

Socioeconomic Changes and Forestland Development: Commonalities and Distinctions between the Eastern and Western United States

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ABSTRACT

Impacts of rural land development on natural resources in the United States have been well documented and research on rural land development provides important inputs to land conservation policy and program development. Although numerous land-use studies have been completed for the western and eastern states, still lacking is a single study examining changes in population, housing, and land development in the two regions. To provide context for natural resource and land conservation programs and policies, we quantify recent and long-term changes in population and housing, rural development rates, and land-use transitions involving forests for the eastern and western regions. Relative to the West, the East has a more evenly distributed population and has experienced greater population increases, rates of land development, and forestland conversion. We discuss these patterns of population growth and land development in the context of natural resource policies and forestland goods and services.

Keywords: rural development, US regions, population growth, forestland loss

Rural land development, including residential development, can have numerous consequences for natural resources and their management. For example, development can increase the probability of wildland fire and complicate fire management efforts (e.g., Cardille et al.

2001, Gebert et al. 2007), impact wildlife habitat (e.g., McKinney 2002, Riley et al. 2003), affect water quality (e.g., Atasoy et al. 2006, Shandis and Alberti 2009), and reduce the likelihood of intensive forest management on private lands (Wear et al. 1999, Munn et al. 2002, Kline et al. 2004). Re-

gional differences in population expansion, increasing incomes, forest ownership, and changing preferences will affect the amount and form of land development as it expands into rural forested areas. The macroscale patterns of land development, driven in part by population increase and housing expansion, are particularly important in the context of national-level natural resource programs and policies, including those responding to climate change or aimed at conserving open space. Research efforts that quantify and map current and projected rural land development are useful for identifying these macroscale patterns and can provide important inputs to the development of natural resource programs and policies.

Residential expansion and urban development in rural landscapes have been well studied in the peer-reviewed literature (e.g., Radeloff et al. 2005, Theobald 2005, Burchfield et al. 2006). Numerous individual

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studies focusing on development of rural landscapes and the ecological implications of that development have been completed for study areas in the East (e.g., Wang et al. 2003, Atasoy et al. 2006, Krester et al. 2008) and West (e.g., Sharma and Hilborn 2001, Riley et al. 2003, Johnson and Collinge 2004). Others have completed national-level analyses quantifying past changes and projecting future land development in the context of natural resources (e.g., Nowak and Walton 2005, Stein et al. 2005, White et al. 2009). What is lacking is a single study to provide a contextual basis for considering commonalities and differences in population growth and rural land development in the western and eastern states. Such a study would aid in interpreting the results of national-level land development research and help provide context for the formulation of natural resource policies. We address this research gap by examining population changes and distribution, migration patterns, residential expansion, current land development and rates of increase, and rural land-use transitions for the eastern and western regions. To help provide context for considering differences in macroscale patterns of population increase and land development, we also discuss the patterns of forestland goods and service flows for the study regions.

Approach

Using currently available data from the US Department of Commerce (USDC) Census Bureau and the Natural Resources Conservation Service (NRCS), we examine patterns of population and housing change, migration, land development, and other factors related to urbanization for the East and West. When the data support doing so, we conduct our analyses at the region, state, and county geographic levels; otherwise, we complete analysis at the finest geographic level reasonable given the data (e.g., state level). Completing analysis at multiple geographic levels supports a better understanding of the change processes occurring in the two regions. When completing analyses of demographic and housing unit change, we consider both long-term (post-1990) and recent (post-2000) time periods. When using the NRCS data, we use the most recent data available to quantify current land development conditions (2003) and long-term land-use transitions (1982–1997; USDA NRCS and Iowa State University [ISU] Statistical Laboratory 2000, USDA NRCS 2007).

Perhaps the most traditional demarcation of the eastern and western regions has been the 100th meridian that passes through the Dakotas, Nebraska, Kansas, Oklahoma, and Texas (e.g., Lang et al. 1997). However, because the 100th meridian eclipses geopolitical boundaries, it is difficult to use for regional analyses. We adopt the Resources Planning Act delineation of the contiguous West that is defined by the eastern boundaries of North Dakota, South Dakota, Nebraska, Kansas, and New Mexico and has been used in other national-level land-use and natural resource studies (e.g., Smith et al. 2004, Nowak and Walton 2005). Hawaii and Alaska were excluded from this analysis because of data constraints.

Statistical tests for differences between the eastern and western regions were conducted for state- and county-level population and housing unit changes. A distribution-free analog to the Student's *t*-test, the Mann-Whitney *U*, was used for all statistical analyses. This test accommodates the non-normal distribution of the data and tests a null hypothesis more appropriate to this study, namely, that the two regional samples were drawn from identical populations (Howell 1997, p. 647). The Mann-Whitney *U* uses a ranking approach and is less influenced by extreme observations than the traditional *t*-test. One drawback to the Mann-Whitney *U*, as well as other distribution-free tests, is that the test is often deemed to be less statistically powerful than the *t*-test.

