Land-Base Changes in the United States: Long-Term Assessments of Forest Land Condition

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Abstract.—Forest land conditions affect the potential of U.S. forests to sustain a wide array of forest goods and environmental services (e.g., biodiversity) that society demands. Forest survey data collected by U.S. Department of Agriculture Forest Service Forest Inventory and Analysis (FIA) units are being used in long-term assessments of U.S. forest land conditions at large scales. Resources Planning Act assessments, which employ a system of models, and FIA data enable a proactive examination of forest resources by projecting long-term changes in forest area and other forest ecosystem attributes in regional and national studies of forest sustainability. Forest land values provide informational signals on what amounts and types of forest land are likely and prospects for the provision of mixes of land-based goods and services. A key part of those land use changes, development of rural land, is related to population growth and affects forest land values, forest fragmentation, forest parcelization, and ownership changes. The FIA survey planning and related assessments would be enhanced by a unified framework, constructed at a scale that adequately serves all assessment areas, to analyze future land conditions.

Introduction

Forests cover about one-third of the United States. These diverse land-based ecosystems provide a variety of habitats for wildlife; help to cleanse the air and water; supply timber, fuel wood, and other harvested products; serve as places for recreation; and provide other goods and environmental services. Long-term assessment of their condition and relations to changes in demographics and other socioeconomic factors is key in defining policy questions and actions needed to sustain those services. Use of long-term databases, such as those compiled by the U.S. Department of Agriculture (USDA) Forest Service Forest Inventory and Analysis (FIA) program pertaining to changes in forest cover, will be integral in monitoring efforts and in supporting long-term projections of changes in forest land condition.

With changes in society, such as growth in population and increases in consumption, human-related pressures on the land base and forest land conditions are likely to increase. Across the United States, forest land conditions are altered by timber harvesting, fire management practices, conversion to other land uses, forest type transitions (including forest succession), recreation, and climate change. For example, wood use has increased by 40 percent since 1960 and is expected to rise by about 30 percent in the next four decades, which has implications for domestic timber harvest levels (Haynes 2003).

Projections of changes in forest land condition support long-range regional and national projections of future supply and demand for agricultural crops, animal products, forest products, recreation land, wildlife habitat, water use, and other landscape and environmental measures (see, e.g., USDA Forest Service 1988, 2001). An abundance of land is seen by some as a hallmark of the United States, and projections of developed area can aid decisionmaking as a forward-looking process in addressing questions such as whether adequate rural land will be available to support valued environmental goods and services in the future.

Periodic U.S. natural resource assessments mandated by the national (Forest and Rangeland Renewable) Resources Planning Act (RPA) of 1974 support USDA Forest Service strategic planning and policy analyses (USDA Forest Service 2001). RPA requires that decadal national assessments, with mid-decade updates, include an analysis of present and anticipated uses; demand for and supply of the renewable resources of forest,

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range, and other associated lands; and an emphasis on pertinent supply, demand, and price relationship trends. The 2000 RPA assessment provides a broad array of information about the Nation's forests and rangelands, including the current situation and prospective area changes over the next 50 years (Alig *et al*. 2003, Alig and Butler 2004). Related data illustrate the dynamics of our Nation's land base and how adjustments are likely to continue in the future. Projections of land use and forest cover changes provide inputs into a larger system of models that project timber resource conditions and harvests, wildlife habitat, and other natural resource conditions (USDA Forest Service 2001). These RPA assessments interface with international assessments (e.g., United Nations Conference on Environment and Development in 1992, Montreal Process set of sustainability criteria and indicators) and regional assessments, such as the study of the South's Fourth Forest (USDA Forest Service 1988) and an update by the Southern Forest Resources Assessment (Wear and Greis 2002). Information from the periodic RPA assessments can shed light on whether we can sustain increasing consumption of forest products and forest resource conditions.

This article has three parts. The first part discusses changes in macro forest land conditions, as evidenced by trends in land use, ownership, cover types, forest age, and proximity to concentrations of developed area. The second component focuses on large-scale modeling systems that use FIA data for investigating prospects for afforestation, reforestation, and deforestation (e.g., conversion to developed uses). The final section summarizes associated information and research needs, with an emphasis on environmental services and the link to human modifications of the environment.

