12 East and Central Farming and Forest Region and Atlantic Basin Diversified Farming Region: LRRs N and S

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12.1 Introduction

The central, unglaciated US east of the Great Plains to the Atlantic coast corresponds to the area covered by LRR N (East and Central Farming and Forest Region) and S (Atlantic Basin Diversified Farming Region). These regions roughly correspond to the Interior Highlands, Interior Plains, Appalachian Highlands, and the Northern Coastal Plains.

12.2 The Interior Highlands

The Interior Highlands occur within the western portion of LRR N and includes seven MLRAs including the Ozark Highlands (116A), the Springfield Plateau (116B), the St. Francois Knobs and Basins (116C), the Boston Mountains (117), Arkansas Valley and Ridges (118A and 118B), and the Ouachita Mountains (119). This region comprises 176,000 km^2 in southern Missouri, northern and western Arkansas, and eastern Oklahoma (Fig. 12.1).

12.2.1 Climate

The mean annual precipitation ranges from 965 to 1675 mm increasing to the south. The average air temperature range from north to south is 12–17 °C. The average growing season ranges from 200 to 240 days decreasing to the north and with elevation. Most of the precipitation falls during the freeze-free period and occurs as high-intensity, convective thunderstorms in summer. An average of 305–355 mm of snowfall occurs annually in the Ozark Highlands, the Springfield Plateau, and the St. Francois Knobs and Basins MLRAs. In the southern half of the region, snowfall is uncommon.

12.2.2 Physiography

The topography of this region ranges from broad, gently rolling plains to steep mountains. In the northern portion of this region, much of the Springfield Plateau and the Ozark Highlands is a dissected plateau that includes gently rolling plains to steeply sloping hills with narrow valleys. Karst topography is common and the region has numerous sinkholes, caves, dry stream valleys, and springs. The region also includes many scenic spring-fed rivers and streams containing clear, cold water (Fig. 12.2). The elevation ranges from 90 m in the southeastern side of the region and rises to over 520 m on the Springfield Plateau in the western portion of the region. The relief ranges from 45 m on the gently rolling plains to more than 245 m in the more dissected parts of the region. The St. Francois Knobs and Basins occurs in the northeastern portion of the Ozark Highlands and is centered on an uplifted "dome" underlain by Precambrian igneous rocks. The topography includes deeply dissected "knobs" or hills, and wide basins and valleys. Elevations range from 135 m along the rivers to 540 m on the highest peak, Taum Sauk Mountain. Relief ranges from 30 m in the basins up to 305 m among the igneous knobs. Greater elevations and relief occur in the rugged Boston Mountains, which lies to the south of the Ozark Highlands MLRA. This dissected plateau features narrow ridges, steep slopes, and narrow valleys that provide more than 45–270 m of relief and elevations ranging from 60 to 850 m (Woods et al. 2004). In the Ouachita Mountains MLRA, valleys are narrow and the slopes are steep. Elevations range from 100 to 800 m and relief ranges from 15 to 480 m (Woods et al. 2004). The Arkansas Valley and Ridges (MLRAs 118A and 118B) occur between the Ozark Highlands and Ouachita

