
Conifer Forest
Hardwood Forest
Herbaceous Rangeland
Rural Development
Shrub and Brush Rangeland
Streams and Wetlands
Urban + Residential

Acres Burned by Fire Severity

Not only is fire size important in measuring the impact of fire on the watershed but the severity at which the fire burns and the amount of area burned at a high severity is just as important.

Measuring and Reducing Fire Severity

Complete elimination of severe wildfire is not desirable, but current forest conditions lead to large fires dominated by high severity burning with unwanted consequences. Varying levels of burn severity within a fire help create or maintain a mosaic of ecosystem habitats and corridors, but when large areas burn with high severity it not only destroys or eliminates critical habitat but creates erosion and water quality problems as well, and provides for the introduction of non-native and invasive species further changing the habitat from the pre-fire regime. Low intensity fires tend to remove fuel and thin vegetation and generally reduce competition for nutrients and water and reduce insect and disease populations. The mosaic of disturbances created by a variety of burn severities within a fire more closely mimic historic natural fire occurrence.

A USFS report, Sierra Nevada Fire Severity Monitoring 1984-2004 (Miller, Stafford), documents that there has been an increase in the proportion of acres burned at high severity in most of the fires experienced on US Forest Service lands in the Sierra Nevada during the survey period. Overall, 14 percent of wildfire burned at high severity in 1984, while 23 percent of fire area was at high severity just twenty years later. Different forest types exhibited varying levels of change in fire severity over the twenty year period. The proportion of severe fire in mixed conifer stand fires increased from 17 percent to 27 percent; while severity in white fir and black oak stands increased 200 – 300 percent, and there was no appreciable increase in fire severity in low-elevation west side Ponderosa pine and high-elevation forests.

While burn severity within a fire perimeter has been documented and measured in this and other studies on some lands, currently a consistent methodology and data set is not available to provide a Region-wide indicator related to fire severity. CAL FIRE is currently developing a methodology to consistently measure burn severity within the fire perimeter on all fires above a certain acre threshold. The SNC will continue to work with CAL FIRE and the US Forest Service to develop a uniform database of fire severity on all lands in the Sierra Nevada, by forest type, ownership category, and level of severity, so that trends in fire severity can be comprehensively tracked over time.

Fire Return Interval and Fire Severity

As discussed in the SNC Forest Health and Carbon Storage Indicators report, the Fire Return Interval Departure (FRID) shows that the frequency of fire return has a great deal of bearing on fire intensity when fires do occur. The fire return interval prior to European settlement (before about 1850) averaged 20 years or less on 75% of the forest lands in the Sierra Nevada, whereas 75 percent of the forest has not experienced fire in the past 103 years. The lack of periodic low severity fire on the land allows forest fuels to become overstocked so that fires burn more intensely when they do occur. As forests and vegetative cover gets denser there is more

competition for moisture and stands get thicker with increased mortality and dead standing and ground fuels.

Landscape Priority for Treatment

As discussed in the Forest Health and Carbon Storage Indicators report, CAL FIRE has identified watersheds with a high potential for risk of damage from severe wildfires. They identified that the North and North Central sub regions have areas with the highest threat to watershed health in the event of a high severity fire. High severity fires on the landscape have the potential to have dramatic impacts of watershed function including sedimentation rates, and changing micro climate by burning up litter, roots and other organics exposing soils to erosive precipitation. The larger the areas burned under a high severity condition, the higher the potential for damage to the ecosystem. Where infrastructure is located in or near these watersheds there is also significant risk to those improvements and assets.

Treatments in these watersheds can be performed in a number of ways and there is no one-size-fits-all approach, though there is general agreement that the ideal situation would be the return of more frequent low intensity fires that would approximate historic conditions. Prescribed fire is the most economical way to maintain low or more historic fuel loads as well as return to more historic fire regimes, but there are a number of factors that make this extremely difficult. Infrastructure and homes built in the wildland areas make it more problematic to conduct burns in these areas. It has also been difficult for land managers to schedule prescribed burns in a “burn window” where the fire will burn to get the desired results and still comply with air quality restriction or limitations. Potential liability in the event the prescribed fire escapes is also a serious consideration. In many instances, prior to introducing fire to the landscape, the heavy fuel loads of overstocked forest stands due to long term fire exclusion would require some mechanical thinning of biomass before fire could be reintroduced to those areas. Steep terrain and other sensitive areas can even require hand thinning. These mechanical and hand treatments are expensive.