Land Use and Land Cover Changes—1953 to 2002

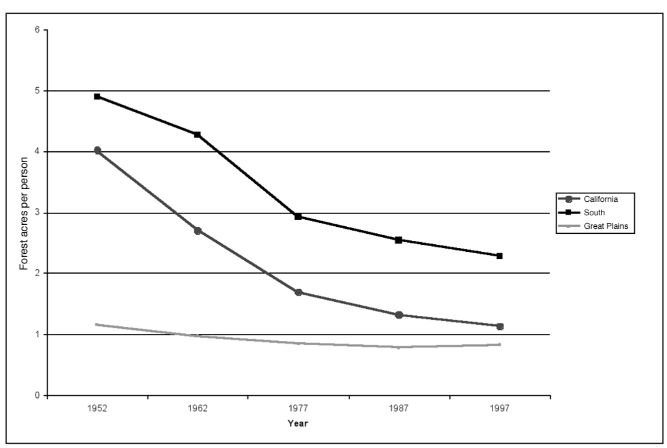
Examining historical trends provides guidance for identifying key factors that are likely to influence forest land conditions and associated natural resources in the future. The discussion of historical trends across time and space lays a foundation for subsequent discussion of projected changes in those same forest attributes. A major data source is the FIA survey program of the USDA Forest Service. Regional FIA units have a long history of inventorying and monitoring the Nation's forests. This program originated with the McSweeny-McNary Forest Research Act of 1928 and has been in continuous operation in portions of the country ever since. During the 1970s, a national forest survey effort, having completed at least one inventory in most States, expanded its mission considerably by adding multiple resource inventories to the historical timber surveys. The FIA reports on status and trends in (1) forest area and location; (2) the species, size, and health of trees; (3) total tree growth, mortality, and removals by harvest; (4) wood production and utilization rates by various products; and (5) forest land ownership. The national FIA program Web site is http://www.fia.fs.fed.us/.

Total Forest Area and Ownership

Key forest-related indicators at a national level are total forest area and trends by ownership. Between 1953 and 2002, the net change in U.S. forest area was a reduction of about 7 million acres, or 1 percent. Timberland area was reduced by a similar amount. Overall, forest area per person has declined notably since 1953 (fig. 1).

The largest forest ownership aggregate in the country, non-industrial private forest (NIPF) owners, experienced a 14-million-acre, or 5-percent, reduction in its timberland area. The largest concentration of NIPF owners is in the South, and their timberland area was reduced 6 percent. Most forest land development

Figure 1.—*Amount of forest area per resident, for selected U.S. regions, 1952–1997). Source: Smith* et al. *2004.*



occurs on land owned by NIPF owners. NIPF owners control the most U.S. timberland—58 percent (118 million ha) of the total. Even where public ownership predominates, NIPF ownership often accounts for land that provides critical habitat such as lowlands or riparian areas—e.g., NIPF ownership of Pacific Northwest land that is critical to threatened and endangered species (Bettinger and Alig 1996).

NIPF-owned timberland areas in the Pacific Northwest and Pacific Southwest, two other regions experiencing above-average growth rates in population and increases in developed area, are also decreasing. In the Pacific Northwest, NIPF timberland area dropped by 4.4 million acres, or 34 percent, between 1953 and 2002, while the corresponding reduction of NIPF timberland area in California (Pacific Southwest) has been 1.5 million acres, or 25 percent over the same period.

Land ownership can be an important determinant of how forest land is managed and the levels of investments in different practices (e.g., Alig *et al*. 1999). The relative proportions of private and public timberland have remained fairly stable since 1953, with about 29 percent of U.S. timberland in public ownership. In the private timberland group, the proportion of NIPF ownership dropped slightly, from 84 to 82 percent of total private ownership, between 1953 and 2002. Family forests are a large component of the NIPF ownership class; the number of family forest owners increased from 9.3 million in 1993 to 10.3 million in 2003, and these owners now control 42 percent of the Nation's forest land (Butler and Leatherberry 2004). The NIPF ownership class is the one most subject to land use changes, as evidenced by the 14-million-acre reduction in NIPF timberland area since 1953; in contrast, forest industry ownership increased by 7 million acres.

