3.1 Land Use

Land ownership and the management objectives of the owners tend to determine how land is used; thus, U.S. lands are used for many different purposes. Nearly 28 percent of the nation (630 million acres) is owned and managed by the federal government. State and local governments manage another 198 million acres (GSA, 1999). The more than 828 million acres of federal, state, and local government lands in the nation are managed for various public purposes. In contrast, the approximately 1.419 billion acres of private and tribal land are more likely to be managed in the interests of their owners, with various land use constraints imposed by zoning and other regulations (GSA, 1999; USDA, NRCS, 1997; Alaska DNR, 2000).

Management objectives are constantly changing on private and public lands and can have both positive and negative effects on the natural environment and human health. Such effects include loss of native habitat to agricultural practices; loss of prime agricultural lands to urban/suburban development; changes in patterns of runoff as a result of impervious surfaces, stream flow, dams, or irrigation systems; habitat restoration based on land reclamation; and urban/suburban development on previously contaminated land.

There are differing estimates of the extent of various land uses. Those discussed in the context of the following questions are often due to different classifications, definitions, approaches to data collection, and the timing of data collection and analysis. Land cover and land use represent two different concepts and both are discussed in this section. Land cover is essentially what can be seen on the land—the vegetation or other physical characteristics—while land use describes how a piece of land is being used (or not) by humans. In some cases, land uses can be determined by cover types, which are visible (e.g., the presence of housing indicates residential land use). Often, however, more information is needed for those uses that are not visible (e.g., lands leased for mining, "reserved" forest land, shrublands with grazing rights). Techniques for assessing land cover and land use vary, with different data required to accurately assess extent and practices. Remotely sensed data are increasingly being used to track land cover. When combined with knowledge of local land use regulations or other information, such data can be useful for tracking land use.

Six questions are posed in this section to examine the extent of various ecological systems and land uses, including development, agriculture, and forest management. The questions considered are:

- What is the extent of developed lands?
- What is the extent of farmlands?
- What is the extent of grasslands and shrublands?
- What is the extent of forest lands?
- What human health effects are associated with land use?
- What ecological effects are associated with land use?

Tracking national patterns of land use and activities that affect the land can be challenging, primarily because land use is regulated by many levels of government and also because of the significant variations in land cover, geography, and land activities nationwide. Data produced by different agencies at different levels of government must be integrated and analyzed continually to gain a national perspective of patterns and trends.

The primary information sources for this section include the National Resources Inventory (NRI) of the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS); the report titled *The State of the Nation's Ecosystems*, which was developed by The H. John Heinz III Center for Science, Economics and the Environment (The Heinz Center, 2002); and data from the Forest Inventory and Analysis (FIA) Program.

This section presents various activities related to land use and land cover. Two examples of activities for which indicators have not been identified, but that can have significant effects in different ways on land are 1) the formal protection or reservation of land for habitat or natural resources and 2) mining and extraction activities. Some data are collected locally and for federal lands (e.g., National Park acreage) or tracked for economic indicators, but the national picture of the extent of land reservation and mining is not generally available. A snapshot of what is known is described in the two sidebars.

PROTECTED LANDS

Across the U.S., lands are protected against or for certain uses in a variety of ways by federal, state, and local land managers and by private landowners. Local zoning ordinances, state and federal land management regulations, and land classifications are used to protect lands for habitat and natural uses. Federal land management agencies protect land in several different use classifications that provide varying degrees of protection. More than 4 percent of the nation is managed as wilderness. Of the 106 million acres of land now designated as federal wilderness, more than half are in Alaska (Wilderness Information Network, 2002). Millions of acres of lands are also protected in the National Park Service System, within the U.S. Fish and Wildlife Service refuge system, as USDA and Bureau of Land Management Wilderness Study Areas, in National Forest Roadless Areas, in the National Trails System, as National Wild and Scenic Rivers, in National Recreation Areas, in Research Natural Areas, and other areas. States also have established park systems, fish and wildlife areas, wilderness systems, and other areas of protected lands. Local government agencies also often manage parks. Conservation easements protect private lands by providing restrictions from development in perpetuity.

MINING AND EXTRACTION ACTIVITIES

The U.S. is the world's largest producer and consumer of energy, and yet there is no inventory of lands used for energy production. There are known to be 1,879 coal mines and associated facilities in the U.S (USGS, 2000a). The West, led by Wyoming, produces about half of the U.S. coal, primarily from surface mines. The Appalachia area, led by West Virginia and Kentucky, accounts for 37 percent of U.S. coal production, mainly from underground mines(DOE, November 2002). Other energy activities include 534,000 producing oil wells (ranging from one to millions of barrels of production per year). Top producing areas of oil and natural gas include the Gulf of Mexico, Texas, Alaska, California, Louisiana, Oklahoma, and Wyoming (DOE, November 2002). Eight uranium mines and 1,965 other mines and processing facilities produce most of the minerals and metals in the U.S (USGS, 2000b). About 5.4 billion metric tons of non-fuel mineral materials were removed in 2000. Overall, 97 percent was mined and quarried at the surface level, and 3 percent was mined underground. The major states in which mining for non-fuel minerals occurs are Nevada, Arizona, New Mexico, Minnesota, California, Florida, Texas, Michigan, Ohio, and Pennsylvania (USGS, 2000b). In addition to active mines, the U.S. Bureau of Land Management estimates approximately 10,200 abandoned hardrock mines are located within the roughly 264 million acres under its jurisdiction. Estimates of abandoned mines on public and private lands range from 80,000 to hundreds of thousands of small to medium-sized sites (DOI, Bureau of Land Management, 2002).

3.1.1 What is the extent of developed lands?

Indicators

Extent of developed lands
Extent of urban and suburban lands

Land development is a process of land conversion that changes lands from natural or agricultural uses to residential, industrial, transportation, or commercial uses to meet human needs. Land development has created urban and suburban ecological systems, which are areas where the majority of the land is devoted to or dominated by buildings, houses, roads, lawns, or other elements of human use and construction (The Heinz Center, 2002). Urban and suburban ecological systems are highly built up and paved, resulting in effects such as more rapid changes in temperature, increased runoff, and increased chemical contaminants than in more natural ecosystems. Plant and animal life is more heavily influenced by species introduced in horticulture and as pets, and native species may be more or less completely removed from large areas and replaced by lawns, gardens, and ornamentals (World Resources Institute, 2000).

The majority of Americans live in areas that are considered "developed land." Between 1950 and 2000, the number of Americans living in U.S. Census Bureau-defined urban areas increased from 64 percent to 79 percent of the total population (U.S. Census Bureau, 2001). Estimates vary widely on the amount of land considered developed in the U.S., depending on definitions of "developed" and different assessment techniques. For example, the Census Bureau definition is a measure of population density; not specifically a measure of actual land use or conversion of land. Census urban areas do not take into account low-density suburbs and other developed lands such as commercial or transportation infrastructure areas that do not include people. The Census definitions may underestimate lands that would be categorized as low-level residential or lands having dispersed development. (See the following sidebar for definitions used in this discussion.)

The two indicators presented in this section provide an estimate of the extent of developed land, with an estimate of urban and suburban lands as a subset of developed lands. These estimates were developed using different definitions and methodologies. The extent of "developed land" indicator uses a national statistical sample that takes into account various development types. The "extent of urban and suburban lands" indicator identifies densely developed areas classified using remotely sensed satellite data.

DEFINITIONS OF DEVELOPED AND URBAN/SUBURBAN LANDS

U.S. Census Bureau Definitions

Urbanized Areas and Urban Clusters. The Census Bureau describes urban areas as Urbanized Areas (UAs) and Urban Clusters (UCs). These are designations for densely settled areas, which consist of core census block groups that have a population density of at least 1,000 people per square mile and other surrounding census blocks that have an overall density of at least 500 people per square mile. UAs contain 50,000 or more people. UCs contain at least 2,500 people, but less than 50,000. Based on 2000 Census data, there are 466 UAs and 3,172 UCs comprising nearly 60 million acres (or 2.6 percent of the U.S. land area). These definitions and delineations of urban areas are used by the Office of Management and Budget to delineate the Census Metropolitan Areas, including Metropolitan Statistical Areas, which are used for various federal and state budget allocation purposes (U.S. Census Bureau, 2001).