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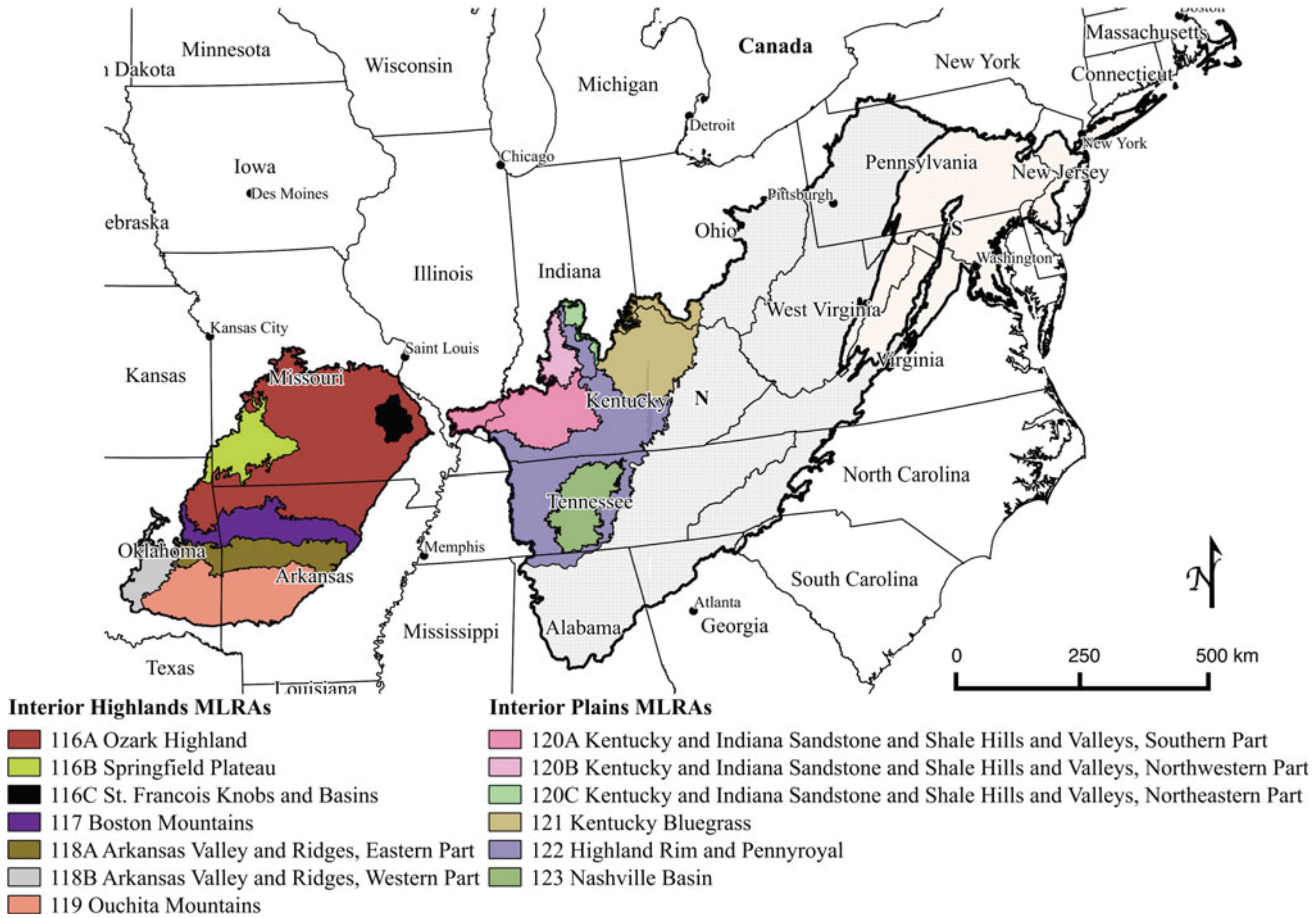

Fig. 12.1 Extent and distribution of MLRAs in the Interior Highlands (MLRAs 116A, 116B, 116C, 117, 118A, 118B, and 119) and Interior Plains (MLRAs 120A, 120B, 120C, 121, 122, and 123.) within LRR N

Mountains and consist of long broad ridges oriented east to west. Elevations range from 90 to 840 m and relief ranges from 15 to 330 m.

12.2.3 Geology

Most of the area is underlain by sedimentary rocks including dolostone, limestone, sandstone, siltstone, and shale although metamorphic rocks are also found in the Ouachita Mountains because of folding and faulting. The oldest rocks in the Interior Highlands occur in the St. Francois Knobs and Basins where Precambrian igneous rocks of volcanic origin are exposed in the center of the "Ozark Dome." These igneous rocks are flanked by Cambrian dolostone and sandstone that dip slightly away from the top of the dome. Ordovician dolostone and sandstone occur throughout the Ozark Highlands. Younger Mississippian limestone and dolostone, and Pennsylvanian sandstone and shale are found in the Springfield Plateau. Throughout the Ozark Highlands and Springfield Plateau, the limestone and dolostone contain horizontal chert beds that are numerous but are generally less than 30 cm thick. Thin, remnant loess deposits also can be found on broad ridges, particularly in the eastern portion of the Ozark Highlands nearest the Mississippi River.

