Preliminary report, has not been subject to peer review.

Forests on the Edge:
A Case Study of South-Central and Southwest Maine Watersheds

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Introduction

The area of developed land in the United States increased by just more than 33% between 1982 and 1997 (USDA NRCS and Iowa State University Statistical Laboratory 2000). Developed land includes urban and built-up land as well as land in rural areas used for roads, railroads, and transportation rights of way. Much of this increase in developed land area can be traced to a loss in rural land area. The expansion of developed land and the loss of rural land is projected to continue over the next several decades. Future land use conversion will likely continue to impact land uses and land cover in rural areas, including forests, agriculture, and open space.

There are approximately 749 million acres of forest within the U.S.; 57% of which is privately owned. Privately owned forests provide a variety of products and services, including traditional and non-traditional forest and timber products, recreation opportunities, improved water quality, aesthetic landscapes, open space, and wildlife habitat, among others. In an effort to "increase public understanding of the contribution of and pressures on private forests," the USDA Forest Service initiated the Forests on the Edge project. The focus of phase one of that project was identifying areas of the United States where private forest land will likely undergo increases in housing density by 2030. Based upon Phase One analyses, an estimated 44.2 million acres (10%) of private forests in the U.S. are projected to experience significant increases in housing development by the year 2030. Nationwide, the greatest increases in housing development in and around private forests are projected to occur in the eastern United States, where the majority of private forests are located. Moderate increases in housing unit density are projected for much of the Southeast, Mid-Atlantic, and New England regions of the east coast of the U.S. Within those regions, several watersheds in North Carolina, Virginia, Vermont, New Hampshire, and Maine are projected to experience substantial increases in housing unit density. This case study focuses on several watersheds located in southern Maine.

Southern Maine

Several watersheds in south-central and southwestern Maine are projected to experience moderate to high increases in residential development by 2030 (fig. 1). Of these watersheds, the greatest increase in residential development is projected to occur within the Lower Penobscot watershed. By 2030, an estimated 310,200 forest land acres in this watershed are projected to experience increased residential development. Significant increases in residential housing density are also projected to occur within the Lower Androscoggin watershed (increased housing density on approximately 213,800 forest land acres) and the Lower Kennebec watershed (increased housing density on approximately 210,000 forest land acres). Lesser increases in housing unit densities are projected to occur in the St. George-Sheepscot watershed (increased housing density on approximately 131,000 forest land acres), and the Presumpscot watershed (increased housing density on approximately 84,800 forest land acres).

Figure 1-Maine watersheds projected to experience moderate to high increases in residential development by 2030.

The conversion of rural land to developed uses results from market forces. Population, income, and economic growth combine to increase demands for land in residential, public infrastructure, and commercial and industrial uses. Demands also increase with people's lifestyle choices when, for example, people relocate to rural areas or desire second homes in scenic forest settings. When demands for developed land uses increase, so do the financial incentives some forest land owners have to sell land for development. The incentive is the revenue owners can earn from selling land above what they can earn from maintaining land in forest. When these market forces are at play, some forest land development is inevitable (see Kline et al. 2004 for a further discussion of the market and non-market values of forest land). In this document, the current conditions and recent trends in many of the factors that influence land use and land use change within the case-study watersheds in Maine, and in the state, are examined.

Conditions and Trends in the State of Maine

Forest Land and Timberland

Approximately 90% of Maine's land area is forest—making Maine the most forested state in the U.S. (McWilliams et al. 2005). The 17.8 million acres of forest land in Maine represent about 2% of the total forest acreage in the United States. The total area of forest land in the State has remained mostly unchanged since the early 1980s (McWilliams et al. 2005). Approximately 94% (16.6 million acres) of the forest land in the state is privately owned. More than 33% of this private forest land (5.7 million acres) is owned by individuals and families, with the remainder (10.9 million acres) owned by forest industry, investment groups, Native American tribes, and clubs, among others. Within the state, forest land in northern Maine is owned primarily by forest industry and corporations and forest land in southern Maine is owned primarily by families and individuals (McWilliams et al. 2005). Publicly owned forest land accounts for just 6% of all the forest land in Maine.

In recent years, there have been significant changes in the ownership of Maine's privately owned forest lands. Many of the traditional forest industry corporations in the state have elected to sell landholdings, leading to increases in the acreage of forest land owned by investment groups and, to a lesser extent, individual and family forest owners. Between 1995 and 2003, the area of forest land owned by investment groups and nonforest industry corporations increased by 60%, most of this owing to the divestment of forest industry landholdings (McWilliams et al. 2005).

Nearly all of the forest land in Maine (97%, 17.2 million acres) is classified as timberland (McWilliams et al. 2005). Timberland is defined as land able to produce at least 20 cubic feet of timber per acre per year and not legally withdrawn from timber production. Approximately 5.5 million acres of this timberland is owned by traditional forest industry corporations; the remainder is owned by families and individuals, non-forest-industry corporations, Native American tribes, and clubs, etc. As with forest land in general, the total area of timberland in the state has remained steady in recent decades. Looking forward, it is unknown whether recent and future divestments of forest industry-owned timberland will lead to greater conversion of these timberlands to other land uses.

From 1996 to 2004, the volume of timber harvested annually from Maine's forests remained fairly constant (fig. 2). Nearly all of this annual timber harvest volume originates from privately owned lands. In 2004, 1,445 million board feet (MMBF) of sawlogs and 3.08 million cords of pulpwood were harvested (Maine Forest Service, 2005c).[1] As the volume of timber harvested annually has remained fairly steady, so has the area (acres) harvested. Between 1996 and 2004, harvests occurred on approximately 530,000 acres of forest land annually (Maine Forest Service 1998-2005b). Over the last decade, the number of acres harvested via clearcutting has steadily decreased while the area undergoing partial harvest has steadily increased. In 2004, nearly 95% of the harvested acres in Maine were partial harvests.

[1] Based upon Maine's wood processor reports (accounting for imports and exports). There may be some discrepancy between volumes harvested and volumes processed or exported.

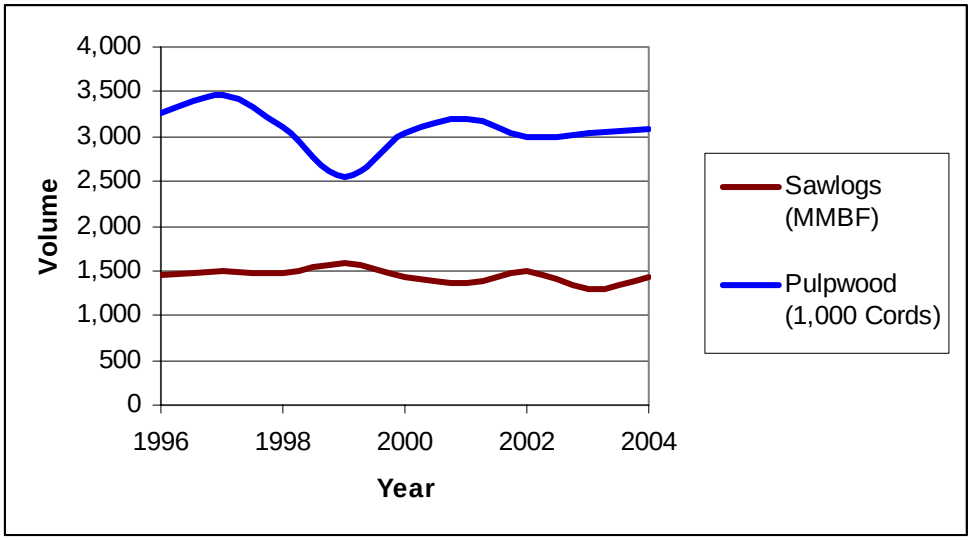

Figure 2-Timber volume harvested from forests in Maine, 1996-2004. Data sources: Maine Forest Service 1998a–2005a.

