Chapter 4

Human Context: Land ownership, resource uses, and social dynamics

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Introduction

The forests and grasslands of the eastern United States have been subject more than two centuries of episodic change, generally characterized by forest clearing, agricultural use, abandonment, reforestation, and recovery. Today rapid colonization of forests and other rural lands by people, the spread of many floral and faunal nonnative invasive species and, in some places, structural change in the forest products sector continue to alter forests. Historical legacies and ongoing disturbances define a complex landscape in the eastern United States where no land is without substantial human influence. Opportunities for and the practice of forest management and fuels treatments is heavily influenced by this human history and by the human context of forest settings.

This chapter describes the history of forest conditions and uses in the region and discusses the implications these dynamics hold for future uses, management, and condition of forest land. In particular, I examine time trends in forest area, biomass, and ownership, juxtaposed with changes in human populations and uses of these vast forest resources. The changing human-forest interface holds implications for future forest uses, including opportunities for fuel treatments and other types of forest management, the availability of timber products and ecosystem services, and the values at risk from wildfire and other disturbances.

Conditions and trends in Eastern Forests

One way to gauge change in forests is to examine how the area of forest cover has changed over time. Surveys of forest conditions conducted in the United States since 1938[1] provide a basis for a systematic analysis of forest conditions including forest area for the United States. In addition, work by Kellogg (1909) provides estimates of forest area in the US for the year 1907 and at the time of European settlement (~1630). These data are compiled for the US as a whole in a series of publications from the US Forest Service, the latest being Smith et al. (2003), that provide the majority of forest data discussed in this chapter.

At the time of European settlement, forest area exceeded 650 million acres in the Eastern United States with roughly 298 million acres in the North (composed of the Northeastern and North Central regions in Figure 1) and 354 million acres in the South (Southeastern and South Central regions in Figure 1). By 1907 forest area in the East had fallen by about 43 percent to roughly 374 million acres overall with 139 million acres remaining in the North (a decline of about 53 percent) and 236 million acres in the South (a decline of about 33 percent). The spatial pattern of deforestation in the East was highly variable through the 19th century (Figure 2). Ohio, Indiana, and Illinois had lost at least

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[1] These forest surveys are conducted by the Forest Inventory and Analysis program of the US Forest Service and were enabled by the Clark McNary Act of 1938.

80 percent of their forest area by 1907, while Maine, Florida, Arkansas, and Oklahoma had lost less than 30 percent of theirs.

Changes in forest area between 1907 and 2002 reveal different patterns (Figure 3). In the twentieth century, forest losses were concentrated in most states west of the Mississippi along with Florida (Florida and Texas were the states with the greatest proportions of forest loss during this period). In contrast, states in the mid-Atlantic from Illinois to New York saw large proportional increases in forest cover, with moderate gains occurring in a few states in the South (Alabama, Georgia, Virginia, and Kentucky). Through much of the region, extensive deforestation in the nineteenth century was followed by some forest area gains in the twentieth. In 2002 the North's forest cover was 43 percent lower than pre-European forest levels. The South, had 39 percent less forest cover in 2002.

Net changes in forest area between 1630 and 2002 were highly variable among States in the East (Figure 4). In 2002, five States (Maine, New Hampshire, Vermont, West Virginia, and Alabama) had more than 75 percent of their pre-settlement forest area. Twenty states, including eleven of the thirteen southern states, retained between 50 and 75 percent of the forest area in 2002. The remaining seven states had less than 50 percent of their pre-settlement forest area in 2002. Three of these "high-loss" States are small states on the eastern seaboard dominated by urban uses (Maryland, Delaware, and New Jersey), and the states with the lowest proportion of residual forests are four states stretching from Iowa eastward through Illinois, Indiana and to Ohio, along with Texas. In these agricultural areas, residual forests are between 23 and 41 percent of original forest area. Between 1907 and 2002, 23 of the 33 States in the East experienced a recovery of some forested area that had been lost between 1630 and 1907. States with the greatest proportional recovery of forest area were mostly in New England (Figure 4).

The net loss of forest area understates the overall impact that European settlement and land exploitation has had on forest conditions. Even in areas where a forest land use was maintained over time, timber harvesting altered forest conditions substantially. Nearly every existing forested acre in the US has been harvested at least once. So, in much of the East's forests, forest biomass has been removed at least once since European settlement—in many places several harvests have occurred in this time period. After harvesting, especially in the late 19th and early 20th centuries, a large share of cleared land had been briefly farmed before the economics of poor soils returned forest cover through land abandonment and natural regeneration. The second growth forests that remain reflect a different productivity, species composition, and structure than existed in pre-European forests.

The extent of harvest disturbances and recovery in eastern forests can be deduced from trends in tree biomass contained in these forests over time. Measures of biomass are available for only the second half of the twentieth century, but they reflect the rapid recolonization and growth of cut over forests, a large portion of which was returned from brief agricultural exploitation between the 1920's and the Great Depression. Figure 5 shows the evolution of standing biomass on eastern forests from the 1950's through 2002. During this period the area of forests was relatively stable in the East but tree biomass (as estimated by growing stock inventories in FIA inventories) nearly doubled from 252 billion cubic feet (bcf) in 1952 to 486 bcf in 2002. Growing stock inventories have increased at a decreasing rate since the 1970's indicating perhaps an approach to a capacity defined by soil conditions and ongoing human dynamics, including timber harvesting, and movement into and out of forest cover across the region. However, the average biomass contained on forest sites in the east increased throughout the last half of the 20^{th} century.

Forest Ownership

Unlike western regions of the United States, the East's forests are dominated by private ownership (Figure 6). Roughly 85 percent of the eastern forests were privately owned in 2002. Of the 15 percent that was held by public entities, 40 percent was in National Forests, 47 percent was owned by States, counties, or municipalities, and the remaining 13 percent was in some other type of federal ownership (predominantly military facilities). Ownership patterns vary somewhat between South and North (Figure 6). The northern subregion has a higher proportion of public ownership (20 percent vs 14 percent) while the South has a higher proportion of private ownership (86 percent vs. 80 percent).

Owner objectives and management styles vary substantially between public and private owners but also within the private ownership group. FIA surveys have tracked a private owner typology over time, which at its coarse grain, splits Forest Industry (i.e., firms that hold both forest land and wood products processing facilities) from all other private owners of forests. Forest Industry owners have been distinct from other types of owners in that they generally have approached forest lands with a timber related profit motive and presented a distinct production style of forest management (Newman and Wear 1993). The result has been a higher level of forest investment and outputs with implications for forest structure. Forest Industry lands have also traditionally represented some of the largest contiguous blocks of forest land in the East with associated values for protecting certain types of ecosystem services. The remainder of private owners has a notoriously varied suite of motivations for owning forest land (Butler and Leatherberry 2004) with a perhaps less predictable management style and more variable forest outcome.