The lithology of the Boston Mountains is more varied. Here nearly level layers of Pennsylvanian and Mississippian shale, sandstone, and siltstone occur. Sandstone, siltstone, and shale also occur in the Arkansas Valley and Ridges, but these are primarily Pennsylvanian in age. The folding and faulting that occurred in the Ouachita Mountains has exposed Ordovician shale and sandstone, Mississippian shale and sandstone, and Pennsylvanian shale, slate, quartzite, and sandstone.

12.2.4 Vegetation

The Interior Highlands occur along an ecotone between the mesophytic forests to the east and the tallgrass prairies to the west. Prior to European settlement, the vegetation comprised a mosaic of oak (*Quercus*) savannas, oak woodlands, pine

Fig. 12.2 The Ozark Highlands include many clear streams. Photograph credit Jaymi LeBrun

(*Pinus*) and oak-pine woodlands, and oak-hickory (Quercus-*Carya*) forests. Common tree species in savannas and woodlands included post oak (*Quercus stellata*), black oak (*Quercus velutina*), shortleaf pine (*Pinus echinata*), and blackjack oak (*Quercus marilandica*). Common tree species in oak-hickory forests included white oak (*Quercus alba*), northern red oak (*Quercus rubra*), and hickories (*Carya* spp.). Prairies and glades were dominated by warm-season grasses such as Indiangrass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and switchgrass (*Panicum virgatum*), particularly in the western portion of the region. Anthropogenic fire along with topography, site conditions, and human population density were important determinants of the vegetation (Guyette et al. 2002). In general, savannas and oak woodlands occurred on the broad to gently rolling plains of the Springfield Plateau and the Ozark Highlands (Hanberry et al. 2014) and in the western portion of the Arkansas Valley and Ridges MLRA (Woods et al. 2004). Oak woodlands, sometimes mixed with shortleaf pine, and oak-hickory forests occurred on the steeper slopes of the more dissected regions of the Ozark Highlands, the St. Francois Knobs, and Boston Mountains (Hanberry et al. 2014, Woods et al. 2004). Oak-pine and pine woodlands occurred in large areas of the eastern Ozark Highlands and in the Boston Mountains.

12.2.5 Soils

The soils of the northern half of the Interior Highlands generally have a mesic soil temperature regime and those of the southern half of the region have a thermic soil temperature regime. Most of the soils are deep or very deep except along steep side slopes where geologic erosion has occurred. The soils are generally well drained unless they have a fragipan or a slowly permeable clay layer that inhibits vertical water movement. The permeability of most of the soils is slow to moderate. Most of the soils have udic or aquic soil moisture regimes and mixed or siliceous mineralogy. About 53 % of the soils are Ultisols, 34 % are Alfisols, and the remaining soils are Inceptisols (6 %), Mollisols (5 %), and Entisols (2 %). The soils vary considerably in depth, texture, and nutrient supply depending on their native vegetation, parent materials, and slope position.

Most of the soils formed under the influence of forest vegetation. Consequently, they have an ochric epipedon comprising a thin A horizon and one or more eluvial horizons overlying an argillic horizon (Alfisols or Ultisols) comprising a series of Bt horizons. Mollisols occur on level plains, particularly along the western boarder of the Interior Highlands where prairie or savanna was the native vegetation. Mollisols also occur adjacent to glades and rock outcrops where few trees are able grow well because of rooting limitations and the native vegetation was dominated by grasses, sedges, and forbs.

Many of the upland soils formed in slope alluvium (also called hillslope sediments or colluvium), residuum, or in a thin layer of slope alluvium overlying residuum. Over time, the downslope movement of the fine-textured sediments has concentrated coarse fragments in upslope positions. The slope alluvium in this region is either highly weathered and/or was derived from sandstone where quartz was the dominant mineral. Consequently, the soils that have slope alluvium as a parent material are gravelly or cobbly with siliceous mineralogy, low cation exchange capacity (CEC), low base saturation, and include Hapludults and Paleudults (Fig. 12.3). Conversely, soils that developed in residuum derived from limestone and dolostone have B horizons with mixed mineralogy, higher clay, and higher CEC than those in the slope alluvium. Part of the calcium and magnesium released during the weathering of the limestone and dolostone was retained in the soil resulting in these soils having a moderate to high base saturation and classifying as Hapludalfs and Paleudalfs (Fig. 12.4).