Although the majority of forest land harvested in Maine remains in forest use post-harvest, the number of acres harvested annually for the purpose of land use conversion has increased since the mid-1990s (fig. 3). In 2004, nearly 8,000 acres were harvested for land use conversion—more than double the land use conversion acres in 1996 (Maine Forest Service 2005a). Nearly 95% of these harvests occurred on lands owned by individuals and families and other non-forest-industry organizations (excluding timber investment groups and real estate investment groups). In 2004, only 35 acres owned by timberland investment management organizations (TIMOs) or real estate investment trusts (REITs) were harvested expressly for the purpose of land use conversion (Maine Forest Service 2005a).

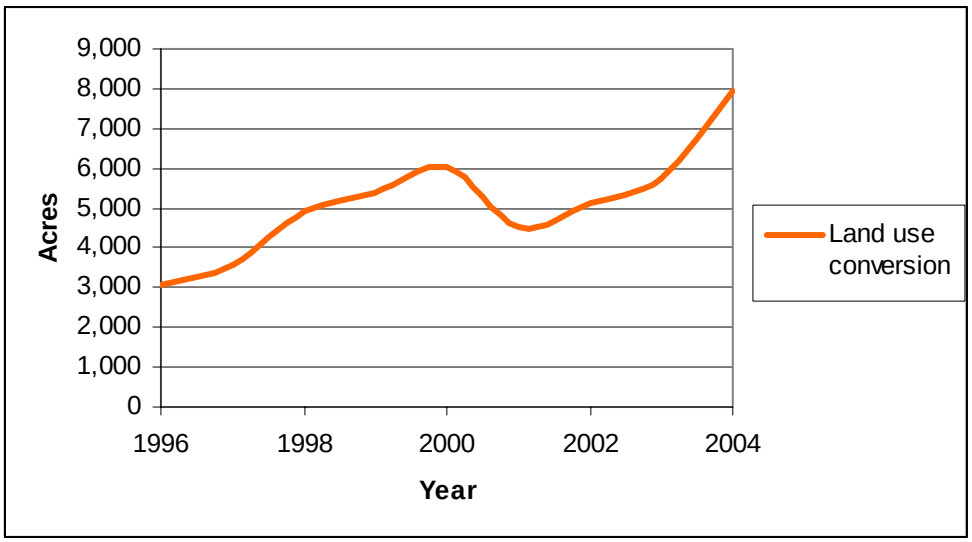

Figure 3-Acres of forest land harvested in Maine for the purpose of land use conversion, 1998-2005. Data sources: Maine Forest Service 1998–2005a.

The counties having the greatest number of acres undergoing some form of timber harvesting activity annually, on average, are located in the northernmost portions of the state (fig. 4). Portions of these northernmost counties extend into the Lower Penobscot and the Lower Kennebec case-study watersheds. Moderate levels of annual harvesting acreages occur in many of the counties intersecting the other case-study watersheds. Whereas the counties with the greatest annual timber harvesting acreages are located in northernmost Maine, counties in southwest and "downeast" portions of Maine have the greatest acreages of timber harvests resulting in land use change, on average (fig. 5). These high and moderate levels of land-use-change timber harvests extend into the Lower Androscoggin, Presumpscot, and the Lower Penobscot case-study watersheds.

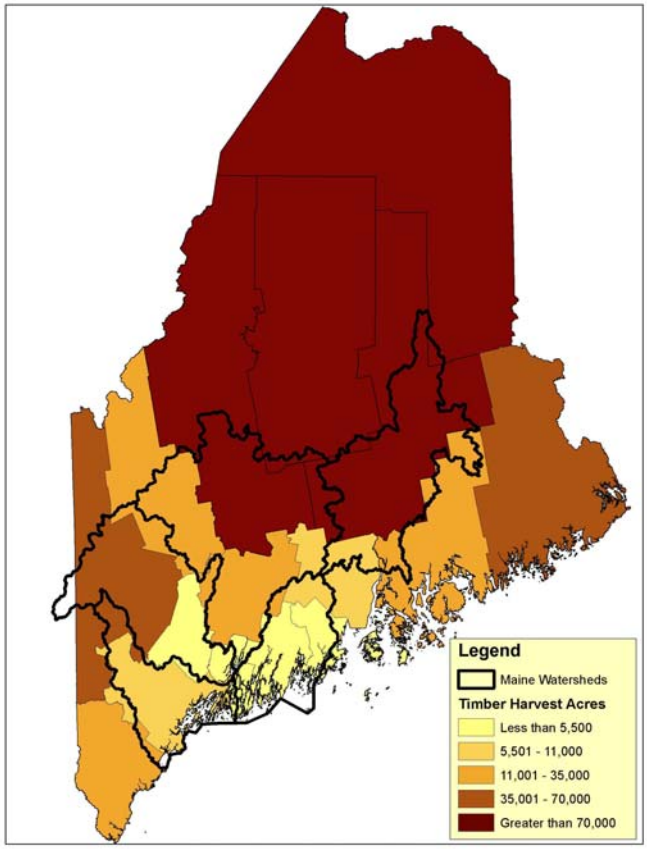

Figure 4-Average annual timber harvest acreage by county, 1997–2004. Data source: Maine State Forest Service 2006.

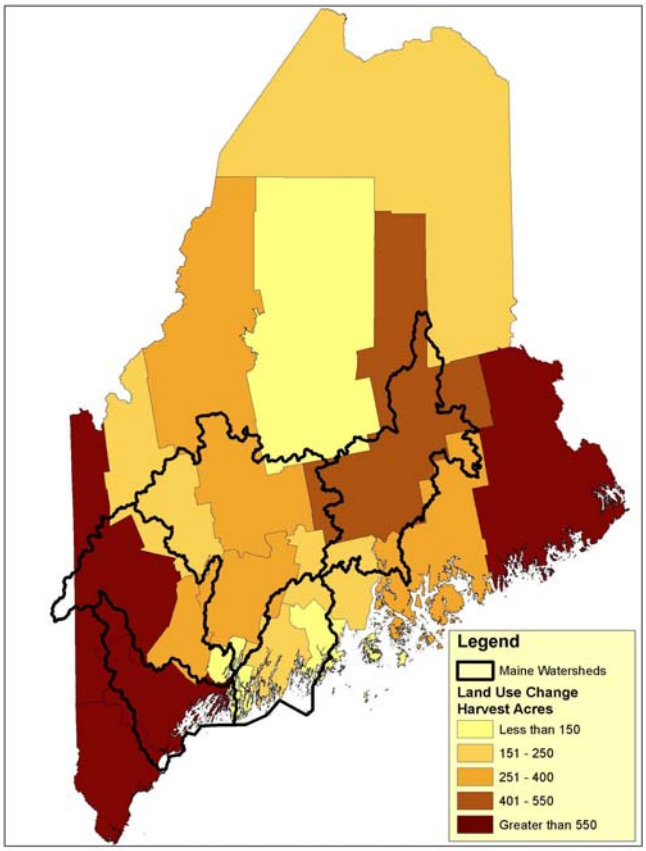

Figure 5-Average annual timber harvest for land use change acreage by county, 1997–2004. Data source: Maine State Forest Service 2006.

Stumpage Values

Spruce (Picea spp.), fir (Abies spp.) and eastern white pine (Pinus strobus) are the most commonly harvested sawtimber species in Maine. Over the last decade, hardwoods have been the most frequently harvested species group for pulp production in the state.

