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CHARACTERISTICS AND LOCATION OF THE WILDLAND-URBAN INTERFACE IN THE UNITED STATES

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1. INTRODUCTION

The Wildland-Urban Interface (WUI) is "the area where structures and other human developments meet or intermingle with undeveloped wildland," or in more general terms, where houses or commercial development and fairly dense vegetation are both present. Interface neighborhoods are found all across the United States and include many of the sprawling areas that grew during the 1990s when low density housing spread across the landscape.

For resource managers, the WUI is an important place because the presence of people and structures in or near the wildlands impacts both the resources they manage, and the social pressures they face in managing them. Housing developments alter the structure and function of forests and other wildlands (Theobald et al. 1997, Friesen 1998). People living in the WUI expect to have some influence on the management of nearby natural areas, and will often pressure managers about what they do, and how they do it (Hull & Stewart 2002). Balancing the many different needs of people and natural resources is the ever-present challenge associated with working in the WUI.

The potential for fire in the WUI adds urgency and complexity to many of these social and biophysical issues. Wildland fire can significantly diminish the resources and services produced by wildlands, including recreation, watershed protection, timber, wildlife habitat, and scenic beauty.

For residents, the outcomes of fire in the WUI are negative and unequivocal. If they are lucky, only smoke, evacuation, and disruption of ordinary life will result; homeowners who are not so lucky may lose their home and everything in it. The WUI is a difficult and potentially dangerous setting in which to fight fires because fire fighters are typically trained to fight either structural or wildland fires, but rarely both. Managers dealing with wildland fire in the WUI thus face the prospect of resource damage along with intense social pressure to mitigate risks and losses.

In this context of social pressure and ecological vulnerability, strategic planning and management of the WUI is essential. Recent wildland fire policy and legislation recognizes this, and targets the WUI as the area where resources will be dedicated to mitigation efforts such as fuel hazard reduction. For example, a recent memorandum of understanding between the departments of Agriculture and Interior, the National Association of State Foresters and the National Association of Counties focuses fuels reduction work in those communities within the WUI (USDA et al. 2002).

The references to the WUI in recent policy and legislation create an opportunity for better, more specific information about its location and characteristics. Despite its importance in wildland fire management, we are only beginning to understand the WUI across the landscape. What is the extent of the WUI, and where is it geographically distributed across the country? The answer to this question holds great value to those involved in wildland fire policy and management. The purpose of our research is to address these questions and create a first-ever national portrayal of the WUI for the lower 48 states of the U.S.

2. APPROACH

There are many ways to define the WUI that capture the basic concept of human presence and wildland vegetation. Policy-specific criteria for delineating the WUI was published in the Federal Register, January 4, 2001 (66 FR 751). The language in the Federal Register drew heavily from a consultant's report about fire in the WUI commissioned by the Council of Western State Foresters (Teie & Weatherford 2000) with only one minor modification: in addition to discussing the population characteristics of the WUI in terms of structures per acre, policymakers added a measure of population per square mile as an "alternative definition." We have chosen to use housing density, because housing density can be a more suitable measure of human presence and influence on the landscape than population density. This is proving particularly true for defining the WUI in relation to fire management issues

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because firefighters must protect homes, as well as wildlands. Housing density information was derived from U.S. Census data. Analysis was conducted at the finest demographic spatial scale possible, Census blocks, from the 2000 Census. For both interface and intermix communities, the Federal Register established a minimum density of one structure per 16 ha (40 acres).

To clarify the meaning and extent of the WUI, we map the WUI using housing density together with the presence of "wildlands." For intermix communities, vegetation is continuous in housing areas; and for interface, housing is within their vicinity. What vegetation types are considered "wildlands" is not specified. We utilized the National Land Cover Dataset, a satellite data classification produced by the USGS with 30m resolution based on 1992/93 imagery, and available for the entire U.S. (Vogelmann et al. 2001) to identify 'wildlands'. Our definition of 'wildlands' encompasses a range of management intensities. NLCD classes that we included as 'wildlands' are forests (coniferous, deciduous and mixed), native grasslands, shrubs, wetlands, and transitional lands (mostly clear-cuts). We exclude orchards, arable lands (e.g., row crops) and pasture.