USDA, NRCS, National Resources Inventory (NRI) Definitions

Developed land. A combination of land cover/use categories: Large urban and built-up areas, small built-up areas, and rural transportation land (USDA, NRCS, 2000a).

> ***Urban and built-up areas.*** A land cover/use category consisting of residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; other land used for such purposes; small parks (less than 10 acres) within urban and built-up areas; and highways, railroads, and other transportation facilities if they are surrounded by urban areas. Also included are tracts of less than 10 acres that do not meet the above definition but are completely surrounded by urban and built-up land. Two size categories are recognized in the NRI: areas of 0.25 acre to 10 acres and areas of at least 10 acres.
>
> > ***Large urban and built-up areas***. A land cover/use category composed of developed tracts of at least 10 acres—meeting the definition of urban and built-up areas.
> >
> > ***Small built-up areas.*** A land cover/use category consisting of developed land units of 0.25 to 10 acres that meet the definition of urban and built-up areas.
> >
> > ***Rural transportation land.*** A land cover/use category that consists of all highways, roads, railroads, and associated rights-of-way outside of urban and built-up areas, including private roads to farmsteads or ranch headquarters, logging roads, and other private roads, except field lanes.

The Heinz Report Definitions

Urban and suburban lands. An area is considered to be urban/suburban if a majority of the lands within a 1,000 foot by 1,000 foot area (pixel) fall into one of the four "developed" land cover types classified in the NLCD (low-density residential, high-density residential, commercial-industrial-transportation, or urban and recreational grasses). In outlying areas, clusters of pixels had to total at least 270 acres to be considered urban/suburban.

Indicator: Extent of developed lands - Category 1

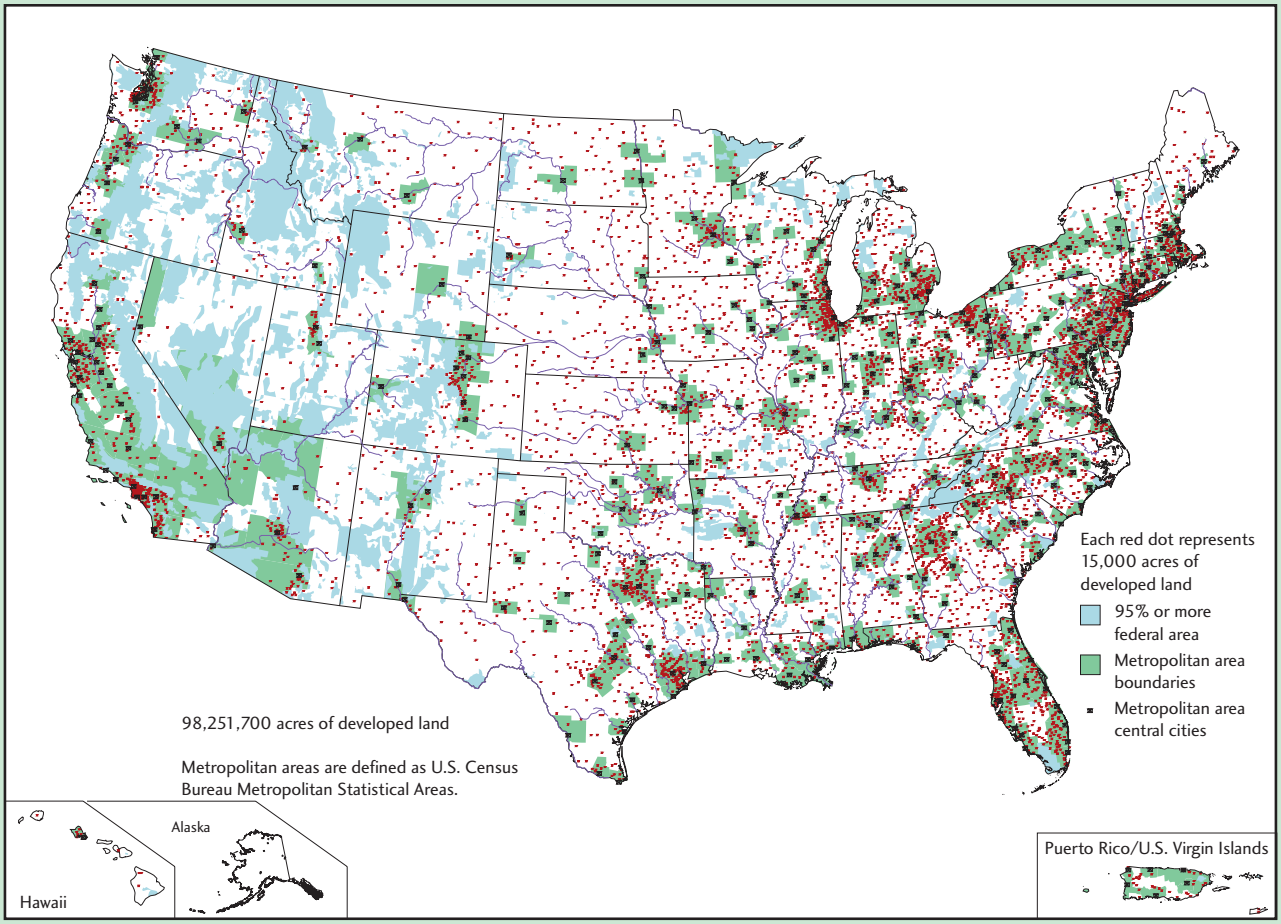
Land development generally results in significant changes in other land uses or cover types. This indicator provides a measure of how much developed land exists, where it is, and how it has changed. The indicator relies on national statistical data samples conducted every five years by the USDA NRCS.

What the Data Show

The NRI reports approximately 98 million acres of developed land in the U.S., not including Alaska (USDA, NRCS, 2001). This figure represents about 4.3 percent of the total land area. Exhibit 3-4 shows the distribution of non-federal developed lands nationwide. Each dot on the map represents 15,000 acres. The map displays the Census Metropolitan Area boundaries, which are larger in western states due to the large size of many counties. States along the Northeast corridor have the highest percentages of developed land, exceeding more than one-third of a state's area in some cases.

Between 1982 and 1997, developed lands increased by 25 million acres, primarily through conversion of croplands and forest lands (USDA, NRCS, 2000a). This represents a 34.1 percent increase. Developed lands as a percentage of the nation rose from 3.2 percent in 1982 to 4.3 percent in 1997 (USDA, NRCS, 2000a). The pace of land development between 1992 and 1997 was more than 1.5 times the rate of the previous 10 years. The distribution of changes in developed land varies nationwide, with extensive changes in the eastern part of the country from south to north.

Exhibit 3-4: Extent of non-federal developed land, 1997



Source: USDA, Natural Resources Conservation Service. National Resources Inventory, 1997, revised December 2000: Acres of Developed Land, 1997. 2000. (January 2003; *http://www.nrcs.usda.gov/technical/land/meta/m4974.html*).

Indicator: Extent of developed lands - Category 1 (continued)

Exhibit 3-5 depicts the change in developed land (urban and suburban areas and rural transportation land) by watershed in the 1982 to 1997 time frame.

Indicator Gaps and Limitations

The NRI data are limited in not providing data on Alaska and not assessing development on federal lands, including recreational development and transportation infrastructure.