Stumpage values for spruce and fir and white pine sawlogs have been steady to increasing (in real dollars) since the mid 1990s (fig. 6). Over the same period, the real stumpage values for mixed hardwood pulp have remained static. As such, the per unit stumpage value landowners can expect has remained steady or increased over the recent period of development and ownership changes.

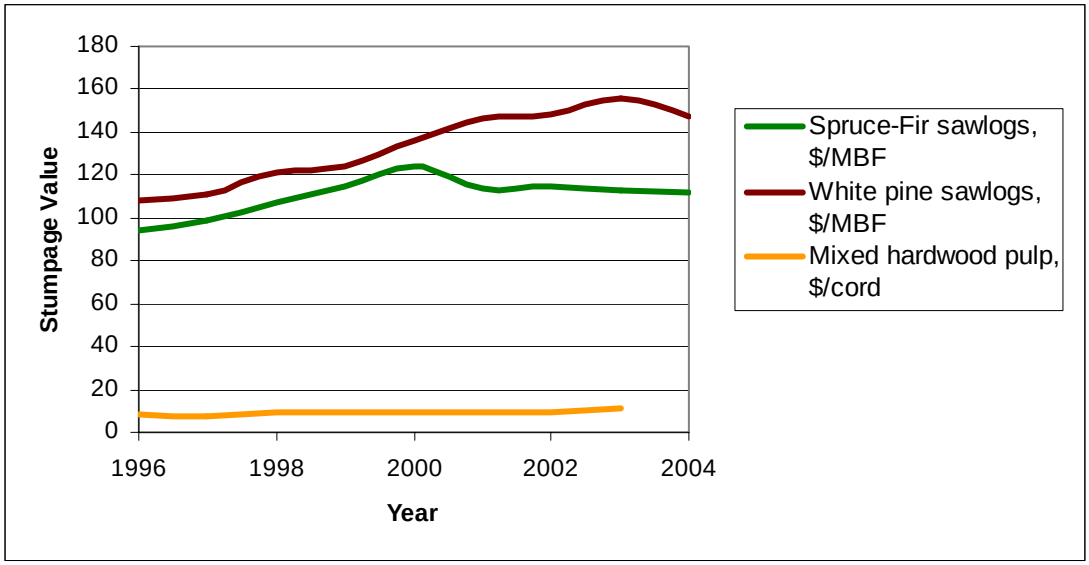

Figure 6-Average stumpage values for sawlogs and pulpwood in Maine (2001 dollars). Data source: Maine Forest Service (1998 – 2005b). Note: 2004 pulpwood stumpage prices are not included owing to a reporting change. $/MBF = dollars per thousand board feet.

Population and Housing

In the decade of the 1990s, the percentage increase in housing units (11%) dramatically outpaced the percentage increase in population (4%). Over the decade, the population of Maine increased by 47,000 individuals to 1.27 million, and the number of housing units in the state increased by 65,000 units to 652,000. This rapid expansion in housing units and the slight increase in population resulted in a decrease in the number of individuals per housing unit, from 2.09 in 1990 to 1.96 in 2000. Maine's average number of individuals per housing unit is well below the 2.43 individuals per housing unit found nationally. In future decades, the state's population is projected to increase moderately—to 1.36 million individuals by 2010 and to 1.41 million individuals by 2030 (USDC Census Bureau 2005c).

The small population increase of the 1990s resulted in a slight increase in population density, from 40 people per square mile in 1990 to 41 people per square mile in 2000. Housing unit density increased more rapidly during the period, from 19 units per square mile in 1990 to 21 units per square mile in 2000. Population and housing unit densities

among regions within the state differ widely; with densities in the southwestern counties more than quadruple the respective statewide densities.

Maine has the highest percentage of housing units being used as seasonal homes of any state in the Nation (USDC Census Bureau, 2004). In 2000, there were more than 100,000 seasonal homes in the state, representing 16% of the housing stock. The 1990s saw rapid growth in the number of seasonal homes in Maine, an increase of 13,000 units or 15%. Seasonal homes are most common in northern and "downeast" Maine, although they occur throughout the state (fig. 7).

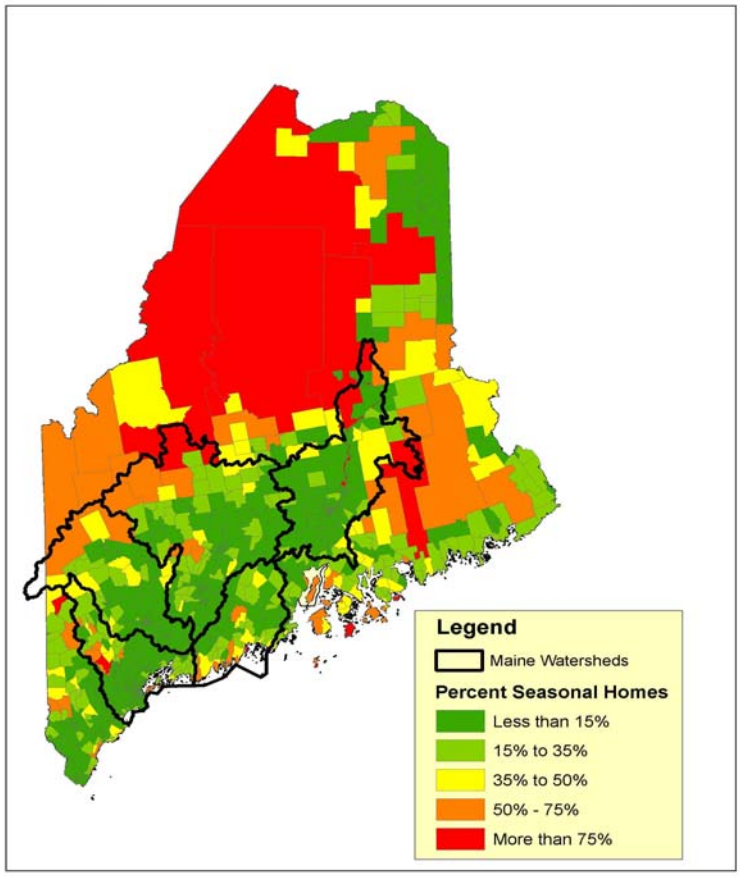

Figure 7-Percentage of housing units identified as being occupied seasonally, 2000. Data source: USDC Census Bureau 2005b.

Conditions and Trends in the Maine Watersheds

Population and Housing Trends

Across the five Maine case-study watersheds, the highest housing unit densities occur in the Presumpscot watershed and southwestern portions of the Lower Androscoggin, Lower Kennebec, and St. George-Sheepscot watersheds (fig. 8). Within the Lower

Penobscot watershed, the highest housing unit densities are associated with the city of Bangor and towns immediately surrounding Bangor. Isolated areas of high housing unit densities occur within each watershed, usually surrounding water bodies. Linear expansions of high housing unit densities associated with major routes occur primarily in the southwestern portions of the watersheds. Areas with the lowest housing unit densities occur in the northernmost portions of the watersheds. The lowest housing unit densities in the case-study area are found in the northernmost portion of the Lower Penobscot watershed—although this area is immediately adjacent to an area with high housing unit density.

