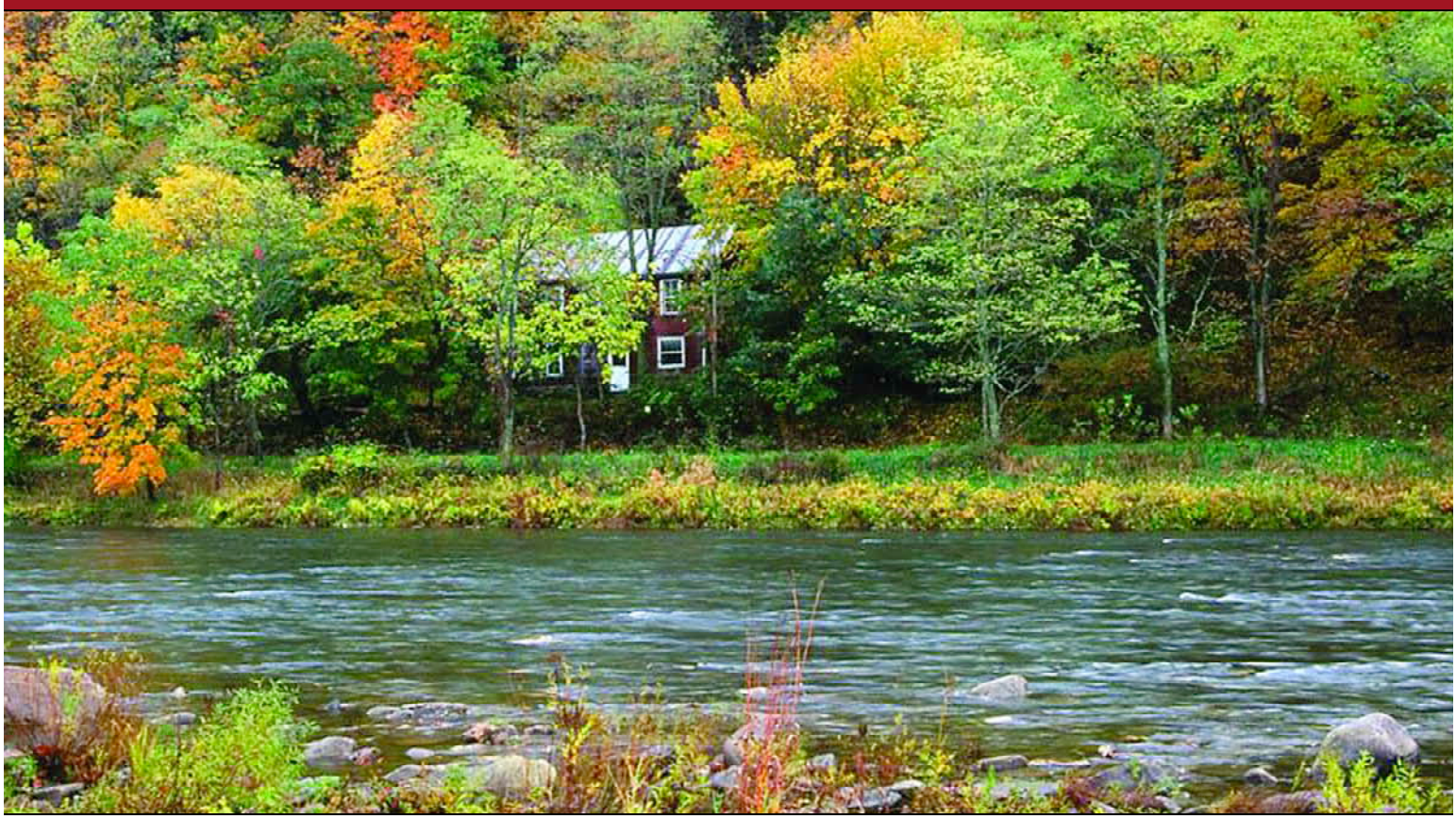
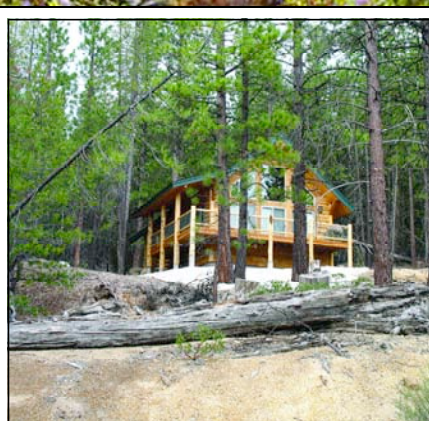
NATIONAL FORESTS ON THE EDGE

DEVELOPMENT PRESSURES ON AMERICA'S NATIONAL FORESTS AND GRASSLANDS





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Susan M. Stein, Ralph J. Alig, Eric M. White, Sara J. Comas, Mary Carr, Mike Eley, Kelly Elverum, Mike O'Donnell, David M. Theobald, Ken Cordell, Jonathan Haber, and Theodore W. Beauvais

ABSTRACT

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Many of America's national forests and grasslands—collectively called the National Forest System—face increased risks and alterations from escalating housing development on private rural lands along their boundaries. National forests and grasslands provide critical social, ecological, and economic benefits to the American public. This study projects future housing density increases on private rural lands at three distances—½, 3, and 10 miles—from the external boundaries of all national forests and grasslands across the conterminous United States. Some 21.7 million acres of rural private lands (about 8 percent of all private lands) located within 10 miles of the National Forest System boundaries are projected to undergo increases in housing density by 2030. Nine national forests are projected to experience increased housing density on at least 25 percent of adjacent private lands at one or more of the distances considered. Thirteen national forests and grasslands are each projected to have more than a half-million acres of adjacent private rural lands experience increased housing density. Such development and accompanying landscape fragmentation pose substantial challenges for the management and conservation of the ecosystem services and amenity resources of National Forest System lands, including access by the public. Research such as this can help planners, managers, and communities consider the impacts of local land use decisions.

Keywords: Land use change, national forest, housing density, road density, ecosystem services, amenity resources, amenity migration, housing development, planning.