In reporting population and housing changes, we rely on median rather than mean values of central tendency, although we also report the mean values for completeness. The median value represents the midpoint of a set of observations. For this study, median values have the attractive characteristic of being stable in the face of extreme observations. Median values are commonly used to measure the central tendency of such things as household income and real estate sale prices. Median values are especially useful for characteristics where most observations are clustered in one area of the range (usually at lower values) and a limited number of observations have extreme values, such as households with very high incomes or sale prices of exceptional pieces of property.

As defined in this study, the East and West are nearly equal in their land areas—946 million ac in the West and 948 million ac in the East (USDC Census Bureau 2007a). However, the West has approxi-

mately 8½ times more federal land area than the East. The preponderance of federal land in the West reduces the extent of privately owned land available for urban and residential expansion. To control for this disparity, we estimated the area of unprotected private land (e.g., private land not under conservation easement) for each region, state, and county using Version 4.6 of the Protected Areas Database modified to include updated, publicly available, spatial layers of protected lands, particularly private lands, in multiple states (Conservation Biology Institute 2007, Theobald 2007). All analyses related to population, migration, and housing unit changes were completed both using absolute figures and figures on an unprotected private land acre basis. We report only the absolute figure because there were no differences between the two metrics in the results of statistical tests and the absolute figures are more intuitive.

Population, Migration, and Housing Change

The Importance of Geographic Unit in Population and Migration Data

Between 2000 and 2007, the population of the contiguous 48 states increased by 20.1 million individuals (7%), surpassing 300 million in early fall 2006. Over that period and at the regional level, the population of the West increased by 10% (7.0 million individuals) and the population of the East increased by 6% (13.1 million individuals). The recent rate of population growth for the West is consistent with the long-term pattern (1990–2007) of population increase of approximately 1 million individuals per year (17.5 million individuals in total over the period, a 31% increase). The population of the eastern region increased by 35.0 million individuals (18%) between 1990 and 2007. In both periods, the percentage increase in population in the West was greater than that in the East. However, the East experienced an increase in number of people that was more than double that experienced in the West.

State-level population growth in the East and West was not statistically significantly different for either the 2000–2007 or the 1990–2007 periods. However, from a practical standpoint, both median and mean state-level population growth in the West were slightly greater than the East over the most recent past (Table 1). Over the longer period, 1990–2007, practical comparisons

indicated that state-level population change was higher in the East than in the West when considering the medians, but the opposite pattern was found when considering the means. The contrary results for the median and mean values reflect the sensitivity of the mean to extreme observations. For example, the population increase in California for the 1990–2007 period was 6.7 million individuals (approximately 2½ times the next greatest state-level population increase in the West) and if California is removed from the West's observations, the mean state-level population increase over the period for that region is recalculated at 772,000 individuals—well below the mean state-level population increase in the East for the 1990–2007 period. Regardless, the increase in state-level population growth in the West for the most recent period is consistent with an increase in migration to the West between 2000 and 2004 (Perry 2006). The recent population increase for the West relative to the East when contrasted to the long-term pattern may be a harbinger of a shift in comparative population growth rates between the West and the East.

Although the state-level patterns of population change indicated no statistically significant differences, county-level population increase in the East was statistically significantly greater than in the West for both periods (Table 1). Median values for county-level population change in the East post-2000 and post-1990 were 372 individuals and 2,397 individuals, respectively. In the West, median changes in county-level population were slightly negative in recent years and an increase of 712 individuals over the long-term period. In the years since 2000, more than half of all western counties experienced a decrease in population. This loss of population at the county level in the West is likely driven in large part by extensive population losses for counties in the Great Plains states and eastern Montana; however, county-level population losses are present in every western state.

The population increase experienced in a given location is a reflection of both the natural population increase (more births than deaths) and net in-migration (more individuals migrating into an area than migrating out of an area). The fastest growing places typically have high rates of net in-migration relative to natural increase. On average, at the state level for the contiguous 48 states, net migration (combining domestic and international migration) had a roughly

Table 1. Population and housing changes in the eastern and western United States over two periods.

		State level		County level		
		West	East	West	East	
Change in population 2000–2007 ^a	Mean	464,026	396,795	9,522	5,511	
	Median	205,449	180,751	–25*	372*	
	1990–2007 ^b	Mean	1,169,770	1,060,415	24,003	14,724
		Median	492,668	619,802	712*	2,397*
Net domestic migration Post-2000 (average annual) ^c	Mean	27,353	20,671	561	287	
	Median	13,174	6,981	–24*	13*	
	1990–1999 ^d	Mean	8,697	4,233	179	59
		Median	47,875	35,058	–0.5*	558*
Change in housing units 2000–2006 ^e	Mean	185,562	229,246	3,808	3,183	
	Median	87,799	162,369	188*	637*	
	1990–2006 ^f	Mean	424,062	531,303	8,723	7,379
		Median	218,037	423,965	578*	2,100*

^a Data source: USDC Census Bureau 2007c and 2007d.