The long-term area increase in U.S. forest industry timberland peaked in 1987 at 70 million acres. Since then, U.S. forest industry timberland area has declined by 5 million acres, with some area reclassified as NIPF timberland because of a transition to institutional and other financial investors without timber-processing facilities. About half of that net reduction was in the Southeast, with a transition of land ownership from consolidated forest products companies to stand-alone financial ownership. Institutional investors currently hold about 8 percent of the investable U.S. timberland (Wilent 2004). By the end of 2003, a Timber-Mart South newsletter reported that the top 10 timberland investment organizations (TIMOs) managed about 9 million acres of U.S. timberland, and some analysts predicted that TIMOs and other investor groups will purchase another 10 to 15 million acres in the next decade (Wilent 2004).

Forest Cover Types

Forest cover is another important variable that affects wildlife habitat, timber supply, global climate change, water, recreation, and other forest ecosystem goods and services. Land cover is the observed biophysical cover on the Earth's surface, e.g., oak-hickory forest and grassland. Cover types are related to land use changes, with land use being the human-defined purpose of that land. For instance, lands can be defined as protected areas, forestry for timber products, plantations, row-crop agriculture, pastures, or human settlements. By examining historical trends of forest land area by forest cover type, we can better understand forest dynamics and their possible implications for sustainability.

The three largest historical cases of area changes for forest cover changes since 1953 have been in the eastern United States (Alig and Butler 2004). A key area change with timber supply implications is the more-than-tenfold increase in the planted pine area in the South since 1953, mostly on private lands. This growth illustrates that the largest recent impact on forest cover dynamics in the United States has been due to human influences, especially from changes in land management objectives. In the last half of the 20th century, application of intensive forestry, as with establishment of some pine plantations, has in some cases influenced the composition, structure, and ecological processes of forests. For instance, plantations and clearcutting have replaced natural regeneration and selective harvesting on some sites in the United States. An example is the conversion of naturally regenerated longleaf and slash pine stands with pine plantations, resulting in a 50-percent reduction in the area of the longleaf and slash pine type since 1953 (Smith *et al*. 2004). Intensive forestry on private timberland has generally reduced rotation lengths, which leads to more frequent regeneration opportunities and increases the probabilities of more forest cover changes.

Along with the human-caused changes are the successional forces that led to a doubling of the area for maple-beech-birch type between 1953 and 2002 in the East. Two other hardwood types, oak-hickory and oak-pine, also increased more than 20 percent in area, gaining some of this area after timber harvests of other types. Although planted pine has increased in portions of the East, the hardwood types continue to dominate the area in this region.

Although softwood types dominate forest cover in the West, the largest area increase since 1953 has been the more than doubling of western hardwoods (Smith *et al*. 2004). In the softwood types, Douglas fir area has increased, sometimes at the expense of the western hemlock-Sitka spruce type. At higher elevations, the spruce fir cover type has almost doubled its area since 1953 due to successional forces. At a national scale, long-term data on forest cover changes are generally more available for private forests because FIA concentrated on private and State lands until recent decades when regional units assembled joint databases to include national forests and other lands.

Stand Age

The FIA program classifies timberland by 10-year age class for even-aged stands, e.g., 0 to 9 years of age. The FIA surveys classified less than 5 percent of timberland as being uneven-aged (Smith *et al*. 2004). Timberland in the West tends to have older stands on average, with 4 percent of stands in the East being 100 years or older in comparison to 35 percent of western stands. The West also has close to 10 million timberland acres with stands that are 200 years old or older, or 7 percent of the total, in contrast to only about 50,000 acres in the East. Conversely, 22 percent of stands in the East are classified as being less than 20 years of age in contrast to 12 percent in the West.

Changes in age-class structure have various implications for timber inventory volumes and growth, with key differences on public versus private timberlands. For much of the country, we are seeing an aging of the forests and an accumulation of acres in the older seral stages as active timber production shifts to fewer acres. These changes are especially true in the North and West and particularly on public timberlands in the Pacific Northwest. In the South, by contrast, a shift from older hardwood stands to younger softwood stands has occurred because of forest management decisions (Haynes 2003).

The combination of forest resource changes described above has been accompanied by an increase of almost a quarter trillion cubic feet (39 percent) in U.S. growing stock since 1953. The increases have been largely in the East, spread almost evenly between the North and South (Smith *et al*. 2004). Hardwoods experienced most of the increase. Since 1953, volumes have increased in all timber diameter classes below 25 inches (Smith *et al*. 2004); however, softwood volumes have decreased for classes above 25 inches whereas hardwood volumes have increased. The decline in large-diameter softwoods is due to harvesting of larger trees and the increased set-aside of timberland as reserved forest land (which reclassifies trees in these areas as nongrowing stock).