During the 20th century, forest industry created and managed some of the most productive forest lands in the East and were a fairly stable component of the forest products sector throughout the East, especially in the southeast (Figure 6). However, commencing in the late 1990's and accelerating since 2005, most large forest industry firms have divested their forest lands (Clutter et al. 2005). The beginning of this trend is revealed in Figure 7 but current estimates indicate a loss of about 80 percent since the late 1990's. These changes, driven by a variety of economic factors, have a number of implications for forest structure. Many of the industry's vast holdings have been split up in the process of being sold, resulting in a more fractured ownership pattern. What's more, while a variety of forest conditions, including environmentally sensitive land had been bundled with production lands on industry tracts, these components are readily split apart as the land is sold in pieces, removing some de facto protection for sensitive lands. In places where other land uses compete for forests, this land has been sold for development.

Productive industry timberlands have largely been sold to private timber investors organized by Timber Investment Management Organizations (TIMO's) which have a strong focus on a profit-maximizing forest management—not unlike the forest industry. This arrangement now provides substantial capital for ongoing investment in the face of good markets. This investment inertia now keeps much land in forest production but could also have the potential to lead to rapid land use switching when markets change. A general outcome of this new landownership arrangement then is a higher liquidity of land in the face of changing economic circumstances.

Another way of explaining this elevated liquidity is to contrast investor objectives and options. If a forest products firm owned land largely as a buffer against future supply shortages, then it had a strong incentive to retain land over a long time frame even in the face of adverse short-run market conditions. There are few options to providing this kind of timber supply insurance. Individual investors are motivated to own timberland for its return on investment, returns that are perceived to be countercyclical to equity markets. However, there are many alternative investment instruments for providing countercyclical returns. The incentives then for long run forest land management are less robust across market conditions under these new ownership arrangements.

This large scale change in the ownership of the nation's most productive timberlands will undoubtedly have an effect on landscape structure in some parts of the East. TIMO holdings are often bundled for investors as closed end funds which must be sold at the end of their fixed term (closed end). With five to fifteen year terms, these investment vehicles imply a relatively rapid turn over of landownership over time. What's more, each transaction offers an opportunity to split parcels and sell portions for different uses, thereby encouraging an ongoing fragmentation of forested lands with implications for the ecosystem services and management potential of remaining forest lands.

Federal forest lands also occupy a distinct portion of the landscape in the East and provide an important suite of forest benefits. National Forests in this region were authorized by the 1911 Weeks Act and acquired through purchases of land from private owners. The national forests acquired land piecemeal, mainly during a period beginning in 1911 and extending through the Great Depression, from cutover and unproductive lands in relatively remote regions—i.e., where the value of land in any other use was very low. Referred to as the "lands nobody wanted" by Shands and Healy (1977) these forests were concentrated in mountainous portions of the East (Ozark, Ouachita, Allegheny, and Appalachian ranges), and not in close proximity to the region's population centers. As a result of the way these lands were accumulated, National Forests are less contiguous in the eastern United States and are often interspersed with private forest holdings. Here private and public good values commingle and define a very challenging management context.

Taken together, these forest ownership dynamics yield a couple of important implications. Public lands tend to be concentrated in areas that are the most remote and rugged and least productive, and are not tightly consolidated. As amenity values increase in these areas, the value of private in-holdings and adjacent private lands also increase, and subsequent development can compromise the provision of several public good values for which the public lands are especially valued. Timber management and production are increasingly concentrated on productive rural lands that compete with other agricultural uses of land. Forest industry set the stage for an increased concentration of production forestry on a smaller land base, and with a new ownership structure, these lands are increasingly guided by shorter term market signals.

Social Context of Forests

Humans directly alter the structure and extent of forest through the uses to which they allocate land and indirectly through alteration of the atmosphere and hydrologic systems, and through introduction of nonnative and often invasive flora and fauna. A simple index of the pressure people place on natural systems within a region is the aerial density of human populations. In the 2000 census, the average human population density of counties in the eastern United States stood at about 244 people per square mile (ppsm) and ranged from less than 5 in Oklahoma to more than 55000 ppsm in metropolitan New York. The average density grew by about 16 percent, from 210 ppsm, between 1970 and 2000. The total population of the region grew from 208 million to 274 million during the same period.

Of course, this growth in population was not spread evenly across the landscape. Figure 8 shows that 46 percent of counties in 2000 were in what we have labeled a rural category (0-50 ppsm). Another 32 percent of counties were in a transitional category (51-150 ppsm), 10 percent were in a suburban class (301-500 ppsm), and the remaining 12 percent of counties was in an urban or a high-density urban class (500-1500 ppsm and >1500 ppsm respectively). This distribution has changed as population has grown in the eastern US. The number of counties in the most rural category has declined substantially since 1970 (from 55 percent of counties in 1970 to 46 percent of counties in 2000), while the number of counties in transitional, suburban, and urban classes have all increased over this time period. Figure 8 also shows that these patterns are expected to continue well into the future (to 2030) based on a set of county-level population forecasts for the

United States. That is we expect a continued movement from rural conditions toward transitional and urban conditions in the eastern United States.

Patterns of population change differ between the regions as well. While the population of the East has grown steadily, some subregions experienced sizable depopulation between 1970 and 2000 (Figure 9). Among the areas with the largest population losses are 1) the agricultural areas of southern Minnesota, Iowa, and Illinois, 2) the lower Mississippi Alluvial Valley from the confluence with the Ohio River to Louisiana, and 3) the Allegheny Highlands from Kentucky and West Virginia into western New York. Smaller areas experiencing depopulation include 1) an area north of Mobile Bay in Mississippi and Alabama, 2) northernmost counties in Minnesota, the Upper Peninsula of Michigan, New York, and Maine, and 3) a grouping of counties in central Ohio.

Population gains were also concentrated in a few subregions. Three large areas of the East have experienced the greatest increase in population between 1970 and 2000: 1) The metropolitan corridor stretching from Boston to Washington DC, 2) the Piedmont of the Southern Appalachians from Raleigh NC to Atlanta Georgia, and 3) peninsular Florida. A large number of moderately large cities have also experienced high rates of population growth, including Dallas and Houston, Texas; Nashville, Tennessee; Detroit, Michigan; Chicago, Illinois; and Minneapolis-St. Paul, Minnesota.

Competing Land Uses

Land use patterns reflect the distribution of human populations (e.g., the density of housing and urban uses) as well as the comparative productivity of land in a variety of rural uses (e.g., crops). The USDA Economic Research Service maintains a consistent time series of land use estimates from 1945-2002 at the state level in their Major Land Uses series (the latest report, for 2002, is Lubowski et al. 2006). The data on land use changes reported below are taken from this source. I distinguish between four major land use groupings here. Total cropland includes both planted and fallow cropland. Pasture is defined by land in a grazing use (including range). Forest land use is consistent with the Forest Inventory and Analysis (FIA) definition of forestland. Urban is land in densely populated areas. An all-other category includes rural transportation, defense and industrial areas, rural parks, and miscellaneous farm and other special uses.