^b Data source: USDC Census Bureau 2000, 2007c, and 2007d.

^c Data source: USDC Census Bureau 2007c.

^d Data source: USDC Census Bureau 2000.

^e Data source: USDC Census Bureau 2007b.

^f Data source: USDC Census Bureau 1999 and 2007e.

* Statistically different median pairs based on Mann-Whitney *U*, $\alpha = 0.05$.

equal role as natural increase in population change between 2000 and 2007 (USDC Census Bureau 2007b). A handful of states in each region experienced particularly high net migration relative to natural increase. In the West, Nevada's net in-migration was almost four times the natural increase, and Arizona, California, and Oregon had amounts of net in-migration that were more than double the natural increase (USDC Census Bureau 2007b). In the East, net in-migration was greater than natural increase by five times in Florida, three times in Maine, and two times in North Carolina and South Carolina. Such influxes of new residents with potentially differing social and natural resource values can have important implications for the social fabric of communities. Less-populated communities with strong rural traditions and connections to the landscape, such as agriculture and timber-dependent communities in the West, may be particularly affected by in-migration of new residents (e.g., Sell and Zube 1986).

Net domestic migration (the movement of US residents around the country) may be the most intuitive migration measure. From a practical standpoint, annual net domestic migration post-2000 and total net domestic migration between 1990 and 1999 were slightly higher for the western states than for the eastern states (Table 1). This indicates that, on average, a state in the West had more domestic migrants moving

to the state than moving out of the state, compared with a state in the East. However, at the county level, annual net domestic migration between 2000 and 2007 and total net domestic migration between 1990 and 1999 were statistically significantly greater for counties in the East compared with the West (Table 1). Furthermore, western counties had median values of net migration that were negative in both periods. If one were to pick a county at random from the West, it is slightly more likely the selected county would have experienced net out-migration rather than net in-migration—the opposite is true for counties in the East.

The pattern of population losses in recent years in many western counties and gains (largely from in-migration) in a subset of counties continues a long-term pattern of population concentration in much of the West and, in particular, the Mountain West, that has been occurring since the 1950s (Shumway and Otterstrom 2001). In the geography and social science literature this pattern of population concentration has been characterized as a process within the transition of some locales from the Old West to the New West (Shumway and Otterstrom 2001, Winkler et al. 2007). For the Mountain West states, Shumway and Otterstrom (2001) found that population gains were greatest among those counties that typified the New West, whereas Old West counties experienced either stable populations or

population losses. Relative to Old West locales, New West areas have a greater number of in-migrants from metropolitan areas and out of state, an employment market more focused on tourism and professional services, and homes that are newer and have significantly higher market values (Winkler et al. 2007).

Concentrated Western Populations

Differing population and migration results by geographic unit of analysis and the sensitivity of mean values to extreme observations suggest population and population growth in the West are concentrated in a few locations relative to the same dynamics in the East. The top five most-populated western counties, based on the 2000 census, (Los Angeles County, California; San Diego County, California; Orange County, California; Maricopa County, Arizona; and King County, Washington) accounted for 30% of the West's population and 1% of its land area. For comparison, the top five most-populated counties in the eastern states (Cook County, Illinois; Harris County, Texas; Kings County, New York; Miami-Dade County, Florida; and Queens County, New York) accounted for a little more than 7% of the East's population. The population centers in both regions have been identified as "megapolitan" areas in other research (e.g., Grimm et al. 2008).

Mapping county-level populations using cartograms is one simple approach to gauge the extent to which the eastern and western populations are concentrated within a subset of locales. We use cartograms to depict the importance of each county's population in contributing to the total regional population. The West's population cartogram is dominated by the large populations found in the southern portions of California and Arizona and, to a lesser extent, the Seattle and San Francisco metropolitan areas (Figure 1A). In contrast to those megapolitan areas, many of the remaining western counties contribute little to the regional population. In the East, no locales dominate the regional population to the extent found for the West (Figure 1B); even the presence of four of the top five most-populated cities in the nation (New York, Chicago, Houston, and Philadelphia) does not dominate the eastern population. Rather, the cartogram for the East is perhaps better characterized by the extent to which many coun-

