Living in Fire Prone Natural Landscapes - Reducing the Risk to Rural Communities from Wildfire

Photo: National Interagency Fire Center

Report by the

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Table of Contents

List of Maps

List of Tables

Summary of Findings

- Fire has played a major role in shaping the globally outstanding forests of the Klamath-Siskiyou ecoregion and any fire management plan striving to protect human lives and property must also be careful to sustain this fundamentally important ecological process.

- The purpose of this study was to develop an approach to mapping fire hazard at an intermediate spatial scale for the Oregon portion of the Illinois River Basin and to demonstrate how such an approach can be used to identify and prioritize fire management activities that would have the greatest chance of minimizing human losses from fire while at the same time protecting the many conservation values of the region.

- In general, it is neither operationally or ecologically feasible to exclude fire or impose an understory fire regime impacted by natural stand-replacing fire across the entire landscape. However, a strategic process that makes use of remote sensing and ground verification methodologies is warranted for prioritizing areas for treatment.

- Using GIS mapping, this study examined fire hazard (as defined by terrain and fuels), fire management zones and ownership, ecological sensitivity, and historic fire ignition.

- Ecological sensitivity results showed the majority of the high and very high fire hazard area (90%) contained one or more known ecological factors. Special management actions are warranted on ecologically sensitive sites throughout the study area.

- The most effective and ecologically responsible fire management strategy would be to focus fuel treatments within the wildland-urban interface (WUI), especially immediately adjacent to human structure and not in remote wildland areas. For this study area, only 2,267 ac of the WUI was mapped as having high or very high fire hazard. Another 3,915 ac of the WUI was mapped as having moderate fire hazard and should be field checked for possible fuels reduction management.

- Nearly 32,000 ac of the WUI buffer (2 km) was also mapped as high or very high fire hazard, 17,650 ac of which was on public land (mostly BLM) and 14,154 ac on private land. One-third of this area (approximately 10,000 ac) was shown to have no known ecological sensitivity and was located primarily east of Cave Junction and Selma.

- The estimated total area of land targeted to receive some form of fire management based on our analysis would be from 12,000 to 26,000 ac (6-12% of the high fire risk area and only 2-4% of the region).

- Although the work focused on southwestern Oregon, we believe a similar modeling approach could be applied to other sites throughout the West. Some regions may require larger areas of fuels treatment, but widespread management of existing wildlands will only diffuse effective treatment that should be applied where it is needed most and where it would be most effective.

Introduction

As more and more people move into remote areas throughout western forests and rangelands, it is becoming increasingly important for scientists, land managers, policy makers, and the public to understand the natural fire dynamics of these systems. Over the last decade, wildfires have burned on average approximately 4.2 million acres each year with lows of 2.3 million acres in 1993, 1995, and 1998 and a decadal high of 8.4 million acres in 2000 (NIFC 2004). Over recent years, there has been a growing concern about the number of severe fires throughout the West and their impact on human communities and local economies. Some argue that the buildup of fuels to unnatural levels is primarily the result of decades of fire suppression while others argue that prolonged and more frequent droughts are most responsible. Each position is correct to one degree or another, but like so many things, it is difficult (and even dangerous in some situations) to oversimplify a complex and ever-changing dynamic between the components and the forces of nature. Natural fire regimes and the human impacts on these regimes can be quite complex and highly variable from place to place (Turner et al. 2003).

In 2002, 6.9 million acres burned in the U.S. with a total suppression cost of over $1.6 billion. Damage to human structures that year totaled over 2,300 including 835 primary residences (NIFC 2004). As the result of major lightening strikes across one region (the Klamath-Siskiyou) on July 13, 2002, four separate fires were ignited in backcountry locations that later coalesced to form the Biscuit Fire. Weather conditions were particularly dry and windy and the fire burned with relatively high severity. But as is typical even in severe fire events, the Biscuit Fire did not burn uniformly across the landscape but in a patchwork of severities. The fire was vigorously fought at a cost of approximately $153 million and included fire line construction and extensive high-intensity backburning. There was no loss of human life as a result of the fire, but several structures were lost including 4 homes, 9 outbuildings, 1 lookout and numerous recreation structures (USDA FS 2003). After the last fires were extinguished approximately two months later, the Biscuit Fire perimeter included approximately 500,000 acres with 92 percent located in the Siskiyou National Forest. It was one of the largest fires that year in the nation and one of the largest fires in Oregon history. Understandably, there was great safety concern for the people living in the region, and those concerns continue in uneasy anticipation for the next fire.

The Klamath-Siskiyou — Site of the Biscuit Fire

The Klamath-Siskiyou ecoregion exhibits an extraordinarily rich flora and fauna (Whittaker 1960, 1961, Kruckeburg 1984) and widely recognized as one of the most diverse temperate forests on Earth (DellaSala et al. 1999). For example, the region contains a continental maximum of temperate conifer species (30) with as many as 17 conifer tree species recorded living together within a single stand. More than 3,500 plants, including 220 endemics are known to occur in the Klamath-Siskiyou (Sawyer 1996). With these characteristics, it is little wonder why the Klamath-Siskiyou is recognized as a place of Global Botanical Significance by the World Conservation Union (IUCN), one of only six global priorities in the United States for the World Wildlife Fund (DellaSala et al. 1999), as well as a global Centre of Plant Diversity (Wagner 1997). Geology, topography, climate, and time created the varied and rich natural communities, and fire has always been critical at shaping the composition and structure of the landscape for thousands of years. In addition to a diverse natural fire regime, Native Americans (especially along the Klamath and Rogue rivers) frequently burned sites to promote foraging habitat for deer and elk (Arno and Allison-Bunnell 2002) as well as to stimulate growth of plant species important for food, construction materials, and medicine. The combined effect of lightning and Native American burning shaped the composition and structure of the vegetation of the Klamath-Siskiyou for thousands of years (Arno and Allison-Bunnell 2002).

> Fire has played a major role in shaping the globally outstanding forests of the Klamath-Siskiyou ecoregion and any fire management plan striving to protect human lives and property must be careful to also protect this fundamentally important ecological process.

Despite its importance, fire regimes operating in the Klamath-Siskiyou are not well understood. In an area of steep climatic and edaphic gradients and rugged topography, fire return intervals and severities are mixed having a significant impact on the composition and structure of native plant communities (Agee 1991, Agee 1993, Taylor and Skinner 1995). Many of the plant species of the Klamath-Siskiyou are finely tuned to periodic fires of mixed severity. Such spatial and temporal variation in disturbance is believed one of the primary elements that promote species diversity through both non-equilibrium dynamics (Huston 1979) and the formation of dynamic vegetation mosaics (Spies and Turner 1999). Ecologically, large stand-replacing fires, which results from canopy fires and hot and lethal sub-canopy fires, are an important source of landscape heterogeneity and play a pivotal role in the population structure, genetics, and evolution of some important species (Turner et al. 2003). Therefore, understanding the role of fire is fundamentally important if we hope to protect rural communities and the many and varied conservation values for which this region is well known.

Post-fire Assessments

As with every major wildfire on Forest Service land, a post-fire assessment is conducted that typically includes a summary of the ecological and economic impacts from the fire. The subsequent post-fire assessment (USDA Forest Service 2003) for the Biscuit fire notes the buildup of fuels in some areas as a pre-fire condition, but the report concludes that the Biscuit fire behaved within its natural range of variability.

