

Biodiversity and Ecosystems

Land Use

Key Findings

- Human land use affects ecosystem function, biological diversity, water quality and quantity and climate. Humans have extensively altered natural land cover in ways that affect the provision of vital ecosystem services.
- The most important human alterations of the natural land cover include widespread changes that have reduced and disturbed forested areas, native grasslands and wetlands to allow farming, ranching, resource extraction and human settlements.
- About 16 percent of North America is designated as “protected” by national governments to preserve valued species, natural spaces and environmental services. Some of these protected areas are affected by encroaching human activities, while other, more remote areas are less directly influenced.
- Compared with overall landscape modification since European colonization, current annual changes are small. However, rates of deforestation and urbanization in certain areas are affecting local ecological systems and global climate.

Land use refers to the purposes to which humans commit land cover such as forests and grasslands. Some land uses—particularly those that are less intensive or involve less alteration of natural systems—cause less disruption to ecosystem services such as water purification, recharging of groundwater, nutrient recycling, decomposition of wastes, regulation of the climate and maintenance of biodiversity.

What Is the Environmental Issue?

Land use is one of the most striking manifestations of humans’ presence and physical impact on the planet. More fundamentally, humans have altered the global patterns and prevalence of species and ecosystems. Several recent studies confirm that human-dominated ecosystems now cover more of earth’s land surface than do natural or “wild” ecosystems. According to one estimate, more than 75 percent of the earth’s ice-free land shows evidence of alteration from human residence and activity, with less than a quarter remaining as wildland. Together, croplands and pastures have become one of the largest land use categories; they occupy about 40 percent of the earth’s land surface.

Intact landscapes with little or no visible signs of influence from human activities such as agriculture, tree felling, mining, highways, pipelines or power lines are increasingly rare. One approach to measuring the extent of intact landscapes is the human influence index, which uses data on population density, settlement patterns, land use and infrastructure to measure the direct human impact on terrestrial ecosystems (see map). The direct human influence is highest in coastal regions and row crop farming areas, along transportation corridors and near population centers.

Although the amount of land in North America is constant, how land is used changes continually. The relationship between land use and land cover is complex because a particular kind of land cover may correspond with a variety of land uses. For example, forested land may be used for timber production, habitat, recreation or watershed protection. Likewise, some

land uses such as agriculture may require maintaining several distinct land covers over time, such as cultivated crops, fallow land, woodlots or even burnt area. Despite this complexity, attempts to categorize land use and land cover can be useful for analyzing humans’ impact on natural ecosystems. Changes in land use can affect the distribution and type of land cover (such as forests, cropland and urbanized areas), the ability of ecosystems to provide valuable services that support life, and even elevation and terrain.

Why Is This Issue Important to North America?

Human activities have modified the original vegetation cover and landscape of North America in ways that have important implications for the environment. Land use and land cover affect many aspects of environmental quality and the services provided by ecosystems.