Finally, the Federal Register identifies interface communities as those where housing is "within the vicinity" of forests and other wildlands as part of the WUI, but it does not quantify "vicinity." In its identification of WUI, the California Fire Alliance (2001) defined "vicinity" as all areas within 2.4 km (1.5 mi) of wildland vegetation, roughly the distance that firebrands can be carried from a wildland fire to the roof of a house. It captures the idea that even those homes not sited within the forest are at risk of being burned in a wildland fire. We adopt this buffer distance to identify interface areas.

With minimum housing densities, vegetation types, and interface buffer distances determined, the operational definition of the WUI is complete: Interface areas have more than 1 house per 16 ha, have less than 50 percent vegetation, and are within 2.4 km of an area (made up of one or more contiguous Census blocks) over 500 ha that is more than 75 percent vegetated. Intermix areas have more than 1 house per 16 ha, and have more than 50 percent vegetation.

The resulting WUI map does not directly address fire risk. Some of the areas identified as WUI are prone to fire, and some are not. When national-level fine-scale fire risk data becomes available, it could be overlaid with this data to produce a map identifying high fire risk WUI. The absence of fire risk data is a limitation of our map, but conversely it also results in a WUI map with applications to resource management beyond fire, such as wildlife management.

3. RESULTS

3.1 The WUI in 2000

The map of the 2000 WUI for the 48 conterminous states illustrates the considerable extent the WUI across the United States, in gold (fig. 1). All states have at least a small amount of land classified as WUI, and some almost three quarters of their land. Across the U.S., 9.3 percent of all land is classified as WUI. The WUI area is divided into two categories; 81.9 percent of it into intermix, and 18.1 percent interface.

Concentrations of WUI can be seen along the eastern seaboard where housing density rarely falls below the threshold of 1 housing unit per 16 ha and forest cover is abundant. In the mid-Atlantic and North Central regions, the areas not dominated by agriculture have interspersed WUI and low density vegetated areas. The amenity areas where recreation and tourism dominate are also places where WUI is common, including the northern Great Lakes and Missouri Ozarks. WUI is least prevalent in the Great Plains. Here housing density is low, and forests are limited to riparian areas as agriculture dominates the landscape. The Gulf Coast has concentrations of WUI outside of its agricultural areas, and around cities and small towns. In the Rocky Mountains and the Southwest, virtually every urban area has a large ring of WUI reflecting the sprawling patterns of recent growth, with extensive medium and low density housing development near or in low elevation forested areas. Although the WUI is not extensive along the west coast, it encompasses a high percentage of homes.

3.2. Intermix and Interface

The two components of WUI, intermix and interface, have some differences that are potentially significant in wildland fire management. In terms of fuels, vegetation dominates intermix, and structural fuels dominate interface. Vegetation and structures ignite and burn differently, and thus fire behavior changes with the mix of these two WUI fuel types (Rehm et al 2001). Housing density is also different in interface and intermix WUI. Areas with high density housing (defined here as more than 7.5 housing units (HU) per ha) and medium density housing (> 1 HU/2 ha<7.5 HU/ha) make up a larger share of the interface than they do of the intermix (table 1). Average housing density for the U.S. interface is 1.68 HU/ha, in the range of medium density housing. Intermix areas average .35 HU/ha (or just over 1 HU per 3 ha), which is low density. Although intermix is much more extensive in the US than interface (at 82 percent and 18 percent of the WUI land area respectively), the distribution of houses across these two types of WUI is just about equal. Interface WUI areas are typically smaller areas at higher housing densities than intermix, and each captures about 18 percent of all the houses in the US (table 1).