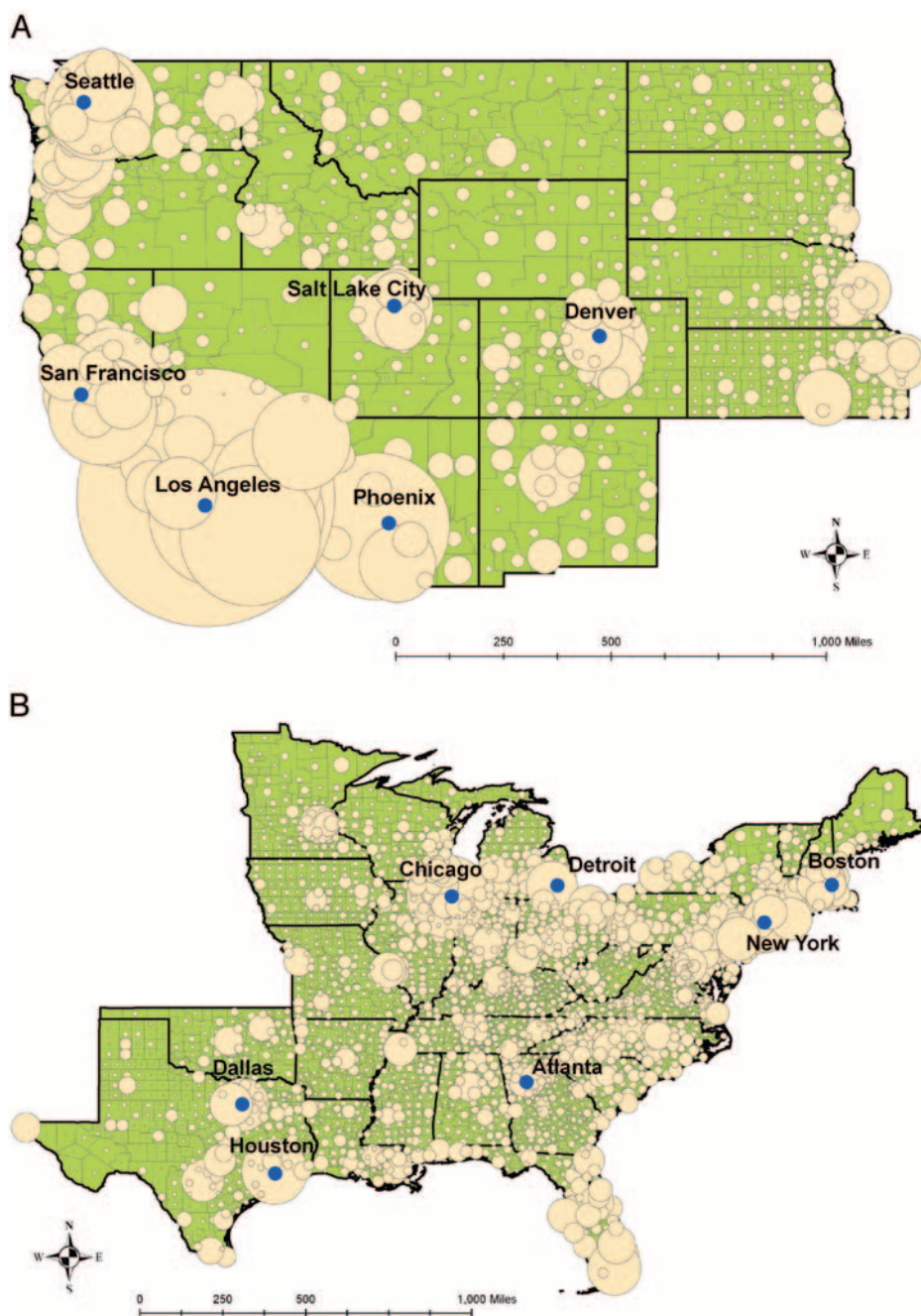


Figure 1. Cartogram of county-level year 2000 populations in the (A) western and (B) eastern United States. Circle size represents county size weighted by the proportional size of the county population relative to the regional (i.e., West or East) population. (Cartogram programming code source: Wolf 2007; data source: USDC Census Bureau 2007d.)

ties throughout the region contribute moderate populations to the regional total.

With the population concentrated in areas that are also rapidly growing, a large percentage of the western population is exposed to substantial metropolitan-area population increases. The population growth in the five most-populated western counties accounted for approximately 25% of the West's population growth between 1990

and 2007 (4.2 million people) and 2000 and 2007 (1.6 million people). If the population growth of the counties adjacent to the most-populated western counties is also included, those living in the five most-populated counties in the West were exposed to approximately 43% of the West's population increase in both time periods. Those living in the five most-populated eastern counties were exposed to just 5% of the East's population growth in both periods.