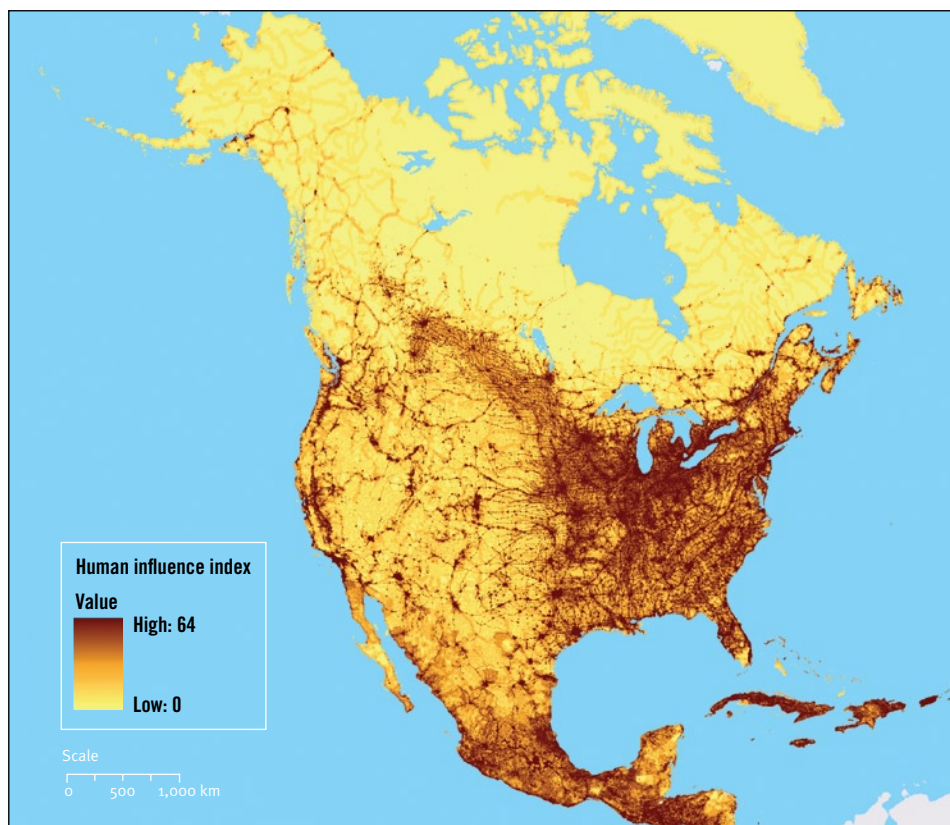
Forests

Forests, both managed and unmanaged, cover about a third of North America’s land area. Within this forested area is a great diversity of forest types of which some 45 percent is classified as boreal, mostly in Canada and Alaska. Temperate and tropical forests make up the remainder of the forested area. North America has almost 20 percent of the world’s forests and over a third of its boreal forests.

The extent of forested land is relatively stable in Canada, increasing slightly in the United States and declining in Mexico. Since 1990, Canada has experienced a net increase in forested area of less than 1 percent, whereas



Human influence index for North America (2000)



Source: Center for International Earth Science Information Network and Wildlife Conservation, Last of the Wild Data Version 2, 2005 (LWP-2): Global Human Influence Index.

forest cover in the United States has grown by about 1.5 percent. In Mexico, between 3.5 and 5 million hectares of temperate and tropical forests have been lost over the last decade. The estimated annual deforestation rates in Mexico range from 0.5 percent to 1.14 percent from the early 1990s to 2000.

Changes in the structure of forest ecosystems introduced by human pressures can make forests more susceptible to damage by fires, drought, insect infestations and air pollution. For example, in Canada, clear-cutting has led to the proliferation of the balsam fir, which is vulnerable to the spruce budworm. In the conterminous United States, almost half of all forests are considered highly fragmented—that is, much of the forested area is in close proximity to a forest edge. Although the United States has many large regions of forest, fragmentation is so pervasive that edge effects disrupt ecological processes and suitability for wildlife habitat on most forested lands. In Mexico, the structure and composition of the remaining woodlands have been altered by the selective extraction of certain preferred tree species and by the extensive conversion of forests to pasture.

Agriculture

In all, almost a third of North America's surface is devoted to agricultural uses. Although it accounts for only 12 percent of the world's agricultural area, North America produces almost 20 percent of the world's cereals and an equal percentage of the world's meat.

Since 1990, the overall amount of land dedicated to agricultural uses in North America has declined by about 1.5 percent. In Mexico, the most significant opening of land for farming and cattle occurred from 1940 to 1965, with annual growth rates of up to 10 percent a year. Although this trend has slowed, Mexico's agricultural land uses continued to expand by 3.5 percent a year after 1990 and remain a major driver of land transformation. In Canada and the United States, the amount of land devoted to crops has declined since the 1950s. However, even with declines in overall agricultural area, the environmental effects of agricultural practices are still significant. Recent research has revealed that excessive nutrient loading from agriculture has created a considerable hypoxic zone of low dissolved oxygen in the northern Gulf of Mexico, which is causing ecological stress and the death of bottom-dwelling aquatic organisms.