Land use in the East reflects a diversity of these conditions. Overall, in 2002, cropland occupied 28 percent of the land base, pasture occupied 17 percent, and forests occupied 38 percent, while urban and all other uses occupied the remaining 17 percent (Figure 10).

The distribution of land uses in the East varies strongly across subregions (Figure 10). For example, crop production is predominant in North Central states of Iowa, Illinois, and Minnesota, reflecting soil and climatic conditions that favor crop production. In addition, crop production is a dominant land use in the Lower Mississippi Alluvial Valley and in Florida. Range and pasture uses are most predominant in the South Central states, especially in Texas and Oklahoma. Agricultural uses represent an aerial majority of states in the western half of the region.

In the eastern half of the region, forests tend to dominate rural land uses, with comparable shares of forest land use in the northeastern and southeastern subregions. Urban and other land use (mainly transportation, parks, and rural developed area) generally comprise between 10 and 24 percent of the eastern landscape (Figure 10).

Between 1945 and 1992, the share of land in non-rural uses expanded in all subregions of the East, with the greatest growth in the Northeast (from 10 percent to 17 percent, Figure 10). The portions of states in rural uses shrank over this period and the distribution among rural uses changed as well. In the Northeast, the dominant loss of rural land was in pasture uses (from 12 to 3 percent), while the area of cropland and forest remained relatively constant. In the North Central, forest and pasture uses shrank slightly while crop land stayed constant. Conversely, in the Southeast cropland declined from 22 to 14 percent while pasture and forest area remained relatively constant. The South Central experienced a loss of forestland as both pasture and cropland were relatively constant between 1945 and 1992.

Among the eight states that gained cropland area between 1945 and 2002, six were along the Mississippi River—the other two were Texas and Florida (Figure 11). Florida experienced the greatest gain in cropland area over this period (29 percent). All other states in the region lost some cropland between 1945 and 2002, with the New England states experiencing the greatest losses (greater than 50 percent loss in all New England States). Total cropland was relatively constant across the region, so these changes indicate a westward shift in and spatial consolidation of crop production.

The spatial distribution of pasture/range land use also shifted between 1945 and 2002 (Figure 12). Total pasture in the East declined slightly over the period (from 19 to 17 percent) but the distribution shifted to the South. Pasture gains were found in only five states—a four state block in the South Central composed of Texas, Oklahoma, Arkansas, and Louisiana along with Florida in the Southeast. As with cropland, Florida experienced the greatest gains in pasture land use. All northern states experienced substantial reductions in pasture land use over this period.

The pattern of change in urban land use (Figure 13) is quite distinct from the patterns for cropland and pasture. Urban uses grew by at least 72 percent in all eastern states and more than tripled in more than half of these. Percentage growth rates for this period were substantially higher in the South than in the North (Figure 13) while the absolute changes in urban area were more evenly distributed between the subregions (northern states had much larger urban area at the beginning of the period). The result is expansion of metropolitan areas into formerly rural lands throughout the region, changing the context for rural uses in many areas.

Conclusions

Eastern forests have been subjected to a series of transformative changes since European settlement. Existing forests are generally the product of multiple human-based disturbances including timber harvesting, cultivation or grazing in a previous agricultural use, and abandonment and recolonization by tree species. The restoration of forest cover was especially strong in the twentieth century as much agricultural land was abandoned beginning in the early part of the century. At this same time the Weeks Act allowed National Forests to be established in a few areas of the East—generally in remote places where land was less valuable for any other kind of use.

Current dynamics most relevant to forest structure and forest management include a fairly rapid growth in human populations along with associated land development throughout much of the region. In addition to the direct effect of losing forested area (see Wear 2002), the current pattern of development places more people in the proximity to residual forests. The ability to manage these forests is compromised by this human presence through reduction in tract size, the increased prevalence of restrictive regulations regarding forest uses, and the negative spillover effects for neighboring landowners (Wear, Foreman and Liu 1999).

The magnitude of this change can perhaps be best summarized by examining the density of human populations with respect to forest area (forest population density or fpd). Figure 15 shows the forest population density of counties in the East in 2000 ranging from less than 40 to more than 750 people per square mile (ppsm). Roughly 20 percent of the forested area in the East has an fpd of less than 40 ppsm, about 40 percent has an fpd of between 40 and 250, and 40 percent has an fpd of greater than 250 ppsm. High fpd's can reflect a small forest area and/or a large human population, but they unambiguously reflect the relative scarcity of forest services relative to the size of the local population and a lowered propensity to manage forests. High fpd's are found surrounding the large metropolitan regions as well as in areas with a high concentration of cropland.

Population growth is expected to continue for the next several decades in the United States. Figure 15 shows the implications of a forecast of population growth to the year 2030 for forest population density in the region.[2] Future fpd's are calculated in a very conservative fashion by dividing forecasted populations by the current forest area within each county. That is, they do not account for the likely loss of forest land due to the development associated with the population growth. Even so, Figure 15 demonstrates a substantial growth in the forest population density for forests throughout the region.

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[2] We use county level forecasts developed by Woods and Poole Econometrics.

Fpd's are projected to grow fastest along the eastern seaboard, especially from Washington DC to Maine, in the Southern Appalachian Piedmont and Florida, and surrounding the Midwestern cities of Chicago and Minneapolis. Thirty five percent of the forested area in the East is projected to realize a growth of at least 25 ppsm, with 15 percent of the forested area experiencing a growth of more than 100 ppsm. In these areas, the opportunities to conduct most forest management practices will likely be diminished.

In addition to population growth, changes in the forest products markets will affect the distribution of forest management in the East. Beginning in the 1950's the forest industry led the way in intensifying management and concentrating management on a smaller land base. This specialization of forest land uses—with some areas seeing an increased focus on timber production and the remaining areas seeing less—will likely continue in spite of the sale of forest industry lands to new owners. The flow of investment capital to the sector during a period when production and prices declined indicates a strong investor interest in the forest growing sector and specifically in the returns to intensive management. To the extent that management becomes more concentrated on plantations and other intensively managed areas, the opportunities for management activities on the remainder of forest areas may become more limited.

These findings suggest that the practice of traditional forest management—i.e., rural forestry—will be limited to a smaller portion of the East. Outside of the Coastal Plain in the South, the Maine woods, and the most northern counties of the Lake States, fuel treatments and other management activities needed to alter forest conditions for ecosystem services will not occur as an adjunct to traditional management. In rural lands throughout a majority of the East, traditional management will be limited by a lack of markets for forest products and by an expanding forest population density. The greatest challenge for forest management is likely to be in designing practices that can be deployed in a cost efficient manner and can complement the increasingly nontimber management needs of landowners in these complex landscapes.