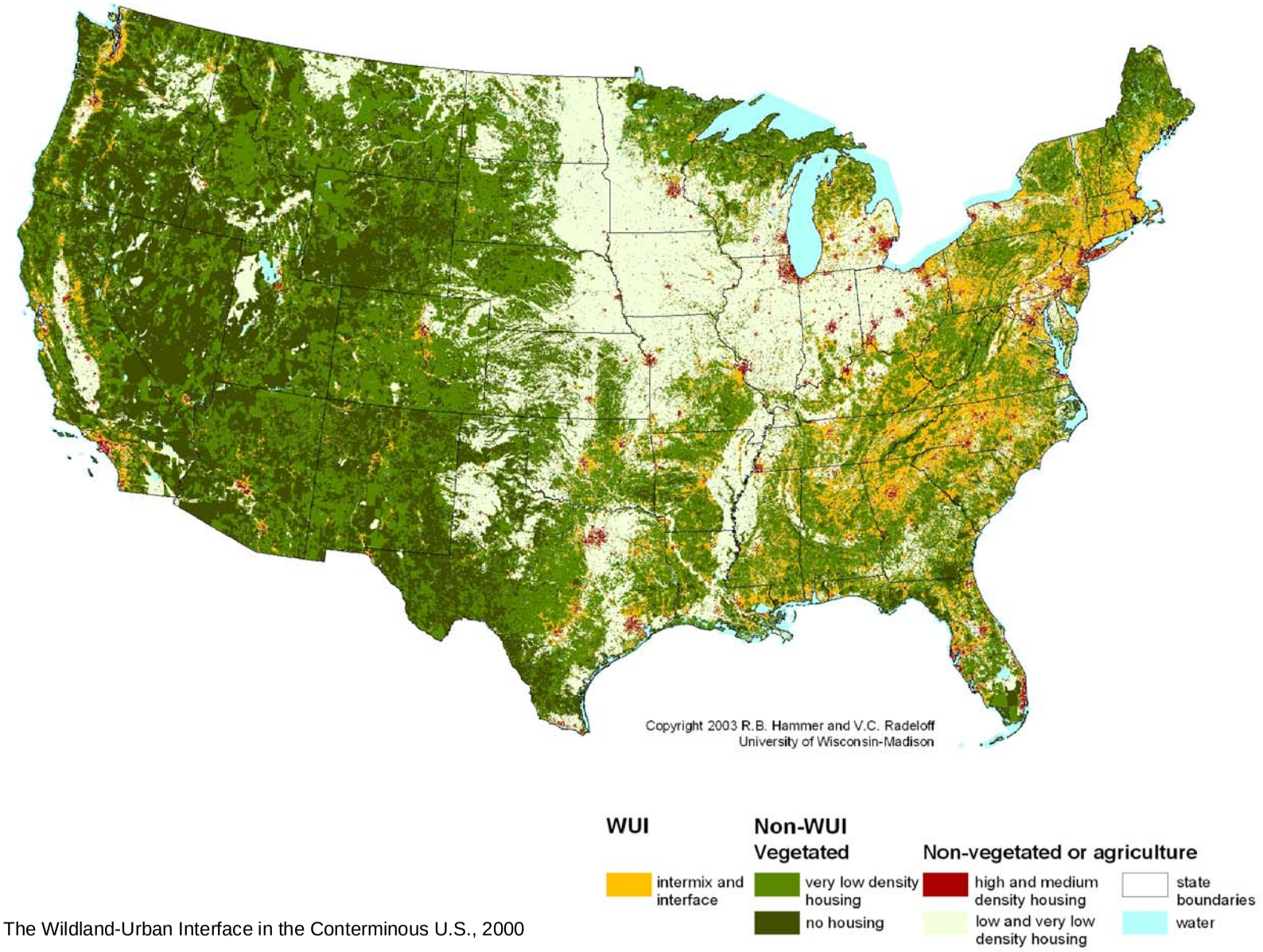

Figure 1. The Wildland-Urban Interface in the Conterminous U.S., 2000

Table 1. Land area and houses in interface and intermix, conterminous United States

	Land Area (hectares)	(percent)	Houses	Percent of all U.S. Houses
Interface				
High density	760,243	5.9%	10,665,201	9.3%
Medium density	4,031,381	31.4%	9,636,597	8.4%
Low density	8,046,870	62.7%	1,339,869	1.2%
Total interface	12,838,493	100%	21,641,666	18.8%
Percent of WUI	18.1%			
Intermix				
High density	186,030	0.3%	2,552,907	2.2%
Medium density	7,680,518	13.2%	10,379,554	9.0%
Low density	50,165,498	86.4%	7,723,636	6.7%
Total Intermix	58,032,047	100%	20,656,097	17.9%
Percent of WUI	81.9%			
Total WUI	70,870,539	9.3%	42,297,763	36.7%
All U.S.	765,647,714	100%	115,183,121	100%

High density housing: >7.5 Housing Units/ha; medium: >1 HU/2ha to 7.5 HU/ha; low: >1 HU/16 ha to 1 HU/2 ha.