By means of the Environmental Impact Statement (EIS) process, a postfire management plan is developed for implementation, which includes – (1) management actions for economic recovery (usually in the form of salvage logging), (2) restoration management, and (3) management actions in preparation for the next fire. At the time of this report preparation, the final EIS is pending release. For a full report on ecological considerations for salvage in the Biscuit area see Strittholt and Rustigian (2004). With regard to fire management in the Biscuit FEIS, the area under consideration is restricted to a slightly larger area of the burn perimeter boundary. This study focused on the Oregon portion of the Illinois Basin, approximately half of which was burned by the Biscuit Fire.

Purpose

The purpose of this study was to develop an approach to mapping fire hazard at an intermediate spatial scale for the Oregon portion of the Illinois River Basin and to demonstrate how such an approach can be used to identify and prioritize fire management activities that would have the greatest chance of minimizing human losses from fire while at the same time protecting the many conservation values of the region. The Illinois River Basin was chosen because the rural communities in this basin were among the most threatened by the Biscuit fire of 2002.

Methods

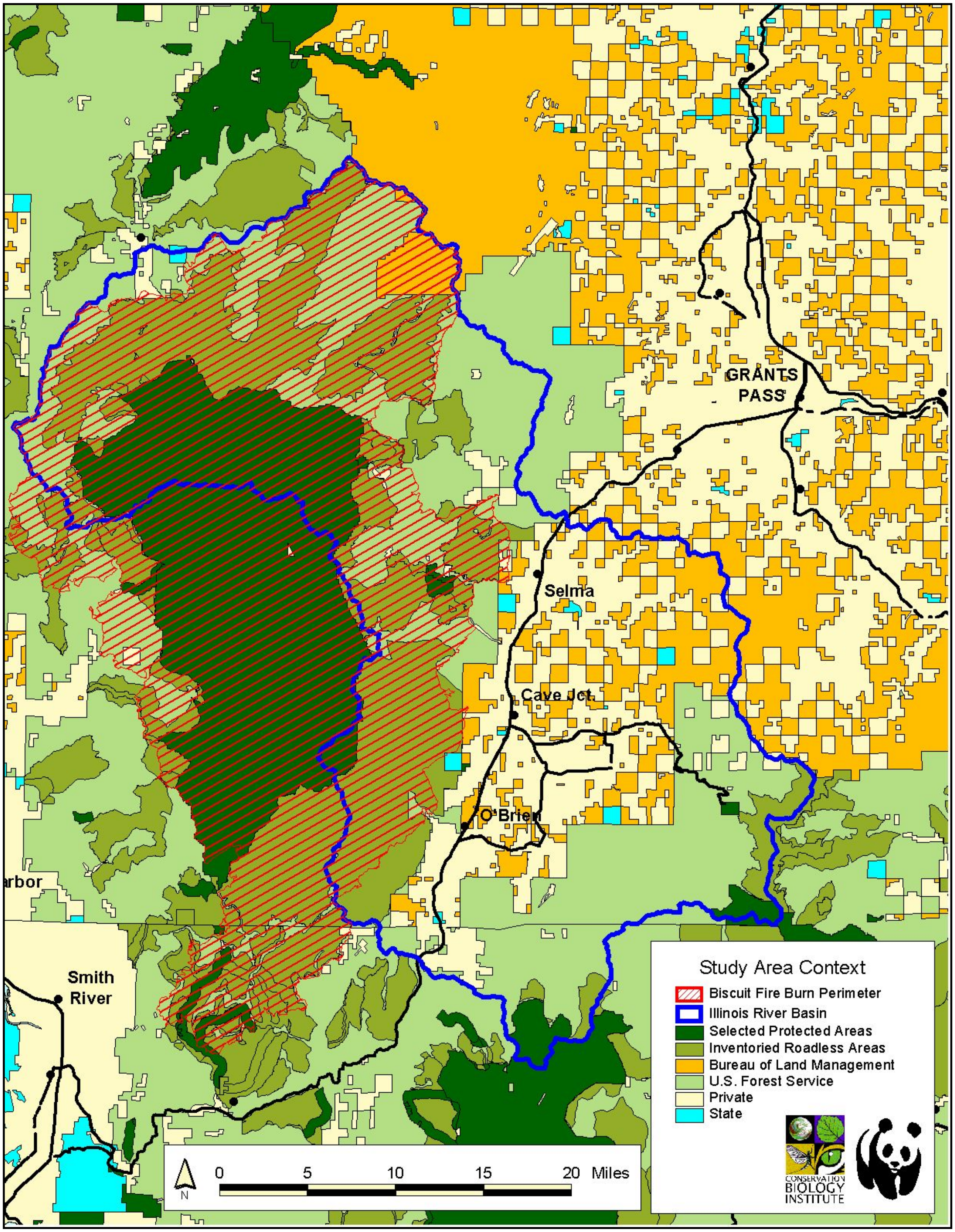
The three components that determine fire intensity – fuels, terrain, and weather – are well documented (McArthur 1967, Rothermal and Rinehart 1983, Beer 1990). Based on the best available spatially explicit data and expert opinion, fire hazard was mapped using geographic information systems (GIS) based on both a terrain and fuels component for the Oregon portion of the Illinois River Basin (Map 1; >590,000 ac) approximately half of which was within the Biscuit fire burn perimeter. All GIS modeling and mapping was done using ArcGIS version 8.2 software.

The terrain hazard component was created by combining four different factors equally weighted. Slope, aspect, relative slope position, and elevation were all derived from a 30m Digital Elevation Model (DEM). Scores, ranging from -1 (low hazard) to 3 (high hazard) were assigned to each terrain component (Table 1). Each of the scored terrain 30 m grids were summed and re-classed with the following fire hazard classes: (1-2 = very low, 3-4 = low, 5-6 = moderate, and 7-9 = high). For example, the most hazardous terrain for wildfire were areas below 4,000 feet, in the top third of relative terrain position, >45% slopes, and on aspects ranging from 135-293 degrees.

Table 1. Scores for the terrain hazard component of the fire hazard map model.

Slope (%)	Aspect (°)	Relative Slope Position	Elevation (ft)	Score
> 45	135 – 293	Top Third		3
20 – 45	68 – 135, 292-315	Middle Third		2
0 – 20	0 – 68, 315 - 360	Lower Third		1
		Valley Bottom	≤ 4,000	0
			> 4,000	-1

The fuel hazard was also evaluated using a 30m-grid cell size and assigned a relative fire hazard score ranging from 1 (very low fire hazard) to 4 (high fire hazard). Relative fuel hazard was assessed using four different databases (Table 2). The most spatially explicit data available for the region (CBI Forest Age), which was derived from 2000 Landsat 7 ETM+ imagery (Jiang et al. 2004), was used as the foundation for mapping fuels.



Map 1. Map showing study area (Oregon portion of the Illinois River Basin) in the context of regional ownership and the 2002 Biscuit fire.

The more spatially coarse GAP vegetation data (Kagan et al. 1992) was used to modify the forest age data by increasing or decreasing the relative fuel hazard depending on the dominant vegetation type.