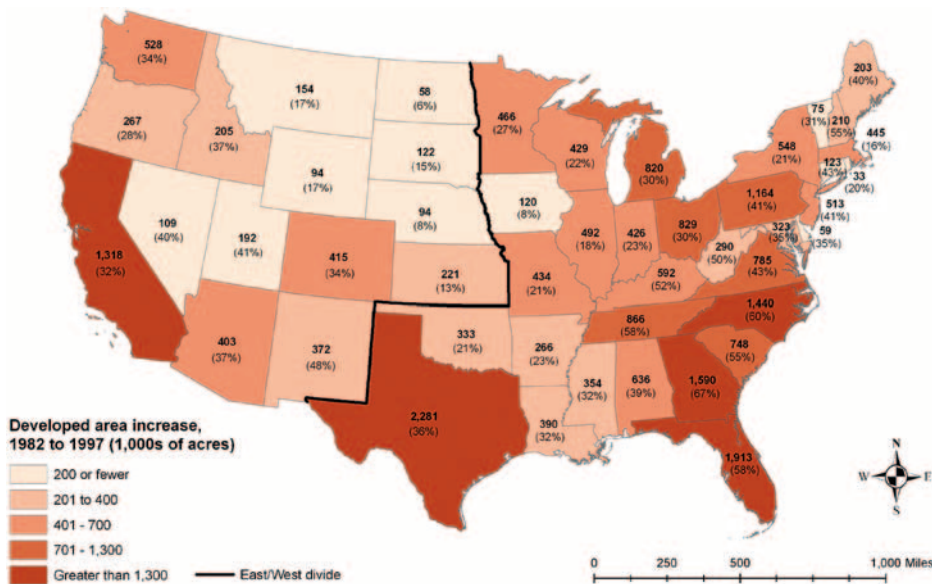


Figure 2. Absolute and (percentage) increase in land area in urban and developed uses, 1982–1997. (Data source: USDA NRCS 2000.)

Housing Units as the Footprints of Populations

Along with households (Liu et al. 2003), housing units (including primary and secondary residences in single- and multifamily structures) are the footprint of populations and are an important factor in considering the ecological impacts of population expansion locally and regionally. On average, in the contiguous 48 states, there are about 2.4 people per housing unit. In places where the average number of people per housing unit is less, population gains yield greater increases in housing units, all else being equal. The number of permanent and seasonal housing units in the West increased by 2.8 million (11%) between 2000 and 2006 (0.5 million annually) and by 6.4 million (28%) between 1990 and 2006. In the East, post-2000, slightly more than 1 million permanent and seasonal housing units were added annually, for a 7.6 million (9%) increase. Between 1990 and 2006, the number of housing units in the East increased by 17.5 million (22%).

No statistically significant differences were found at the state level between the East and the West in the change in housing units for either the recent or the long-term periods (Table 1). At the county level, over the long term and in the recent past, individual counties in the East have experienced statistically significantly greater increases in housing units than those in the West. Median county-level change in housing units in the East was 637 units in recent years and

2,100 units over the long-term period. In the West, median county-level changes in housing were 188 units between 2000 and 2006 and 578 units between 1990 and 2006. Again, the mean values, influenced by a few extreme observations, indicate greater increases in housing units in the West compared with the East.

Current Developed Area and Past Rates of Development

Population growth and the associated demands for housing lead to residential expansion. In turn, residential expansion is a factor in commercial and transportation expansion (e.g., White et al. 2009). Collectively, those three demands for land plus industrial expansion can lead to development of rural lands. One data source for tracking the area of developed land and conversion of rural land to developed uses is the National Resources Inventory (NRI) data collected by the NRCS (USDA NRCS and ISU Statistical Laboratory 2000, USDA NRCS 2007).

Approximately 6% (108 million ac) of nonfederally owned land in the contiguous 48 states was in urban and developed land uses in 2003 (USDA NRCS 2007). Urban and developed lands include residential, commercial, industrial, and institutional lands, highways, and small non-built-up areas if they are surrounded by developed land (USDA NRCS and ISU Statistical Laboratory 2000). The East had 9% (84 million ac) and the West had 4% (24 million ac) of their respective nonfederal land bases in devel-

oped uses. The most developed eastern state was New Jersey, with 42% (1.9 million ac) of its nonfederal land base developed, and the most developed state in the West was California, with 11% (5.9 million ac) of its nonfederal land base developed. Over the most recent extended period for which we can estimate state-level land-use transitions (1982–1997), the area of developed land in the contiguous states increased by approximately 24.3 million ac (47%). Development in the East accounted for 19.9 million ac (82%) of this increase. In the East, Texas had the greatest absolute increase in developed area (2.3 million ac; Figure 2). In the West, California had the greatest extent of rural land converted to developed uses (1.3 million ac). On a percentage basis, increases in state-level developed area between 1982 and 1997 ranged from 67% (Georgia) to 6% (North Dakota). New Mexico was the western state with the highest-ranked percentage increase in developed area (48%), but an absolute increase of 371,000 ac.

Area of additional developed land per additional person, household, or housing unit can be a useful measure of the efficiency of land development (Kline 2000, Liu et al. 2003, White et al. 2009). Approximately 1.2 ac of land was converted from rural to developed land uses (combining land developed for residential, commercial, industrial, and transportation uses) for each housing unit added in the United States between 1982 and 1997 (White et al. 2009). Region-wide for the 1982–1997 period, the West had a smaller area of land developed per additional housing unit (0.8 ac) than the East (1.4 ac). Collectively, Pacific Coast states had the smallest increases in developed land area per additional housing unit (0.7 ac); states in the South-Central region (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas) had the highest (1.6 ac; White et al. 2009).