Shaded fuel breaks can complement general forest thinning and help control the potential spread of wildland fires, and is particularly important in protecting communities from catastrophic wildfire. An understanding of fire threat and fire severity history can aid in strategically designing and locating fuel breaks. There are many areas in the Sierra that have developed Community Wildfire Protection Plans (CWPP) that do identify priority areas or actions to reduce the potential for large damaging fires, but coordinating across ownerships has been difficult for many communities due to a lack of funding or coordinated timing for available funding to either start or finish a project.

Conclusion

Much of the Sierra does not have the same forest conditions as in the past, and a changing climate regime may have additional impacts to those conditions. Restoring the health of the forest and reducing fire threat will take a significant amount of time (most likely decades) and increased investment. These Fire Threat Indicators can help us track the progress that is being made in terms of on-the-ground efforts to improve forest conditions and reduce fire threat over time and help inform strategic investment.

References

California Department of Forestry and Fire Protection, Resource Assessment Program, California's Forests and Rangelands: 2010 Assessment

USDA Forest Service, Pacific Southwest Region, Jay Miller and Hugh Stafford, R5-TP-027, August 2008, Sierra Nevada Fire Severity Monitoring 1984-2004

Contact Information

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Appendices

Table 1

Number of Acres in SNC Region by Threat Class						
	Extreme	Very High	High	Moderate	Little or No Threat	Total
Number of Acres	21,170	11,024,776	6,433,159	5,110,773	2,971,554	25,561,433
Percent of total SNC area	0.10%	43.10%	25.20%	20.00%	11.60%	

Table 2

Acres in Threat Class by Subregion and Percentage of Area within That Subregion												
Threat Class	North Sierra		North Central		Central Sierra		South Central		South		East	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Extreme	3,993	0.1%	17,178	0.5%								
Very High	3,162,779	49.9%	1,764,495	48.6%	1,243,943	48.3%	1,545,528	46.2%	2,670,537	45.6%	637,493	16.7%
High	1,633,071	25.8%	1,044,112	28.8%	477,920	18.6%	902,304	27.0%	1,175,066	20.1%	1,200,686	31.4%
Moderate	751,306	11.9%	562,998	15.5%	683,069	26.5%	549,627	16.4%	1,161,359	19.8%	1,402,414	36.7%
Little or No	785,844	12.4%	241,467	6.7%	170,315	6.6%	344,960	10.3%	850,240	14.5%	578,728	15.2%
Total	**6,336,993**		**3,630,250**		**2,575,247**		**3,342,419**		**5,857,203**		**3,819,322**	

Table 3

Federal and Non-Federal Ownership by Subregion and Threat Class							
	Threat Class						
	High and Above	Percent	Moderate	Percent	Little or No	Percent	Total
All Federal Lands							
North Subregion	2,724,695	82.6%	367,568	11.1%	204,578	6.2%	3,296,841
North Central Subregion	1,560,917	78.7%	341,596	17.2%	81,124	4.1%	1,983,637
Central Subregion	559,028	52.3%	430,470	40.2%	80,059	7.5%	1,069,556
South Central Subregion	1,039,236	57.6%	452,789	25.1%	312,891	17.3%	1,804,916
South Subregion	2,187,673	53.9%	1,046,859	25.8%	824,295	20.3%	4,058,827
East Subregion	1,647,412	53.2%	1,044,504	33.7%	403,731	13.0%	3,095,647
Total	**9,718,961**	63.5%	**3,683,786**	24.1%	**1,906,678**	12.5%	**15,309,424**
Non-Federal Lands							
North Subregion	2,075,148	68.3%	383,739	12.6%	581,266	19.1%	3,040,153
North Central Subregion	1,264,868	76.8%	221,402	13.4%	160,343	9.7%	1,646,613
Central Subregion	1,162,835	77.2%	252,599	16.8%	90,256	6.0%	1,505,691
South Central Subregion	1,408,596	91.6%	96,838	6.3%	32,069	2.1%	1,537,502
South Subregion	1,657,931	92.2%	114,500	6.4%	25,945	1.4%	1,798,376
East Subregion	190,767	26.4%	357,910	49.5%	174,997	24.2%	723,675
Total	**7,760,145**	75.7%	**1,426,988**	13.9%	**1,064,876**	10.4%	**10,252,010**