AUTHORS

Susan M. Stein is a private forest-land studies coordinator, **Sara J. Comas** is a natural resource specialist, and **Theodore W. Beauvais** is an assistant director, U.S. Department of Agriculture, Forest Service, Cooperative Forestry Staff, Mailstop 1123, 1400 Independence Avenue, SW, Washington, DC 20250-1123. **Ralph J. Alig** is a research forester and team leader, and **Eric M. White** is a research economist, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331. **Mary Carr** is a technical publications editor, U.S. Department of Agriculture, Forest Service, Publishing Arts, 1835 Black Lake Boulevard, SW, Olympia, WA 98512. **Mike Eley** is a geographic information system (GIS) coordinator, American Farmland Trust, 1200 18th Street, NW, Washington, DC 20036. **David M. Theobald** is a research scientist, Colorado State University, Natural Resource Ecology Laboratory, Fort Collins, CO 80523-1499. **Kelly Elverum** and **Mike O'Donnell** are GIS analysts, Elverum Mapping Services, 1627 Cedarwood Drive, Fort Collins, CO 80526. **Ken Cordell** is a pioneering research scientist, U.S. Department of Agriculture, Forest Service, Southern Research Station, Forestry Sciences Laboratory, 320 Green Street, Athens, GA 30602-2044. **Jonathan Haber** is a regional conservation planner, U.S. Department of Agriculture, Forest Service, Northern Region, 200 E Broadway, P.O. Box 7669, Missoula, MT 59807.

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INTRODUCTION

America's National Forest System is composed of 155 national forests and 20 national grasslands managed by the U.S. Department of Agriculture, Forest Service. Many of these forests and grasslands are facing increased risks and impacts from escalating housing development on private rural lands along their boundaries. Encompassing about 192 million acres across 44 states, Puerto Rico, and the Virgin Islands, national forests and grasslands account for 8.5 percent of the total U.S. land area and 20 percent of its forest land (USDA Forest Service 2004a) (fig. 1). Nearly a quarter of the U.S. population lives in a county that contains National Forest System land (Johnson and Stewart 2007).

National Forest System lands provide critical social, economic, and ecological benefits to the Nation, including aesthetic and spiritual values, recreation opportunities, fresh drinking water, clean air, timber and other forest products, minerals, oil and gas, livestock grazing, and abundant habitats for fish and wildlife species (see page 4 for examples). These ecosystem services and amenity resources can be altered when new houses are built on private lands within or near forest and grassland boundaries.

The population of the United States is projected to increase by at least 135 million people to approximately 420 million people by 2050 (U.S. Census Bureau 2004), resulting in substantial projected expansion in U.S. developed area (Alig and Plantinga 2004, Alig et al. 2004, Cordell and Overdevest 2001, Macie and Hermansen 2003, Nowak and Walton 2005). Counties with national forests and grasslands already are experiencing some of the highest population growth rates in the Nation as people move near public lands (Garber-Yonts 2004, Johnson and Stewart 2007, USDA Forest Service 2006a). Even **within**

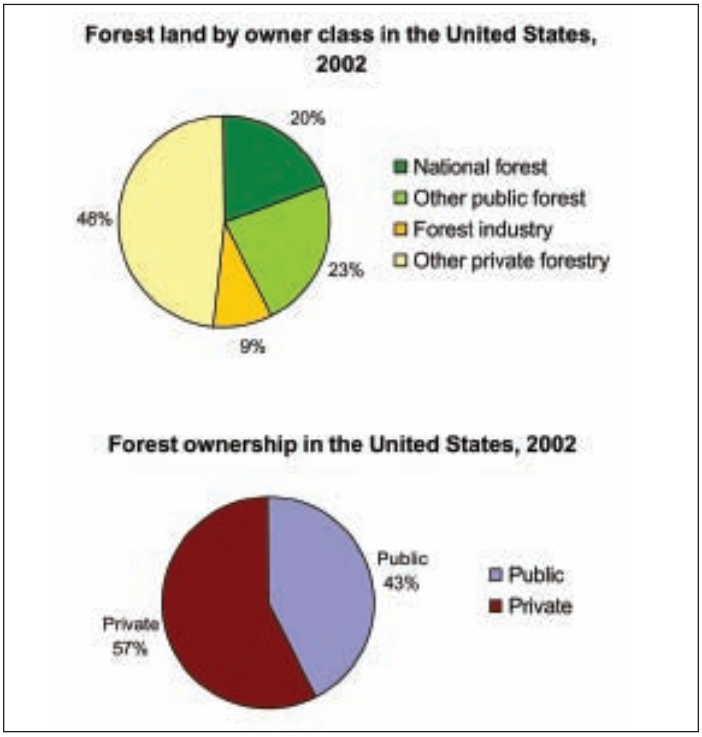

Figure 1—**Who manages America's forests?** National Forest System lands are managed by the U.S. Forest Service and account for about 20 percent of America's forested land. Some 148 million acres of National Forest System lands are forest; about 44 million acres are nonforest. Other forested lands in the country are managed by private landowners (57 percent) or by other public agencies or local governments (23 percent). Source: Smith and Darr (2004).

national forest boundaries, the number of housing units on privately held lands increased from 500,000 to 1.5 million between 1950 and 2000 (Radeloff et al. 2005a).[1]

[1] Nationwide, some 17 percent of all lands located within the boundaries of national forests or grasslands are "inholdings" held by private or other non-Forest-Service landowners (USDA Forest Service 2005b). Inholdings may be managed by other federal agencies; state, county, local, or tribal governments; private individuals; or corporate entities. Inholdings are particularly prevalent in the East, where national forests were established much later than those in the West, often to protect damaged watersheds and restore abandoned farmlands (Shands and Healy 1977); nearly half (46 percent) of the lands located within Eastern national forest boundaries are inholdings (USDA Forest Service 2006a). Western national forests generally have a more consolidated ownership pattern providing larger blocks of public land with fewer inholdings.

Although most National Forest System lands are in the West, national forests along the Appalachian Mountain chain and scattered across other Eastern and Midwestern States are within a day's drive for millions of Americans (USDA Forest Service 2005b). Private lands in the vicinity of national forests and grasslands are becoming developed at an increasing rate across the country.

A third of all federally listed threatened or endangered species currently occur on National Forest System lands or are potentially affected by national forest and grassland management (Bosch 2006). Photos courtesy of U.S. Fish and Wildlife Service.