Where soils are shallow to moderately deep to bedrock, their properties greatly reflect the nature of the underlying lithology. They are clayey, have mixed mineralogy, and a moderate to high base saturation where derived from limestone or shale. Soils are loamy or sandy with siliceous mineralogy and low base saturation where derived from sandstone. For example, in the Boston Mountains, the Arkansas Valley and Ridges, and the Ouachita Mountains MLRAs, Dystrudepts occur on steep side slopes where the depth to the underlying sandstone is less than 50 cm and soil development is minimal. In many locations, sandstone is interbedded with limestone, dolostone, or shale and the mineralogy and soil textures of overlying soils have been influenced by multiple lithologies.

Fig. 12.3 Paleudults in the Interior Highlands formed in weathered slope alluvium. Photograph credit Satchel Gaddie

In upland waterways and in floodplains of this region, the soils reflect the properties of the source material from the surrounding uplands. However, because of their lower landscape position and the deposition of sediments during flood events, the soils on these landforms are enriched with organic carbon and nutrients. The sediments were sorted by the flood water during deposition, resulting in considerable lateral and vertical textural variation. Consequently, the soils of upland waterways and floodplains are variable in texture and organic carbon content and have moderate CEC, mixed mineralogy, and moderate to high base saturation. They include Hapludalfs, Hapludolls, Paleudalfs, Eutrudepts, and Udifluvents.

Fragipans (Fig. 12.5) are common throughout the region and occur along or above lithologic discontinuities in the soil, particularly on gentle slopes where the soils are more stable and soil movement is less likely to disrupt fragipan development. Although their genesis is poorly understood,

Fig. 12.4 Hapludalfs with gravelly slope alluvium overlying clayey residuum from dolostone. Photograph credit Satchel Gaddie

fragipans are thought to have formed where close packing by deposition and desiccation by trees has occurred (James et al. 1995). Many of these soils are Fragiudults or Fragiudalfs.

12.2.6 Land Use

The majority (50 %) of the land in this region is forested (Figs. 12.6 and 12.7), and forest cover ranges from 22 % in the Springfield Plateau to 72 % in the Ouachita Mountains. Harvesting of forest products is an important economic driver throughout the Interior Highlands on both private and public land, and forest products include lumber, cooperage, flooring, poles, posts, ties, pallets, blocking material, charcoal, and bedding material. About one-third of the land is used for forages for beef and dairy industry while the remaining land is split between 3 % water bodies (man-made lakes, rivers, and streams) and 5 % urban development, mostly along the interstate corridors, major highways, and large lakes. There is a small amount of