The potential application of fuel treatments needs to be evaluated in the context of this changing human-forest landscape:

1) An increasing human population density in the vicinity of a large portion of eastern forests (i.e., rising forest population densities) is likely to be associated with less forest management, including fuel treatments.

2) Increased fragmentation and smaller parcels work against the economies of scale in fuel treatments--that is treatments become more costly to implement on a per acre basis. Treating these smaller parcels also reduces the effectiveness of treatments on management objectives. Both work against the cost: benefit assessment of fuel treatments.

3) Increasing population densities and incomes in commingled public and private ownership raise significant challenges for public forest managers. Administrative as well as management costs increase in the face of conflicting values and scale issues.

4) The trend toward forest specialization implies a lack of timber markets and timber management in many rural areas of the East. In these areas,

it is increasingly difficult to apply fuel treatments or other management solely for the purposes of nontimber benefits.

All of these observations suggest challenges for the application of fuel treatments in the eastern United States. However, expanding populations in rural lands also imply that the returns to fuel treatments, especially in the form of avoided costs of wildfire, may grow in commensurate ways—that is, we might expect an increased demand for the returns from fuel treatments. Realizing these returns will require innovative programs and policies to encourage management that spans parcels and owners to deliver benefits at meaningful landscape scales.

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Figure Captions

Figure 1. Four subregions of the eastern United States used in this article.

Figure 2. Forest area in 1907 as a proportion of forest area in 1630 by State (Sources: Smith et al. 2003 and Kellogg 1909).

Figure 3. Forest area in 2002 as a proportion of forest area in 1907 by State (Sources: Smith et al. 2003 and Kellogg 1909).

Figure 4. Forest area in 1907 and 2002 as a proportion of forest area in 1630 by State (Sources: Smith et al. 2003 and Kellogg 1909).

Figure 5. Accumulated tree biomass measured as growing stock inventory 1952-2002 (million cubic feet, mmcf): a) by eastern region for total biomass, b) by softwoods and hardwoods for the North, and c) by softwoods and hardwoods for the South. (Source: Smith et al. 2003.)

Figure 6. Percentage of forest area by broad ownership class, 2002, for the East, North and South. (Source: Smith et al. 2003.)

Figure 7. Area of timberland by broad ownership class, 1952-2002 for the East. (Source: Smith et al. 2003.)

Figure 8. Distribution of counties by population density classes (people per square mile), 1970-2030. (Sources: US Census for historical data, Woods and Poole Econometrics for projections).

Figure 9. Change in population density (people per square mile) by county in the East. (Source: US Census.)

Figure 10. Percentage of land area by broad land use classes, 1945 and 2002 by subregion in the East. (Source: Lubowski et al. 2006.)

Figure 11. Percentage change in cropland area, 1945-2002, by State in the East. (Source: Lubowski et al. 2006.)

Figure 12. Percentage change in pasture area, 1945-2002, by State in the East. (Source: Lubowski et al. 2006.)

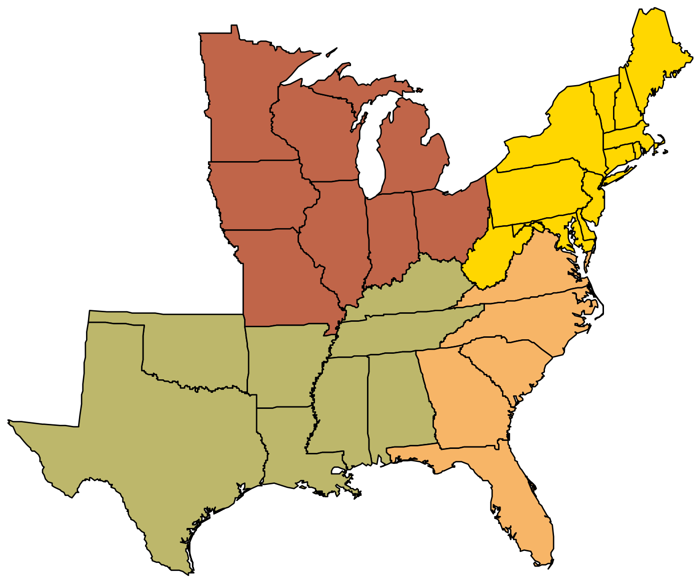
Figure 13. Percentage change in urban area, 1945-2002, by State in the East. (Source: Lubowski et al. 2006.)

Figure 14. Forest population density, 2000, by county in the East. (Source: US Census, and NRI data reports).

Figure 15. Forest population density forecast to 2030 by county in the East (Source: Woods and Poole Econometrics).

Figures

Figure 1.



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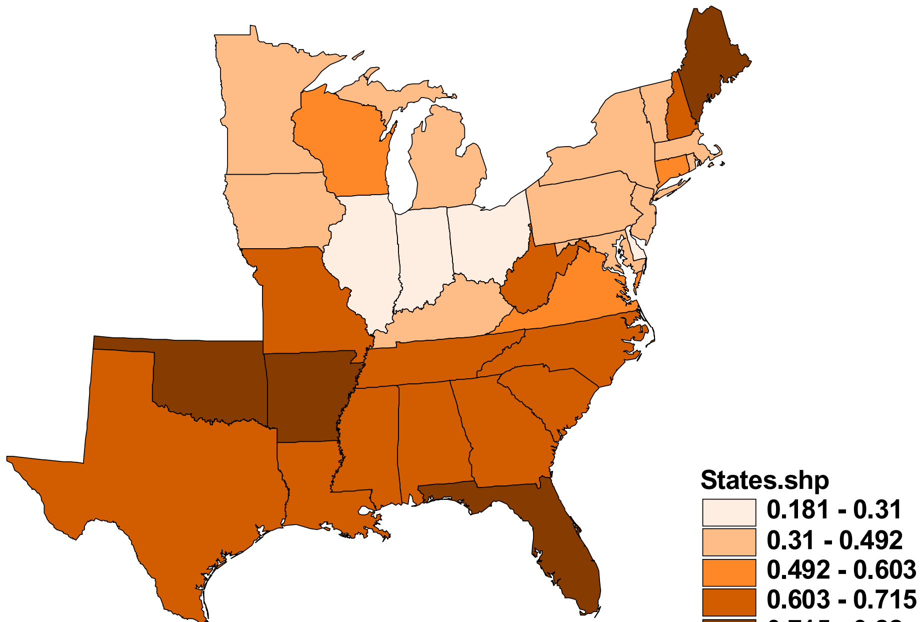