Examples of benefits and resources associated with management objectives on National Forest System lands

National forest/grassland objective[a]	Benefits and resources
Maintain national forests for future generations (93.5)[b]	All those listed below
Protect streams and other sources of clean water (94.9)	The largest single source of fresh water in the U.S., providing 14 percent of the country's water runoff and high-quality water valued at $3.7 billion per year[c]
Provide habitat for wildlife and fish (89.2) Protect rare plant or animal species (86)	Wildlife and fish habitats for numerous species, including a third of all federally listed threatened or endangered species[d]
Manage national forest areas to leave them natural looking (86.8) Provide quiet, natural places for personal renewal (75.8)	Special areas, such as wilderness, research natural areas, national scenic areas, and national monuments
Emphasize planning and management for timber (79.1)	2 billion board feet of timber in a single year, valued at $224 million[e]
Provide recreation access, facilities, and services (74.5)	205 million recreation visits annually; 4,300 campgrounds with 122,000 camp sites; 135 alpine ski areas; 4,418 miles of wild and scenic rivers; 133,087 miles of hiking trails[f]
Provide roads, services, accommodations to support local tourism businesses (57.0)	$7.5 billion annually in direct spending in local economies resulting from recreation visits to national forests[f]

[a] Identified in Tarrant et al. (2003) as "assets."
[b] Numbers in parentheses represent the percentage of the public responding to a survey (Tarrant et al. 2003) who said they considered this management objective ("asset") important.
[c] Dissmeyer 2000, USDA Forest Service 2000b.
[d] Bosch 2006.
[e] USDA Forest Service 2005a.
[f] USDA Forest Service 2004b.

National Forests on the Edge is the second analysis conducted by the Forests on the Edge project sponsored by the Forest Service, State and Private Forestry, Cooperative Forestry staff. This report identifies national forests and grasslands across the conterminous United States most likely to be affected by increased housing density on rural private lands outside the external boundaries[2] of National Forest System lands. It also discusses how this type of development may affect national forests and grasslands; similar effects might logically be expected to confront other local, state, and federal public lands. These findings and discussions should prove useful as tools to facilitate decisionmaking about future land use options.

About Forests on the Edge

Sponsored by the U.S. Forest Service, State and Private Forestry, Cooperative Forestry staff, the Forests on the Edge project identifies areas across the country where public and private forests might change because of housing development and other factors. The project focuses on lands that currently are rural and becoming more developed. Development on rural lands is often overlooked because it may not be as visible as higher density development found closer to urban centers. The project's first report (Stein et al. 2005a) identified watersheds across the conterminous United States containing substantial amounts of private forest projected to experience increased housing densities by 2030. In total, more than 44 million acres of private forests were projected to experience increased housing density by 2030.

IDENTIFYING NATIONAL FORESTS AND GRASSLANDS ON THE EDGE

This study focuses on national forests and grasslands in the conterminous United States that might experience change owing to increased housing development on private rural lands along their boundaries. Data necessary to prepare nationally consistent housing density forecasts for lands bordering national forests in Alaska and Puerto Rico are not adequate at this time, and there are no national forests in Hawaii.

[2] "External boundary" refers to the perimeter boundaries of a national forest or grassland. In some cases, this boundary is also referred to as a "proclamation" boundary, or the outer boundary within which Congress authorized a particular national forest to be established. "Internal boundaries" are those boundaries located within the external boundaries that distinguish National Forest System lands from other lands (often referred to as inholdings). The National Forests on the Edge analysis focuses on development on private rural lands outside the national forest or grassland external boundaries.

The analysis ranks individual national forests and grasslands according to the percentage and total area of private lands (including both forest and nonforest vegetation types) adjacent to each that are now rural and are projected to experience increased housing density.

These projections of housing density increases were limited to private lands outside national forest and grassland external boundaries (fig. 2). Although private lands also may be located within the external boundaries, it was not possible to make nationwide estimates for such "internal" private lands because no nationally consistent data were available at the time of this study.

Three distances from external boundaries were chosen—0 to ½ mile, ½ to 3 miles, and 3 to 10 miles. In selecting these distances, it was assumed that changes to national forest and grassland benefits will differ depending on how close development activity is to the boundary. A literature review was conducted to identify several distances as broad indicators within which housing density increases can affect national forest functions and values. Relevant distances were found to differ widely, depending on the type of impact being studied. The distances selected for this study correspond to those routinely used by recreation managers to identify areas where visitor experiences can be affected by the sounds and sights of development.

Distances for Recreation Planning

Research-based distances form the core of the Recreation Opportunity Spectrum (ROS), which is widely used by federal agencies and a number of state agencies in recreation planning. For example, ROS remoteness criteria were used for the Forest Service's Forest and Rangeland Assessment to inventory land available for outdoor recreation at three distances from roads—0 to ½ mile, ½ to 3 miles, and beyond 3 miles (Cordell et al. 1990). Similar applications have been used by federal and state agencies to classify primitive recreation settings that lie beyond 3 miles of roads, semiprimitive settings from ½ to 3 miles from roads, and more accessible settings closer to development and within ½ mile of roads.

Terry Tollefsbol

Grizzly bears have been reported to be sensitive to road densities as low as 1 to 2 miles of road per square mile of land (Mace et al. 1996).

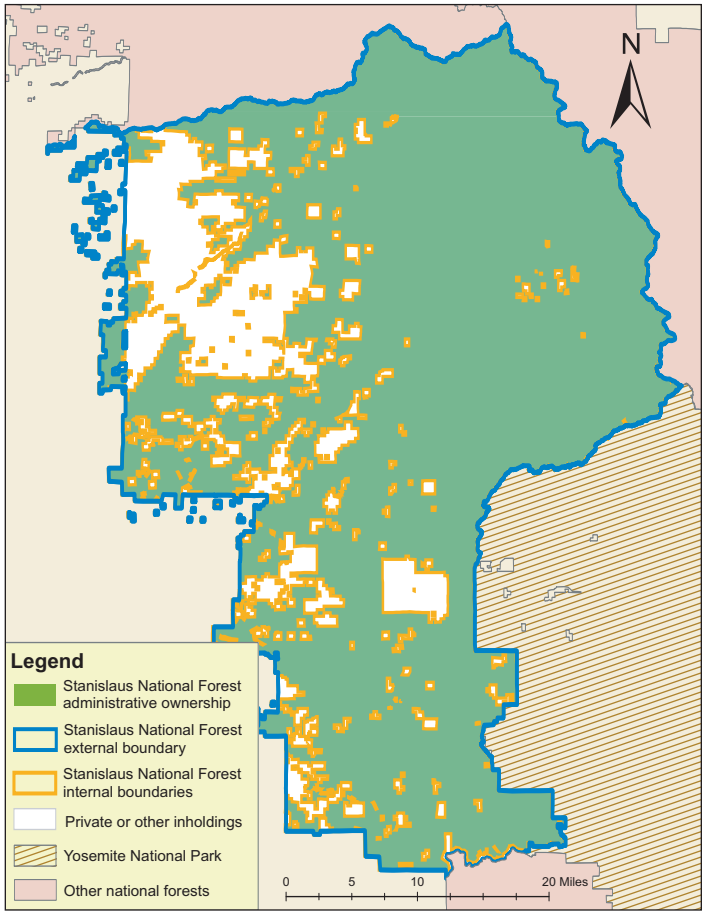

Figure 2—Internal and external boundaries for the Stanislaus National Forest, California.