The agricultural area devoted to permanent pasture in North America has remained relatively steady since 1990. However, based on historical land use changes for farming and ranching, temperate North American grasslands have undergone significant changes that have transformed the ecosystem and led to significant losses of biodiversity, especially species such as grassland birds, bison, prairie dogs and the black-footed ferret. Grasslands are one of the continent's most endangered ecosystems (see case study). In 2001 about 55 grassland wildlife species in the United States were either threatened or endangered. In Mexico, overgrazing is reducing the productivity of grasslands and threatening biodiversity.

Wetlands

Wetlands cover over 10 percent of North America. At 2.5 million square kilometers, this area represents some 40 percent of the global wetland area. Historically, wetlands, which include swamps, bogs and marshes, were undervalued as wasteland to be dredged for ports and marinas or drained for farms, housing and other development. In recent years, scientists have cataloged the many important ecological contributions of wetlands—as breeding grounds for waterfowl, fish and crustaceans; as areas to capture and filter sediments and organic matter; for water retention and flood mitigation; and as protective barriers against storms in coastal areas, among others. As of 2004, North America had almost 200,000 square kilometers of "Ramsar" wetlands, denoted as having international importance.

In the conterminous United States, almost half of all wetlands have been drained since European settlement. In Canada, only 14 percent of wetlands have been lost over this period, primarily in southern Canada. In both countries, agricultural uses have accounted for about 85 percent of the historical loss. But agricultural conversion has slowed in recent years, and urban and suburban development has become a more important driver of wetland loss. Mexico's wetland area is estimated at 36,000 square kilometers, and the historical loss is estimated to be 16,000 square kilometers. Much of Mexico's wetlands are found in coastal areas, where they are pressured by oil infrastructure, urban and tourist development, livestock production and aquaculture.

Urban Areas

Human settlements such as cities, towns and suburbs vary widely in density, form and dis-



tribution. Urban settlements, as they have been defined by the census bureaus of Canada, Mexico and the United States, contain 75–80 percent of the population of the continent. Determining the extent of human settlements across North America presents a challenge because definitions of such settlements vary greatly, particularly among nations. However, one estimate, based on satellite imagery of nighttime lights, puts North America's human settlement area at almost 5 percent of the total continental land area. With settlement and urbanization, there has been an increase in the construction of impervious surfaces, which reduce the absorption of water on-site and groundwater recharge and increase storm water diversion, flows and impacts on surface water systems.

Because both the majority of North America's population and its best agricultural land generally occupy the same regions, urbanization and sprawl have also led to the loss of agricultural land. Over the last 30 years, about half of the area transformed to urban uses in Canada was once agricultural land. In the United States, of the more than 36,400 square kilometers of land developed between 1997 and 2001, 20 percent came from cropland, 46 percent from forestland and 16 percent from pastureland. In recent years, the extent of developed land (urban and industrial) in the United States has increased rapidly. More specifically, from 1982 to 2002 the area of developed land grew

at a rate of 47 percent, almost twice the rate of population growth. In Mexico, 995 square kilometers were converted to urban uses between 1993 and 2000.

The expansion of low-density suburban and rural developments are associated not only with the loss of prime agricultural land, but also with the fragmentation and loss of

Biodiversity

Habitat loss is the single greatest threat to biodiversity. When habitat is lost or fragmented, species that depend on this habitat experience a variety of pressures that ultimately lead to reduced species populations. During the last 200 years, North America has experienced dramatic transformations of ecological systems

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forests, wetlands, grasslands and other wildlife habitats and the associated loss of biodiversity. Development in rural areas has also increased the risk of "interface" fires, which are associated with the intermingling of settlements with flammable forests and grasslands.

What Are the Linkages to Other North American Environmental Issues?

Changes to land cover threaten biological diversity, contribute to climate change and alter the functioning and provision of ecosystem services.

and significant changes in the abundance of species. As nations have sought to find solutions to transportation, housing, energy and other material needs, the natural environment has been subjected to pressures arising from land cover conversion, habitat fragmentation and pollution. At the same time, protected areas have been established in an attempt to preserve valued species and natural spaces.