3.3. WUI distribution across the U.S.

State by state, distribution of the WUI varies with the physical and biological settings an area affords for home building, and the infrastructure to support development. State Foresters play a role in fire management in the WUI, and much of the fire hazard mitigation work in and around communities is coordinated through state agencies. These responsibilities create a need for state-level policy makers and managers to understand the size and characteristics of the WUI in their state. While a complete listing of state level WUI statistics is beyond the scope of this paper, several state rankings are shown, and they provide useful insights about how the WUI varies across the country (table 2). Looking at overall interface area, the only non-Eastern state ranked in the top five is California. Eastern and Southern states have the most land area in interface, intermix, and WUI. Not surprisingly, the smaller states, all northeastern, have the highest percentage of land in the WUI. While the number of hectares of WUI these states must manage is small, it represents a very large proportion of their land base. For fire-prone areas, this puts a strain on fire fighting resources. In areas that are not fire prone, a high proportion of WUI in relation to wildland areas suggests that resources for wildlife habitat, recreation, watershed protection, scenic beauty, and other ecosystem services are heavily burdened because homes co-exist with vegetation and habitat within much of the available land base.

The big, populous states dominate when states are ranked by the number of homes that fall within the WUI. The large number of California homes located in the WUI, many of them in the fire-prone ecoregions of southern California, underscores the significance of WUI management in that state. Texas and Florida, also in the top five for number of homes in the WUI, are similarly challenged with huge numbers of homes in areas that can be expected to burn often. The states with high proportions of their homes in the WUI are Western states with sparse population. In these states, there are very few people, but most of them live in the WUI. Across the country, 37 percent of all homes are in the WUI. State by state, there are 20 states out of the 48 included here where the majority of homes – over 50 percent – are located in the WUI.

Table 2. State rank by area and homes in interface, intermix and total WUI

	RANK	INTERFACE		INTERMIX		WUI	
AREA (ha)							
	1	PA	1,047,996	NC	4,784,799	NC	5,168,959
	2	CA	746,037	GA	3,328,643	PA	4,338,163
	3	NY	707,520	PA	3,290,167	GA	3,647,157
	4	TN	594,908	VA	2,911,322	NY	3,573,620
	5	VA	592,546	NY	2,866,100	VA	3,503,868
AREA (percent)							
	1	DC	19%	RI	61%	CT	72%
	2	NJ	15%	CT	60%	RI	69%
	3	CT	12%	MA	53%	MA	65%
	4	MA	12%	NH	38%	NJ	46%
	5	PA	9%	NC	38%	NH	41%
HOMES (number)							
	1	CA	3,480,285	CA	1,607,624	CA	5,087,909
	2	PA	1,394,977	GA	1,479,368	PA	2,541,343
	3	FL	1,169,090	NC	1,451,811	TX	2,310,811
	4	NY	996,583	PA	1,146,366	FL	1,947,409
	5	MA	982,921	TX	1,141,721	NC	1,776,212
HOMES (percent)							
	1	WY	62%	ME	50%	NH	82%
	2	NM	41%	NH	47%	WV	80%
	3	MT	40%	GA	45%	WY	80%
	4	UT	40%	WV	42%	ME	79%
	5	WV	38%	NC	41%	NM	79%

4. CONCLUSIONS AND IMPLICATIONS

This first-ever fine-scale national map of the WUI offers insights about the extent and distribution of the interface across the U.S. The characteristics of the WUI vary across regions, with more interface in the west, and more intermix and the east and south. The fire management issues associated with the WUI are significant, and the 2000 U.S. WUI map can facilitate better planning and coordination of hazard mitigation work. There are a host of other resource management issues that are also important in WUI. Wildlife habitat and contact with human settlement relates directly to the size and extent of the WUI. Timber management is increasingly constrained as houses spread through the forest. Growing numbers of people live in direct contact with wildlands, potentially affecting their perceptions and understanding of the resources and their management.

The key to future trends in size, extent, and location of the WUI lies in housing growth, which is in turn a function of many local and state policy decisions and economic conditions. Our preliminary analysis of change in the WUI over time indicates that in some western states the growth in WUI housing was rapid during the 1990s. Across the US, it appears that the counter urbanization trend of the 1970s also added considerably to the extent of the WUI and the number of houses it encompasses. Further analysis of change over time in the WUI will provide us with useful insights about WUI dynamics, an essential foundation for projections of future WUI growth.

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