Forests in the Rural-Urban Continuum

Forest land development increases the number of people who are living closer to remaining forest lands, in view of growing cities and other urban areas. A measure added in recent periodic FIA surveys has been the identification of forest lands by rural-urban continuum class. Based on nationwide rural-urban continuum classes (Smith *et al*. 2004), 13 percent of U.S. forest land now are located in major metropolitan counties, and 17 percent are in intermediate and small metropolitan counties and large towns, for a total of 30 percent of all U.S. forest land (Smith *et al*. 2004). Between 1997 and 2002, the forest area in major metropolitan areas increased by more than 5 million acres, or 5 percent, as developed areas in the Unites States expanded considerably.

The aforementioned descriptions of changes in the forest resource since 1953 provide a brief look at some of the natural resources and societal changes that are considered when projecting area changes for forest land and timberland by U.S. region. A method used increasingly in RPA assessments that uses FIA data is econometric modeling based on statistical methods used to quantify relationships between land uses and hypothesized determinants such as landowners' profit from land management (e.g., Kline and Alig 1999).

Systems Modeling: Projecting Forest Land Conditions

FIA data are used in the system of models employed for the periodic RPA assessments and related studies. For example, for the 2000 (fifth) RPA Timber Assessment (Haynes 2003), forest inventory data collected by the USDA Forest Service's FIA units were used to characterize current forest conditions and project forest inventories. A key model is the Timber Assessment Market Model (TAMM) for the solid wood products sector, which provides the linkage between product markets (solid wood and pulpwood) and the timber inventory (Adams and Haynes 1996). The North American Pulp and Paper Model (NAPAP) is a model of the paper and board sector, with detailed treatment of fiber supply (recycled, roundwood, and short-rotation woody crops) (Ince 1999). The Aggregate Timberland Assessment System (ATLAS) is a structure for projecting timber inventory over time based on FIA periodic data (Mills and Kincaid 1992). The AREACHANGE model explains the shifting of land between forest and nonforest uses and among forest types (Alig *et al*. 2003, Alig and Butler 2004). The RPA system of models is an example of a bioeconomic model because it combines representations of biological and economic processes.

In the RPA family of models, projecting land use changes requires FIA data pertaining to ownership, forest cover, site productivity, stand age, and removals. By using these and other data, the AREACHANGE model projects land use for the entire land base, including conversion of forest lands to urban and other built-up uses and land exchanges between forestry and agriculture. The information generated from the RPA family of models, in turn, is used for input into other models, such as the Forest and Agricultural Sector Optimization Model (FASOM). In FASOM, the forest sector is patterned in large part after the basic structures of the TAMM, NAPAP, ATLAS, and AREACHANGE models (Adams *et al*. 1996; Alig *et al*. 1998, 2002). The FASOM model endogenously allocates land between forest and agricultural use, such as in the case of afforestation. For example, in the two southern RPA regions, FASOM results indicated that the South Central region has relatively more potential for afforestation on agricultural land. Population growth in the Southeast has led to more deforestation for developed uses in that region, based on projections by Alig *et al*. (2003, 2004), and the next section of this article indicates that forests are the largest source of developed land.

Highlights of the projections to 2050 by the 2000 RPA assessment include (1) U.S. consumption of forest products will continue to increase over the next 50 years, but the rate of increase will be slower than over the past 50 years; (2) most of the increase in the Nation's timber harvest will be in the East, especially on NIPF timberlands in the South; (3) softwood plantations will play an important role in future domestic timber harvest expansion, but such plantations will occupy less than 10 percent of U.S. timberland; (4) timber inventory volumes will increase—softwoods by 53 percent and hardwoods by 27 percent; (5) tree species composition will shift toward softwoods in the South and hardwoods in the North and remain largely unchanged in other regions; (6) the age-class structure of timberland managed on an even-age basis will be similar to current conditions on private lands but will shift toward older age classes on public lands; and (7) diversity indices that combine age class and forest type exhibit limited change over the projection period for the United States as a whole (Haynes 2003). In summary, based on broad-scale measures of forest resource conditions, the RPA assessment does not project dramatic changes in U.S. forest conditions over the next 50 years, even as timber harvest levels rise. Deforestation trends are examined more closely in the next section because this issue increasingly draws attention to current policy (e.g., open space concerns) and whether changes would be desirable.