Table 4

Acres Burned Per Year by Major Ownership															
Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Federal	9,084	139,283	142,018	104,772	198,662	63,598	50,998	20,366	51,004	122,447	230,639	57,382	52,786	40,852	389,758
Private	6,376	95,367	17,698	41,443	11,647	14,858	28,602	12,958	10,072	32,337	89,081	10,906	5,953	35,536	79,813
Other	1,048	24,086	1,237	2,711	4,184	1,996	1,227	875	278	5,682	12,492	2,375	1,463	4,263	4,911
Total	**16,508**	**258,735**	**160,953**	**148,927**	**214,493**	**80,453**	**80,827**	**34,199**	**61,353**	**160,467**	**332,213**	**70,663**	**60,202**	**80,652**	**474,482**

Table 5

Acres Burned By Subregion by Year for All lands and Threat Classes															
Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
North Subregion	2,751	33,352	1,243	42,643	9,775	15,420	19,653	3,479	14,845	8,811	28,038	33,177	11,967	3,052	336,966
North Central	3,127	175,511	57,905	14,348	1,940	2,190	3,217	2,873	6,424	89,780	160,092	1,085	1,404	88	95,499
Central Subregion	344	12,673	592	28,078	6,302	1,378	8,838	255	812	9,059	25,818	4,894	1,467	1,460	2,763
South Central	320	23,123	11,726	41,420	4,339	21,164	37,693	3,678	11,015	2,950	44,284	19,985	3,752	9,591	5,994
South Subregion	6,215	7,738	86,698	14,132	155,946	32,422	8,050	22,566	16,589	12,229	66,636	7,350	39,611	58,062	19,383
East Subregion	3,751	6,339	2,788	8,304	36,192	7,879	3,376	1,347	11,668	37,638	7,344	4,171	2,001	8,399	13,877
Total Acres Burned	**16,508**	**258,735**	**160,953**	**148,927**	**214,493**	**80,453**	**80,827**	**34,199**	**61,353**	**160,467**	**332,213**	**70,663**	**60,202**	**80,652**	**474,482**

Table 6

Acres Burned Per Year by Threat Class for All Lands															
Threat Class	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Extreme		2,454				20	8	27		25	1,176	47	35		549
Very high	11,280	158,722	86,409	69,830	114,843	24,092	35,190	18,218	21,969	75,117	198,645	37,013	45,068	51,938	325,312
High	4,622	83,947	63,513	70,299	87,800	44,272	38,892	8,209	17,481	53,485	91,737	22,020	8,292	7,179	91,074
Moderate	380	7,592	4,366	6,617	4,433	6,515	4,970	6,653	15,715	26,394	35,466	9,570	5,117	19,828	28,762
Little or No	225	6,021	6,665	2,181	7,418	5,555	1,766	1,093	6,188	5,445	5,190	2,012	1,689	1,707	28,786
Total Acres Burned	**16,508**	**258,735**	**160,953**	**148,927**	**214,493**	**80,453**	**80,827**	**34,199**	**61,353**	**160,467**	**332,213**	**70,663**	**60,202**	**80,652**	**474,482**