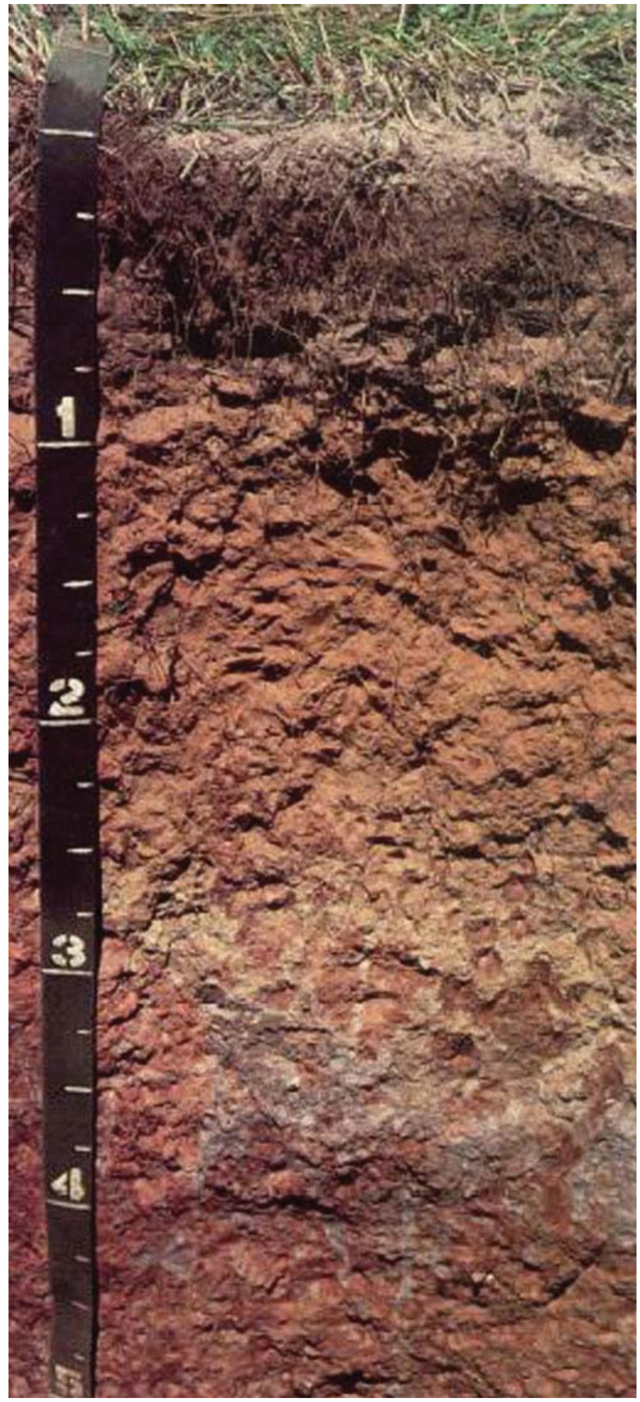

Fig. 12.5 Fragipans like this one occurring from 75 to 120 cm below the soil surface are common in soils of the Interior Highlands. The scale is shown in *feet*

cropland (6 %) primarily growing soybeans and winter wheat. This area contains one of the largest poultry production regions of the USA in northwestern Arkansas, northeastern Oklahoma, and southwestern Missouri.

Fig. 12.6 Forests are an important resource in the Interior Highlands. Photograph credit Stephen Shifley

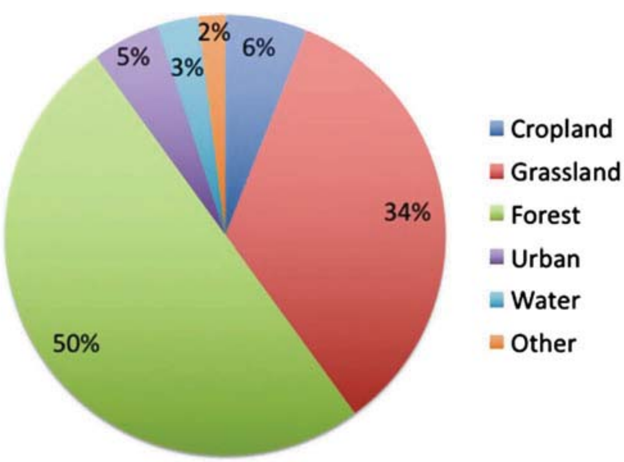

Fig. 12.7 Land use distribution in the Interior Highlands

12.3 Interior Plains

The Interior Plains occur within the central portion of LRR N and includes six MLRAs including the Kentucky and Indiana Sandstone and Shale Hills and Valleys (120A, B, C), Kentucky Bluegrass (121), Highland Rim and Pennyroyal Plateau (122), and Nashville Basin (123). This region comprises 131,720 km^2 in south central Indiana, central and western Kentucky, and central Tennessee (Fig. 12.1).

12.3.1 Climate

The mean annual precipitation ranges from 1040 to 1450 mm increasing to the south. Temperature averages 10–16 °C. The growing season lasts 180 days in the northern part of Kentucky and Indiana Sandstone and Shale Hills and Valleys and about 205 days in the Nashville Basin. Most of the precipitation falls during the freeze-free period and occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter but does not remain on the surface for a long period of time.