How Housing Density Projections Were Made

Housing density projections in this study focus on increased housing densities on lands that are currently rural. The projections are based on past and current statistics on housing density and population, road density data, past growth patterns, proximity to urban areas, and other factors (see "Appendix" for details; see also Stein et al. 2005b, Theobald 2005). Housing density projections are based on human population estimates of 276 million for the year 2000 (U.S. Census Bureau 2001a) and 385 million for the year 2030 (NPA Data Services, Inc. 2003).

To facilitate description of estimated changes, three housing density categories were defined:[3]

- **Rural I**—Lands with 16 or fewer housing units per square mile.
- **Rural II**—Lands with 17 to 64 housing units per square mile.
- **Exurban/urban**—Lands with 65 or more housing units per square mile.

[3] These housing density categories are identical to those used in the first *Forests on the Edge* report (Stein et al. 2005a, 2005b), but the names of the categories have been changed.

Increased housing density was defined to mean increased number of housing units per unit area on lands defined here as rural I or rural II, such that the housing density would shift to a higher level category.

Because this study focuses on areas where the 2000 housing density was 64 or fewer units per square mile, housing density increases for private lands already above this housing density level are not reflected in this analysis. Similarly, many national forests surrounded by housing densities greater than 64 units per square mile also may not be highlighted in this study because they have too little surrounding rural land that would change to a higher category.

Private land refers to all lands not identified as "public" (under federal, state, or local government management).

Urban National Forests

A number of national forests and grasslands located in the conterminous United States and Puerto Rico have been designated as "urban national forests" based on their proximity to large urban centers. An urban national forest is defined as one within an hour's driving distance of a million or more people (USDA Forest Service 2003b). Owing to the presence of large urban areas, the densities of residential development around many of these urban national forests may already be higher than the rural densities that are the focus of this report, so further changes in housing densities near these urban national forests may not be represented in this study. However, these forests are likely facing many of the same management challenges as those forests where rural residential development is projected to increase.

How This Analysis Was Conducted

The analysis quantifies and displays the extent of projected increases in housing density on rural lands located near National Forest System lands throughout the conterminous United States.

Each national forest or grassland consists of numerous, often disconnected parcels (see "Appendix" for details). Three basic steps were completed to estimate increases in housing densities on private lands surrounding these parcels:

- **Step 1**—For each of the three distances, we determined the area of private land surrounding each national forest or grassland parcel that is currently under each of the three housing density categories (rural I, rural II, or exurban/urban).
- **Step 2**—For each of the three distances, we determined the area of private land now classified as rural I or rural II that is estimated to experience housing density increases between 2000 and 2030, such that the housing density would change to a higher density category.
- **Step 3**—We determined the total area and percentage of private land around each national forest and grassland estimated to experience increased housing density within each of the distances studied.

Metropolitan Design Center Image Bank, © University of Minnesota

It's a familiar and accelerating trend—new houses with large individual lots scattered across a rural landscape. Dispersed low-density housing can create disproportionately high ecological and economic impacts **per housing unit** because each rural residence occupies more land area than an urban residence (Lubowski et al. 2006, Radeloff et al. 2005b, Theobald 2005, USDA Forest Service 2006a) and because desirable home sites often lie in environmentally sensitive places such as shorelines, riparian areas, or wildlife winter ranges (Johnson and Beale 2002, USDA Forest Service 2006a).

Table 1—Percentage and area of private land at four distances from national forest and grassland boundaries nationwide projected to experience housing growth, 2000 to 2030

Distance from boundary	Amount of private rural land projected to experience housing density increase	
Miles	*Percent*[a]	*Million acres*[b]
0 to 0.5	7	1.5
0.5 to 3	7	6.2
3 to 10	8	14.1
0 to 10	8	21.7

[a] Percentage of **all** private lands (rural and nonrural) within the respective distances.

[b] Area of **rural** private lands within the respective distances.

The resulting figures give an estimate of the magnitude of land area within each distance from National Forest System lands in the conterminous United States projected to experience increased housing density. As with any national assessment, our estimates may not completely capture changes in housing density at all local levels.

KEY FINDINGS

This study estimates that between 2000 and 2030, a substantial increase in housing density will occur on more than 21.7 million acres of rural private land (8 percent of all private land) located within 10 miles of national forests and grasslands across the conterminous United States (table 1). The percentages of private land area projected to experience increases in residential development are consistent across the three distances considered—7 percent for the 0-to-½-mile and ½-to-3-mile distances and 8 percent for the 3-to-10-mile distance.

Individual national forests projected to experience the greatest increases in residential development on private lands within 10 miles of forest boundaries are located throughout the conterminous United States (fig. 3). In the East, almost all national forests are projected to experience moderate or high increases in residential development. In the West, moderate and high increases in residential development are projected around national forests located in Colorado, California, Oregon, Idaho, and Montana. We project the nine national forests most affected could see increased housing development on at least 25 percent of the private lands within one or more of the three distances studied (table 2). Three of these national forests are in the West and the other six are located in the East. Overall, the range in