For the area within the Biscuit fire burn perimeter, relative fuel hazard was modified according to the degree of change from the prefire condition. For example, a site of old conifer forest in a Douglas Fir- Mixed Conifer Forest type prior to the fire that was highly changed as a result of the fire went from a fuel hazard class of 2 (low) to a fuel hazard class of 4 (high), because for the next few decades this area is likely to produce highly flammable fuels from hardwood sprouting and young conifer regeneration. Areas that burned severely in the Biscuit fire are essentially fire proof for at least a year or two after fire. Many of these areas will then become more packed with fuels as the shrub and young tree stage dominates. Within a decade or two, these same areas will begin loosing their flammability as the forest matures. This relatively high flammability is a more temporary condition as contrasted with logging slash, which can remain much longer on a particular site and has been shown to be the most flammable component in these forests.

Hazard was not determined for areas classed as Urban, Agriculture, Open Water, and Wetlands from Oregon GAP or Agricultural and Urban lands identified by the USGS National Land Cover Dataset (Vogelmann et al. 1998). The fuel hazard component is only appropriate at intermediate spatial scales. It is not reliable enough to accurately reflect actual fuel conditions at the site level. That level of detail needs to be done either by aerial photograph interpretation or stand level assessments.

Fuel hazard and terrain results were field verified using 46 randomly generated points within 2 miles of the existing road network to improve access. For each sample, one or more digital photos were collected and fuel and terrain condition recorded. Two different reviewers evaluated fuel condition independently. Disagreements were settled by a third reviewer. User's and Producer's Accuracy was calculated on the results for fuel hazard and terrain hazard separately.

Table 2. Scores for fuel hazard. The higher the number, the higher the potential combustible fuels that can lead to high severity fire.

CBI Forest Age	Outside Biscuit (GAP veg type)		Within Biscuit (Vegetation Change)[3]		
	A[1]	B[2]	1 & 2	3	4
Old Conifer	2	1	1	3 (2)[4]	4 (3)[4]
Mature Conifer	2	1	1	3 (2)[4]	4 (3)[4]
Young Conifer	4	4	3	4	4
Early Regen/ Young Brush	2	2	2	2	2
Hardwood	3	3	3	4	2
Open Woodland	1	1	1	1	1
Non-Forest	2	1	2	2	2
Water	0	0	0	0	0

[1] Siskiyou Mountains Mixed Deciduous Forest, Douglas Fir- Mixed Conifer Forest, Douglas Fir – White Fir/Tanoak-Madrone Mixed Forest

[2] True Fir- Hemlock Montane Forest, Shasta Red Fir – Mountain Hemlock Forest, Douglas Fir-Western Hemlock-Western Redcedar, Douglas Fir-Port Orford Cedar, Jeffrey Pine Forest and Woodland, Serpentine Conifer Woodland, Siskiyou Mountains Serpentine Shrubland, Grass-shrub-sapling or regenerating young forest

[3] Vegetation change 1&2 = no to low change in vegetation due to the Biscuit fire; 3 = moderate change; 4 = high change

[4] Score for GAP veg type B in parentheses.

The resulting 30 m resolution terrain hazard grid and 30 m resolution fuel hazard grid were then added together to form a combined fire hazard grid and mapped as very low (2-3), low (4), moderate (5), high (6), and very high (7-8) fire hazard for the entire study area. Statistics were generated for each fire hazard class for the study area and for each of the four mapped management zones.

Areas of high ecological sensitivity were identified to determine where potential fuel treatment efforts could potentially compromise ecological values. Ecological sensitivity was measured as the occurrence of one or more of the following ten criteria: protected areas, roadless area, key watershed, serpentine soils, high erosion potential, riparian, critical spotted owl (*Strix occidentalis caurina*) habitat, critical marbled murrelet (*Brachyramphus marmoratus*) habitat, and two rare or unique habitats – meadows and old growth forest. Data source for each criterion is listed in Table 3.

Table 3. Data sources and descriptions used in mapping ecological sensitivity.

Criterion	Data Source	Scale/Resolution	Description
Protected Areas	GAP land management (Kagan et al. 1999)	1:100,000	All GAP Status 1 and 2 sites
Roadless Areas	Strittholt et al. 1999	1:24,000	All roadless areas 1,000 ac or larger
Sensitive Soils: Serpentine	Siskiyou National Forest	unknown	Serpentine soils
Sensitive Soils: High Erosion Potential	Siskiyou National Forest	unknown	Based on high slope and erosive parent material
Key Watersheds	FEMAT 1993	1:126,720	Watersheds identified by fish biologists as important for salmonids
Riparian Areas	Siskiyou National Forest	1:24,000	Streams buffered by 200 ft
Critical Habitat: Northern Spotted Owl	Siskiyou National Forest	1:24,000	Known spotted owl locations

Critical Habitat: Marbled Murrelet	Siskiyou National Forest	1:24,000	Known marbled murrelet locations
Rare/Unique Habitat: Meadows	Siskiyou National Forest	1:24,000	Meadow locations
Rare/Unique Habitat: Old Growth	Jiang et al. 2004	1:24,000	Old growth conifer locations

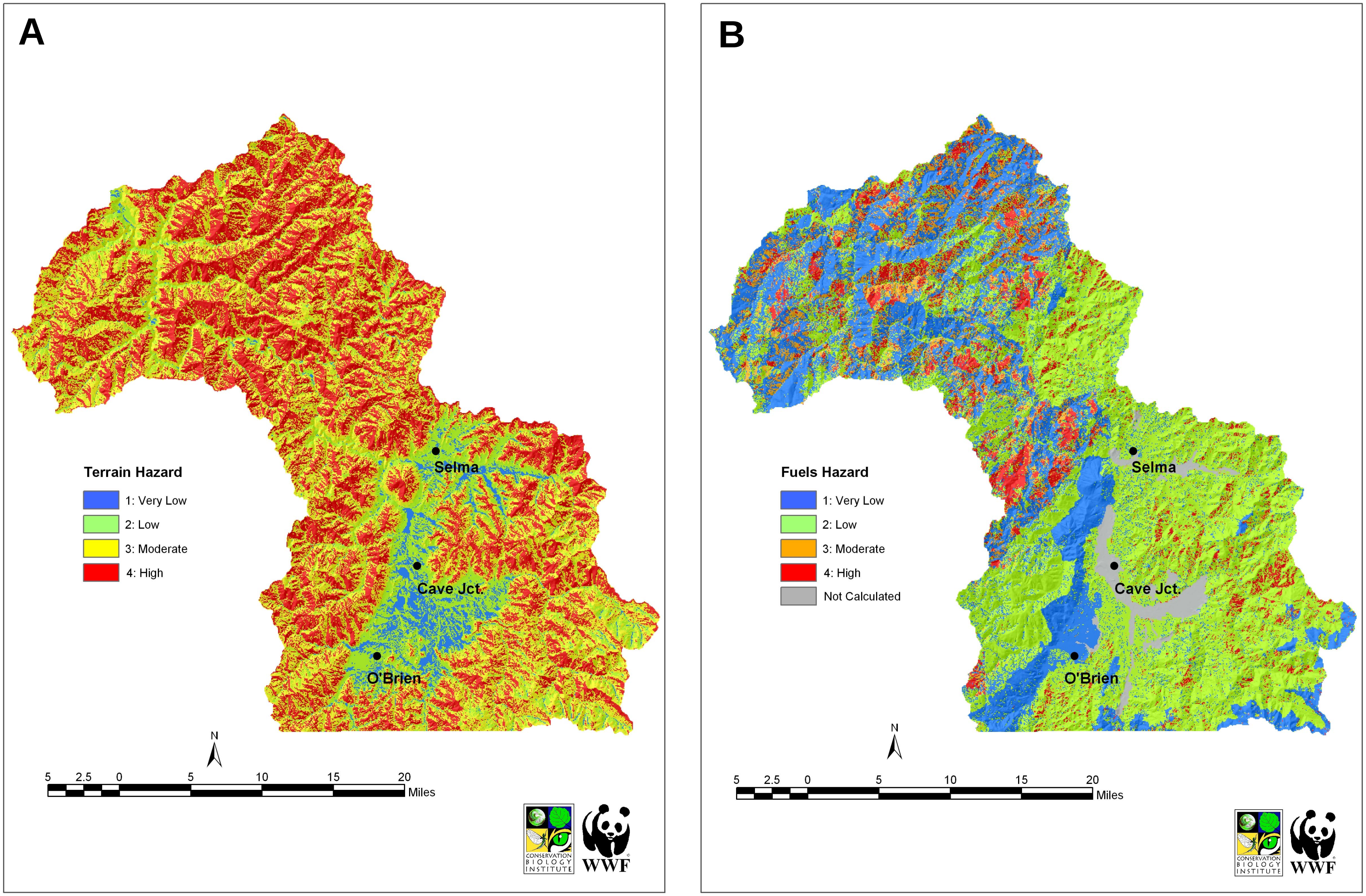
The wildland-urban interface (WUI) was created following USDA (2001) guidelines using 2000 U.S. Bureau of the Census population data. Census blocks with population densities of at least 28 people per square mile defined the WUI. The WUI was then buffered by two kilometers providing another fire management zone. Because of the importance of roads in providing access and possible ignition locations by humans, we also buffered the existing 1:24,000 roads data layer for the study area by 100 m outside the WUI to generate another fire management zone. All of the remaining area (wildlands) was mapped as the final fire management zone. In this context, “wildlands” are those areas predominantly in public ownership and largely forested; these are not areas that necessarily fit the more accepted definition for wildlands. However, in this particular region, most of the “wildlands” are truly wild being either designated wilderness or roadless. Each fire management zone was evaluated in terms of its ownership, fire hazard class, and ecological sensitivity.