Forest and Rural Land Conversion

Some of the land needed to support new development will come from existing urban areas via such things as infill development and urban revitalization; the remainder will come from land previously in rural land uses such as forestry and agriculture. Transition matrices estimated from the NRI data can reveal the patterns of land exchange over time between major land use/land covers (e.g., forestland, cropland, urban and de-

veloped) for study regions (e.g., Alig and White 2007). In both the East and the West, approximately 94% of the nonfederal land that was in forested land uses in 1982 remained in forested land uses in 1997 (Table 2). In the West, rangeland was the largest receiving land use, or destination, of converted nonfederal forestland (1.8 million ac or 2.7% of 1982 forestland). In the East, the largest receiving land use for converted forestland was developed land (8.9 million ac or 2.7% of 1982 forestland).

Developed land area in the West expanded by approximately 46% (4.4 million ac) between 1982 and 1997. Over the same period, the East experienced a similar percentage increase (48%) but a more than fourfold absolute increase (19.9 million ac) in developed land. Over the 15-year period, rural open space declined by approximately 0.3 million ac per year in the West and 1.3 million ac per year in the East. In the eastern states, forestland was the greatest source, or provider, of rural land converted to developed uses (8.9 million ac or 45% of newly developed land; Figure 3). In the West, rangeland was the greatest source of newly developed land (1.7 million ac or 38% of newly developed land). Forestland was the third greatest source of newly developed land in the West (behind rangeland and cropland), with 800,000 ac converted to developed and urban uses between 1982 and 1997 (18% of the newly developed land).

Goods and Services from Forest Resources

Forest resources in the United States provide a variety of market and nonmarket goods and services. As the population and development patterns differ between the regions, so too do the services that people receive from the western and eastern forests. Population growth and land development can, of course, have impacts on the output of forest goods and services and the supporting ecosystem processes.

Private forests constitute approximately 56% of all Forest Inventory and Analysis-defined forest in the United States but accounted for approximately 90% of all timber volume harvested in the nation in 2002 (Adams et al. 2006). The majority of the nation's timber is harvested in the East, with the South, in particular, having become the nation's "woodbasket" (Adams et al. 2006). In the West, timberland is most common in the Pacific Northwest states; in the Rocky

Table 2. Transition probabilities for land covers/uses for US regions.

Initial land use	Final land use (%)					
	Crop	Pasture	Forest	Urban	Range	Other
Western contiguous states						
Crop	84.6	2.3	0.0	0.8	1.3	10.9
Pasture	17.3	72.4	1.2	2.2	3.7	3.2
Forest	0.1	0.2	94.4	1.2	2.7	1.5
Urban	0.0	0.0	0.0	100.0	0.0	0.0
Range	1.8	0.4	0.7	0.6	94.9	1.6
Other	0.3	0.1	0.1	0.1	0.7	98.8
Eastern states						
Crop	82.4	5.9	2.1	2.1	0.6	6.8
Pasture	10.6	69.4	12.3	3.2	1.6	2.9
Forest	0.6	1.2	94.3	2.7	0.1	1.1
Urban	0.0	0.0	0.0	100.0	0.0	0.0
Range	1.3	1.6	0.7	1.1	94.1	1.1
Other	1.1	0.9	2.8	0.5	0.2	94.4

Based on the 1982 and 1997 Natural Resources Inventory data (USDA NRCS and ISU Statistical Laboratory 2000).

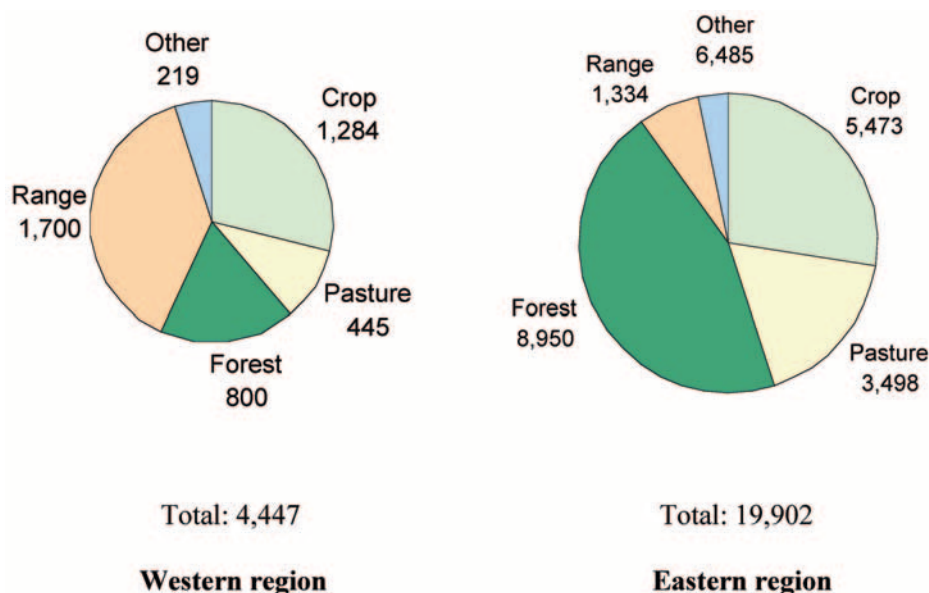


Figure 3. Area of nonfederal rural land converted to urban and developed uses, 1982–1997 (1,000 ac). (Data source: USDA NRCS 2000.)