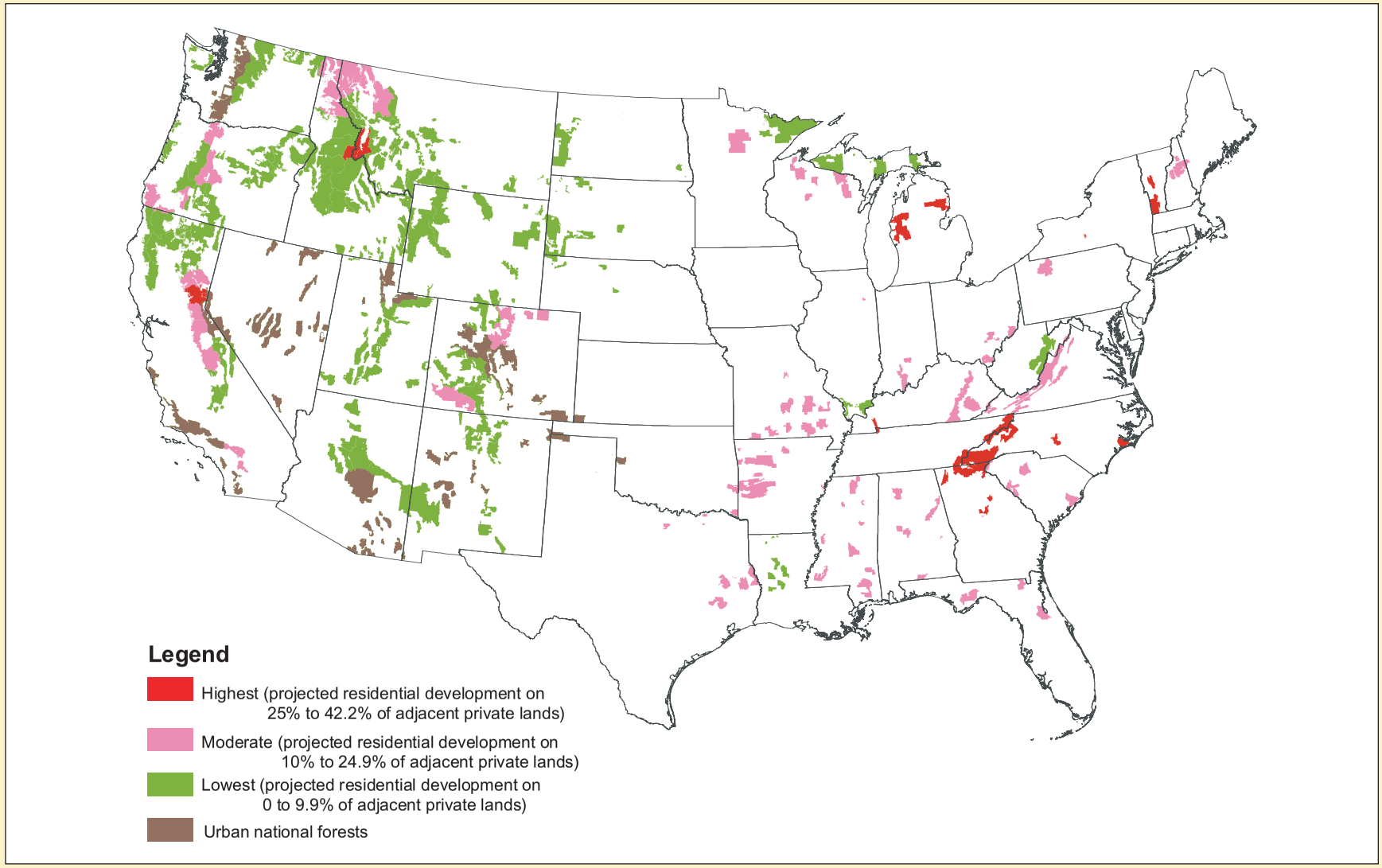

Figure 3—National Forest System lands with private lands within 10 miles projected to experience increased housing density, 2000–2030. Areas shown in brown are designated "urban national forests" (USDA Forest Service 2003b) that were not identified in this study as likely to experience significant increases in rural residential development. Housing densities near the borders of these forests may already be higher than the rural densities that are the focus of this report. Those urban national forests that do register high or moderate change in figure 3 include the Arapaho-Roosevelt, San Bernardino, Eldorado, Mount Hood, Chattahoochee-Oconee, Cherokee, and White Mountain National Forests; the National Forests of Florida; and the Midewin National Tallgrass Prairie. These urban national forests are surrounded by sufficient quantities of rural land projected to change to higher residential densities.

Table 2—National Forest System (NFS) lands with at least 25 percent of adjacent private land (at one or more distances) projected to experience housing growth by 2030

National forests and grasslands	State	Percentage[a] of adjacent private land projected to experience housing density increase[b] — Distance from NFS boundary (miles) (0 to 0.5)	(0.5 to 3)	(3 to 10)	(0 to 10)
Western United States					
Bitterroot National Forest	Idaho, Montana	**33**	**42**	**50**	**42**
Tahoe National Forest	California	18	24	**29**	**26**
Plumas National Forest	California	**25**	24	24	24
Eastern United States					
Chattahoochee-Oconee National Forest	Georgia	**31**	**35**	**35**	**35**
Cherokee National Forest	Tennessee	**30**	**36**	**31**	**32**
National Forests in North Carolina[c]	North Carolina	**26**	**29**	**30**	**30**
Huron-Manistee National Forest	Michigan	**31**	**32**	**26**	**28**
Land Between the Lakes National Recreation Area	Kentucky, Tennessee	5	23	**31**	**28**
Green Mountain and Finger Lakes National Forests	Vermont, New York	**28**	**31**	**25**	**27**

[a] Percentage of all private lands (rural and nonrural) within the respective distances.

[b] Percentages of 25 percent or higher are highlighted red.

[c] Croatan, Uwharrie, Pisgah, and Nantahala National Forests.

percentages of housing density increases for these nine national forests is from 5 percent to 50 percent across all the distances. The Bitterroot National Forest in Idaho and Montana ranks highest in the Nation, with projected housing density increases occurring on 42 percent of the private lands within 10 miles of the forest boundary. The greatest percentage increases on the Bitterroot National Forest are projected to occur in the 3-to-10-mile category.

The percentage of adjacent private lands projected to experience housing density increases does not necessarily become higher with distance from the national forests. For example, the Cherokee National Forest and the Huron-Manistee National Forest have their highest percentages (36 and 32 percent, respectively) at the distance of ½ to 3 miles from their external boundaries, whereas the Plumas National Forest is projected to experience the highest increases in residential housing density at the 0-to-½-mile distance.