High priority areas for fuel hazard reduction have high or very high fire hazard, high probability of ignition, and close proximity to rural communities (DellaSala and Frost 2001). Fire ignition data was acquired from the Siskiyou National Forest, which contains a source of ignition data field. Two separate ignition density data layers (lightning ignitions and human-caused ignitions) were generated for the study area and evaluated for this priority setting exercise.

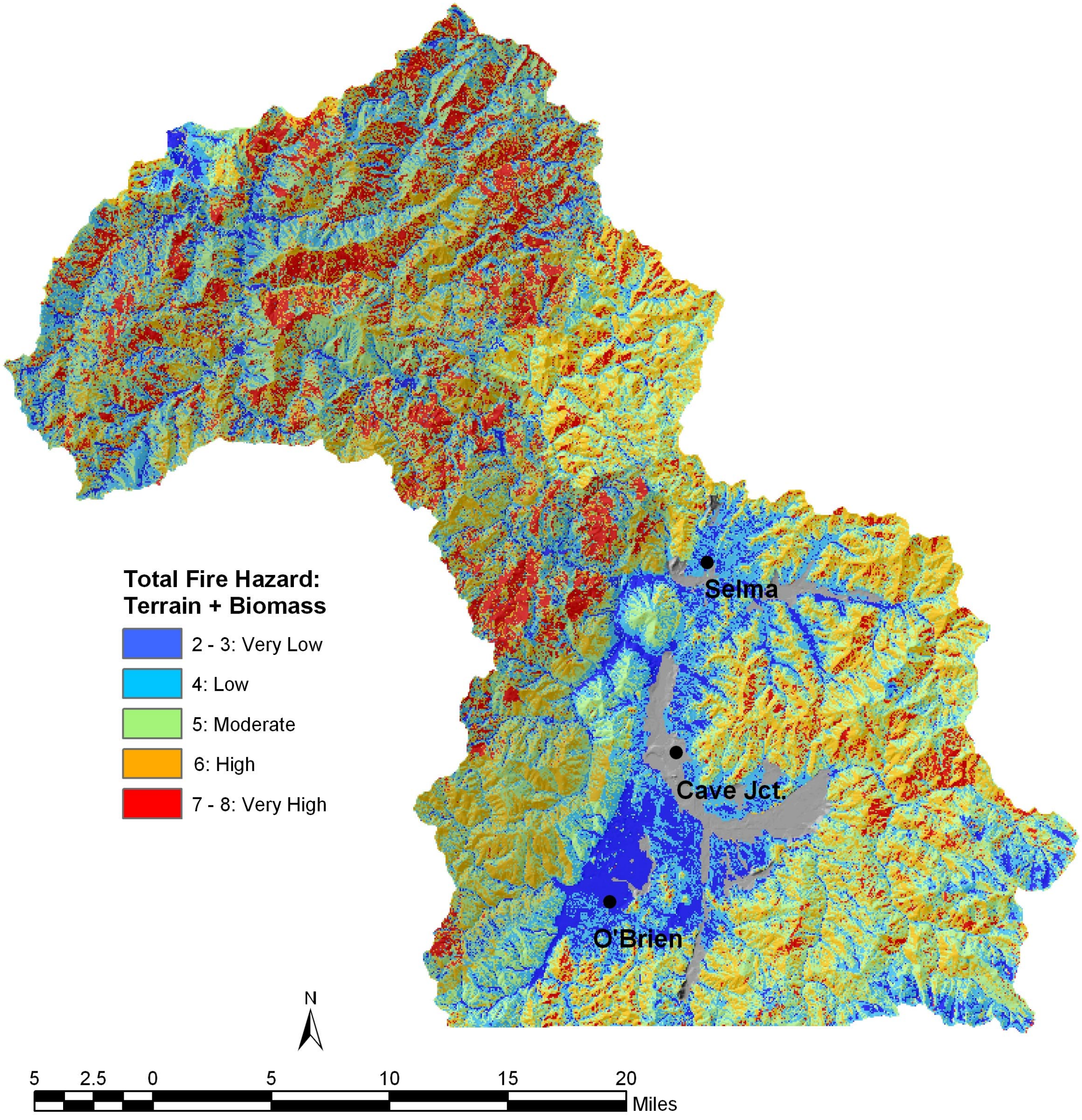
Results and Discussion

The Illinois River Basin (592,079 ac) is largely in public ownership (82%) most of which under management of the USDA Forest Service (nearly 71% of the basin). The Bureau of Land Management manages nearly 11 percent of the basin. A very small area of the basin (<1%) is state or other federal land. The remaining 18 percent of the basin is held in private ownership.

Results of the terrain and fuels components (Map 2A and Map 2B) show the spatial distribution of fire hazard for the Oregon portion of the Illinois Basin, and Map 3 shows the combined fire hazard scoring results. Just over 35% (210,508 ac) of Oregon’s Illinois Basin was evaluated as having high and very high fire hazard (Table 4). The majority of this area (152,131 ac, 72%) was located in the wildlands of the public land base; especially in the area recently burned in the Biscuit fire (Map 3). The WUI contained only 2,268 ac of high or very high fire hazard lands (approximately 1% of the total). The buffer area around the WUI contained much more area of high or very high fire hazard (26,749 ac and 5,096 ac respectively), especially on the eastern side of the valley and existing population centers.



Map 2. (A) Terrain hazard results and (B) fuels hazard results for the Oregon portion of the Illinois Basin.