Table 7

Acres of Land (Excluding WUI) Burned Per Year by Vegetation Type															
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Agriculture	323	402	-	80	34	117	10	26	235	79	93	7	126	116	324
Barren	2,111	11,895	21,241	6,658	2,812	2,476	946	289	1,655	1,290	2,145	971	776	1,104	2,406
Conifer Forest	3,187	66,004	70,515	76,524	99,464	42,118	35,795	17,248	33,575	94,187	182,896	41,523	17,014	24,058	151,053
Hardwood Forest	6,960	80,723	9,155	23,155	20,244	4,619	18,286	4,879	2,935	9,786	68,714	8,890	7,061	11,984	14,958
Herbaceous Rangeland	-	39,342	41,187	5,469	5,883	5,960	4,641	7,196	3,054	7,166	18,484	1,772	3,511	25,681	6,612
Rural Development	3	28	10	79	106	6	20	6	-	62	48	45	53	28	44
Shrub and Brush Rangeland	3,708	53,343	16,902	31,712	83,011	23,515	12,884	3,419	18,865	45,045	51,239	15,461	30,743	16,554	295,940
Streams and Wetlands	49	446	588	1,156	746	342	210	105	383	326	1,306	831	124	614	2,060
Urban + Residential	14	30	8	108	24	19	8	0	2	24	15	21	12	3	10
Total	**16,252**	**252,214**	**159,607**	**144,941**	**212,325**	**79,171**	**72,800**	**33,167**	**60,703**	**157,965**	**324,938**	**69,521**	**59,420**	**80,140**	**473,408**

Table 8

Acres of WUI Burned Per Year by Vegetation Type															
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Agriculture		66		0	8	14	51	4	1	20	204		11		0
Barren	0	520	13	46	2		11	0	16		27	4		2	5
Conifer Forest	4	1,063	389	801	297	5	1,231	96	349	338	2,432	195	15	33	737
Hardwood Forest	67	3,407	553	1,834	678	550	4,664	291	150	447	2,718	679	106	100	223
Herbaceous Rangeland	103	795	169	925	432	227	936	134	67	511	1,134	76	158	202	50
Rural Development	0	107	15	12	98	0	102	0		27	43	106	4	8	3
Shrub and Brush Rangeland	81	539	194	356	582	455	1,012	499	66	1,138	649	52	485	126	52
Streams and Wetlands		4	8	2	16	31	15	7		11	34	2	0	38	1
Urban + Residential	0	22	4	9	56	0	5	0	1	8	34	29	3	1	4
Total	**256**	**6,522**	**1,346**	**3,985**	**2,169**	**1,282**	**8,026**	**1,032**	**650**	**2,502**	**7,275**	**1,142**	**782**	**511**	**1,075**

Table 9

Acres of Wildland Urban Interface (WUI) Burned Per Year by Subregion and Threat Class

Acres in WUI burned in Moderate and Little or No Threat Classes

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
North Subregion		225	1	5		9	208	12	14	8	6	1			
North Central		42	57	48	11		69	26	55	74	175				331
Central Subregion		41		8	188	1	25	5	5	14	300	109	16		4
South Central	2	6	0	17			201	4		1	40			14	61
South Subregion		1	2		100	1	2	5		8		2	4	67	0
East Subregion			0		226	50	1			71				31	
Total	**2**	**315**	**61**	**78**	**526**	**60**	**506**	**51**	**73**	**177**	**522**	**112**	**20**	**112**	**396**

Acres in WUI burned in Very High, High, and Extreme Threat Classes

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
North Subregion		2,986	5	58		372	2,493	391	60	573	204	1	11	1	202
North Central	56	666	677	1,057	247	91	127	342	2	466	4,043		0		135
Central Subregion		1,974	15	276	650	96	877	54	413	131	603	935	55	17	100
South Central	12	352	233	2,067	44	221	3,696	111	90	206	1,902	31		276	187
South Subregion	186	229	304	450	286	436	154	83	13	166	1	64	696	104	55
East Subregion			51		416	6	173			782					
Total	**254**	**6,207**	**1,285**	**3,908**	**1,643**	**1,222**	**7,520**	**981**	**577**	**2,325**	**6,753**	**1,030**	**762**	**399**	**679**