The study also ranked National Forest System lands according to the total **area** of adjacent private lands projected to experience increased housing density. Thirteen national forests or grasslands are each adjacent to more than 500 thousand rural acres projected to experience housing increases. As displayed in table 3, ten of these forests or grasslands are found in the South. This finding is not surprising given that (a) many of our southern national forests are surrounded by private lands (in part because the National Forest System lands in the South tend to be smaller, separated parcels); and (b) the South is experiencing the highest rate of urban development in the country (Alig et al. 2004, Macie and Hermansen 2003) (fig. 4). The George Washington-Jefferson National Forest in Virginia and West Virginia is projected to have the most area of increases in housing density of all national forests or grasslands, with projected changes on more than 1.4 million adjacent private rural acres. The Mark Twain National Forest in Missouri stands out among the midwestern forests with more than 1.3 million acres of adjacent rural lands projected to experience an increase in housing density.

Table 3—National Forest System lands with over 500,000 acres of adjacent rural private land (within 10 miles) projected to experience increased housing by 2030

National forest or grassland[a]	Main state	Adjacent rural private land projected to experience housing density increases
		Thousand acres
George Washington-Jefferson	Virginia	1,424
Mark Twain	Missouri	1,326
Chattahoochee-Oconee	Georgia	1,176
National Forests in North Carolina[b]	North Carolina	1,073
National Forests in Mississippi[c]	Mississippi	1,071
National Forests in Alabama[d]	Alabama	963
Huron-Manistee	Michigan	834
Francis Marion-Sumter	South Carolina	720
Ozark-St. Francis	Arkansas	702
Daniel Boone	Kentucky	650
National Forests in Texas[e]	Texas	596
Green Mountain and Finger Lakes	Vermont, New York	590
Cherokee	Tennessee	544

[a] Figures reported for individual national forests in this table should not be combined because of the potential for double counting of residential development around national forests that are close to each other.

[b] Croatan, Uwharrie, Pisgah, and Nantahala National Forests.

[c] Bienville, Chickasawhay, Delta, Desoto, Holly Springs, Homochitto, and Tombigbee National Forests.

[d] Bankhead, Conecuh, Talladega, and Tuskegee National Forests.

[e] Angelina, Davy Crockett, Sabine, and Sam Houston National Forests.

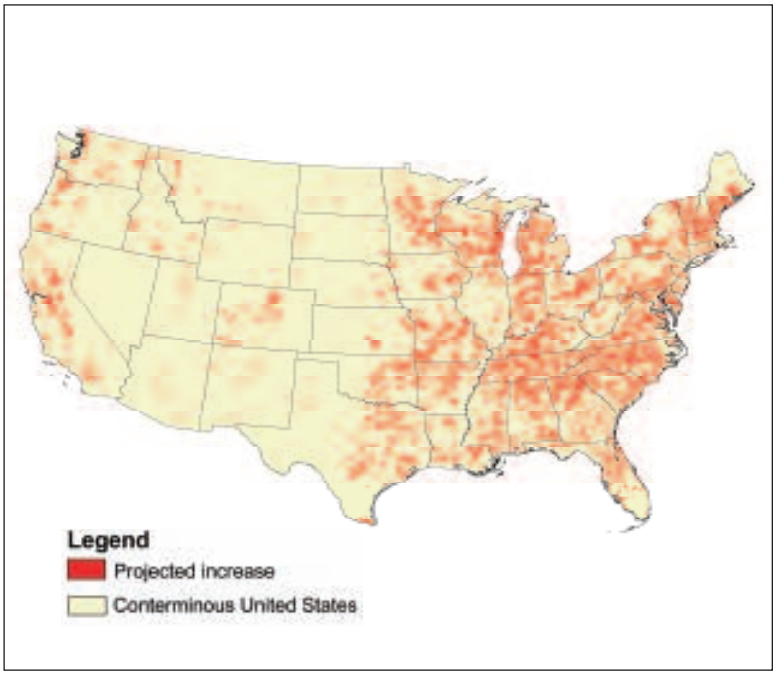

Figure 4—A broader perspective. Across the conterminous United States, approximately 1.4 billion acres of all lands are privately owned. Of these, some 153 million acres (about 10 percent) are projected to experience increased housing density in rural I and rural II areas in coming decades (regardless of their proximity to national forests or grasslands), mostly in the eastern half of the country (Theobald 2004a, 2004b). These national-level figures for all private lands may under- or overstate the situation for specific rural areas where housing development could be more or less intense.

Larry Korhnak

About the movement of people to rural areas.

National Forests on the Edge findings are consistent with recent studies on rural population change in America. Since the 1990s, there has been a substantial trend toward increased population growth in many rural counties, especially those with federal lands and abundant natural amenities (Garber-Yonts 2004; Hammer et al. 2004; Johnson 1999, 2006; Johnson and Beale 1999, 2002; Johnson and Stewart 2005, 2007; Johnson et al. 2005).

Population growth in rural ("nonmetropolitan") counties containing national forests has been consistently higher than in other rural counties over each of the past three decades (Johnson and Stewart 2007). Between 1990 and 2000, nonmetropolitan counties with more than 10 percent of the land in national forest grew by 18 percent —considerably higher than the growth rate in other nonmetropolitan counties (10.8 percent). Cordell and Overdevest (2001) further showed that population growth was particularly acute in counties near national forests in the southern Appalachians, northern New Mexico, southern California, and southeastern Idaho.

Many of the national forests and grasslands projected in this study to experience the highest levels of increased housing density near their boundaries fall within areas identified by Johnson and Beale (1999) as having had the highest recent rural population growth.

This type of lakeshore in northern Minnesota attracts second-home development, potentially affecting water quality and resulting in loss of wetland habitat.

A CLOSER LOOK: FUTURE HOUSING DEVELOPMENT AROUND FOUR NATIONAL FORESTS

Four examples from different regions illustrate how the projected 2030 housing densities (Theobald 2004b) compare to 2000 housing densities (Theobald 2004a) at the local level. Note that internal boundaries were used for these local analyses because adequate geographic information system information was available for these forests. Thus, the maps presented here (figs. 5–8), unlike our national-level maps, do include private inholdings.

On a subzero January morning, a group of elk makes its way over the snowy grassland/sagebrush winter range overlooking the Bitterroot Valley, Montana. Photo by John Vore, courtesy of Montana Department of Fish, Wildlife and Parks.