Mountains and Pacific Southwest regions, because of, generally, a productivity threshold, less than half of private forestland is considered timberland (Smith et al. 2004). In contrast, timberland is distributed throughout the East, with at least 95% of forestland classified as timberland in each eastern subregion (Smith et al. 2004). Regardless of the distribution of timberland, studies completed in both the East and the West have found that population growth and associated residential development can reduce the likelihood of commercial forest management (Wear et al. 1999), timber harvest (Munn et al. 2002), and the application of intensive forest management activities (Kline et al. 2004). However, these studies differ in their findings regarding the impact

of residential development on harvesting behavior and additional research is needed to better quantify the influence of historic patterns of land use and changes in economic parameters such as stumpage prices on harvesting behavior within developing landscapes.

Forested open space and public lands have consistently been found to have positive impacts on residential property values (e.g., Irwin 2002, Kim and Johnson 2002). The desire to live in proximity to natural resource amenities is reflected in increased migration to amenity-rich areas—commonly termed amenity migration. Amenity migration has spurred increases in population and residential development in rural counties rich in natural features and federal

lands (e.g., Frentz et al. 2004, Johnson and Stewart 2005). Those counties with greater forest area are prone to high rates of in-migration (e.g., McGranahan 2008). Although amenity migration is often associated with the West, areas in the northern Great Lakes, the Northeast, and portions of the South are also considered amenity migration destinations. Population growth in amenity-rich “recreation counties,” many of which are in the West, have outpaced population growth in other rural counties (Johnson and Beale 2002). Increased populations in recreation counties may put increased pressure on the forested recreation resources in those locales. Especially affected might be those publicly accessible recreation resources located in areas experiencing extensive residential development and also having high per capita rates of nature-based recreation, such as the West (Cordell 2004, p. 146, 204).

Forests in both study regions provide a variety of ecosystem services and support important ecological processes. Across the contiguous 48 states, approximately $\frac{2}{3}$ of Hydrologic Unit Code 4 watersheds with private forestland support at least one at-risk plant or animal species (Robles et al. 2008). Private forestland watersheds with the greatest number of at-risk species are most concentrated in the southern Appalachians, Florida, and the West Coast states, particularly California (Robles et al. 2008)—areas rich with endemic species. Forests throughout the country are also an integral resource for sequestering carbon from the atmosphere. Woodbury et al. (2007) have estimated that in recent years US forests accounted for a net annual carbon flux of -101 Tg of carbon, where a negative flux indicates sequestration of carbon from the atmosphere to the forest ecosystem. The largest negative annual fluxes of carbon in trees were in Minnesota, Maine, New York, and Florida (Woodbury et al. 2007). Annual net fluxes of carbon are influenced by a number of factors in addition to forest area and forest growth rates, e.g., historic land use, management intensity, landowner behavior, and other factors. The greatest stocks of forest-sequestered carbon were in the Pacific Northwest, with large stocks also found in the Lake States and Northeast (Woodbury et al. 2007). Forests and open spaces in both regions serve important roles in the provision of quality water for human use and wildlife habitat. In both regions, land development, including the conversion of forests for residential development, can lead

to reduction in water quality (e.g., Atasoy et al. 2006, Shandis and Alberti 2009). The generally lesser supply of water in the arid West further complicates the impacts that land development can have on the provision of quality water in that region.

Conclusions

Both the West and the East have experienced considerable gains in population and developed land area over long-term and recent periods. In nearly all characteristics, the East has experienced greater absolute increases but the West has experienced greater percentage increases, owing to generally lesser starting points in the West for such things as population and developed land area. Relative to the East, the West’s population and recent and long-term population and housing growth are concentrated geographically. In the West, population and housing gains have been focused in a subset of counties and slightly more than half of all western counties lost population after the year 2000. The population and population expansion in the East are more evenly distributed across the region, with even the presence of four of the top five cities in the country not leading to significant concentration of the East’s population.

Regionwide, the East has exhibited higher rates of marginal development per additional housing unit than the West—1.4 ac per additional housing unit versus 0.8 ac per additional housing unit, respectively. All else being equal at the margin, the addition of homes to the western landscape leads to less additional developed area than in the eastern landscape. These patterns of land development likely will change over time and continued monitoring will be necessary to identify future relationships between housing growth and developed land area. Forestland contributes the greatest number of acres for new development in the East; rangeland is the primary contributor of land for development in the West. Most of the forestland lost in the West is converted to rangeland. Over time, it is possible that western forestlands converted to rangeland may ultimately end up in developed land uses. Residential development on rangeland in the West is likely very noticeable, having deleterious effects on the visual characteristics of open space landscapes.

