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Forum

Demographic Trends, the Wildland–Urban Interface, and Wildfire Management

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In this article, we provide an overview of the demographic trends that have impacted and will continue to impact the “wicked” wildfire management problem in the United States, with particular attention to the emergence of the wildland–urban interface (WUI). Although population growth has had an impact on the emergence of the WUI, the deconcentration of population and housing, amenity-driven population growth in select nonmetropolitan counties, and interregional population shifts to the West and Southeast have had and will continue to have much greater impacts. In the coming decades, we can expect the retirement of the baby boom generation to exacerbate these trends.

Keywords demographic trends, wicked problem, wildfire management, wildland–urban interface

Demographic processes, notably migration and population growth and redistribution, are profoundly changing landscapes and ecosystems across the United States. The location, extent, and future expansion of the wildland–urban

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interface (WUI) in the United States will impact a host of natural resource management-related issues, including wildfire management, forest productivity, and ecological change. In this article, we provide an overview of the demographic trends that have impacted and will continue to impact the “wicked” wildfire management problem in the United States, with particular attention to the emergence of the WUI. Our own adaptation of the classic formula (Rittel and Webber 1973) posits that a wicked problem (1) is both a cause and consequence of a complex set of related problems; (2) is embedded in a dynamic social, political, and economic context that (3) results in stakeholder groups developing valid but contradictory and evolving definitions, explanations, and solutions with (4) every solution generating myriad consequences, some undesirable, that cannot be understood prior to implementation; and finally (5) lacks any final resolution. The appellation “wicked problem” has been aptly applied to wildfire in the United States for more than 20 years (Allen and Gould 1986; Carroll et al. 2007).

Population more than doubled in the United States between 1940 and 2000, reaching 280 million in 2000 and surpassing 300 million in 2006 (U.S. Census Bureau 1992a; 2002a; 2006). Due to a variety of factors, including declining average household size and changes in vacancy rates, the number of housing units, that is, “building blocks” for the WUI, more than tripled during the same six-decade period, reaching 116 million in 2000. Multiple homeownership and the seasonal occupation of homes have also expanded significantly since 1940, when there were 5.6 seasonal housing units for every 1,000 persons (U.S. Census Bureau 2005 and authors’ calculations). By 2000 that rate had more than doubled to 12.8 seasonal units per 1,000 persons, 3.6 million units (U.S. Census Bureau 2002a and authors’ calculations).

The population of the United States is expected to continue to grow, surpassing 360 million around 2030 (U.S. Census Bureau 2006). Housing can be expected to continue growing at a faster rate to accommodate population growth and future changes in household structure and housing occupancy. Conservatively, the number of housing units will reach 158 million by 2030 (U.S. Census Bureau 2006 and authors’ projections).

Although the magnitude of population and housing growth are important, the changes in population distribution and, by extension, housing patterns have a much larger impact on the wildfire problem. Since 1940, a significant interregional migration in the United States has led to higher population growth in the West and South than in the Northeast and Midwest. Population deconcentration has resulted in suburbanization and exurbanization, the very conditions necessary for WUI expansion. Population growth among nonmetropolitan counties is closely associated with natural amenities (McGranahan 1999). During the 1990s, nearly 3 million new housing units were built within 25 km of national forests, an 18% increase that was considerably higher than the 13% national rate (U.S. Census Bureau 1992b; 2000; 2000b; USDA Forest Service 2006; and authors’ reconciliation of 1990 and 2000 block boundaries using housing unit interpolation method described in Hammer et al. 2007).

During the 2007 wildfire season nearly 8.8 million acres burned in the 14 contiguous states of the western United States (henceforth the West), accounting for 75% of acres burned in the 48 contiguous states (National Interagency Fire Center 2008). The West also contains approximately 88% of the federally owned land in the contiguous 48 states. Florida and Georgia (henceforth the Southeast) accounted for another 1.4 million acres burned (National Interagency Fire Center 2008). Thus,

these 16 states combined accounted for 91% of the acres burned by wildfire in the 48 contiguous states in 2007. The wicked wildfire management problem in these two regions is exacerbated by past demographic trends, and the future consequences of those trends have contributed to the growth and expansion of the WUI, a wildfire-related wicked problem that has been recognized as an important element of wildfire policy since as early as 1960 (USDI and USDA 1995).

The population of the West grew 4.5 times larger between 1940 and 2000 (to 85.5 million) and the population of the Southeast grew 4.8 times larger (to 24.1 million). In contrast, the population in other contiguous states grew by only 1.7 times. Between 1940 and 2000, the number of housing units increased by a factor of 5.8 in the West and 7.6 in the Southeast but only by a factor of 2.6 in the remainder of the contiguous United States. Thus, 28.3 and 9.2 million housing units were added in the West and Southeast, respectively, many of them in the WUI. The WUI is the area where houses meet or intermingle with undeveloped wildland vegetation (Stewart et al. 2007). We present results from a National Fire Plan funded research project that delineates the WUI at the block level (as defined by the U.S. Census Bureau 2002b) for the entire United States. Our definition is derived from a *Federal Register* notice (USDA and USDI 2001), which itself was derived from a report by the Western States' Governors' Association (Teie and Weatherford 2000). According to the definition, WUI areas must contain at least 1 housing unit per 40 acres (16 units/mile² or 6.17 units/km²). The WUI is comprised of intermix, in which at least 50% of the area is vegetated, and interface, in which less than 50% of the area is vegetated but it is within 1.5 miles (2.4 km) of a large area (>5 km²) that is more than 75% vegetated (Radeloff et al. 2005).