Currently, 16 percent of North America is covered by nationally designated protected areas. In some areas, this legal protection status has reduced the extent of human impacts in populated regions. Elsewhere, remoteness,

Protected areas of North America (left) and areas of least human influence (right)



Source: Commission for Environmental Cooperation and Center for International Earth Science Information Network and Wildlife Conservation, Last of the Wild Data Version 2, 2005 (LWP-2): Global Last of the Wild.



terrain and climate have provided large expanses of territory with *de facto* protection from direct human influence (see maps). However, as the climate changes the impacts of human activity will be felt directly and indirectly in even the most remote areas.

Climate Change

Decisions about land use can have significant effects on the contribution of human activities to the emissions of greenhouse gases associated with climate change. For example, decisions about the extent and patterns of human settlement have had important and long-lasting implications for transportation and its associated greenhouse gas emissions. Likewise, decisions affecting the protection of North American forests affect, in turn, the service provided by those forests as a carbon sink—they have drawn in some 269 million metric tonnes of carbon per year over the last decade or so. Indeed, North American forests contain more than 170 billion tonnes of carbon, of which 28 percent is in live biomass and 72 percent in dead organic matter. Most of the current net removal of carbon from the atmosphere and its storage in vegetation and soil is not a product of deliberate management practices, but instead can be attributed to a combination of past management and the response of terrestrial ecosystems to environmental changes. The substantial carbon removals by the forests of Canada and the United States result largely from the abandonment of agricultural land and subsequent regrowth of shrubs and trees.

Water Quality and Quantity

Land use activities often affect water quality and hydrology. For example, deforestation may lead to greater susceptibility to flash flooding and sediment loading in nearby streams. Urban development creates large volumes of excess storm water runoff, which can cause flooding, add pollution, create groundwater recharge deficits and alter stream ecology. Development of rural areas also has impacts on stream flows, altering aquatic ecosystems and their ability to maintain habitat and sediment balance. Some of the common impacts of changes in land use on water quality include increased organic matter and biological oxygen demand, changes in stream temperature and sediment load, salinization, changes in water flow and loadings of toxic chemicals, including pesticides and fertilizers. 🐛

Case Study – North American Grasslands



Source: Commission for Environmental Cooperation.

The natural prairie of central North America is a transboundary ecological region shared by Canada, Mexico and the United States. The prairie grasslands are an immense, contiguous geographic region (see map) with a wide variety of species, land uses and cultural and social practices, as well as economic conditions and political-administrative regimes. The North American prairie is one of the planet's largest biomes.

The northern grasslands are North America's most productive breeding grounds for aquatic birds, featuring species characteristic of both the eastern and western regions of the continent. The prairies maintain resident bird populations, in addition to providing nesting sites and stopover sites for migratory species. More than half the nesting ducks and many other grassland-dependent wildlife species in the United States depend on this crucial habitat. This region is also home to the largest known populations of certain species of hummingbirds, orioles, buntings, warblers, quail and thrashers. The southern grasslands are known for their varied mosaic of species, including 23 percent of the more than 1,500 cactus species found worldwide.

Unfortunately, this ecosystem has suffered extensive deterioration over the last 150 years. In the United States, less than 10 percent of the native Tallgrass prairie remains as grassland; 71 percent has been converted to cropland and 19 percent to urban areas. The main causes of the extensive loss of grassland habitats are changes in land use, such as the historical conversion to farmland or pasture, chemical pollution from farming, overuse of aquifers and unsustainable ranching practices. Extensive cattle raising in such a fragile region often has a negative impact on vegetation and soil properties and characteristics, and thus on the survival of multiple plant and animal species. The diminished grassland coverage also increases the area's vulnerability to wind erosion, which reduces its suitability as a wildlife habitat. Soil compaction impedes natural recovery and leads to desertification. Other major threats include gas and oil drilling; urbanization with the associated highway networks, population density and groundwater overutilization; the growing presence of invasive species; and the increasing aridity arising from climate change.