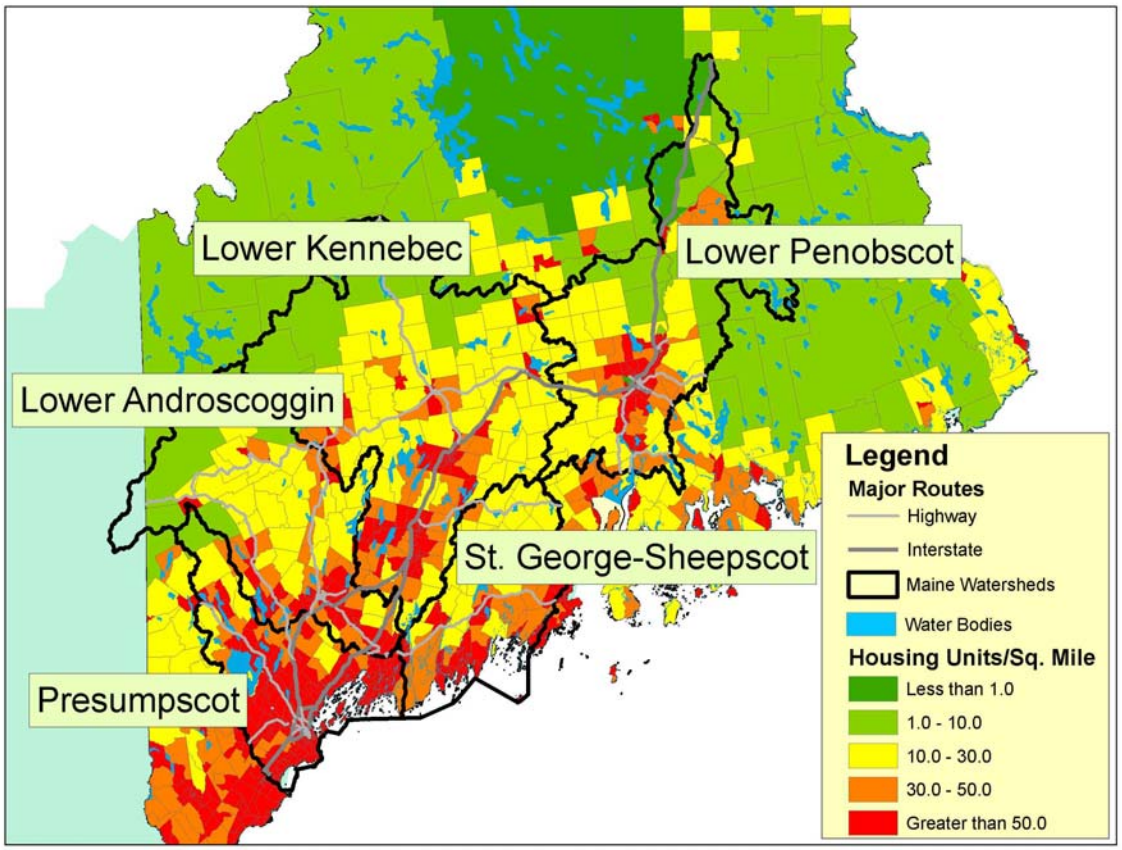

Figure 8-Housing units per square mile by census block group, 2000. Data source: USDC Census Bureau 2005b.

Between 1990 and 2000, the populations and numbers of housing units within the Maine case-study watersheds have changed at varying rates.[2] The greatest percentage increases in population (11%) and housing units (18%) occurred in the St. George-Sheepscot

[2] These results are based on analyses incorporating the 1990 and 2000 census block groups having geographic centroids within the watershed boundaries. Changes in the configuration of block groups from the 1990 to 2000 census can influence the results of comparisons between censuses using block groups.

watershed (table 1). The smallest percentage increase in housing units and the only loss in population occurred in the Lower Androscoggin watershed. In the Lower Penobscot watershed the population increased 2% and the number of housing units increased 10% between 1990 and 2000. The greatest percentage increases in number of seasonal homes occurred in the St. George-Sheepscot and the Lower Kennebec watersheds—two watersheds also experiencing significant expansions in population and housing units. The percentage increases in seasonal homes within the Lower Penobscot and the Presumpscot watersheds were similar to the statewide percentage increase. There was a loss in the number of seasonal homes in the Lower Androscoggin watershed. This may have resulted, in part, from the conversion of seasonal homes to primary homes.

Table 1-Percentage increases in population, housing units, and seasonal homes in the Maine watersheds and the State of Maine between 1990 and 2000

	Population	Housing units	Seasonal homes
Lower Penobscot	2%	10%	14%
Lower Androscoggin	-2%	2%	-7%
Lower Kennebec	4%	14%	31%
St. George-Sheepscot	11%	18%	25%
Presumpscot	10%	13%	14%
Case study watersheds	5%	11%	15%
Maine State	4%	11%	15%

Data sources: USDC Census Bureau 2000a, 2005b.

There is substantial spatial variability within the case-study watersheds in the percentage changes in the number of housing units between 1990 and 2000 (fig. 9). The percentage housing unit increase for the whole case-study area is 11%, and a number of towns experienced housing unit increases consistent with this percentage change. However, many municipalities had increases between 20% and 40% and several had housing unit increases of more than 40%. The Lower Penobscot watershed had the greatest number of municipalities with housing unit increases of greater than 40%. A handful of towns in the Lower Penobscot, Lower Androscoggin and the Lower Kennebec watersheds lost housing units during the 1990s. The majority of these losses were minor (5% or less).

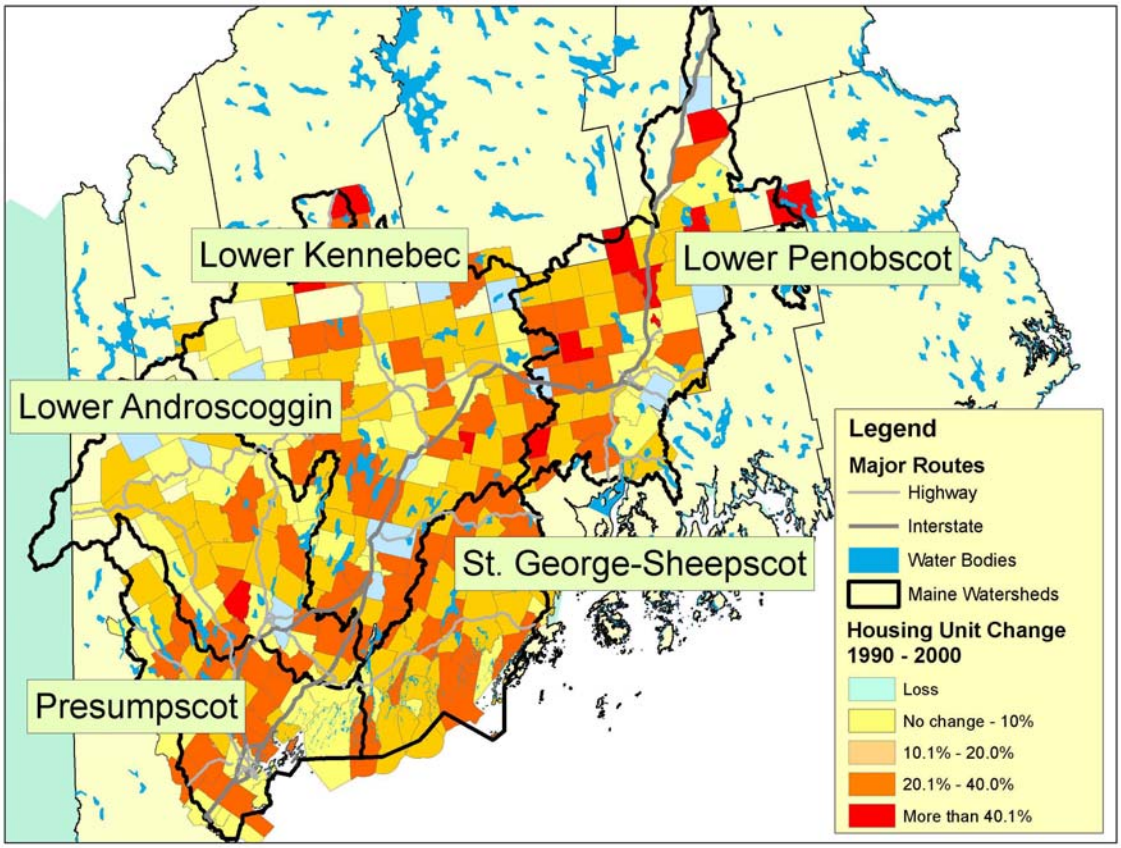

Figure 9-Percentage change in housing units in case-study watershed towns, 1990 to 2000. Data Source: Maine State Planning Office N.d.