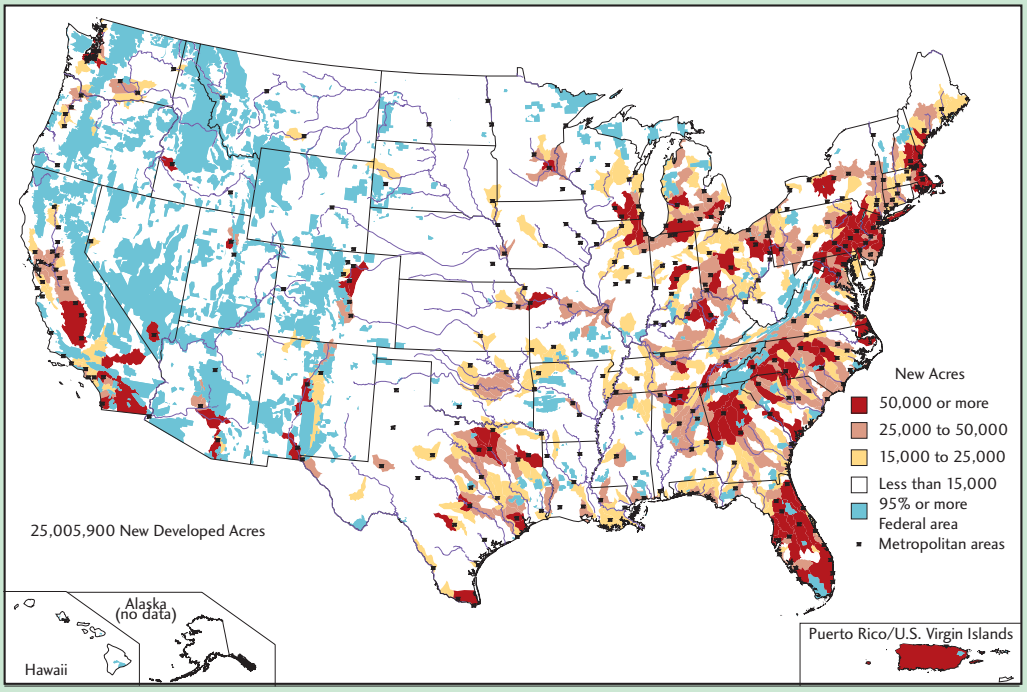
Data Source

Acreage estimates and map data presented for this indicator are from the National Resources Inventory, U.S. Department of Agriculture, Natural Resources Conservation Service, 1997 (Revised December 2000). (See Appendix B, page B-18, for more information.)

National Resources Inventory

The NRI is a longitudinal survey designed to assess conditions and trends of soil, water, and related resources on non-federal lands in the U.S. The NRI statistical sample involves approximately 300,000 sample units and 800,000 sample points on non-federal lands. The sample is a stratified two-stage unequal probability design that can be modified to address specific national survey goals or special studies. Stratification was developed county by county, based on the Public Land Survey System (PLSS) where possible, and on latitude/longitude, Universal Transverse Mercator Grid, or artificial superimposed lines when necessary. The national sampling varies across strata and ranges from 2 to 6 percent. The NRI measures numerous variables, which are then extrapolated as national totals. Variables include the following: soil characteristics, earth cover, land cover and use, erosion, land treatment, vegetative conditions, conservation treatment needs, potential for cropland conversion, extent of urban land, habitat diversity, and Conservation Reserve Program cover. NRI sample data are generally reliable at the 95 percent confidence interval for state and certain broad sub-state area analyses (Goebel, 1998).

Exhibit 3-5: Land development patterns, 1982-1997



Source: USDA, Natural Resources Conservation Service. National Resources Inventory, 1997, revised December 2000: Land Development, 1982-1997. 2000. (January 2003; *http://www.nrcs.usda.gov/technical/land/meta/m5009.html*).

Indicator | Extent of urban and suburban lands - Category 2

Urban and suburban lands are considered a subset of developed lands and one of the ecological systems described in Chapter 5, Ecological Condition. These are highly developed areas and surrounding suburbs, including developed outlying areas above a minimum size. Acreage estimates are based on an analysis of the remotely sensed NLCD data conducted by the U.S. Geological Survey (USGS), Areas of at least 270 acres that are substantially covered with roads, buildings, concrete, and other hard surfaces must be identified to be classified and counted as urban/suburban (The Heinz Center, 2002). This definition excludes smaller built-up areas.

What the Data Show

Urban and suburban ecological systems occupied 32 million acres in the conterminous U.S. in 1992, or about 1.7 percent of that land area (The Heinz Center, 2002). This estimate was derived from a re-analysis of the 1992 NLCD. The analysis includes information on the amount and character of undeveloped land within urban/suburban areas. Most of the lands designated urban and suburban are in the South and Midwest, but they account for less than 2 percent of the land in those regions. In the Northeast, urban and suburban lands account for more than 5 percent of the landscape.

Indicator Gaps and Limitations

The NLCD database is derived from a one-time interpretation of satellite imagery of the nation from the early 1990s. Although limited by the ability to detect land use remotely based on spectral characteristics, NLCD data are available for all of the conterminous U.S. Original estimates of the NLCD indicated a total of 36.7 million acres of land in three different "developed" land cover classifications (low density residential, high density residential, and commercial/industrial/transportation) (The Heinz Center, 2002).

Data Source

Acreages presented for this indicator are derived from a re-analysis of the National Land Cover Data, a product of the Multi-Resolution Land Characteristics Consortium, which is a partnership between the U.S. Geological Survey; the U.S. Department of Agriculture, Forest Service; the National Oceanographic and Atmospheric Administration; and the EPA. (See Appendix B, page B-18 for more information).

3.1.2 What is the extent of farmlands?

Indicators
Extent of agricultural land uses
The farmland landscape

Farmlands represent one of the nation's major ecological systems and are discussed in Chapter 5, Ecological Conditions.(The Heinz Center, 2002). As noted in the sidebar, on the following page, croplands, which can include pasturelands and haylands, are at the heart of the farmland ecosystem. The broader "farmland landscape" also includes other lands that are not actively used for crop, pasture, or hay production. The composition of lands that surround croplands, such as forests, wetlands, or built-up areas, are discussed further in the "farmland landscape" indicator.

The U.S. produces a wide range of food crops, grains, and other agricultural products over vast areas of the country that are part of the farmland landscape (see adjacent sidebar). Agricultural lands can be thought of as all those lands that contribute to this production. Other words such as farmland, cropland, pastureland, rangeland, grazing land, or grassland are also used to describe aspects of agricultural lands. Some of these words define cover types, while others define land use. The areas overlap but do not necessarily coincide with each other. This situation creates challenges in establishing accurate estimates of extent. Under the discussion of the agricultural land use indicator, an effort is made to distinguish the various definitions and provide a measure of acreages. (Current definitions as used by the USDA NRCS NRI are shown in the sidebar that follows.)

Aside from the challenges of defining types of agricultural land, assessing the amount of land used for crops is an imperfect science, given the seasonality of agricultural practices and changes in economics and technology. As with developed land, estimates vary depending on the classification criteria and mapping or sampling methodologies. Until the 1950s, the amount of agricultural land needed to meet demands for food continued to grow, reaching a peak of more than a billion acres of cropland and rangeland in the mid 1960s. Since then, crop and farmland acreages have decreased and increased in cycles, as both economics and technology have changed demands and as production capabilities have increased.

Two indicators are considered on the following pages. The first assesses the extent of land used to grow food crops and forage. The second considers the farmland landscape, which includes not only land used for agricultural production but also adjacent areas.

NRI Land Cover Definitions for Agricultural Land

Cropland. A land cover/use category that includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and noncultivated. Cultivated cropland comprises land in row crops or close-grown crops and also other cultivated cropland, such as hayland or pastureland in a rotation with row or close-grown crops. Non-cultivated cropland includes permanent hayland and horticultural cropland.

Conservation Reserve Program (CRP). A federal program established under the Food Security Act of 1985 to help private landowners convert highly erodible cropland to vegetative cover for 10 years.

Pastureland. A land cover/use category of areas managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding or renovation, and control of grazing. For the NRI, it includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether it is being grazed by livestock.