Map 3. Total fire hazard results for the Oregon portion of the Illinois Basin. Shaded area depicts burn perimeter of the 2002 Biscuit Fire.

Table 4. Area of fire hazard classes (ac) and percent for each mapped zone.

Fire Hazard Class	**Wildlands**	**Percent**	**Wildlands Road Buffer**	**Percent**	**WUI**	**Percent**	**WUI Buffer**	**Percent**	**Total**	**Percent**
very low	18,669	4.97	3,432	5.12	11,359	26.72	14,060	13.13	47,520	8.03
low	77,639	20.68	14,130	21.07	13,559	31.90	25,213	23.54	130,542	22.05
moderate	126,533	33.71	25,204	37.58	3,915	9.21	30,905	28.86	186,557	31.51
high	94,973	25.30	**16,299**	24.30	**1,985**	4.67	**26,749**	24.98	140,006	23.65
very high	57,158	15.23	**7,965**	11.87	**283**	0.67	**5,096**	4.76	70,502	11.91
na	407	0.11	42	0.06	11,409	26.84	5,065	4.73	16,924	2.86
	375,380	100.00	67,071	100.00	42,511	100.00	107,088	100.00	592,051	100.00

> It is neither operationally or ecologically feasible to either exclude fire or impose an understory fire regime impacted by natural stand-replacing fire (Romme et al. In Press).

The fact that the majority of the high and very high fire hazard area was located in the wildlands zone (particularly inside the recent Biscuit fire burn perimeter) is not surprising. After all, this is the region with the most rugged terrain and available fuels (at least over the short-term with regard to fuels).

Some would argue that these results provide the rationale for penetrating into the backcountry with more roads and more intensive human manipulation of the landscape in the hopes of preventing future losses to human interests from fire. The idea is that by engineering the existing forest, humans can control wildfires to a large degree and in so doing protect human life and property.

However, mounting scientific evidence strongly suggests that in forests impacted by natural stand-replacing fire events, it is neither operationally or ecologically feasible to either exclude fire or impose an understory fire regime (Romme et al. In Press). In such systems, human interventions such as low-intensity prescribed fire and mechanical thinning to restore natural fire dynamics are largely inappropriate (Turner et al. 2003). In areas with histories of natural stand-replacing fires, regional fire management plans must accept and incorporate large, severe infrequent fires throughout much of the landscape (Romme et al. In Press).

Actively managing forests in a widespread fashion including considerable backcountry locations would – (1) cause irreparable harm to the native communities present; (2) would further disrupt and alter the natural fire dynamics in the region; and (3) would not serve the purpose for which the management was intended – it would not lower the risk of wildfire. In fact, such management would likely have the reverse effect. First, most advocates for such an approach state they would have to remove some of the large trees in order to finance thinning of small diameter stems and other management activities such as controlled burning. Removing the most important fire resistant structures in these forests (Franklin and Agee 2003) would actually increase hazardous fuels and therefore have the opposite effect of intended action. Second, in areas where new roads were built, there would be an increase in potential for human-caused fire ignition. This in turn would also open up currently isolated areas to both conventional transportation as well as off-road vehicle (ORV) users, which is a serious and growing concern in the region. Better access by humans also translates into higher probabilities of human-induced fire ignitions, which as discussed later in the report, is a significant source of fire starts. The most effective and ecologically responsible fire management strategy (one that protects human life and property) is to focus fuel treatments immediately adjacent to human habitation and not in remote wildland areas.

> The most effective and ecologically responsible fire management strategy is to focus fuel treatments immediately adjacent to human habitation and not in remote wildland areas.

The majority of the study area (64%) was mapped in the wildlands zone. Buffering of 1:24,000 roads by 100 m in the wildlands region resulted in an area making up 11 percent of the region. WUI area accounted for only seven percent of the region and the WUI buffer region (2 km buffer of the WUI) resulted in another 18 percent (Map 4A). Mapping of the high and very high fire hazard according to these four zones (Map 4B) shows the distribution of high and very high fire hazard areas throughout the basin. Note the concentration immediately east of Cave Junction in the WUI buffer area. The combined high and very high fire hazard areas are also presented according to the major ownership categories for additional information (Map 5).

Major land ownership within the WUI is private (82%) followed by the BLM (18%). State and U.S. Forest Service land makes up less than one percent of the WUI. The WUI Buffer area is more equally comprised of private and BLM land, 52 percent and 32 percent respectively. U.S. Forest Service land makes up 14 percent of this area (primarily along the western side) with state and other federal land making up the remaining area. Not surprisingly, the wildlands and wildlands roads buffered areas are largely U.S. Forest Service land (>92%).

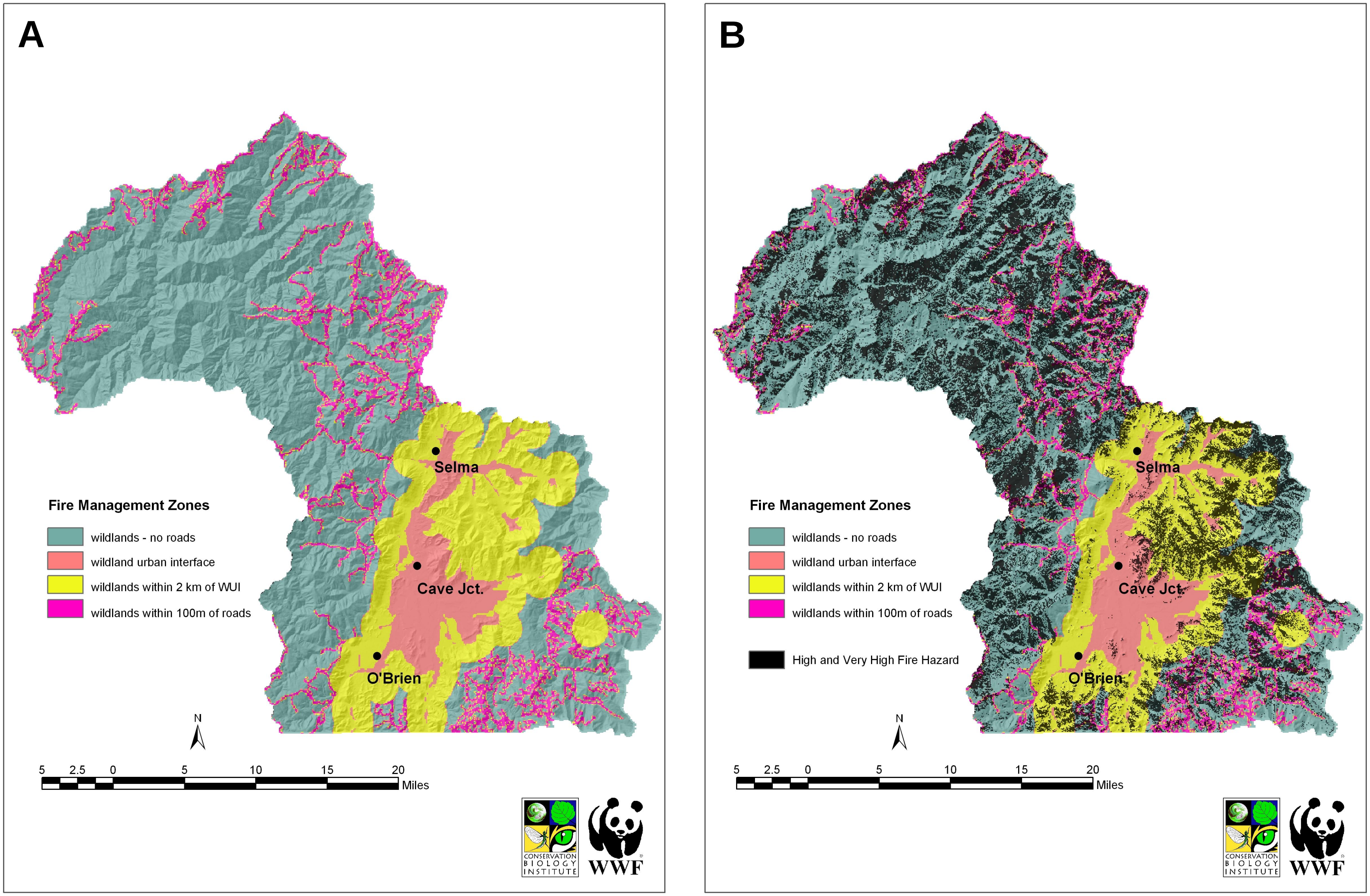
The dominant federal land management agency inside the WUI and WUI buffer area is the Bureau of Land Management.