The WUI encompassed 11% of the land area (715,000 km²) and 38% of all housing units (44.3 million) in the contiguous United States in 2000. Of the total WUI area, 82% was intermix and 18% interface, but 49% of WUI houses are in the intermix and 51% are in the interface. In 2000, the WUI accounted for 104 million people, 37% of the population. In the West, only 3% of the land area was WUI in 2000, but in the Southeast 26% of the land area was WUI. However, in both the West and Southeast just over 45% of the housing units were located in the WUI (11.1 and 4.1 million units respectively). The WUI is a national phenomenon, although wildfire risk varies widely.

During the 1990s, the WUI area grew by 19% (115,000 km²) and the number of WUI housing units increased by 22% (8.0 million) in the contiguous United States. In the West 2.2 million housing units were added to the WUI (25% growth), as were 1.4 million (39% growth) in the Southeast. During the 1990s, for every 100 additional housing units constructed nationally, 53 housing units were added to the WUI. New housing units can be constructed in a WUI area or in an area that becomes WUI due to increasing density, in which case the existing units in that area also become WUI. Through this "WUIfication" process, the West added 66 additional WUI housing units for every 100 new housing units constructed and the Southeast added 74. If the relationship between new housing unit construction and additional housing units in the WUI remains unchanged, between 2000 and 2030 there will be an additional 12.3 million WUI units in the West and an additional 4.6 million in the Southeast, representing 111% growth in the West and 93% growth in the Southeast. In contrast, WUI housing would grow by only 44% in the remaining contiguous states.

Births, specifically, the more than 72 million births that occurred in the United States between 1946 and 1964, the baby boom years (Plane and Rogerson 1991),

are another demographic process that substantially affects the WUI and fire management. Baby boomers comprise nearly one quarter of the U.S. population. The net migration, that is, the difference between the number of out-migrants and the number of in-migrants, of baby boomers added 6.7 million people to the population of the West and 3.8 million to the population of the Southeast over the course of the four decades between 1960 and 2000 (authors' regional summation of state-level age-specific net migration estimates for baby boom cohorts using data described in Johnson et al. 2005). During each of those decades, except the 1990s, the remaining contiguous states experienced a net outflow of baby boomers.

With each life-cycle change, the baby boom generation has had a profound impact on this country, and another change, retirement, is imminent. In January 2008, the oldest baby boomers reached Social Security eligibility age, 62, and began applying for benefits. The largest baby boom cohorts occurred between 1954 and 1964, with births exceeding 4 million annually, so the effects of baby boom retirement will increase during the next few years and cannot be expected to abate for at least another 20 years. Amenity migration has largely determined population growth patterns among nonmetropolitan counties (McGranahan 1999), and much of it is retirement migration. Between 1960 and 2000, the net migration of retirement-age persons (age 50 to 69 years) added 1.5 million people to the West and 3.1 million to the Southeast (authors' regional summation of data described in Johnson et al. 2005). During the 1990s, the net migration rate for the retirement-age population was 2.4% in the West and 20.0% for the Southeast. Given that the baby boom generation is 1.6 times larger than the 1990 retirement-age cohort, during each decade that it is occurring baby boom retirement may add 400,000 persons and 1.2 million to the populations of the West and Southeast, respectively. This influx of population will probably result in further expansion of the WUI. As with past retirement migration, individual states, counties, and communities will not be uniformly affected, and these trends may have different meanings for different subregions of the West and Southeast.

To summarize, although population growth has had an impact on the emergence of the WUI, the deconcentration of housing, amenity-driven population growth in select nonmetropolitan counties, and interregional population shifts to the West and Southeast, the regions accounting for 91% of wildfire acres burned in 2007, have had and will continue to have much greater impacts on the wicked wildfire problem. In the coming decades, we can expect the retirement of the baby boom generation to have extensive impacts on these trends, including further population shifts to the West and Southeast and the concomitant expansion of the WUI in those regions. Nowhere is the contribution of WUI expansion to the problem of wildfire management more obvious than in Southern California, where wildfires in the WUI destroyed 3,079 structures in 2007 and suppression costs to the state totaled nearly \$300 million (California Department of Forestry and Fire Protection 2008), which may serve as the bellwether for other areas of the West, the Southeast, and nationally. At the very opposite extreme of the West, both geographically and demographically, from Southern California, Montana has also experienced WUI-related wildfire problems. In Montana, 39% of the area accorded wildfire protection by the state government is within the WUI, but over 66% of the wildfires suppressed occurred in the WUI and the cost of suppressing any individual WUI wildfire was 46% higher than for non-WUI fires, even though initial attack success rates were similar in the two areas (Montana Department of Natural Resources

Conservation 2007). In conclusion and as illustrated by these two disparate examples, Montana and Southern California, the wicked WUI problem is significantly exacerbating the wicked wildfire problem in the United States, especially in the West and Southeast where wildfire is most prominent.

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