Rangeland. A land cover/use category on which the climax or potential plant cover is composed principally of native grasses, grasslike plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.
(USDA, NRCS, 2000a)

Indicator

Extent of agricultural land uses - Category 1

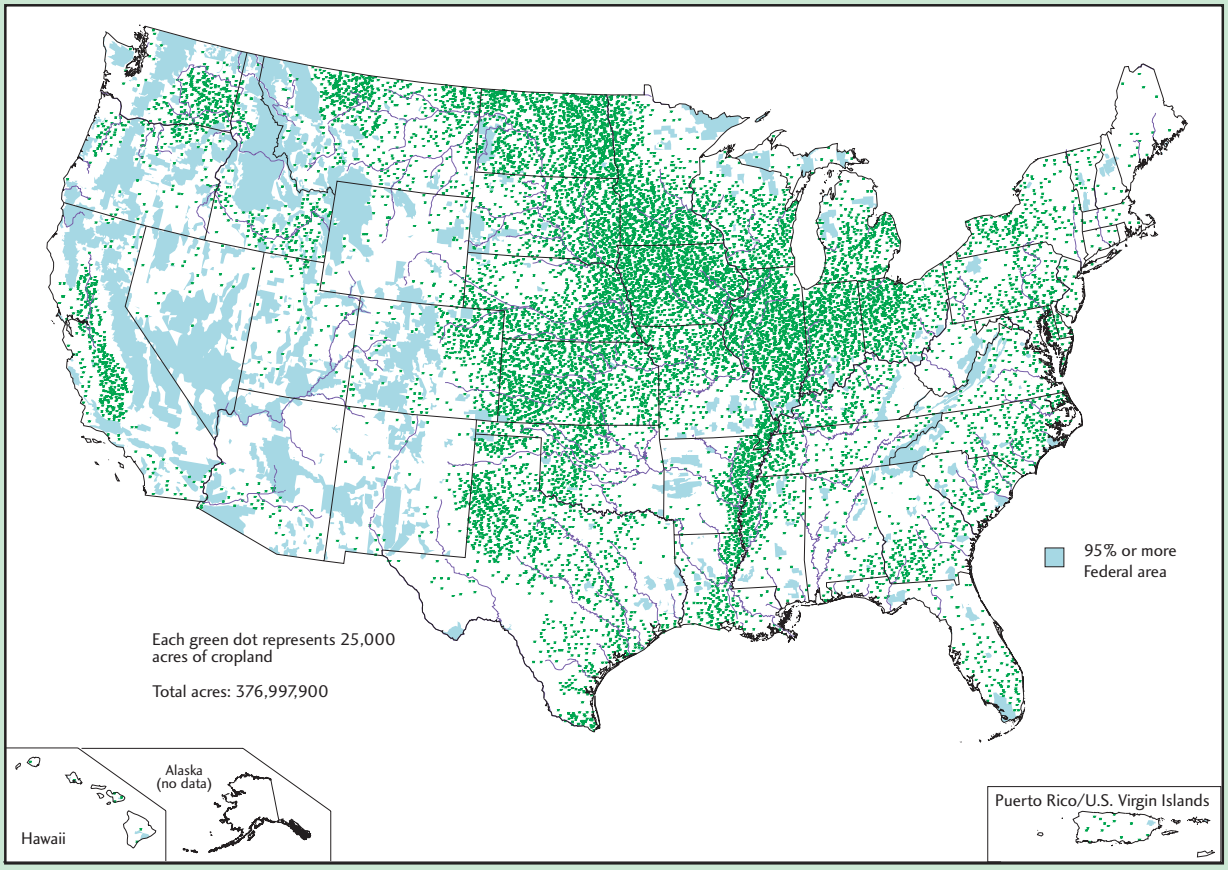
Land can be used for a variety of agricultural purposes. Two general categories are differentiated in this discussion. The first includes lands that are actively managed to cultivate food crops or forage. This category comprises croplands, or lands that grow perennial and annual crops such as fruits, nuts, grains, and vegetables; and pasturelands, or lands that are actively cultivated to produce forage for livestock. The second category includes lands that may be used to produce livestock as an agricultural commodity, but are not planted, fertilized, or otherwise intensively managed. These livestock production lands may be called grazing lands or rangelands and can include forest land, shrubland, and grassland, which are described in the following sections. Livestock production may also include concentrated animal feedlot operations, acreages of which are not included in this discussion.

What the Data Show

In 1997, the NRI identified nearly 377 million acres of cropland and more than 32 million acres of Conservation Reserve Program (CRP) land. CRP lands, as noted in the sidebar, are croplands that are set aside (farmers are provided incentives) for up to 10 years for conservation purposes, but that could be returned to crop production if the program ceased. This total equals nearly 410 million acres of land currently growing or specifically identified with the potential to grow crops in the U.S. (USDA, NRCS, 2000a) (Exhibit 3-6).

The NRI reports about 120 million acres of pastureland. As defined in the sidebar, pastureland includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of

Exhibit 3-6: Extent of croplands, 1997



Source: USDA, National Resources Conservation Service. National Resources Inventory, 1997, revised December 2000: Acres of Cropland. 2000. (January 2003; www.nrcs.usda.gov/technical/land/meta/m4964.html).

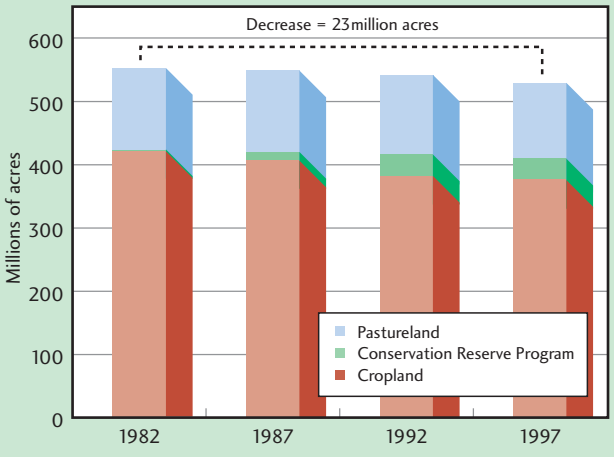
Indicator: Extent of agricultural land uses - Category I (continued)

whether it is being grazed by livestock. It is usually managed to produce feed for livestock grazing, using fertilization, weed control, and reseeding. Thus the total estimate from the NRI for cropland, CRP land, and pastureland is 530 million acres.

The Heinz Center (2002), using four different sources of data, estimated that cropland, including pasture and haylands, covered between 430 and 500 million acres in 1997. For the most part, the report did not include CRP lands in its estimates. According to the 1992 NLCD, the U.S. had 510 million acres of agricultural land in the 1990s (EPA, ORD, 1992).

Grazing to support livestock production can potentially occur on pastureland, rangeland, and, in some cases, forest land. These lands can also be defined based on their cover type (e.g., grasslands, shrublands, or forested range). Not counting pasture-land, the NRI identified nearly 406 million acres of non-federal rangelands and another 62 million acres of non-federal forest land that can be used for grazing livestock (USDA, NRCS, 2000a). In addition, according to estimates generated by the Bureau of Land Management, more than half of the federal land in the lower 48 states, or 244 million acres, is available for livestock grazing (DOI, 1994). The total of these estimates is 712 million acres of lands that may be used for grazing, but are not cultivated. Adding in the pastureland acreage results in 832 million acres of land that may be used for grazing livestock nationwide (excluding Alaska).

Exhibit 3-7: Change in cropland, Conservation Reserve Program (CRP) land and pastureland, 1982–1997



Source: USDA, Natural Resources Conservation Service.
Summary Report 1997 National Resources Inventory (revised December 2000). 2000.

Agricultural lands constantly shift among crop, pasture, range, and forest land to meet production needs, implement rotations of land in and out of cultivation, and maintain and sustain soil resources. Within these shifts, however, trends indicate a gradual decrease in cropland acreage. Between 1982 and 1997, cropland decreased 10.4 percent, from about 421 million acres to nearly 377 million acres (Exhibit 3-7). Of this 44 million acre decrease, however, 30.4 million acres are now enrolled in the CRP, resulting an 13.6 million fewer acres of cropland as a result of conversion to other land uses (USDA, NRCS, 2000a). During this same time frame, pastureland area decreased 9.1 percent, or about 12 million acres (USDA, NRCS, 2000a). The total change in acreage, considering lands in the CRP was 23 million fewer agricultural land acres in 1997 than in 1982.

Decreases in cropland have occurred particularly in the southern and southeastern part of the U.S. The distribution of change in cropland acreage is displayed in Exhibit 3-8. There are no comprehensive estimates of changes in acreages of grazing lands.