Bitterroot National Forest, Montana and Idaho

The percentage of private land projected to experience increases in housing density within 10 miles of the Bitterroot National Forest is greater than for any other national forest or grassland (table 2, fig. 5). The northernmost portion of this forest lies along either side of the Bitterroot Valley, in rapidly growing Ravalli County, Montana. One concern related to residential development within the Bitterroot Valley is its potential impact on elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) populations that seasonally inhabit the Bitterroot National Forest. Many areas of elk and mule deer winter range coincide with areas projected to experience substantial increases in the level of housing development. Increased housing density could potentially reduce the availability of winter habitat and browse, serve as impediments to habitat connectivity, and lead to increases in human/wildlife conflicts.

Stanislaus National Forest, California

The Stanislaus National Forest is located in east-central California, extending from the foothills to the crest of the Sierra Nevada. The national forest is bordered to the south by Yosemite National Park and to the east and north by the Humboldt-Toiyabe National Forest and the Eldorado National Forest, respectively. Given this pattern of federal ownership, private residential development is constrained to areas along the western boundary of the Stanislaus National Forest and along

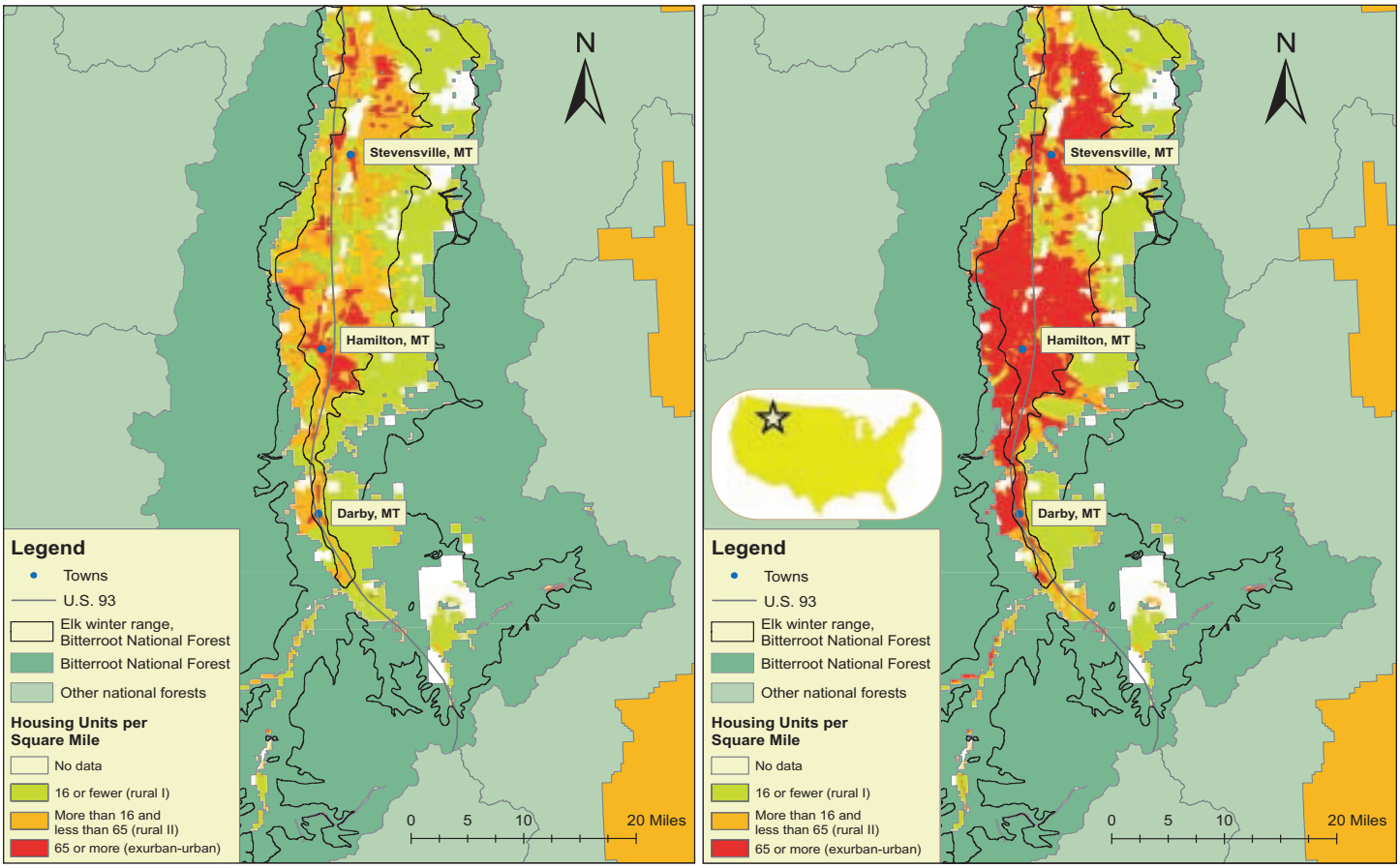

Figure 5—Housing density in the Bitterroot Valley, Montana/Idaho, 2000 and 2030. Source: Theobald 2004a, 2004b.