Individuals electing to relocate to rural areas often do so at the cost of having an increased commute time to their workplace, which is frequently located in an urban area. The increased cost of a longer commute is offset by the gains in utility the individual receives from moving to the rural area (e.g., lower housing prices, aesthetics, proximity to natural resource amenities, larger lot sizes, etc.). Between 1990 and 2000 the average commute time nationally rose from 22.4 minutes to 24.3 minutes. This increase occurred concurrently with the further expansion of residential housing into rural areas. The percentage of commuters in the Maine case-study watersheds with commute times longer than the 2000 national average (25 minutes or longer) increased by 29% between 1990 and 2000. The most notable spatial changes in the percentage of long commutes occurred in the northern half of the Lower Kennebec watershed and some parts of the western portion of the Lower Penobscot watershed (figs. 10 and 11). Areas with the highest percentages of long commutes may be those experiencing increased residential development. Changes in rural commute times may also reflect changes in the workplace location of long-term residents.

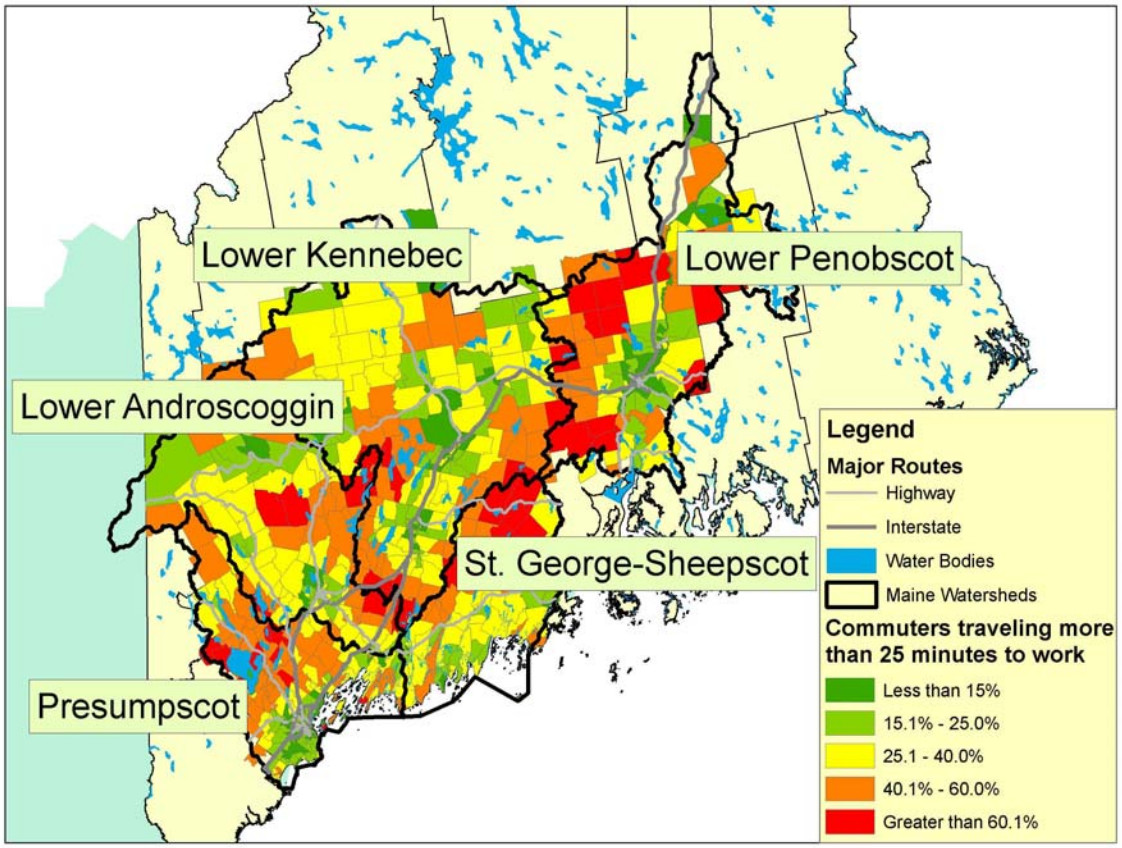

Figure 10-Percentage of commuters with a commute to work of 25 minutes or longer, 1990. Data source: USDC Census Bureau 2005a.

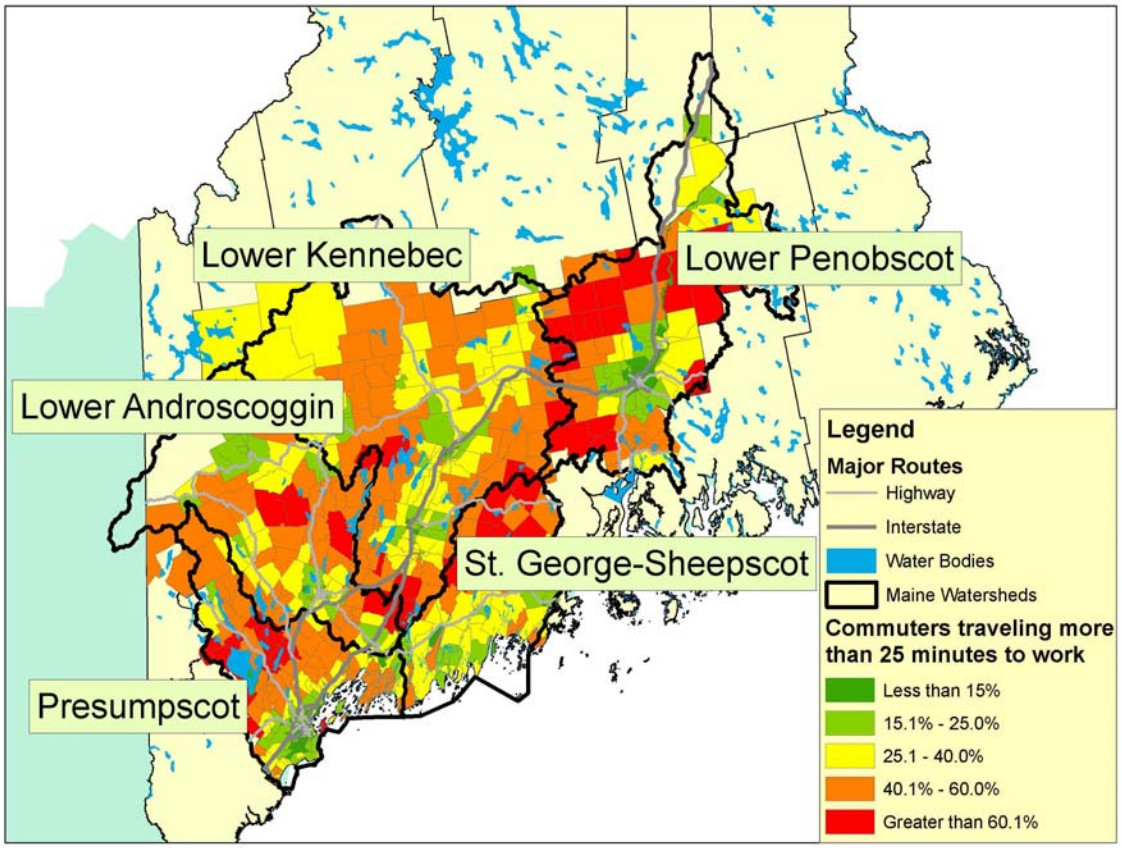

Figure 11-Percentage of commuters with a commute to work of 25 minutes or longer, 2000. Data source: USDC Census Bureau 2005a.