Indicator Gaps and Limitations

A specific objective of the NRI is to assess changes in cropland. Again, however, the ability to couple it with current remote sensing imagery would likely contribute to improved resolution and national mapping of cropland types (See the discussion about NRI data in the "Extent of Developed Land" indicator box).

There is no single, definitive, accurate estimate of the extent of cropland. Estimates of the amount of land devoted to farming differ because different programs use different methods to acquire, define, and analyze their data. Cropland is also a flexible resource that is constantly being taken in and out of production. The Heinz report used four different data sources to describe the range of estimates. The four data sets are not fully consistent, and comparisons are difficult to make. For example, the USDA Economic Research Service (ERS) and Census of Agriculture data include croplands in Alaska and Hawaii, while NRI does not. The ERS data used in the Heinz report estimate included CRP lands, while the Census of Agriculture and NRI estimates used by the Heinz report did not (The Heinz Center, 2002).

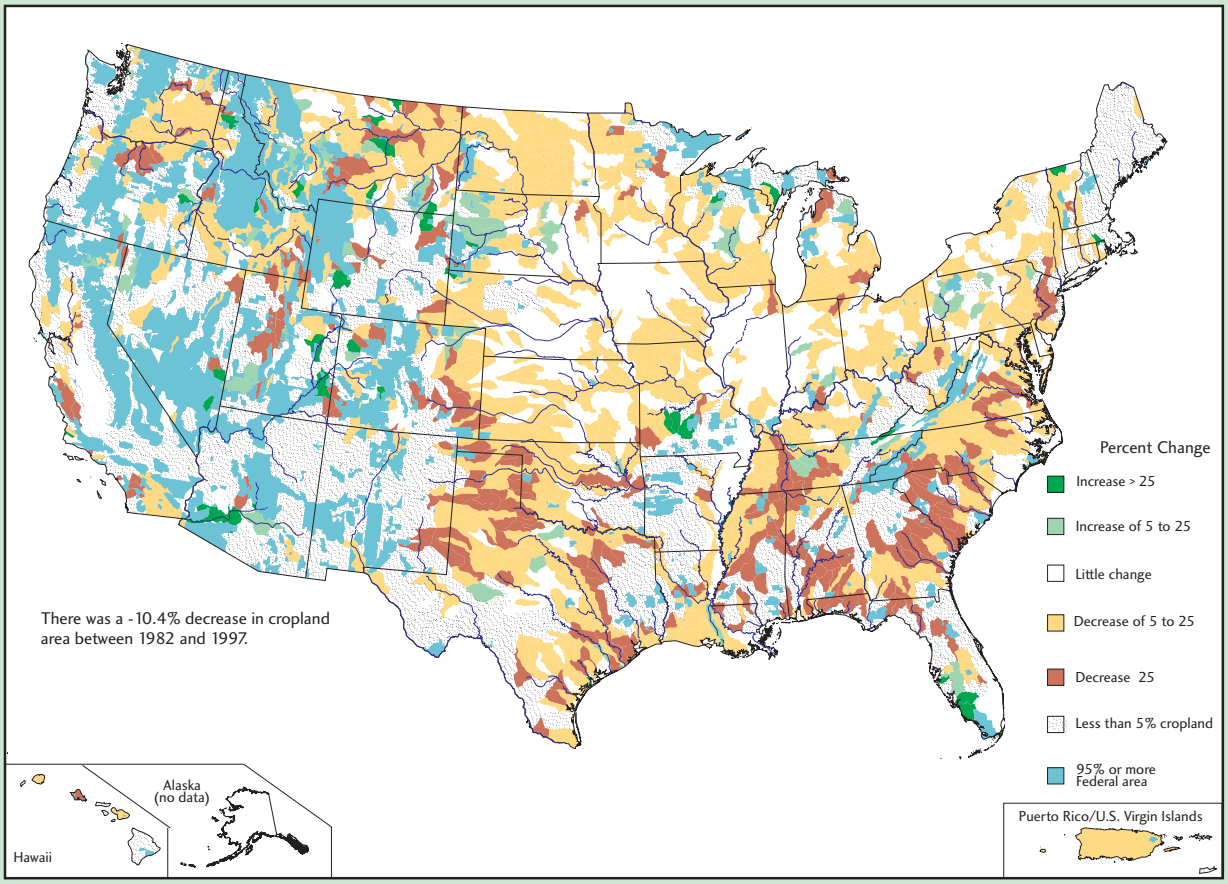
Data Sources

The data sources for this indicator are the National Resources Inventory, U.S. Department of Agriculture, Natural Resources Conservation Service, 1997 (Revised in December 2000); Summary Report: 1997 National Resources Inventory (Revised December 2000), U.S. Department of Agriculture, NRCS; and

Indicator: Extent of agricultural land uses - Category I (continued)

Draft Environmental Impact Statement, U.S. Department of the Interior, Bureau of Land Management, 1994. The Heinz Center estimates of cropland acreages are derived from the National Land Cover Data, a product of the Multi-Resolution Land Characteristics Consortium, which is a partnership between the U.S. Geological Survey; the U.S. Department of Agriculture, Forest Service; the National Oceanographic and Atmospheric Administration; and the EPA. (See Appendix B, page B-19, for more information.)

Exhibit 3-8: Percent change in cropland area, 1982-1997



Source: USDA, Natural Resources Conservation Service. National Resources Inventory, 1997, revised December 2000: Percent Change in Cropland Area, 1982-1997. 2000. (January 2003; www.nrcs.usda.gov/technical/land/meta/m5874.html).

Indicator The farmland landscape - Category 2

Examining the broader context of agricultural lands can provide a better understanding of agricultural ecosystems. As previously noted, the Heinz report defined this term as not only the lands used to grow crops, but also the field borders, windbreaks, small woodlots, grassland and shrubland areas, wetlands, farmsteads, and small villages and other built-up areas within or adjacent to croplands. These covers/uses support not only agricultural production, but provide habitat for a variety of wildlife species as well.

What the Data Show

The farmland landscape indicator describes the degree to which croplands dominate the landscape and the extent to which other lands are intermingled (The Heinz Center, 2002).

Croplands comprise about half of the farmlands in the East and Southeast, while in the Midwest, almost three-quarters of the farmland ecosystem is cropland (The Heinz Center, 2002). Forests make up the remainder of the farmland ecosystem in the East, wetlands the remainder in the Southeast, and both forests and wetlands in the Midwest. In the West, about 60 percent of farmland ecosystem is cropland, with grasslands and shrublands dominating the remainder in the western and northern Plains areas. Forests and grasslands/shrublands are about equal in the farmland landscape for the non-cropland area of the South Central region. In many U.S. areas, other land cover types are almost as prevalent as croplands and can provide habitat for non-agronomic species.

Indicator Gaps and Limitations

This indicator uses satellite data from the early 1990s to describe the farmland landscape. Remote sensing technology can underestimate dispersed land development that is denser than scattered rural settlements, but not as dense as traditional "suburbs."

Data Source

The National Land Cover Database, with 21 land cover classes, was used to estimate the area coverage for the U.S. The NLCD is based on remotely sensed imagery from the Landsat 5 Thematic Mapper. Data are available from <www.usgs.gov/mrlcreg.html>. (See Appendix B, page B-19, for more information.)

3.1.3. What is the extent of grasslands and shrublands?

Indicator

Extent of grasslands and shrublands

Grasslands and shrublands can be viewed as one of the major ecological systems of the U.S. and are discussed in Chapter 5, Ecological Condition, (The Heinz Center, 2002). Grasslands and shrublands can be used for grazing and, in that sense, overlap in extent with agricultural land. As previously defined, pastureland and rangeland are covered by grass and shrub species. This ecosystem is one of the largest types in the U.S. and includes not only the grasslands and shrublands of the American West, but also coastal meadows, grasslands and shrubs in Florida, mountain meadows, hot and cold deserts, tundra, and similar areas in all states.