Ecological sensitivity results showed the majority of the high and very high fire hazard area (90%) contained one or more known ecological factor (Map 6). Interestingly, the highest concentration of high or very high fire hazard with no known ecological sensitivity as mapped by our 10 criteria was located in the WUI buffer area to the east of the populated areas in the valley located on primarily private and BLM land. That is not to say that these areas require no care. Every treatment area warrants some level of scrutiny and responsible management. The number of kind of ecological factors present (identified by the 10 criteria or not) will ultimately dictate the most appropriate management actions. For example, areas on highly erodable soils in key watersheds would not be subjected to intensive mechanical treatment. Prescribed fire may be inappropriate in some mature or old forest stands.

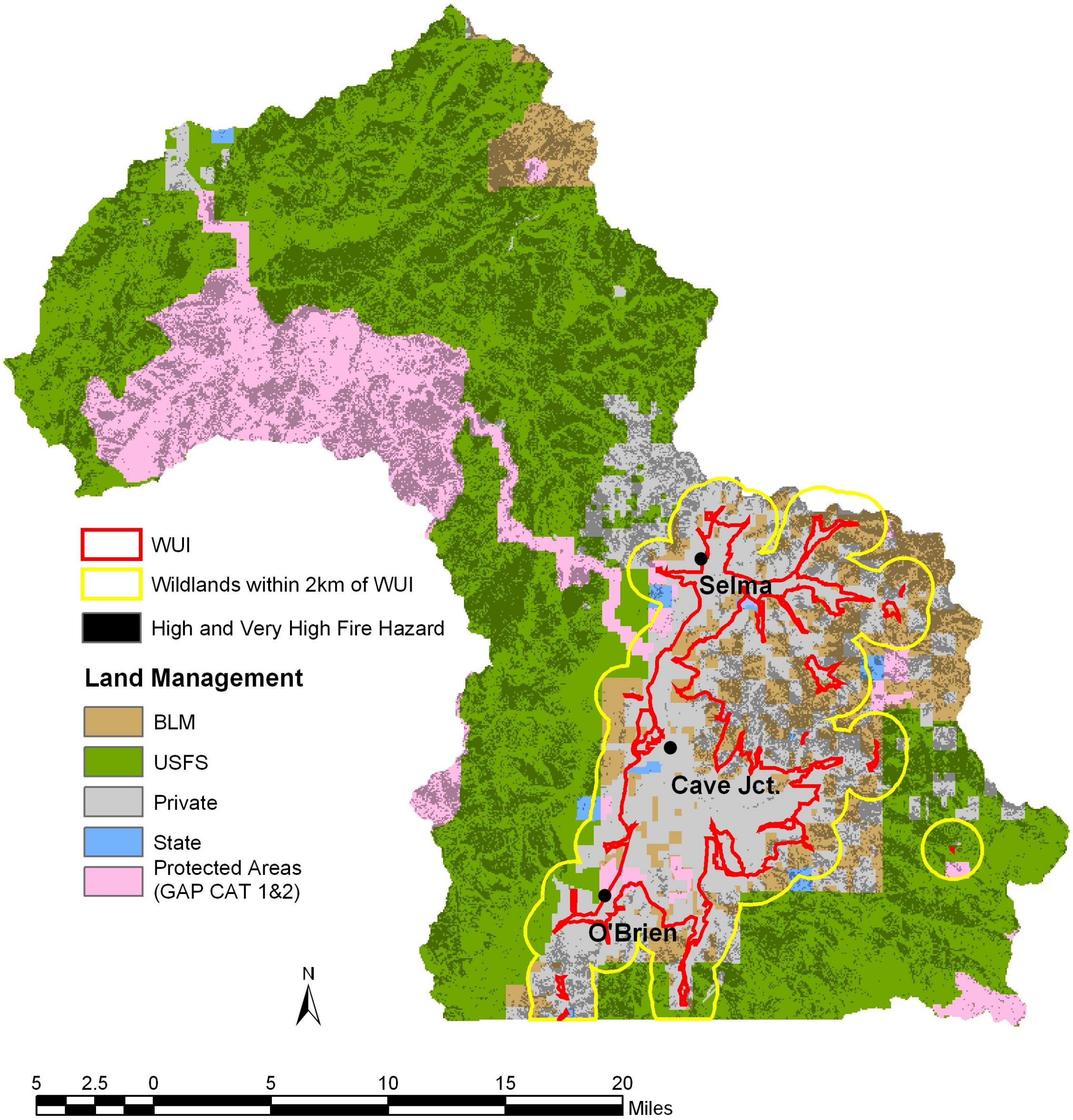
The highest concentration of high or very high fire hazard with no known ecological sensitivity was on private and BLM land in the WUI buffer area east of the more populated areas.

The total area of high or very high fire hazard in the WUI was 2,267 ac with the majority (1,418 ac, 62%) on private lands (Table 5). The WUI buffer contained larger area of high or very high fire hazard (31,804 ac) split between private (14,154 ac) and public lands (17,650 ac), primarily BLM. As stated previously, the overwhelming majority of the high and very high fire hazard area (151,878 ac) was found on the wildlands portion of the basin on Forest Service lands. The wildlands buffered roads zone was considerably smaller (24,168 ac) but shared the same percentage of public versus private lands.