Forest Ownership

Individual and family ownership accounts for the vast majority of the forest land area within the Maine case-study watersheds (fig. 12). Forest land owned by forest industry and other private corporations is primarily located in the northern portions of the watersheds, although some industry and corporation landholdings are located in the interior portions of the case-study watersheds. Based on recent trends in divestment, it can be expected that the amount of land owned by forest industry will decrease in the future, with much of these lands being purchased by “other private corporations” and lesser amounts purchased by individuals and families. The acreage of publicly-owned forest land in the watersheds, and in Maine, is limited.

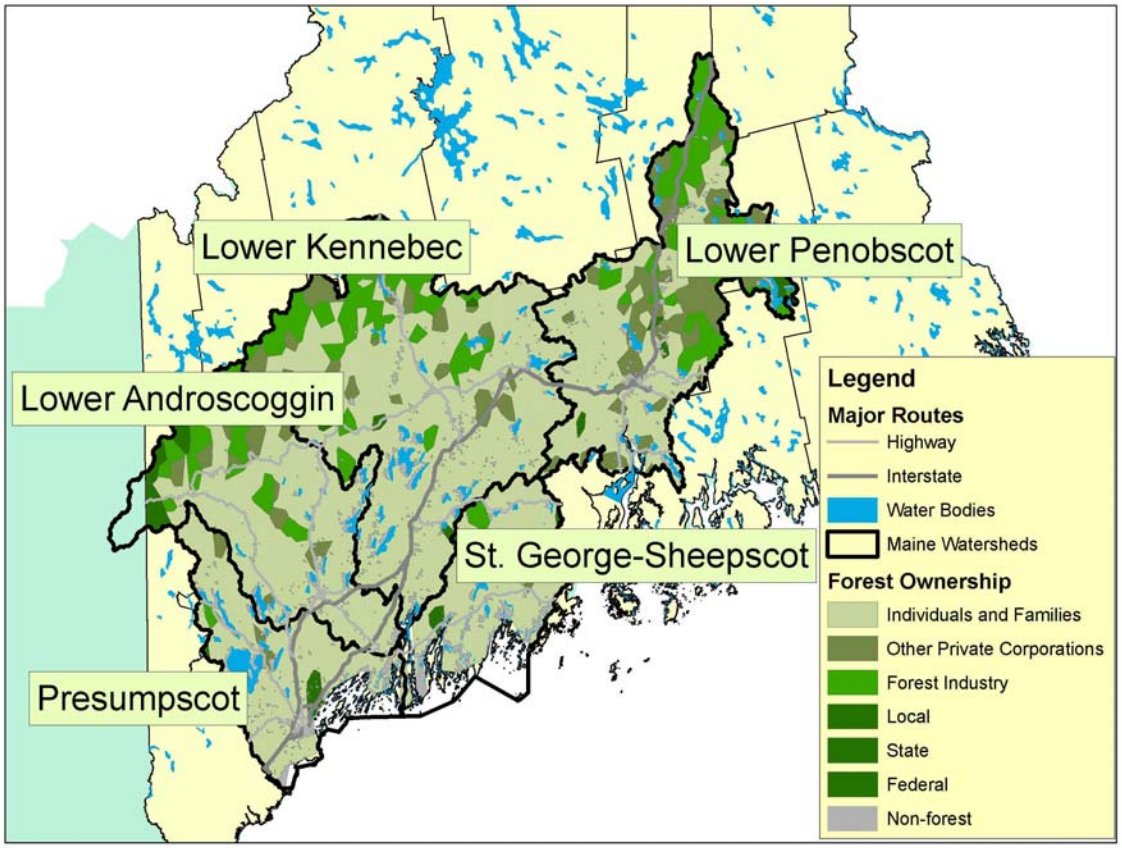

Figure 12-Forest ownership distribution in the Maine case-study watersheds, 2003. Data source: Butler 2005.

Individual and family owners have indicated that they own forest land for a variety of non-market and market objectives. Reasons for owning forest land frequently cited by these owners as important or very important include privacy, aesthetics, nature protection, family legacy, and recreation (McWilliams et al. 2005). Land investment and the production of timber products are less frequently cited as important reasons for owning forest land (see Birch et al. 1998, Jones et al. 1995, McWilliams et al. 2005).

Forest Parcel Size

The size of forest parcels is of concern because declines in forest parcel size have been associated with reduced propensity to adopt forest management plans and/or conduct timber harvests (see Dennis 1989, Row 1978). A variety of forest parcel sizes occur within the case-study watersheds. Forest parcels in the broad size class of greater than 50 acres and less than 1,000 acres are most common and are distributed throughout the watersheds (fig. 13). Parcels larger than 1,000 acres are less common and are generally located along the northern boundary of the watersheds, in areas more frequently owned by forest industry and other private corporations. Parcels of less than 50 acres are frequently located near urban centers, along interstates and highways, and near water

bodies. These areas frequently have high housing densities (fig. 8), suggesting the existence of many individual and family landowners.

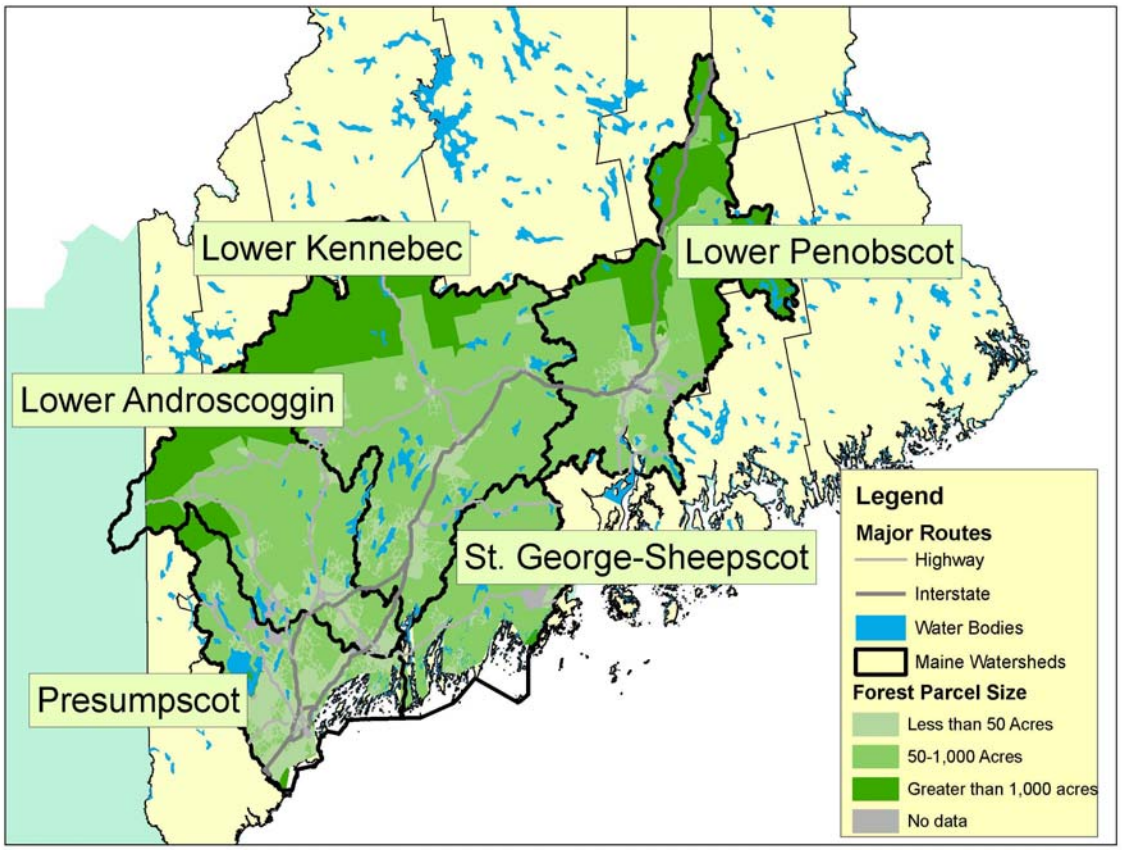

Figure 13-Forest land parcel size in the Maine watersheds, 2003. Data source: Butler and King 2005.