Indicator: Extent of grasslands and shrublands - Category 2

There was an estimated 900 million to 1 billion acres of grasslands and shrublands in the lower 48 states before European settlement (Klopatek, et al., 1979). By 1992, between 40 million and 140 million acres had been converted to other uses. Many pastures are managed in such a way that little of their original grassland character remains, however. Thus, the area of relatively unmanaged grasslands and shrublands has probably declined more than the overall figures would indicate (The Heinz Center, 2002). One factor in the decline of grassland pasture and range acreages since the 1960s is that forage productivity has increased and the number of domestic animals has declined (Vesterby, 2003).

What the Data Show

Based on remote sensing satellite data, it is estimated that grasslands and shrublands (including pasturelands and haylands) occupy about 861 million acres in the lower 48 states and 205 million acres in Alaska, for a total of 1.066 billion acres or about 47 percent of the U.S. (not including Hawaii) (The Heinz Center, 2002) (Exhibit 3-9). This estimate distinguishes 178 million acres of pasturelands and haylands, which are also considered to be part of the farmland landscape, leaving 683 million acres of grasslands and shrublands in the lower 48 states (The Heinz Center, 2002).

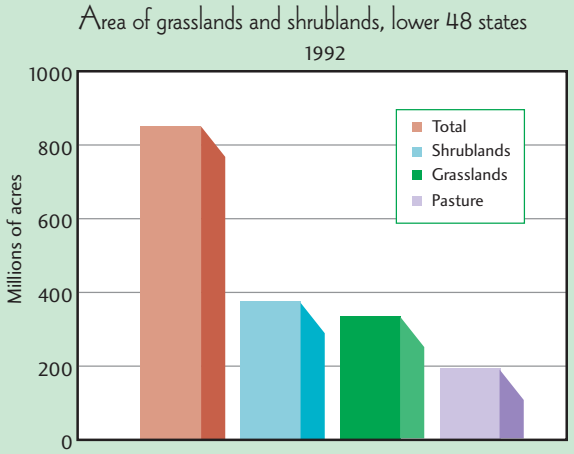
Indicator Gaps and Limitations

NLCD was used to estimate extent of grasslands and shrublands in the lower 48 states. Other data were estimated for Alaska. This is a complicated and changing ecosystem that is subject to conversion to other uses. It would be useful to have better means to characterize and track extent.

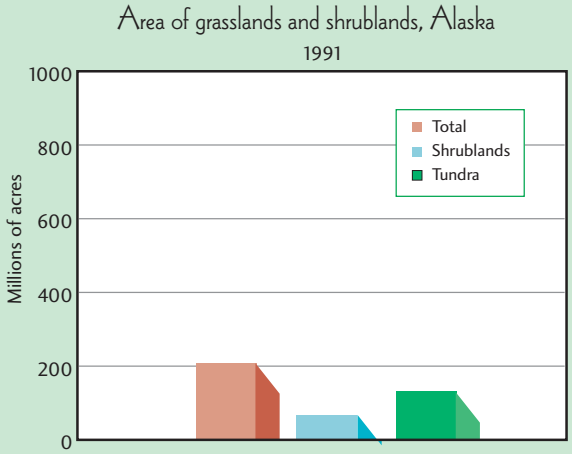
Data Sources

The National Land Cover Database with 21 land cover classes, was used to estimate the area coverage for the U.S. The NLCD is based on remotely sensed imagery from the Landsat 5 Thematic Mapper. Data are available from <www.usgs.gov/mrlcreg.html>. Data for Alaska were estimated from a vegetation map of Alaska by Flemming (1996), based on Advanced Very High Resolution Radiometer remote sensing images with an approximate resolution of 1 kilometer on a side (The Heinz Center, 2002). (See Appendix B, page B-19, for more information.)

Exhibit 3-9: Extent of grasslands and shrublands, 1991 and 1992



Source: EPA, Office of Research and Development. Multi-Resolution Land Characteristics Consortium, National Land Cover Data. 1992. (February 19, 2003; *http://www.epa.gov/mrlc/nlcd.html*).



Source: Flemming, M.D. *A Statewide Vegetation Map of Alaska Using a Phenological Classification of AVHRR Data.* February 1996.

3.1.4 What is the extent of forest lands?

Indicator

Extent of forest area, ownership, and management

Forests provide a range of important benefits to society. In addition to providing wood products, such as paper and lumber, forest lands help to purify air and water, mitigate floods and droughts, regulate climate through storage of carbon dioxide, regenerate soils, provide habitat for fish and wildlife, and support recreational opportunities. Trends in the extent of forests are an important indicator of human management of the landscape, since forest lands cover about one-third of the total U.S. land area. This section provides information on the status and trends relating to the amount and management of forest land. Additional information on the condition of forest land is found in Chapter 5, Ecological Condition.

Indicator: Extent of forest area, ownership, and management - Category I

It is estimated that in 1630, 1.045 billion acres of forest land existed in what would become the U.S. land area. (USDA, FS, 2001). Nearly 25 percent of these lands were cleared by the early 1900s, leaving 759 million acres in 1907. Since that time the total amount of forest land nationwide, while changing regionally has remained relatively stable, with an increase of 2 million acres between 1997 and 2001.

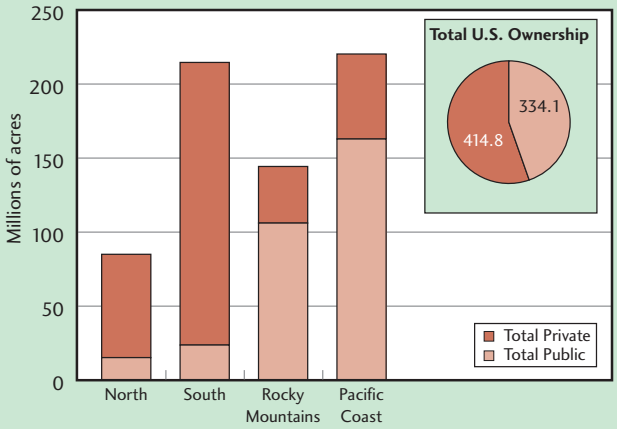
What the Data Show

There were an estimated 749 million acres of forest land in the U.S. in 2001 (USDA, FS, 2002). In the period between 1987 and 2001, forest land acreage increased by about 11 million acres (USDA, FS, 2002).

There have been regional changes in the amount of forest land due to changing patterns of agriculture, development, and reversion to forests. Since the 1950s, forest lands in the northeast and northcentral states have increased by almost 10 million acres, while the South has lost about 11 million acres (USDA, FS, 2001). Private forest lands are being converted to developed land uses faster than any other land type (USDA, NRCS, 2001).

Forest land management varies greatly depending on differences in ownership, management intent, and desired outcomes, ranging from lands managed intact to protect water supplies, to harvesting for timber production. About 55 percent of the nation's forest lands are in private ownership (USDA, FS, 2002). Most forest lands are managed for a mix of uses, such as recreation, timber harvest, grazing, and mining. In the southern and eastern U.S., most forest land is privately held in relatively small holdings, while in the Rocky Mountains and western U.S., most forest lan d is in large blocks of public ownership in national forests (Exhibit 3-10). As previously noted, ownership affects how lands are managed and used.

Exhibit 3-10: Forest land ownership by region, 2001



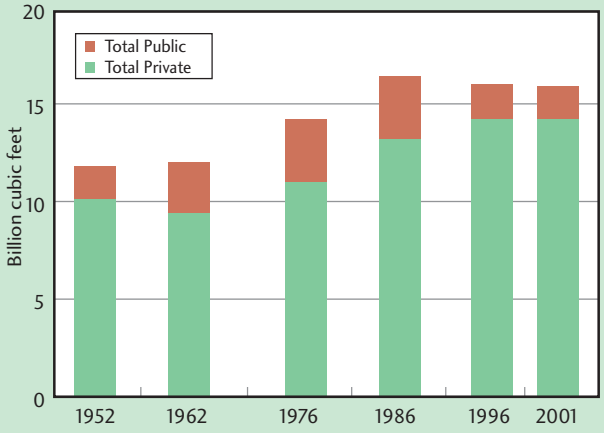
Source: USDA, U. S. Forest Service. Draft Resource Planning Act Assessment Tables. May 3, 2002 (updated August 12, 2002). (September 2003; *http://www.ncrs.fs.fed.us/4801/FIADB/rpa_tabler/Draft_RPA_2002_Forest_Resource_Tables.pdf*).