Deforestation Projections

In recent years, most U.S. deforestation has been due to conversion of forest land to developed uses, e.g., residential areas. The United States had a 34-percent increase in the amount of land devoted to urban and built-up uses between 1982 and 1997, according to the National Resources Inventory by the USDA (USDA NRCS 2001). The annual rate of conversion during the past 5 years of this period was more than 50 percent higher than during the previous 5 years. Forests in particular have been the largest source of land converted to developed uses in recent decades, with resulting impacts on forest cover and other ecological attributes. The largest increases in U.S. developed area between 1982 and 1997 were in the South, a key timber supply region. Between 1982 and 1997, 7 of the 10 States with the largest average annual additions of developed area were in the South. Expansion of developed area and urban sprawl in the South has been described as a major issue for future natural resource management, especially for the region's forests (Seelye 2001, Wear and Greis 2002). A recent FIA survey for North Carolina turned up a larger reduction in timberland area than in previous surveys. Wear and Greis (2002) project more than a 10-million-acre increase in developed area in the South over the next 25 years.

Development of rural land does not just result in direct conversion of forest land but can also involve forest fragmentation (Alig 2000, Butler *et al*. 2004), forest parcelization, and ownership changes. Development pressures can also add to uncertainty about how forest land will be managed if owners anticipate higher financial returns in an alternative use. Because forest land prices capture information regarding current as well as anticipated uses of land, land prices anticipate future development of forest land near urbanizing areas, casting a speculative shadow over timberland values (Wear and Newman 2004). With anticipated population and income growth, such dynamics could hold important implications for conditions of forest land and environmental benefits.

Projections suggest continued urban and other developed area expansion over the next 25 years, with the magnitude of increase differing by region (Alig *et al*. 2004). For nonfederal land in the contiguous 48 states, the U.S. developed area is projected to increase by 79 percent, raising the proportion of the total developed land base from 5.2 to 9.2 percent. Because much of the growth is expected in areas relatively stressed with respect to human-environment interactions, such as some coastal counties, implications for landscape and urban planning include potential impacts on sensitive watersheds, riparian areas, wildlife habitat, and water supplies. The projected developed and built-up area of about 175 million acres in 2025 represents an area equal to 38 percent of the current U.S. cropland base, or 23 percent of the current U.S. forest land base.

When examining land use dynamics, the many pathways by which land use can change warrant examining both net and gross area changes for major land uses. The total or gross area shifts involving U.S. forests are relatively large compared to net estimates. Gross area changes involving U.S. forests totaled about 50 million acres between 1982 and 1997, an order of magnitude greater than the net change of 4 million acres. Movement of land between forestry and agriculture in the last two decades resulted in net gains to forestry that have offset forest conversion to urban and developed uses in area terms. The conditions of forested acres entering and exiting the forest land base, however, can be quite different; entering acres may have young trees, such as for old-field natural succession cases, whereas exiting acres often contain large trees before conversion to developed uses. Concern about the attributes of exiting or entering forested acres was heightened in the 1990s when the rate of development increased, with about 1 million acres of forests converted to developed uses per year (USDA NRCS 2001).

The deforestation projections do not include remaining forest land that over time has added more people per square mile but not enough to be reclassified as nonforest land. Within current FIA definitions, the major effective use of forest land could conceivably shift to a nontimber use as housing density per acre increases, but the shift may not be enough to reclassify the land as nonforest. This point is also relevant later in this article in the discussion of forest parcelization. Empirical studies using FIA data are investigating thresholds at which the actual use effectively shifts (e.g., Kline *et al*. 2004b).

Implications for Forest Land Values

Implications of the projected increases in developed area for forestry extend to effects on forest land values. Land prices embody information on relative valuations by different sectors of the economy. For example, valuation of land currently in forest uses in some areas is strongly influenced by trends in developed areas (e.g., Wear and Newman 2004). Land values for developed uses typically exceed those for rural uses by a substantial amount (Alig and Plantinga 2004). Agricultural values are usually second to developed uses in potential value, and they are often influenced by development potential. With rural land uses subject to increasing conversion pressure, open space concerns have heightened. The earliest significant U.S. efforts to preserve open space involved preserving and restoring publicly owned forests and parks at national and State levels. These efforts were inspired by public concern for rapid loss of forests to agriculture and logging in the late 19th century and the desire to protect timber and water resources and lands of extraordinary beauty and uniqueness. Since then, public concern for land use change has evolved to recognize the contribution of open space to our day-to-day quality of life—its recreation, aesthetic, ecological, and resource protection benefits.