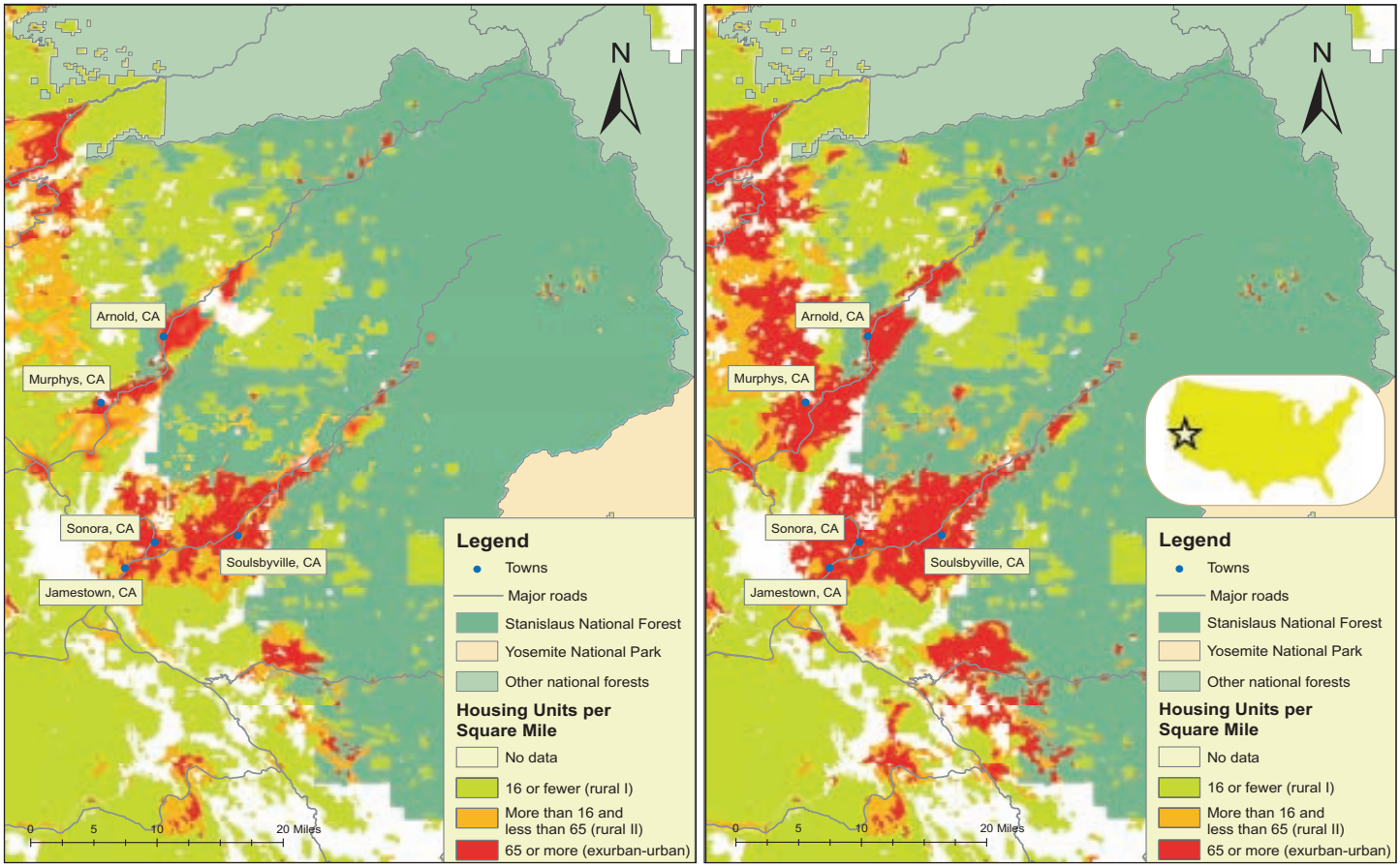

Figure 6—Housing density near the Stanislaus National Forest, 2000 and 2030. Source: Theobald 2004a, 2004b.

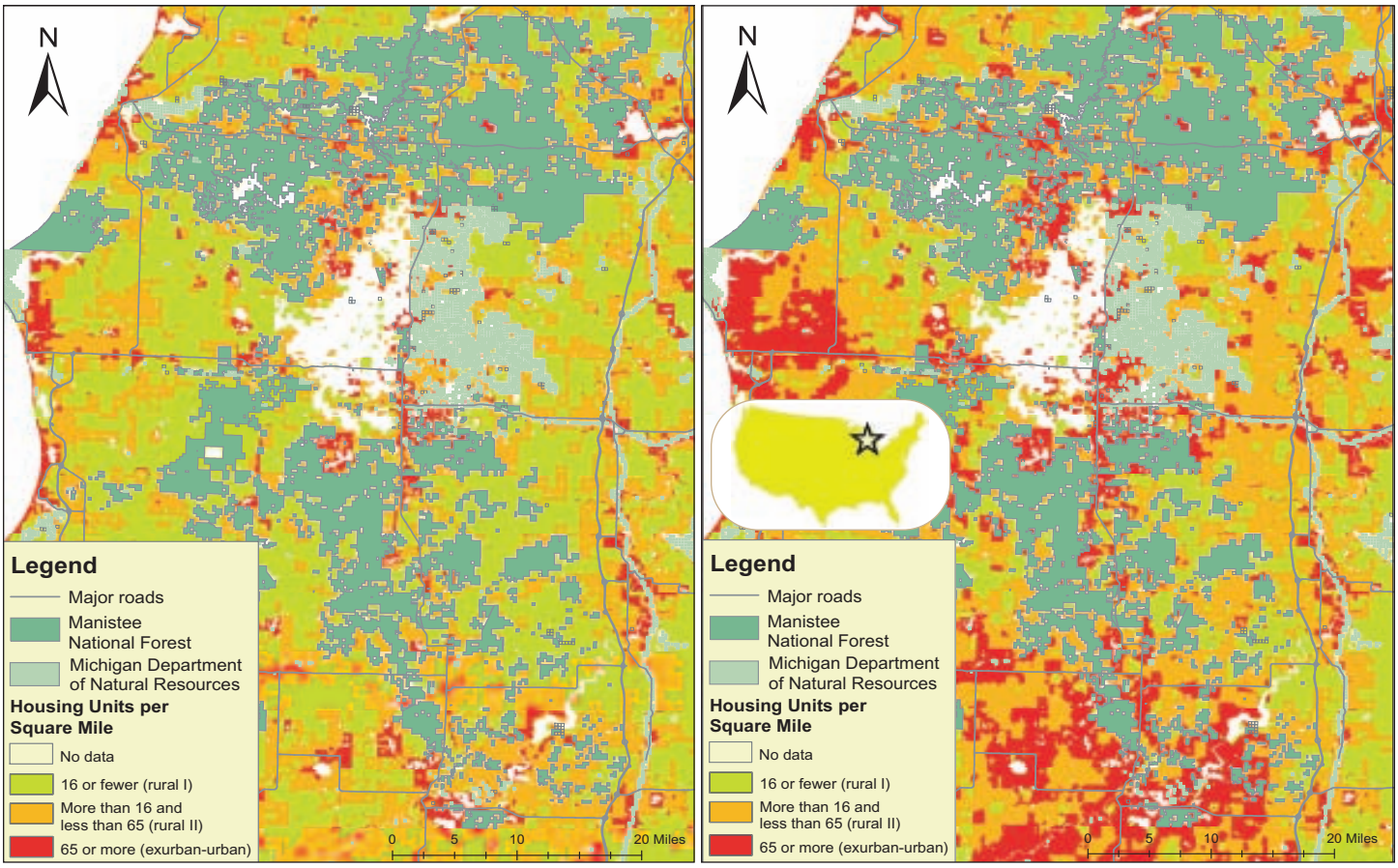

Figure 7—Housing density near the Manistee portion of the Huron-Manistee National Forest, 2000 and 2030. Source: Theobald 2004a, 2004b.

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