12.3.2 Physiography

The topography of this region is mostly rolling plains with smaller areas of fairly rugged hills, swampy alluvial valleys (Fig. 12.8), and deeply entrenched rivers and streams in broad karst plains. Several large rivers traverse the region including the Ohio and several of its tributaries including the Tennessee, Cumberland, Kentucky, and Licking rivers. In the western part of the region (MLRAs 120 A, B, and C; Shawnee Hills), sandstone bluffs, steep-sided ridges, gentle hills, broad valleys, karst terrain, and gentle rolling lowland plains and bottomlands along major rivers and their tributaries are common. Elevation ranges from 105 m along the Ohio River to 325 m on high ridges.

In the Highland Rim and Pennyroyal Plateau to the south, elevation generally ranges from 200 to 300 m, and the uplands consist of broad, rolling to gently sloping interstream areas. This karst area is has numerous limestone sinks and the longest cave system (>640 km) in the world, Mammoth Caves. Many of the permanent streams are steeply incised and are few due to the internal drainage of the karst terrain.

The Highland Rim and Pennyroyal Plateau surrounds the Nashville Basin, and at the transition between these two MLRAs, the terrain is deeply dissected and consists of steep slopes between narrow, rolling ridgetops and narrow valleys. The inner part of the Nashville Basin is undulating and rolling with limestone sinks and abundant outcrops of limestone. Elevation is generally about 200 m ranging from 135 m in deep stream channels to 405 m on isolated hills. The terrain in the Kentucky Bluegrass is similar to the Nashville Basin and is gently rolling with isolated hills and

Fig. 12.8 Seasonally inundated cypress swamp. Photograph credit Jerry McIntosh

ridges, limestone sinks, and occasional limestone outcrops. Local relief is about 50–100 m on dissected hills and 25 m on the broad upland plains.

12.3.3 Geology

Most of the region is characterized by erosional landforms on slightly dipping Paleozoic carbonate rocks resulting in a series of dissected plateaus and rolling plains separated by scarps. Karst topography and residuum of variable thickness from the weathering of carbonate rocks is typical of most of the region (Newell 2001). The borders between the MLRAs commonly have abrupt slope changes due to changes in erosion rates between parent rocks. Sedimentary rocks underlying the Shawnee Hills include Early and Middle Pennsylvanian and Late Mississippian-age flat-lying, interbedded sandstone, shale, coal, and siltstone. The Highland Rim and Pennyroyal Plateau, Kentucky Bluegrass, and Nashville Basin are underlain by Ordovician- to Mississippian-age limestone, part of the Cincinnati Arch. Quaternary alluvium is found on valley floors and terraces along rivers and streams.

12.3.4 Vegetation

Oak-hickory (*Quercus*-*Carya*) forest is found in the uplands of Illinois and Kentucky and oak-gum-cypress (*Quercus*-*Liquidambar*-*Taxodium*) forest occupies the bottom lands throughout the section. Uplands are dominated by the white oak, black oak, shagbark hickory (*Carya ovata*) community; the blackjack oak, scarlet oak (*Quercus coccinea*), pignut hickory (*Carya glabra*) community occupies drier sites; and the beech (*Fagus grandifolia*), yellow-poplar (*Liriodendron tulipifera*), bitternut hickory (*Carya cordiformis*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*) community occupies deep ravines. The southern flood plains along the Ohio and Wabash rivers are dominated by the sycamore (*Platanus occidentalis*), Kentucky coffeetree (*Gymnocladus dioicus*), sugarberry (*Celtis laevigata*), and honeylocust (*Gleditsia triacanthos*) community, with tupelo (*Nyssa* spp.) and baldcypress (*Taxodium distichum*) swamp communities occupying areas with more poorly drained soils. On undisturbed flood plains sites, Shumard oak (*Quercus shumardii*), sweetgum (*Liquidambar styraciflua*), swamp white oak (*Quercus bicolor*), cherrybark oak (*Quercus pagoda*), pin oak (*Quercus palustris*) as well as sedges and grass meadows are common. In the northern section (MLRA 120C), the protected areas and north-facing slopes support mixed forests of beech, sugar maple, and yellow-poplar.