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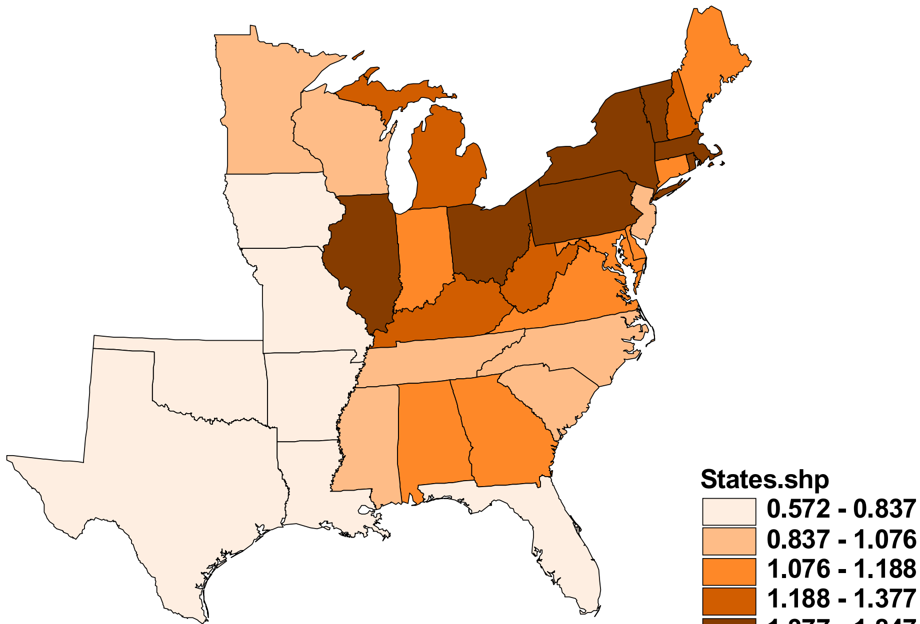

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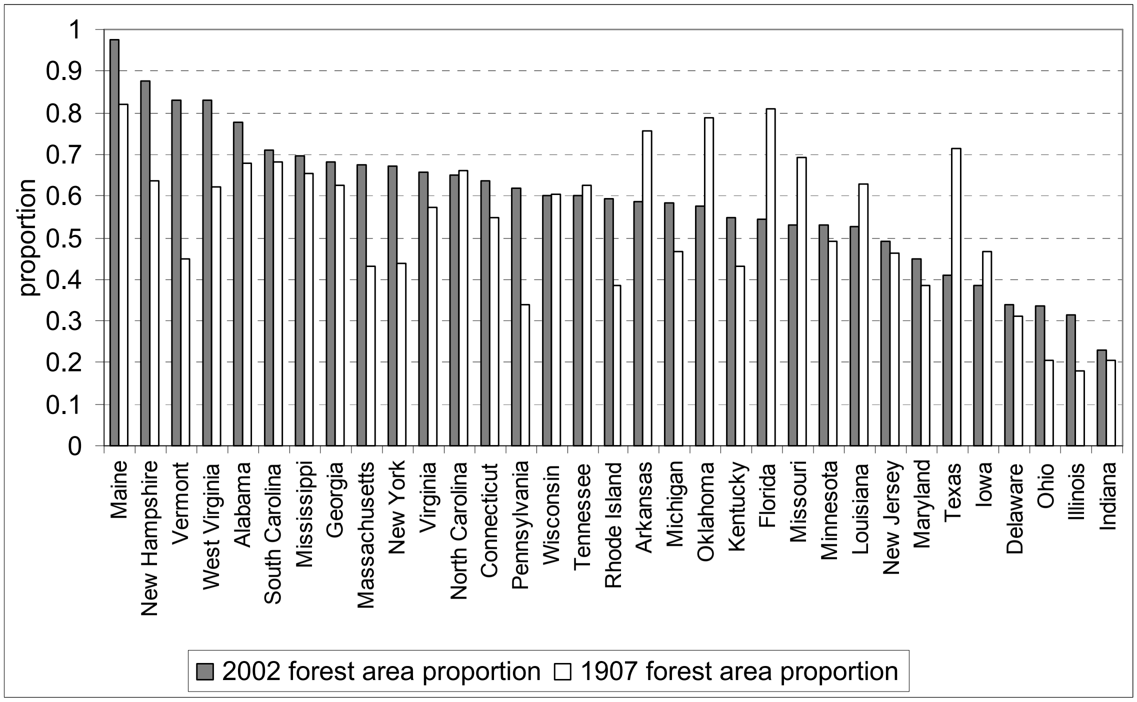

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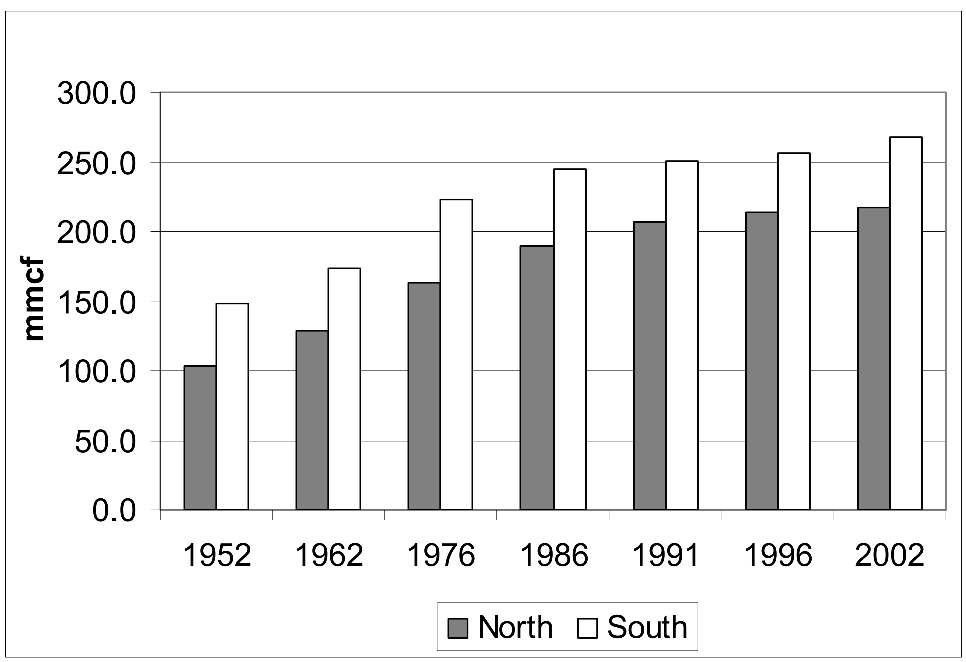