Over the last several years, in general, annual harvest acreages have been moderate within many of the counties intersecting the case-study watersheds (fig. 4). Additional forest parcelization, which may result from residential development and changes in forest ownership, will likely make traditional forest production activities more difficult within the case-study watersheds. Small forest parcels frequently pose greater operational difficulties for timber harvesting and have greater per acre harvesting costs than large forest parcels—likely reducing both the feasibility of harvest and any potential landowner revenue from timber production. Concomitantly, smaller parcels of undeveloped land typically have a higher per acre market value, leading to an increased opportunity cost to the current owner of retaining the land in forest. If residential development continues to expand in the case-study watersheds, these market factors will likely make the retention of land in forest use increasingly difficult.

Land Use Planning

Comprehensive land use plans and the associated zoning regulations form the approximate boundaries of future land use and land use change. Maine is a home rule state, and, as such, comprehensive planning and the adoption of zoning ordinances are primarily the responsibility of local municipalities (i.e., towns and incorporated areas) under the state's Planning and Land Use Regulation Act, as amended. In unincorporated areas or areas with no local government, the state's Land Use Regulation Commission (LURC) is responsible for land use planning and development of any zoning ordinances. Within the case-study watersheds there are several townships and unorganized areas, primarily along the northern boundary of the case-study area, that fall under the responsibility of the LURC. For municipalities and incorporated areas, technical assistance in developing comprehensive plans and land use ordinances is available from the regional council of governments serving the municipality. This technical assistance is funded, in part, via the State Planning Office of Maine. The case-study watersheds are served by seven regional councils.

Current and Projected Residential Development

The current level of residential development differs considerably across the landscapes of the Maine watersheds (fig. 14). In general, the highest levels of residential development are most common in the southwestern portion of the area and near current urban centers, as expected. Moderate levels of residential housing density expand outward from these urban centers. Of the Maine watersheds, the Presumpscot watershed has the greatest concentration of high-density residential development. Areas of low residential housing unit density are located primarily in the northern portions of the area. Although some linear expansions of moderate and high residential housing exist along the interstates and highways, this pattern is not as clearly evident as in some watersheds examined throughout the United States. Currently, there are a few pockets of moderate and high residential development adjacent to forest land owned by forest industry and other private corporations (e.g., TIMOs and REITs). Development pressure in these areas may increase the land values for these parcels.

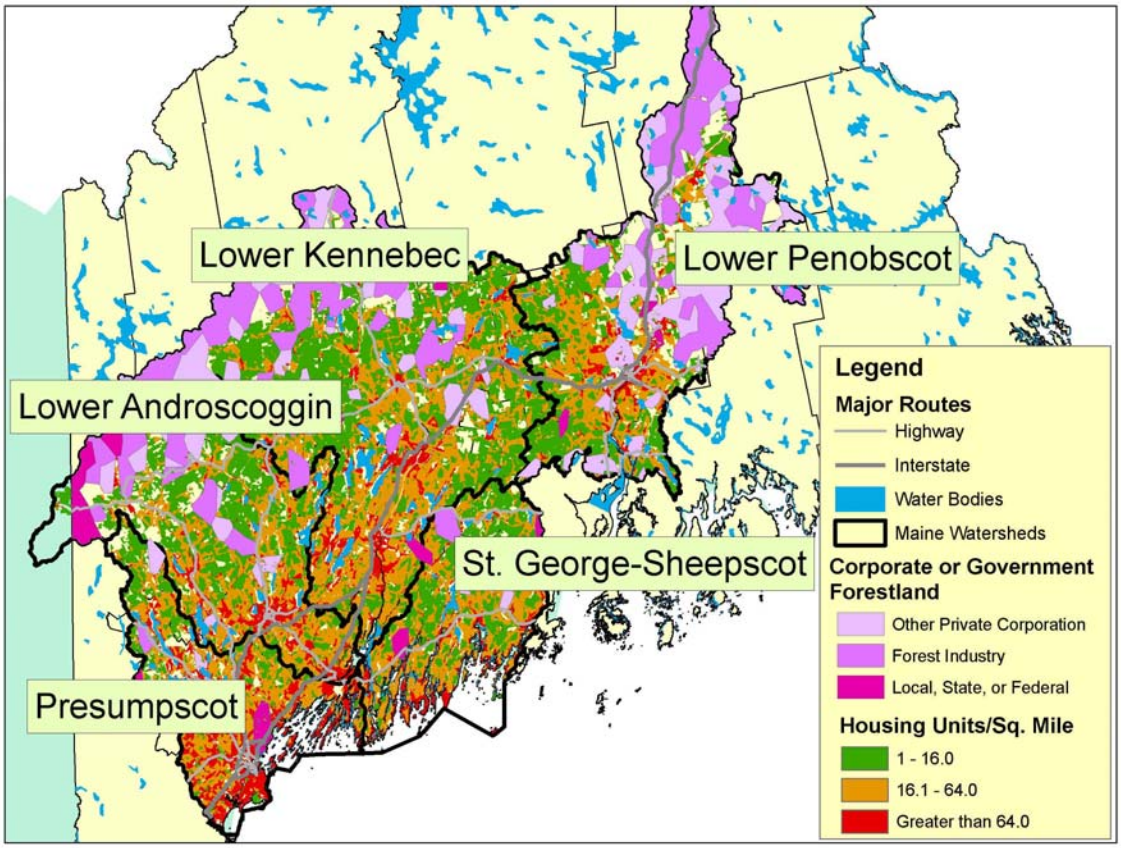

Figure 14-Year 2000 Maine watersheds baseline housing unit density as identified for the USDA Forest Service Forests on the Edge project. Data sources: Butler 2005 and Theobald 2004a.

Projections of residential development for 2030 indicate significant increases in residential housing unit densities within some portions of the Maine watersheds (fig. 15). Substantial increases are projected to occur in much of the western portion and Bangor region of the Lower Penobscot watershed, the southern portion of the Lower Kennebec watershed, and the southern portion of the Presumpscot watershed. Some significant increases are projected in the northern portion of the Lower Androscoggin watershed and the coastal portions of the St. George-Sheepscot watershed. By 2030, nearly all of the land within the western portion of the Lower Penobscot watershed and the southern portion of the Presumpscot watershed are projected to have housing unit densities above 64 units per square mile. A linear expansion of housing unit densities above 64 units per square mile is also projected north of the Bangor area, along the Penobscot River. Areas of substantial housing density increase in the Lower Penobscot and Lower Androscoggin watersheds occur in proximity to forest land currently owned by forest industry and other private corporations. Forest land owned by individuals and families occurs throughout the watersheds and specifically in areas projected to experience substantial increases in residential housing.