Forest land values can differ in a variety of geographic, biological, regulatory, economic, and social situations and are important in determining how much land is allocated to forest use. Given that complex of factors, forest use valuation is increasingly becoming more complicated, as is our economy, by overlays of land use zoning, environmental laws, forest practices regulation, site-specific environmental considerations, and recognition of forest resource values other than timber. For example, the State of Oregon is currently dealing with land value issues as part of its response to Ballot Measure 37. This ballot measure may have substantial impacts on the State's land use planning, which includes protecting forest and agricultural lands in certain zones. The measure was promoted as a land valuation supplement to earlier land use planning that focused on biophysical measures. Approved by Oregon voters on November 2, 2004, Measure 37 allows a landowner to apply for relief from land use rules created since the landowner's family acquired a property. If the landowner shows that the property value has been harmed, the government responsible for the rule must waive it or pay for the loss of value. Other States in the West are monitoring the Oregon case because the West has experienced larger than average population growth, and a recent FIA survey in western Washington estimated that conversion of forest land to developed uses had increased compared with the previous survey period.

The Oregon case illustrates that people differ in the values that they place on environmental, economic, and social aspects of forests. This affects the social valuation and is in contrast to the private cost of providing goods and services that others may value from private forest land. An example is that many forest lands and open spaces include social values—ecological, scenic, recreation, and resource protection values that are typically not reflected in market prices for land when some forest land is developed (Kline *et al*. 2004a). For open space policy, one needs to understand social values in the context of forest land market values and the economic rationale and impetus for public and private efforts to protect forest land as open space. Kline and Alig (1999) used FIA data to investigate the effectiveness of Oregon's land use law, and current research is examining whether forest land values can reveal what it may cost to pursue different sustainability options if land easements, purchases, or rentals are desired. The land values reveal what people are actually willing to pay for a bundle of rights necessary to gain access to land that can provide goods and services for a certain period. Changing perceptions about forest land mirror those in farmland preservation. National interest in preserving farmland arose in the 1970s from concerns about rapid loss of farmland to development and the supposed threat to food security and agricultural viability. These concerns led to the gradual and nearly nationwide implementation of local, State, and Federal farmland preservation programs (Kline *et al*. 2004a). More recently, recognition has grown for the environmental amenities and the social values of farmland and the role they play in motivating public support for preserving farmland. Incorporating land-based values into farmland protection policies and programs helps to ensure that the public is getting what it desires from preserved farmland. Similar efforts may now be needed for forest lands to ensure that public and private open space protection efforts are tailored to provide the social values desired from forest lands.

Land-base changes can affect many goods and services, including those for historically nontraditional forest-based goods and environmental services such as biodiversity, which is increasingly used as an ecosystem indicator. Human-environment impacts that affect biodiversity can vary across space and time, such as physical fragmentation of forest cover from land use changes, which can affect natural resources in a variety of ways. For example, development of rural land may cause fragmentation of wildlife habitat. A landscape that is optimal for a private owner can depart from a socially optimal landscape that reflects society's preferences for public goods associated with interior forest parcels. Future policy-related research can examine land use shifts for parcels to identify optimal ways for reducing forest fragmentation. Spatial configurations make this complex, however, in that benefits of converting (or retaining) a parcel will depend on the land uses of the neighboring parcels as well as on other parcels affected by the policy.

Future Directions

Forests are increasingly subjected to human-caused modifications and stresses. For the FIA program, one challenge is to increasingly link forest resource data to socioeconomic data, such as characteristics of forest land owners. This challenge reflects the large diversity of data needed to address policy questions (e.g., well-being of natural-resource-dependent communities) that arise given increased attention to sustainability and activities associated with the environment, economy, and societal institutions. Much discussion in forest policy circles today is about forest sustainability (Alig and Haynes 2001), which seems to be part of a larger societal concern about quality of life and the long-term capability of land to provide goods and services that we as a society demand. Issues for land use and land cover monitoring and assessment include consistent coverage across the entire land base. Analogous to the snapshot of land use information by USDA's National Resources Inventory, land cover modeling would benefit from periodic nationwide estimates of changes in forest cover, e.g., National Land Cover Data mapping project. Field-based observations are also needed to provide complementary data such as land ownership and site quality.