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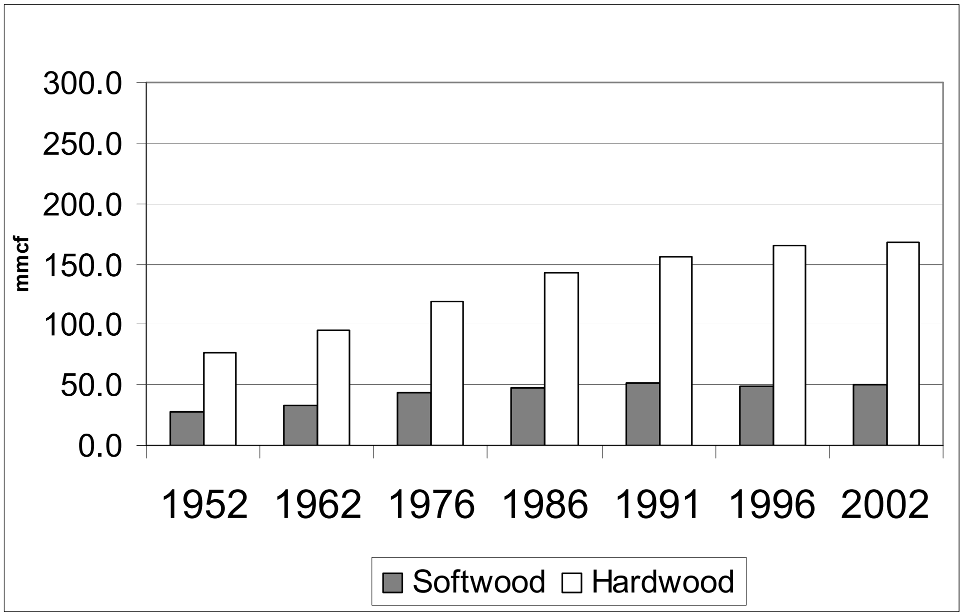
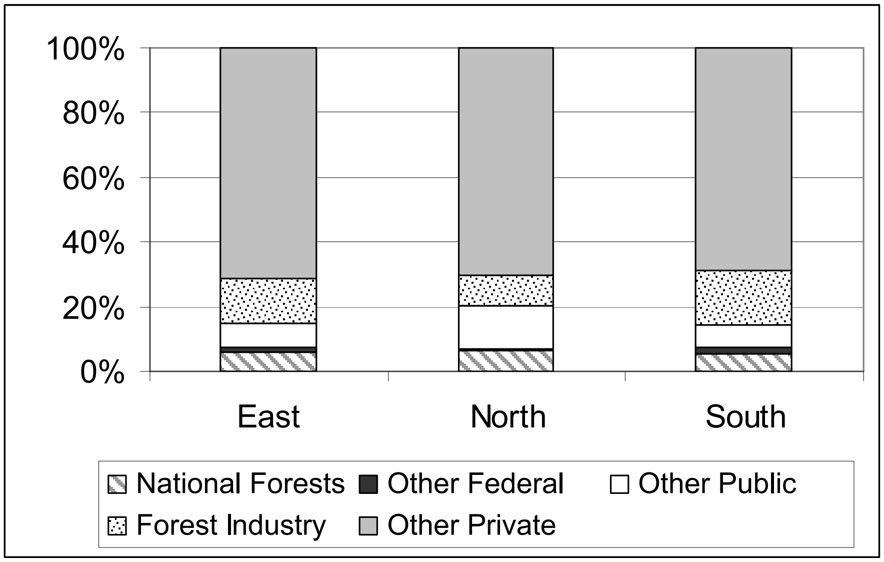


Figure 5c.

Figure 6.



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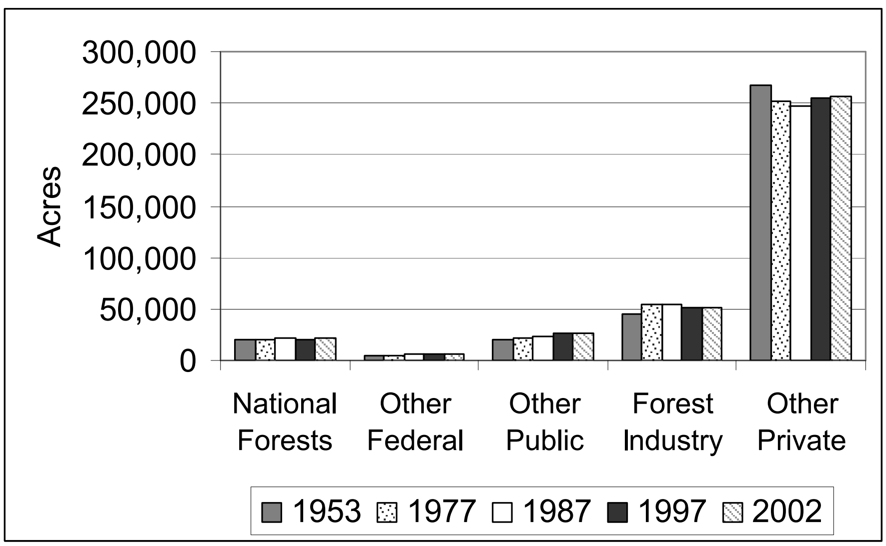

Figure 8.