About 76 million acres, or 10 percent of the nation's forests are "reserved" and managed as national parks or wilderness areas (USDA, FS, 2002). These estimates of reserves include state and federal parks and wilderness areas, but do not include conservation easements, areas protected by non-governmental organizations, or most urban and community parks and reserves. There are significant regional differences in the amount of forest reserves. In the West, reserves are common, comprising nearly 18 percent of the total forest area. Much of the protected forest in the West is in stands over 100 years old. Only 3 percent of eastern forests are in reserves such as parks and wilderness (USDA, FS, 2001).

Indicator: Extent of forest area, ownership, and management - Category 1 (continued)

About 66 million acres, or 9 percent of forest lands, are managed by private forest industries to produce timber (USDA, FS, 2002). Much of the remaining forest land receives less intensive management activity, such as periodic harvest of mature timber. Approximately 503 million acres of public and private forest land are currently classified as timberlands by the USDA Forest Service, an increase of 17 million acres since 1987 (USDA, FS, 2002). Approximately 63 percent of all U.S. timber harvesting is conducted in the South, predominately from private lands. Total timber harvest increased substantially between 1976 and 2001 in the East. In the West, after increasing steadily from 1952 to 1986, timber harvesting on public lands has declined sharply. Public lands harvested nationwide dropped nearly 47 percent from 1976 to 2001, to less than 2 billion cubic feet per year. In the same time frame, private lands harvested increased by about 29 percent, from 11 to 14 billion cubic feet annually. (USDA, FS, 2002) (Exhibit 3-11).

Exhibit 3-11: Timber removals in the United States by owner group, 1952-2001



Source: USDA, U. S. Forest Service. Draft Resource Planning Act Assessment Tables. May 3, 2002 (updated August 12, 2002). (September 2003; *http://www.ncrs.fs.fed.us/4801/FIADB/rpa_tabler/Draft_RPA_2002_Forest_Resource_Tables.pdf*).

Between 1980 and 1990, approximately 10 million acres were harvested annually. Of the public and private forest lands harvested for timber approximately 62 percent are selectively cut, while 38 percent are clearcut. Most of the clearcutting occurs in the South (USDA, FS, 2001).

Indicator Gaps and Limitations

Limitations for this indicator include the following:

- The data for this indicator were collected by the USFS FIA program. Forest Industry and Analysis (FIA) currently provides updates of assessment data every five years. Field data are collected on a probability sample of 125,000 forested sites and extended to a remote sensing database on 450,000 sites by the FIA program (Smith, et al., 2001). The resulting data on extent have an uncertainty of 3 to 10 percent per million acres for data reported since 1953. Regional estimates have errors of less than two percent (The Heinz Center, 2002).
- The FIA data on reserved lands do not include information on private lands that are legally reserved from harvest, such as lands held by private groups for conservation purposes. In addition, other forest lands are at times reserved from harvest because of administrative or other restrictions.

Data Source

The data for this indicator are from the *Draft Resource Planning and Assessment Tables*, U.S. Department of Agriculture, Forest Service, 2002. (See Appendix B, page B-20, for more information.)

USDA Forest Service Definitions

Forest land. Land that is at least 10 percent stocked by forest trees of any size, including land that formerly had tree cover and that will be naturally or artificially regenerated. The minimum area for classification of forest land is 1 acre.

Timber land. Forest land that is capable of producing crops of industrial wood (at least 20 cubic feet per acre per year in natural stands) and not withdrawn from timber utilization by statute or administrative regulation.

Reserved forest land. Forest land withdrawn from timber utilization through statute, administrative regulation, or designation. (USDA, FS, April 2001)

3.1.5 What human health effects are associated with land use?

Land development patterns have direct and indirect effects on air and water quality, which can then affect human health. For example, the increased concentration of air pollutants in developed areas can exacerbate human health problems like asthma. Increased storm water runoff from impervious surfaces threatens the waterbodies that urban and suburban residents rely on for drinking and recreation. Development patterns can affect quality of life by limiting recreational opportunities, decreasing open space, and increasing vehicle miles traveled and the amount of time spent on roads. Also, as discussed later, agricultural land uses may expose humans to dust and various chemicals. No specific indicators have been identified at this time.

Land use also can have indirect effects on air quality. Low-density patterns of development can often increase commutes—more people drive more miles. "Heat islands," or domes of warmer air over urban and suburban areas, are caused by the loss of trees and shrubs and the absorption of more heat by pavement, buildings, and other sources. Heat islands can affect local, regional, and global climate, as well as air quality. Agricultural land uses also result in increased wind erosion. Degraded air quality can contribute to human health issues such as asthma. Additional discussion of the effects of land uses on air and water quality, human health, and the environment is included in other chapters.

3.1.6 What ecological effects are associated with land use?

Indicator

Sediment runoff potential from croplands and pasturelands

Land use and land management practices change the landscape in many ways that have both direct and indirect ecological effects. One direct effect is the loss or conversion of acres of certain cover or ecosystem types to other more human-oriented land uses such as developed and agricultural uses. Indirect effects may include changes in runoff patterns or increased soil erosion.

The 25 million acre increase in developed land that occurred between 1982 and 1997 came about through the conversion of about 10 million acres of forest land, 7 million acres of agricultural land, 4 million acres of pastureland, 4 million acres of rangeland, and 1 million acres of various other land cover types including wetlands (USDA, NRCS, 1997). The causes of wetland loss are detailed in Chapter 2, Purer Water. Changing land use patterns have also affected the extent and location of agricultural land. Between 1982 and 1997, approximately 13.6 million acres were converted from cropland to other uses, including 7.1 million acres converted to developed land. At the same time, approximately 4 million acres of rangeland were converted to more intensive crop uses (USDA, NRCS, 2000a). The conversions of land from agricultural, forest land, and rangeland cover types to developed land can affect different species in specific locations that depend on those cover types for habitat and food. Species effects in various ecosystems are discussed in more detail in Chapter 5, Ecological Condition.

Land development also creates impervious surfaces through construction of roads, parking lots, and other structures. Impervious surfaces contribute to non-point source water pollution by limiting the capacity of soils to filter runoff. Impervious surface areas also affect peak flow and water volume, which heighten erosion potential and affect habitat and water quality (e.g., temperature increases). They also affect ground water aquifer recharge. With sufficient storm water infrastructure, higher population density in concentrated areas can reduce water quality impacts from impervious surfaces by accommodating more people and more housing units on less land and developing water runoff systems that address issues of pollutants and sediment. Impervious surfaces developed as the result of suburban or dispersed development patterns are more difficult to mitigate, given that the effects are more dispersed and development of runoff infrastructure is costly.

Storm runoff from urban and suburban areas contains dirt, oils from road surfaces, nutrients from fertilizers, and various toxic compounds. Point source discharges from industrial and municipal wastewater treatment facilities can contribute toxic compounds and heated water. Directing water through channels alters hydrologic flow patterns. Increases in siltation and temperature can make stream habitats unsuitable for native microinvertebrate and fish species. Changes in the nutrient and chemical composition of stream water can encourage growth of toxic algae and harmful organisms. The types of crops planted, tillage practices, and various irrigation practices can limit the amount of water available for other uses, such as municipal, industrial, and natural ecosystems. Livestock grazing in riparian zones also can change landscape conditions by reducing stream bank vegetation and increasing water temperatures, sedimentation, and nutrient levels. Runoff from pesticides, fertilizers, and nutrients from animal manure can also degrade water quality.