Monitoring changes in ownership of forests would also be useful because sales and acquisitions of forest lands reflect active market forces, globalization, and consolidation effects on the forest sector. The forest industry is increasingly viewing its forests as strategic financial assets (Wilent 2004). Fragmentation of private lands and expected resulting changes from conversion of forest to developed uses are being assessed in an ongoing "Forests on the Edge" national project (Stein 2004). Breaking up of ownerships into several smaller ownerships—parcelization—can also have profound impacts on the economics of farming or forestry, even when land is not physically altered in any major way.

Trends in population density warrant further study for different classes of rural and urban land (Alig 2000). The United States had about 80 people per square mile of land in 1999 (U.S. Department of Commerce, Census Bureau 2001). This population density compares to about 5 people per square mile in 1790 and a world average of more than 100 people per square mile in 1999 (United Nations 2002). More people on the landscape include those in rural areas with attractive recreational land and aesthetic amenities, often involving forests. People migration because of amenity attractions is related to concerns about changes in quality of life. Such demographic changes increase the size of the wildland-urban interface, exacerbating wildfire threats to structures and people.

Human demands for forests will escalate as populations grow and personal incomes increase, challenging land managers to provide for a diverse array of societal needs, including ecological (e.g., biodiversity), economic, and social needs. In addition to substantial demand for environmental services such as biodiversity, water quality improvement, and carbon sequestration, there is growing interest in spiritual values associated with forests and in forests' sustainable use and restoration after certain disturbances. Related research is needed to help dovetail design of incentives and assistance for private landowners to promote conservation objectives and other social values while meeting their personal objectives. NIPF owners will increasingly experience pressures to produce multiple goods and services from their forest lands, often in the face of mounting pressure from development. Insights might be gained by reviewing forest survey methods and analyses in other countries with large NIPF components, such as Finland. Spatial and temporal scales of inquiry are important, too, in that specific issues can emerge at particular scales. A growing population will affect choices in the United States, which has a rich legacy of forests managed by a variety of individuals, corporations, governments, and others for many goods and services (Beuter and Alig 2004).

Advances in land use analyses will likely rest in part on the continued improvement of spatial databases, including spatial socioeconomic data, and improvements in spatial econometric methods to support empirical data analyses. Tradeoffs must be considered when assessing the costs and benefits associated with providing more spatial detail, as well as tradeoffs and costs in the FIA transition from periodic to annual surveys. Related issues are privacy and disclosure considerations for private owners of forest lands in light of increasing availability of spatial data. Along with improved databases, monitoring of developed area trends, associated investment in infrastructure (e.g., transportation networks and nodes), and related socioeconomic factors will be important in facilitating updated projections of U.S. developed area. Monitoring such changes will be important, as will be defining key policy-relevant questions that can lead to effective land use and land cover monitoring and assessments and land management.

Given the expected growth in U.S. population and changes in economic activity, a key question is how society can make positive progress toward "sustainability" in the face of needing more developed land to serve more people in the future. Agreement among stakeholders of the forests when it comes to sustainable use is likely to be a contentious issue because of the inherent tensions and conflicts. Location-specific balancing of interests may be possible, but overall progress toward such goals may rest on a more integrated approach for describing the complex interplay between human activity and the environment. To help evaluate progress, we need a useful definition of sustainability along with measurable indicators that fundamentally reflect the long-term ecological, economic, and social well-being as they relate to alternative uses of land. Data collection by FIA units could play an important role, e.g., by monitoring impacts of global climate change on future forest conditions such as forest type and biodiversity changes.

A major complication in past FIA survey planning, RPA assessments, and global climate change assessments has been the lack of a unified view of future land conditions at a scale that serves all these assessment areas adequately. Attaining the ideal unification is a substantial undertaking, and this unification could be assisted up front by an assessment of common information needs. A modeling system that can project land base conditions for forest ecosystems could provide a thorough and unified description of anticipated change in the extent, structure, and condition of the Nation's forests at useful regional and subregional scales. At the same time, such a system could augment economic measures, which would be useful when investigating changes in land markets and analyzing trends in land values.

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