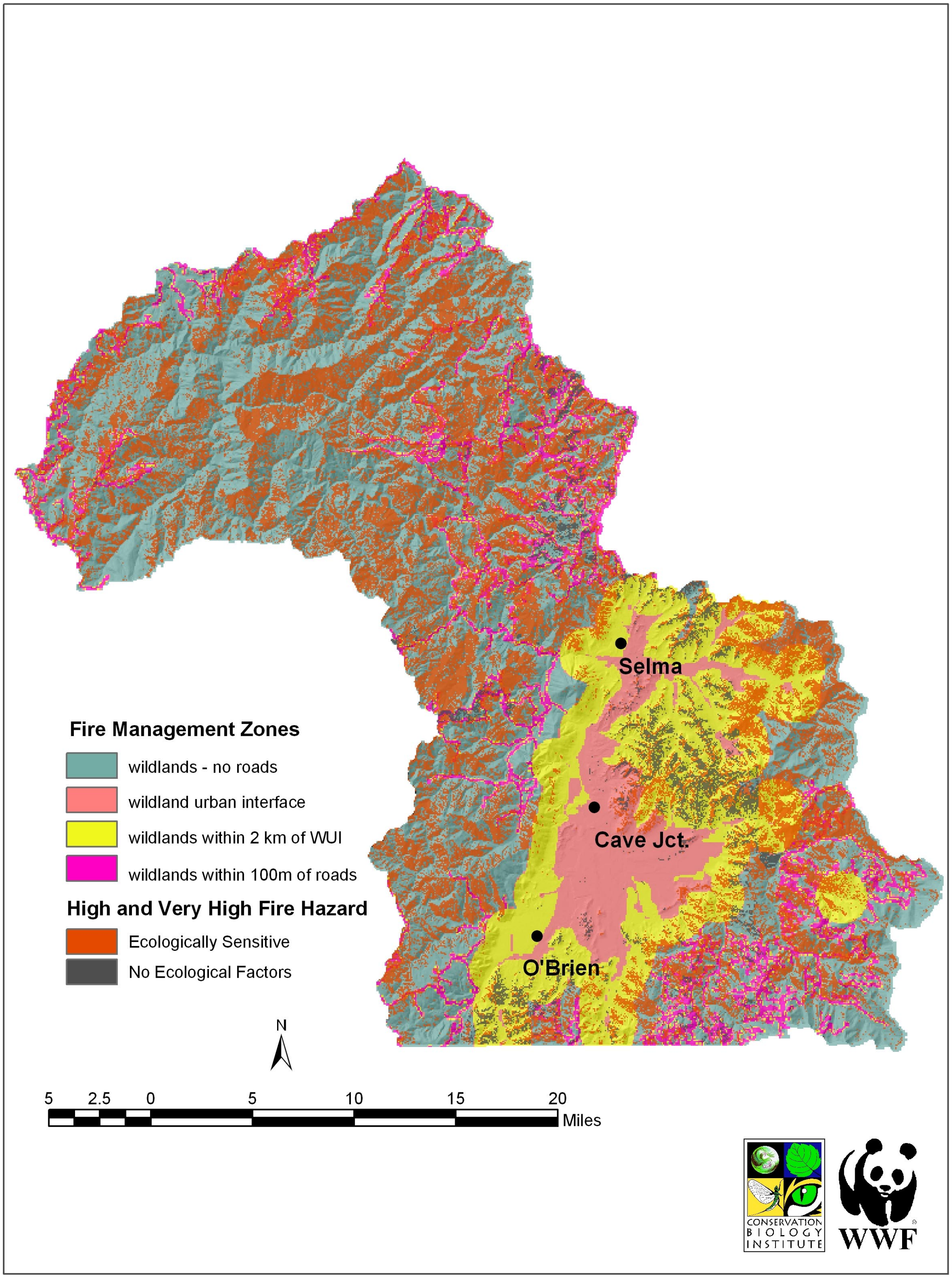
The last consideration for our analysis was on the concentration of past fire starts both in terms of naturally caused fires by lightning and by human ignitions (Map 7). Natural fire ignitions are most commonly at higher terrain position with the main concentration in this region immediately to the west and northwest of Cave Junction and Selma predominantly within the Siskiyou National Forest. Secondary concentrations are scattered further to the west with a few nodes to the southeast of O'Brien and Cave Junction.



Map 4. (A) Fire management zones mapped for the Oregon portion of the Illinois Basin. (B) High and very high fire hazard areas in the Oregon portion of the Illinois Basin plotted over mapped fire management zones.



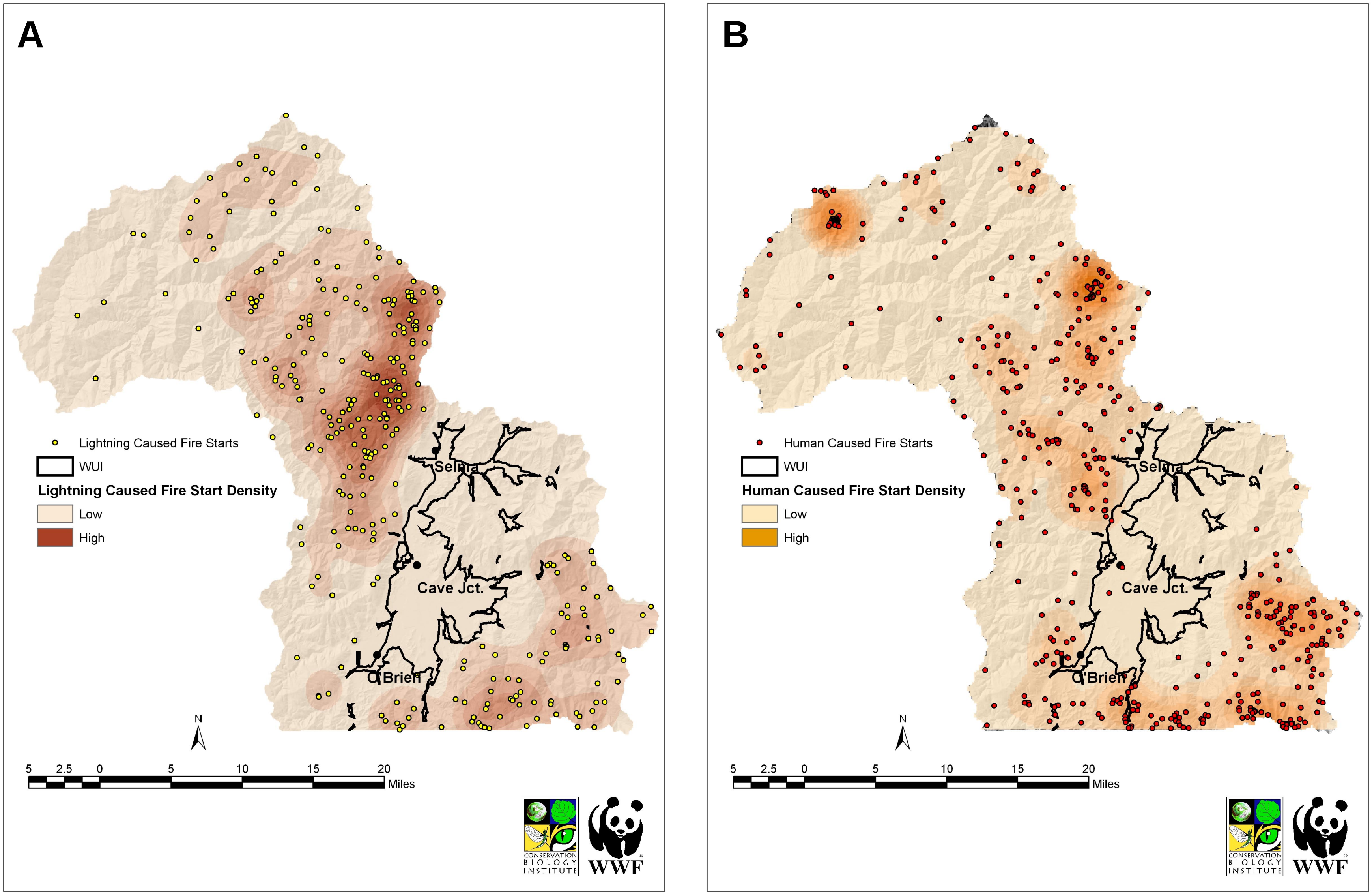
Map 5. Map of high and very high fire hazard areas according to major ownership for the Oregon portion of the Illinois Basin.