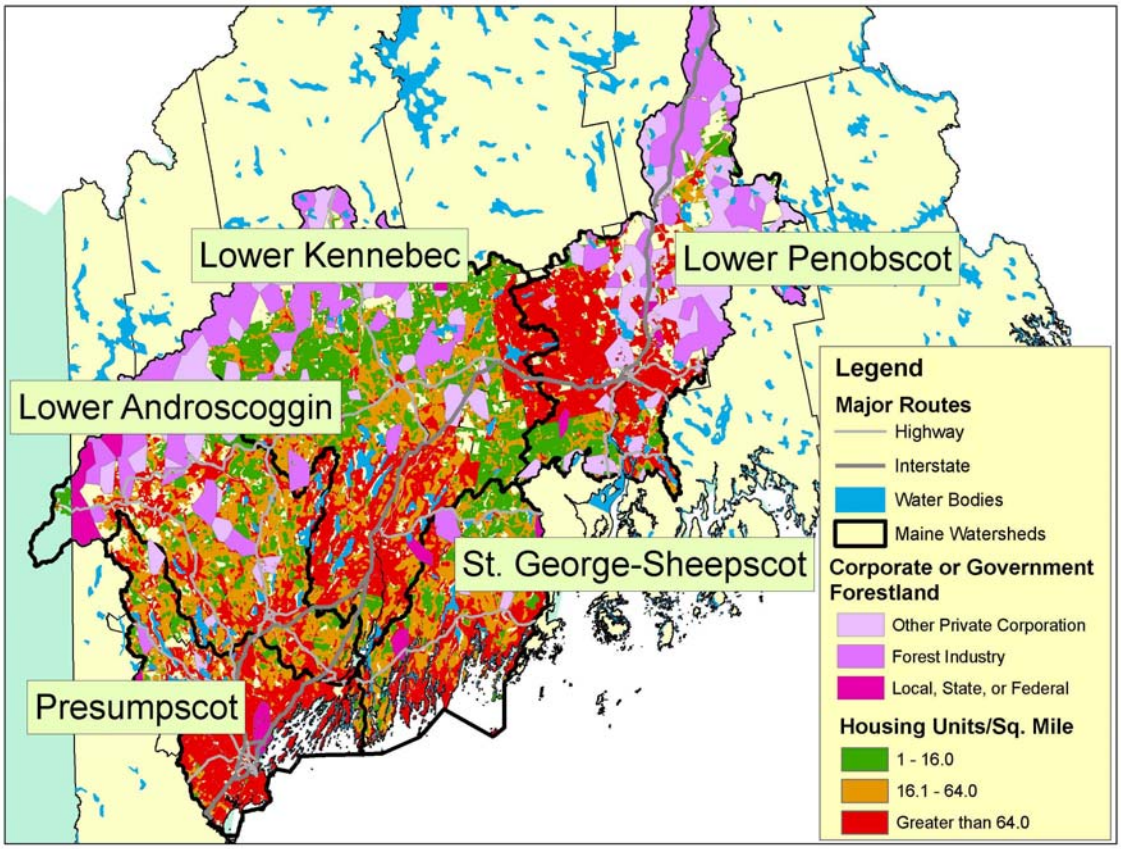

Figure 15-Year 2030 Maine watersheds baseline housing unit density as identified for the USDA Forest Service Forests on the Edge project. Data sources: Butler 2005 and Theobald 2004b.

Based on the spatial distribution of forest ownership, it appears that much of the projected development will occur on forests owned by individual and family forest landowners, particularly in the Lower Penobscot watershed (figs. 12 and 15). In addition, some projected areas of residential development will be adjacent, and extend into, forest land currently owned by other private corporations and forest industry. Development pressures on existing forest land within the watersheds will likely increase incrementally with future projected expansions of residential development.

One uncertainty, looking forward, is what impact the eventual closure of Naval Air Station Brunswick (NAS Brunswick), located near the confluence of the Lower Androscoggin, Presumpscot, and St. George-Sheepscot watersheds, will have on the economy of Maine and, in turn, future population and residential housing development. Currently, NAS Brunswick employs 4,800 military and civilian personnel and is associated with $187 million dollars of economic activity. Closure of NAS Brunswick will result in an estimated reduction of nearly 4,300 jobs between 2006 and 2011 (US Department of the Navy 2005).

Summary

Over the last decade, Maine has experienced a modest increase in population and a more significant increase in the number of housing units. The population of the case-study watersheds increased at a slightly greater rate than the whole state and the percentage change in housing units was similar to the statewide average. Within the case study-watersheds, the change in housing units during the 1990s differed widely—a few towns lost housing units while several experienced increases of more than 40%. The percentage of housing units in Maine used as seasonal homes is greater than any other state in the Nation. Between 1990 and 2000, the number of seasonal homes increased 15%. Seasonal homes represented 16% of the state's housing stock in 2000.

Statewide, the area of forest land and timberland has remained steady in recent decades. Although total forest land area has remained static, owing in part to reforestation of agricultural land offsetting forest land losses, the number of acres harvested annually for land use conversion has been increasing since the mid-1990s. Most of the acres undergoing land use conversion are located in southern Maine. The ownership of Maine's forests has changed dramatically in recent years. As a result of divestment of landholdings by forest industry, the acres of forest owned by other private corporations (including TIMOs and REITs) and by individuals and families has increased substantially. In 2003, individuals and families, forest industry, and other private corporations each owned just more than 30% of the forest land area in Maine. The impact of recent and future divestments of forest industry land on future land use change in Maine is unknown.

Maine's annual timber harvest volumes and harvest acreages have been steady in recent years. During the same time, stumpage prices for sawlogs have increased while stumpage prices for hardwood pulpwood have remained steady, in real dollars. This is contrary to trends found in other parts of the country experiencing rural development, such as northwest Washington. In northwest Washington, annual harvest volumes over the last several years have been steady to slightly declining while stumpage values for the primary timber species have been declining, in real dollars, for the last 10 years. It is uncertain how recent changes in forest ownership and increasing residential development within the state will impact long-term harvesting rates and stumpage values. Declines in real stumpage values and/or increases in operational difficulty because of parcelization or rural residential development, occurring concurrently with future potential increases in per acre land values, may make it increasingly difficult for forest landowners to maintain lands in forest use.

Projected increases in population and the anticipated increases in the number of housing units will likely result in expansion of the land area dedicated to residential development in the Maine case-study watersheds. In particular, substantial increases in the area of high housing unit density are projected in much of the western portion of the Lower Penobscot watershed, the southwest portion of the Lower Kennebec watershed, and the southern portion of the Presumpscot watershed. Moderate expansions of high residential housing densities are projected within the northern portion of the Lower Androscoggin watershed

and coastal portion of the St. George-Sheepscot watershed. There is considerable coincidence of the boundaries of areas of projected high residential development and areas currently owned by forest industry and other private corporations. Forest land owned by individuals and families exists throughout the case-study watersheds and these lands intersect areas projected to undergo increased residential development.

Recent trends and projections indicate that residential development in south-central and southwest Maine will continue to increase in the coming decades. With these changes, it is increasingly important to recognize the importance of the services provided by privately owned forests and to identify appropriate strategies and tools to conserve private forests in the face of increasing land use change.

Metric Equivalents

1 foot = 0.305 meters
1 acre = 0.405 hectare
1 acre = 4,046.86 square meters
1 cubic foot per acre = 0.07 cubic meters per acre
1 mile = 1.609 kilometers
1 square mile = 2.59 square kilometers

Citations

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