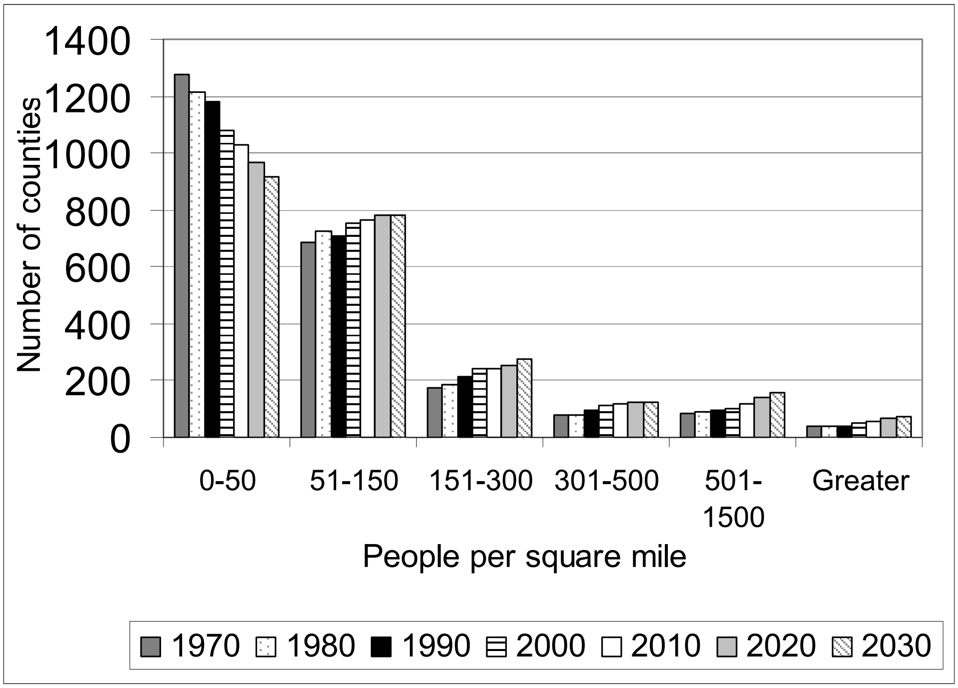

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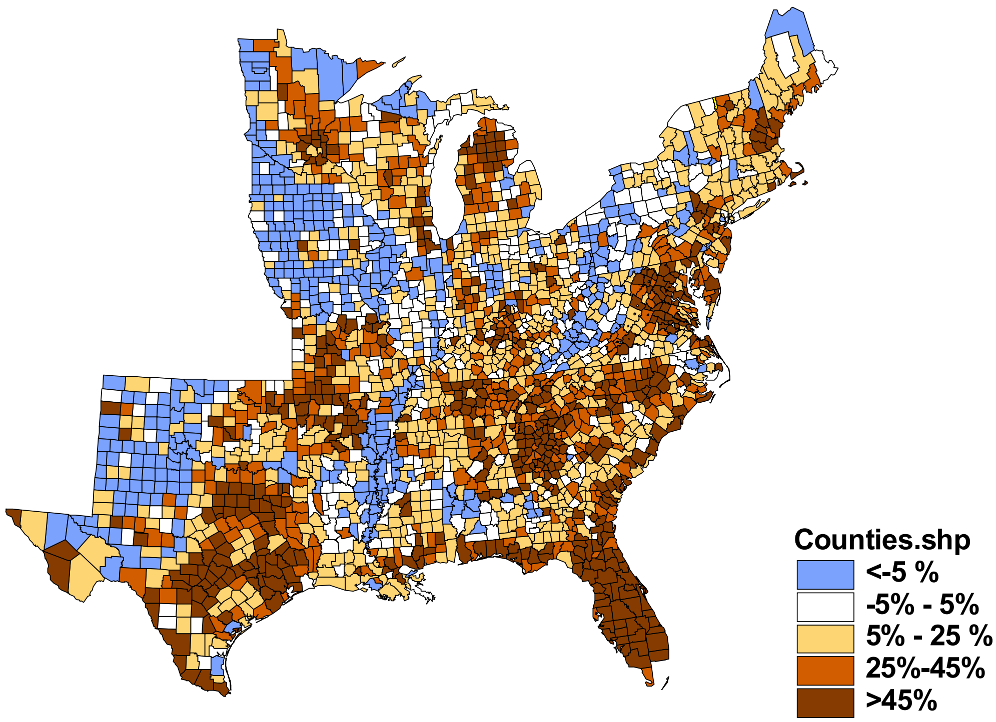
Figure 9



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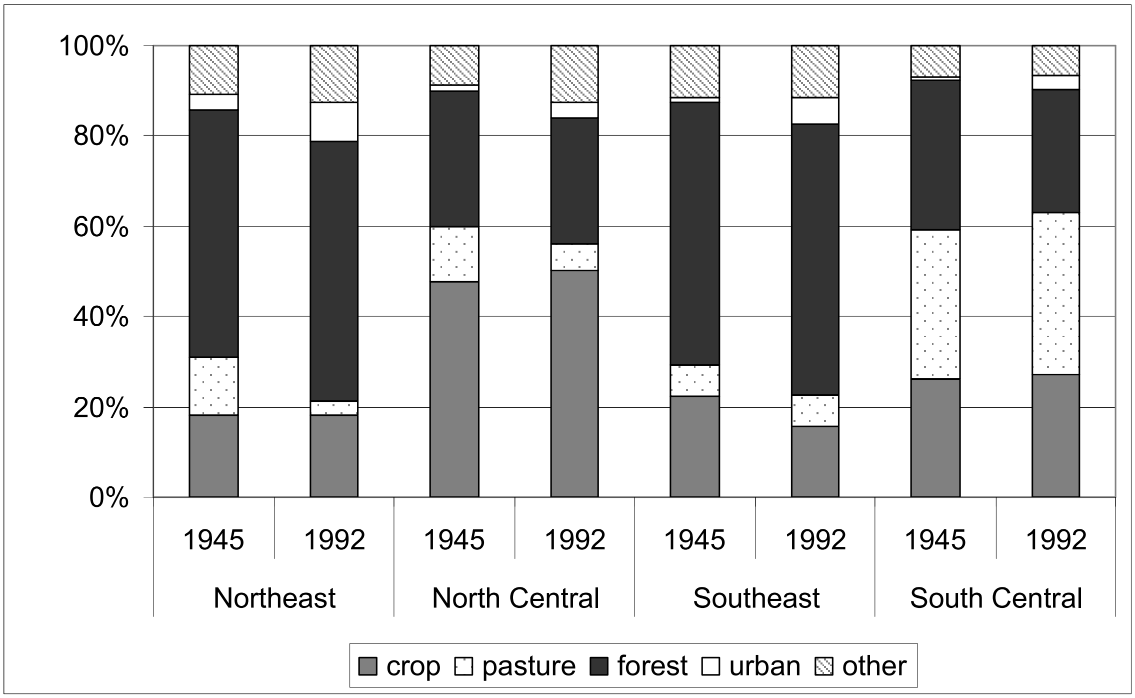

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Figure 11.

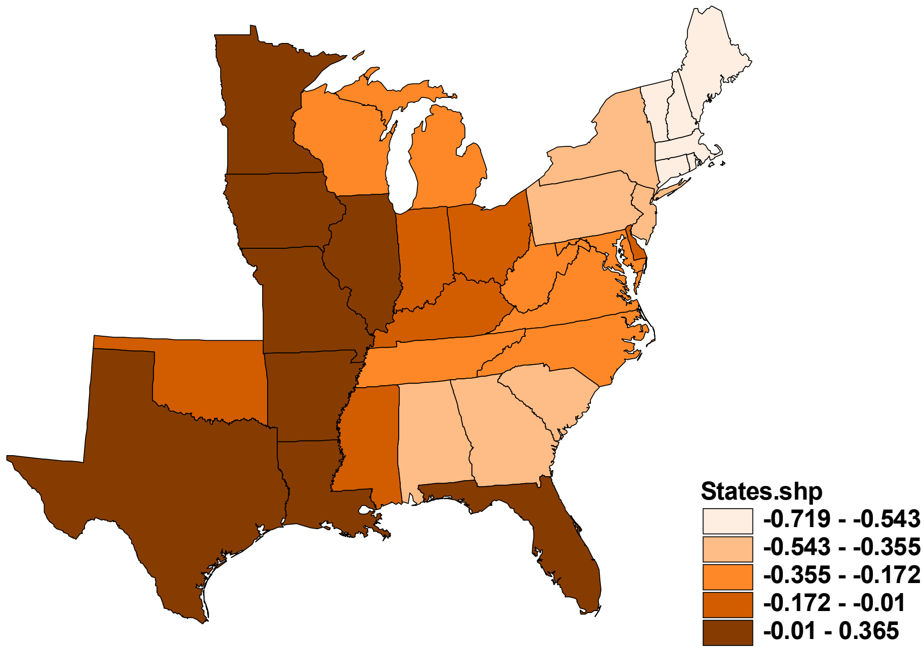

Figure 12.