An indirect ecological effect of land use is the introduction of invasive species. Certain land use practices, such as overgrazing, land conversion, fertilization, and the use of agricultural chemicals can enhance the growth of invasive plants. Other human activities can result in unstable or disturbed environments and encourage the establishment of invasive plants. These activities include farming; creating highway and utility rights-of-way; clearing land for homes and recreation areas such as golf courses; and constructing ponds, reservoirs, and lakes (Westbrooks, 1998). Failure to manage invasive species can lead to a major threat to native ecosystems. Non-native species can alter fish and wildlife habitat, contribute to decreases in

biodiversity, and create health risks to livestock and humans. Introduction of invasive species on agricultural lands also can reduce water quality and water availability for native fish and wildlife species; clog lakes, waterways, and wetlands; weaken the ecosystem; and adversely affect water treatment facilities and public water supplies. Agricultural uses also can encourage the growth of invasive species (USFWS, 2002).

Land practices related to development, timber harvest, and agriculture can affect soil quality both positively and negatively. Some agricultural practices encourage soil conservation, minimizing effects on soil resources. These practices include organic farming; creating buffer strips in riparian zones; tree planting for windbreaks or to decrease water temperature to improve fish habitat; soil erosion control; integrated pest management; and precision pesticide and fertilizer application technology. In contrast, other agricultural activities promote soil compaction or result in loss of topsoil through soil erosion. The indicator identified for this question addresses the potential for sediment to run off from croplands and pasturelands.

Indicator: Sediment runoff potential from croplands and pasturelands - Category 2

Soil erosion and transport can occur both by wind and by water and have several major effects on ecosystems. Sediment is the greatest pollutant in aquatic ecosystems—both by mass and volume—and soil erosion and transport are the source (EPA, OW, August 2002). Soil particles also can transport nutrients and pesticides into aquatic systems where they may degrade water quality. Although rates of erosion declined between 1982 and 1997 by about 1.4 tons/acre, more than one-quarter of all croplands still suffer excessive wind and water erosion (USDA, NRCS, 2000f). Excessive is defined as exceeding tolerable rates as defined by USDA NRCS models (USDA, NRCS, 2000g).

Agricultural soil erosion decreases soil quality and can reduce soil fertility, and soil movement can make normal cropping practices difficult (The Heinz Center, 2002). The loss of productive top soil and organic matter affects the productivity of agricultural lands. Further discussion on the extent and effects of soil erosion can be found in Chapter 2, Purer Water, and in Chapter 5, Ecological Condition.

What the Data Show

The potential for soil erosion and sediment runoff varies depending on specific land use, rainfall amounts and intensity, soil characteristics, landscape characteristics, cropping patterns, and farm management practices. This indicator is the result of analyses conducted by combining land cover, weather patterns, and soil information in a process model that incorporates hydrologic cycling, weather, sedimentation, crop growth, pesticide and nutrient loading, and agricultural management to estimate the amount of sediment that could potentially be delivered to rivers and streams in each watershed. The simulation estimated sheet and rill erosion using a process model known as the Soil and Water Assessment Tool (SWAT).

SWAT is a model that is supported by the USDA Agricultural Research Service. The sediment runoff data have been categorized and are presented as low, medium, and high potential for runoff.

Exhibit 3-12 displays the distribution of watersheds (based on 8-digit hydrologic unit codes [HUCs]) nationwide and the potential for sediment runoff (or delivery to rivers and streams) from croplands and pasturelands. The highest potential for sediment runoff is concentrated in the central U.S., predominately associated with the upper Mississippi River Valley and the Ohio River Valley. Most of the western U.S. is characterized by low runoff potential (lower percentage of cropland and pastureland).

Indicator Gaps and Limitations

This indicator has several limitations for:

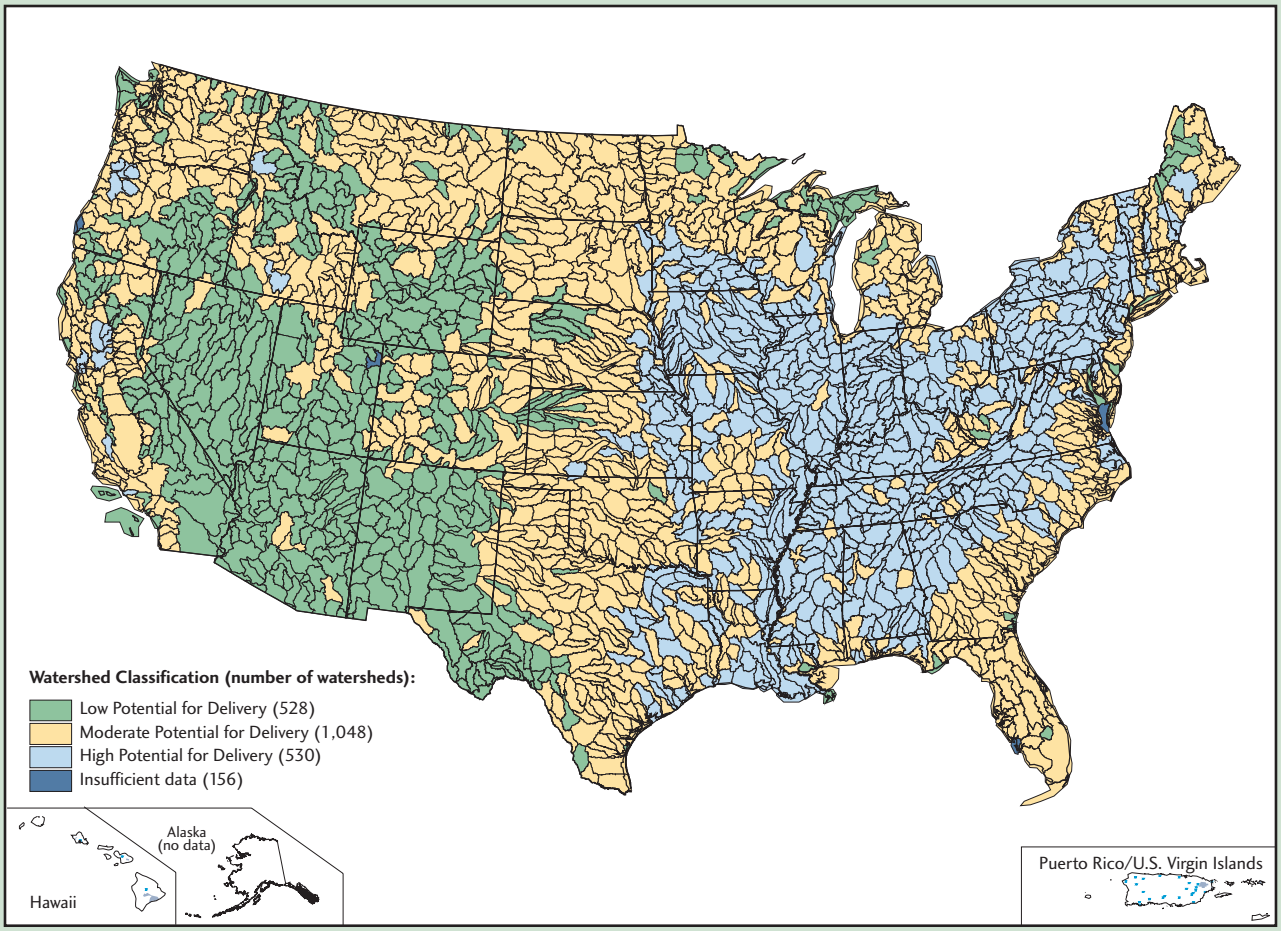
- Sediment loads from non-agricultural land uses are not included in these estimates.
- Estimates represent potential loadings to rivers and streams, and do not represent in-stream loads.
- Gully erosion and channel erosion are not included.

Data Source

The Soil and Water Assessment Tool is a public domain model actively supported by the U.S. Department of Agriculture, Agricultural Research Service at the Grassland, Soil and Water Research Laboratory in Temple, Texas (see http://www.brc.tamus.edu/swat/).
(See also Appendix B, page B-22, for more information.)

Indicator | Sediment runoff potential from croplands and pasturelands - Category 2 (continued)

Exhibit 3-12: Sediment runoff potential from croplands and pasturelands, 1990–1995



Source: Walker, C. Sediment Runoff Potential, 1990-1995. August 24, 1999. (September, 2002; *http://www.epa.gov/iwi/1999sept/iv12c_usmap.html*).