Concentrated population and housing centers, lower marginal rates of developed area expansion, and the pattern of developing rangeland in the West help to illuminate

the disparity between the development and population growth experienced firsthand and that found when viewed from a national perspective. This is reinforced when also considering the distribution of forest resources in each region. The more distributed eastern population and forest resources and higher rates of marginal land development combine to promote more expansive areas of forestland conversion in the East. Differing characteristics of the East and West do not diminish the utility of national-level land-use studies, rather, they highlight the importance of such studies in providing a broad-scale context for considering rural land development that is not captured in studies where the focus is on smaller geographies.

In developing land conservation programs and policies, decisionmakers should recognize the differences in land development and growth rates between the East and the West, in addition to inherent land productivity differences. The changes in drivers of land development, population, and housing expansion, as well as land development itself, are greater in magnitude in the East but the West has experienced greater change relative to previous conditions. Policy deliberations about promoting more investment in land conservation would benefit from recognizing such regional variations. For example, the East has a larger amount of agricultural land suitable for afforestation as part of any strategy to mitigate climate change; however, the West has local areas that could benefit proportionately more from shelterbelt tree plantings to address both wind erosion and climate change concerns, in addition to enhancing other forestland goods and services. Any afforestation in the East is likely, on average, in the future to face a higher likelihood of land conversion pressure from growth in developed areas. At the same time, tree plantings in the West could be arranged to supplement public forestland holdings and create larger blocks of unfragmented forest.

Land conservation policies also can be strengthened by considering comparative advantages by region in providing forestland goods and services, in view of regional differences in development pressures. Important information for decisionmakers is the relative importance of magnitude versus rate of development change based on the goals of the program or policy being considered. In recognizing differences in potential service flows received from forested resources in the two regions (e.g., timber flows in the South

and higher per capita nature-based recreation in the West), policies can be formulated accordingly and with a useful prospective view of likely land-use changes. The concentrated nature of land development and population growth in the West highlights the importance of recognizing spatial variation in the extent of development in natural resource conservation programs for that region. A regionwide approach may not be efficient in the West where most locales are experiencing limited growth and a minority is experiencing rapid changes. Failure to recognize localized variation in growth may also lead to missed opportunities to make important land conservation gains in the West.

As the gap closes between the East and West for some socioeconomic measures, an important one to monitor will be net domestic migration of people. However, tracking differences in net migration by parts of each region will be useful, in that a relatively few states in each region had very high net domestic migration. For both recent and long-term periods, slightly more counties in the West experienced net out-migration than net in-migration, suggesting that the high in-migration rates for the West as a whole are largely caused by a subset of counties (e.g., Maricopa County, Arizona). Furthermore, a significant component of residential development and population growth in the West is associated with the desire to live in proximity to natural resource amenities. With the West having proportionately more public land, that region faces more development in such locales (Frentz et al. 2004, Stein et al. 2007), which can have a number of implications for natural resource management and protection (e.g., wildland fire management).

Substantial growth in population and personal income projected for the East and West (Su 2007) and subsequent increases in developed area have significant implications for open space conservation and natural resource management in both regions. In aggregate, developed land area is projected to increase by more than 50% by 2030 (Alig et al. 2004, White et al. 2009). For forestland specifically, more than 40 million ac is projected to experience substantial increases in housing density between 2000 and 2030 (Stein et al. 2005). Given that many of the goods and services from forests are public goods that are not reflected in land markets, increased fragmentation and rural land loss could have a

substantial impact on these public goods. Land-use change studies indicate that land development will continue to be substantial but that climate change, rising energy costs, and other large-scale changes may alter human settlement patterns and should be monitored in the future. For example, people may choose to reduce commuting distances and costs, with some moving closer to employment centers, while others rely on telecommuting. This could affect the future path of residential development in rural areas and thereby change the prospects for long-term maintenance of forests and afforestation to expand forest area to promote multifunctional landscapes to better attain goals of carbon sequestration, wildlife habitat availability, and open space conservation, among others.

In addition to the variety of ecosystem services and goods, forests serve as a connection to nature, which varies markedly in the East and West. Citizens living where farms and forestlands were a common feature of the landscape are in many cases now surrounded by new subdivisions, shopping malls, and other infrastructure. The magnitude is larger in the East but the recent changes in their neck of the woods have many westerners experiencing marked changes in quality of life. Outdoor recreation is a particularly important way to connect to nature, and as forestland is developed, some citizens must travel farther to relax in a forested setting. Public and private forests provide many opportunities for outdoor recreation, with population growth in recreation counties outpacing growth in other rural counties. To aid in future assessments, updated data on land use, socioeconomic variables, and land values will be crucial. Expanded attention to the issue of data updates on current land use and land-use transitions can help address outcomes from increasing populations and incomes that result in more forests at risk for development in both regions, with watersheds perhaps affected differently depending on their location and characteristics. Although the current business as usual trajectory suggests diminished capacity of forests to provide goods and services, policymakers can make positive gains by developing useful conservation programs that recognize the important commonalities and distinctions between regions in the pressures on natural resources.

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