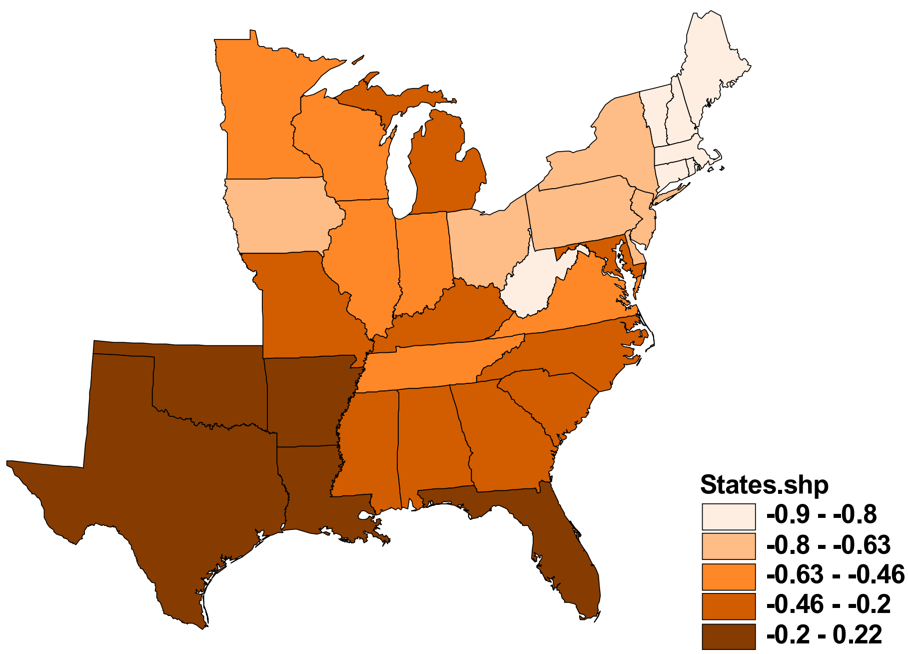

Figure 13.

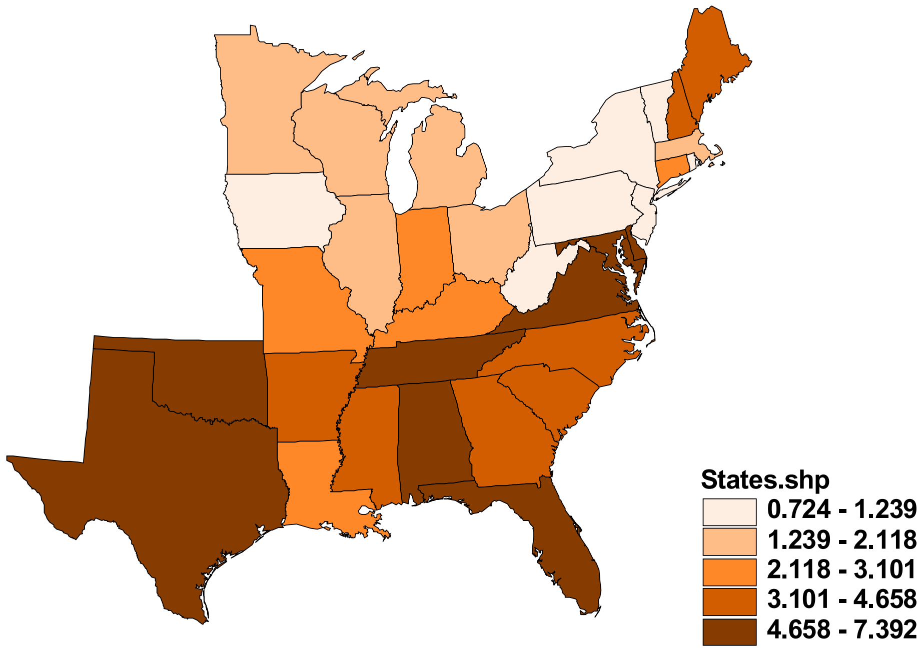

Figure 14.

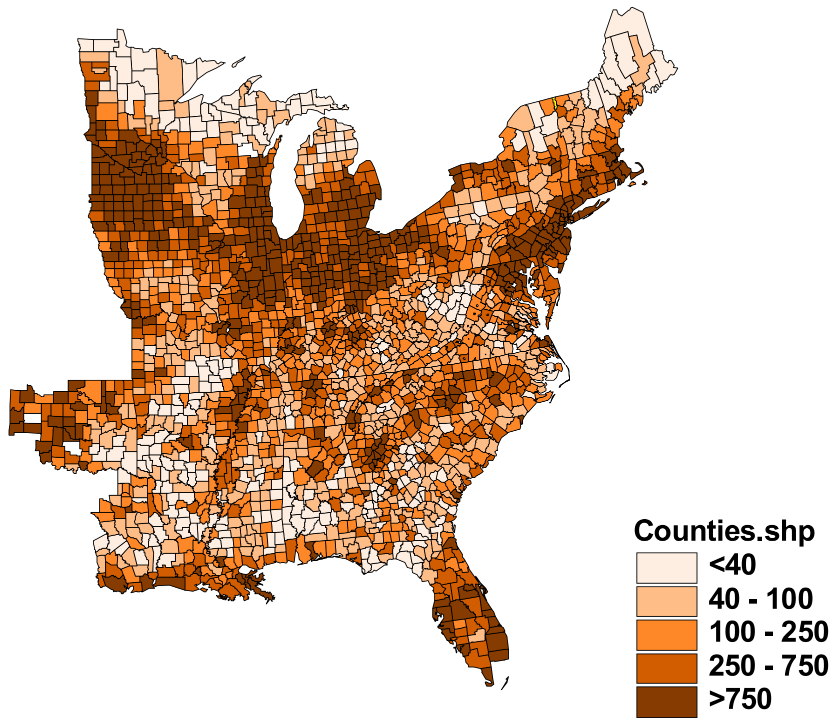

Figure15.