12.3.5 Soils

The Interior Plains soils have a mesic soil temperature regime, udic or aquic soil moisture regime, and dominantly mixed mineralogy. Over half (58 %) of the soils are Alfisols while the remaining soils are Ultisols (20 %), Inceptisols (15 %), Mollisols (6 %), and Entisols (1 %). The majority of the less eroded uplands and ridges in the Shawnee Hills are covered with a veneer of loess (windblown silts). In the Shawnee Hills, the thickest loess veneer (several meters thick) is south of the Ohio River and it thins the southeast. Due to the abundance of loess in this area, most of the soils have a silt or silt loam surface texture. Underlying the loess is residuum derived from interbedded sandstone, shale, or siltstone. In uplands with thin loess over residuum, the soils range from moderately deep to very deep and are typically Hapludalfs. Most soils are well drained unless the soil has a fragipan that restricts vertical movement of water resulting in moderately well or somewhat poorly drained soils (Fragiudalfs). The fragipan horizons often occur at the lithologic discontinuity between loess and residuum or between two different loess depositions.

The surface loess deposit in this region is the Peoria Silt which was deposited between 27,000 and 17,000 years ago (Muhs et al. 2013) and is associated with the most recent glacial advance in the lower Midwest. Often underlying the Peoria Silt is the Roxana Silt, which was deposited between about 60,000 and 30,000 years ago (summarized in Curry et al. 2011) and is associated with the next-to-last glacial advance. In these loess-covered landscapes, Hapludults and Fragiudults are common on sideslopes and often have a limited plant available water holding capacity due to their shallow depth to a fragipan or horizons with fragic properties.

Within the Interior Plateau, fragipan formation has been described as primarily occurring in loess deposits 0.75–2.5 m thick that overlie residuum (interbedded sandstone and shale), or another loess layer. Soluble silica moves downward with percolating water and accumulates at the lithologic discontinuity. Removal of water from the zone immediately above the lithologic discontinuity by tree roots results in a preferential concentration of amorphous silica. As a result, silica precipitates between grain contacts and in the fine pores thus bonding the soil minerals resulting in horizons with brittle consistence and dense prismatic structure (Franzmeier et al. 1989; Karathanasis 1989).

On younger sediments in alluvial flood plains, soils range from well to poorly drained (Dystrudepts and Endoaquepts). Some of these poorly drained areas with sandy and loamy soil materials can be drained artificially through ditching or tile drainage. The latter is more common in this region and is accomplished by installation of 10–15 cm diameter perforated pipe approximately 0.5–1 m deep in the soil profile to remove free (zero tension) water by gravity. The perforated pipes are connected to a main pipe, often of a larger diameter, that discharges the collected water to a lower elevation surface outlet, often a ditch or creek. These drainage systems have been used in the corn belt of the Midwest for decades but in recent years have become more common in the poorly and somewhat poorly drained alluvial soils of the Interior Plains.

Endoaquepts, Epiaqualfs, and Hapludalfs formed in lacustrine sediments occur on lacustrine terraces or lake plains. Lacustrine sediments and the soils that form from these parent materials are fine textured (e.g., clay, clay loam, and silty clay loam) and are not suitable for drainage due to their high clay content and low saturated hydraulic conductivity, making them difficult to cultivate in wet growing seasons.

In the Highland Rim and Pennyroyal Plateau, the soils are generally well drained due to the lack of a water restrictive horizon, moderate to strong structure, and deep fractures in the underlying limestone making them well suited for row crop production. In the upland areas, soils have generally developed in deep clayey limestone residuum, old alluvium, or thin loess deposits over residuum or alluvium and are deep Paleudalfs and Paleudults (Smalley 1983) (Fig. 12.9). On younger alluvial surfaces near streams and on flood plains, Eutrudepts and Fluvaquents are common.

Soils in the Nashville Basin and Kentucky Bluegrass are similar as they share the same parent material derived from Ordovician-age limestone deposits associated with the Cincinnati Arch. The soils in these regions are moderately well to well drained, loamy or clayey in texture, and formed from residuum or thin loess over residuum. Upland soils are predominantly Hapludalfs, Paleudalfs, or Fragiudalfs while Eutrudepts are found in floodplains. Although most of the soils are Alfisols, there are large areas of Hapludolls in the uplands, and Aquolls are common on floodplains where native prairies once covered the landscape.