Map 6. Map showing distribution of high and very high fire hazard by fire management zone differentiated as to whether or not they are located in areas of known ecological sensitivity.

Table 5. Area of high and very high fire hazard (ac) by ownership within each mapped zone.

Zones	Ownership	No known ecological sensitivity		Known ecological sensitivity						
		Very High	High	Very High	High					
WUI	BLM	**24**	**248**	**38**	**536**					
	Private	113	551	106	648					
	State	0	1	1	1					
	USFS	**0**	**0**	**0**	**0**					
	NPS	0	0	0	0		**Public**	**Percent**	**Private**	**Percent**
Totals		137	800	145	1,185	2,267	849	37.45%	1,418	62.55%
WUI Buffered	BLM	**842**	**2,915**	**977**	**9,302**					
	Private	1,761	4,827	964	6,602					
	State	12	18	4	324					
	USFS	**17**	**146**	**512**	**2,529**					
	NPS	0	0	1	51		**Public**	**Percent**	**Private**	**Percent**
Totals		2,632	7,906	2,458	18,808	31,804	17,650	55.50%	14,154	44.50%
Wildlands	BLM	**80**	**376**	**1,836**	**7,307**					
	Private	419	1,172	2,945	5,217					
	State	1	2	1,291	223					
	USFS	**412**	**841**	**50,075**	**79,681**					
	NPS	0	0	0	0		**Public**	**Percent**	**Private**	**Percent**
Totals		912	2,391	56,147	92,428	151,878	142,125	93.58%	9,753	6.42%
Wildlands Buffered Roads	BLM	**0**	**8**	**117**	**112**					
	Private	60	294	201	689					
	State	2	4	0	9					
	USFS	**921**	**2,042**	**6,616**	**13,093**					
	NPS	0	0	0	0		**Public**	**Percent**	**Private**	**Percent**
Totals		983	2,348	6,934	13,903	24,168	22,924	94.85%	1,244	5.15%



Map 7. Densities of known (A) lightning and (B) human caused fire ignitions in the Oregon portion of the Illinois Basin.

Human-induced fire starts are more closely associated with roads and trails and more geographically scattered than the lightning caused fires. Concentration nodes are located to the west of the Selma, Cave Junction, and O'Brien in relatively small pockets as well as to the south and east of the valley.

Based on the mapping results for fire hazard, ecological sensitivity, WUI, and historic fire ignition, we propose the following recommendations. The highest priority areas for fire management should be those high or very high hazard areas closest to existing human structures within the WUI. This accounts for 849 ac of public (primarily on BLM lands) and 1,418 ac on private lands. Approximately 937 ac of this area has no known ecological sensitivity, which allows for greater flexibility of fire management techniques including various combinations of mechanical thinning and prescribed fire. The other 1,330 ac in this zone contain various ecological sensitivities and special attention should be paid to these areas so as not damage their known ecological values. Of the 2,267 ac inside the WUI, the highest priority should be placed in areas closest to homes and businesses. Another 3,915 ac inside the WUI, which were mapped as being of moderate fire hazard, should be field checked and treated as needed. It is expected that some subset of this area will require treatment. Nearly 32,000 ac of the WUI buffer was also mapped as high or very high fire hazard, 17,650 ac of which was on public land (again mostly BLM) and 14,154 ac on private land. Sites with known ecological sensitivity exceeded sites without by a 2 to 1 margin. As shown in Map 6, the highest concentration for these acres was also to the east of Cave Junction and Selma.

A coordinated effort between private land owners and federal land management agencies (primarily the BLM) should strive to reduce fuels over a portion of this WUI buffer zone experimenting with various types (i.e., size, shape, and treatment regime) of fuel breaks with particular caution to (or complete avoidance of) sites with known ecological sensitivities.

We recommend that the largest component (72%) of the high or very high fire hazard acreage (inside the wildlands and mostly under the management of the U.S. Forest Service) not be targeted for fuels management other than in small areas already heavily managed or near existing human structures. Some portion of the high or very high fire hazard areas immediately adjacent to roads in the wildlands (24,168 ac) may warrant some treatment, perhaps in strategic locations where there has been numerous fire ignitions on the past. Some particular attention should be paid to areas east of the valley. Because of their ecological importance, all designated wilderness and roadless areas should not receive any fuels management whatsoever. To do so would have serious ecological consequences including – (1) altering fire regimes over large areas inappropriately; (2) increasing exotic species invasion and diseases; (3) opening up more area to ORV users and subsequent ecological damage; and (4) further degradation to a region of world class biological significance.

In summary, fire management activities inside the WUI should range between 2,267 to 6,182 ac. Over half of this area would require management activities that would not damage the ecological values mapped in this exercise. Some subset of the nearly 32,000 ac of the WUI buffer lands (mostly private and BLM lands) would also be targeted (especially along the east side of the valley) for fire management with special emphasis on those sites with no known ecological sensitivities (approximately 10,000 ac). We estimate that the WUI buffer zone would be earmarked for strategically placed fuel break experiments and would include 10,000 - 20,000 ac. High fire hazard areas in the wildlands would be minimal and only in selected locations to protect structures or in already heavily managed areas. The estimated total area of land targeted to receive some form of fire management would be from 12,000 to 26,000 ac (6-12% of the high fire risk area and only 2-4% of the region).

This analysis demonstrates an approach that will allow for fire risk reduction to rural communities in fire-dominated natural landscapes that is effective, affordable, and ecologically responsible. Although the work focused on southwestern Oregon, we believe a similar modeling approach could be applied to other sites throughout the West where rural communities are threatened by wildfire whether these communities are threatened by a normal fire regime or one skewed by past forest management. Some regions may require larger areas of fuels treatment, but widespread management of existing wildlands will only diffuse effective treatment that should be applied where it is needed most and where it would be most effective.

Accuracy Assessment

Overall accuracy for fuel hazard was 69.56 percent. Errors of Commission (or User's Accuracy) were greatest for the highest fuel hazard classes and not at all for the moderate fuel class (Table 6). No Errors of Omission (Producer's Accuracy) were committed for the high fuel hazard class. A considerable number of omission errors occurred for the moderate fuel class with the modeled results over-predicting fuel hazard.

Table 6. Accuracy assessment for fuel hazard.

	very low	**low**	**moderate**	**high**	**totals**	User's (%)
very low	9	2	3	0	14	64.29%
low	1	16	2	0	19	72.73%
moderate	0	0	5	0	5	100.00%
high	1	1	1	5	8	62.50%
totals	11	19	11	5	46	
Producers's (%)	81.82%	84.21%	45.45%	100.00%		
Overall Accuracy	69.56%					

Overall accuracy for the terrain hazard component was a bit higher than for fuels (approximately 74%). Relative accuracy (User's and Producer's) was fairly consistent for each of the classes.

Table 7. Accuracy assessment for the terrain hazard.

	very low	**low**	**moderate**	**high**	**totals**	User's (%)
very low	4	0	0	1	5	80.00%
low	0	6	0	2	8	75.00%
moderate	0	2	10	1	13	76.92%
high	1	1	4	14	20	70.00%
totals	5	9	14	18	46	
Producers's (%)	80.00%	66.67%	71.43%	77.78%		
Overall Accuracy	73.91%					

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