Fig. 12.9 Paleudalf (Crider series, State soil of Kentucky) is a well-drained soil formed from limestone residuum found in upland landscape positions of the Pennyroyal Plateau. Photograph credit Jerry McIntosh

12.3.6 Land Use

Much of the Interior Plains is in row crop production (27 %) of corn, soybeans, wheat, or tobacco on the plateaus and other gently sloping terrains as well as on recently drained floodplains and bottomlands (Fig. 12.10). Tobacco (burly and dark tobacco) is a very important crop for this region as Kentucky is the 2nd largest tobacco producer in the USA, and it makes up almost $400 million of Kentucky's Gross State Product (Brown 2007). Forests occupy 36 % of the area and commonly occur in fragmented woodlots on slopes too steep to farm or soils too shallow for row crops. Managed grasslands occupy 23 % of the landscape and commonly occur on rolling terrain where soils are shallow. These areas are used for hay production or animal grazing operations. Of particular interest are the equine production facilities in the Kentucky Bluegrass, which has the largest

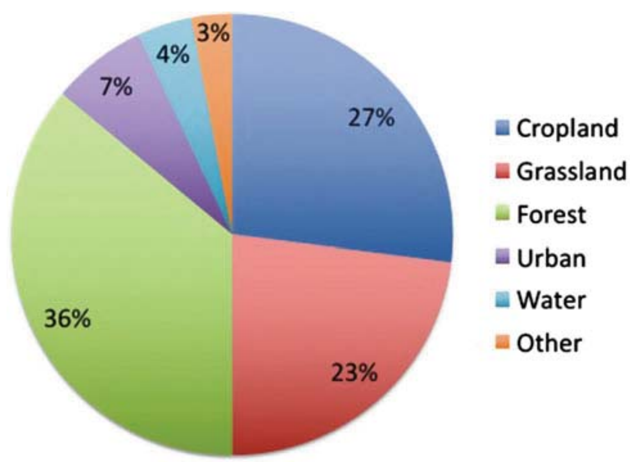

Fig. 12.10 Land use distribution in the Interior Plains

Fig. 12.11 Horses grazing on the Bluegrass, Interior Plains. Photograph credit University of Kentucky

equine sales in the nation (USDA NASS 2012). The success of the equine industry in this region has been attributed, in part, to the phosphorus-enriched limestone associated with the Cincinnati Arch (Harrison and Klotter 1997; McGrain 2001; Kentucky Geological Survey 2012) (Fig. 12.11). Urban areas occupy 7 % of the landscape and are mostly concentrated around major cities including Nashville TN, Louisville KY, and Cincinnati OH.

12.3.7 Appalachian Highlands

The Appalachian Highlands occur in the eastern part of LRR N and western part of LRR S and include nine MLRAs across 4 provinces: Appalachian Plateau Province (MLRAs 124 Western Allegheny Plateau, 125 Cumberland Plateau and Mountains, 126 Central Allegheny Plateau, 127 Eastern Allegheny Plateau, 129 Sand Mountain), Blue Ridge Province (MLRAs 130A and B Northern and Southern Blue Ridge Mountains), Valley and Ridge Province (MLRAs 128 Southern and 147 Northern Appalachian Ridges and Valleys), and Piedmont Province (MLRA 148 Northern Piedmont). The region comprises 358,115 km^2 in eastern Kentucky, eastern Ohio, southern Pennsylvania, West Virginia, western Maryland, western North Carolina, Eastern Tennessee, northern Alabama and Georgia, southeastern Pennsylvania, and west-central New Jersey (Fig. 12.12).

12.3.8 Climate

The average annual precipitation ranges from 915 mm to as high as 3025 mm at the highest elevations in the Blue Ridge Mountains. Orographic precipitation occurs in the higher elevations of the Appalachian Highlands due to moist air from the Gulf of Mexico being too heavy to cross the mountain range from west to east resulting in areas of high precipitation (>1900 mm) in some areas. Precipitation is lowest in autumn and generally increases with elevation. Snow is common in the high elevations of the northern latitudes; however, it melts quickly. In general, the fall is the driest season. The average annual temperature ranges from 8 to 17 °C and decreases with increased latitude and elevation.

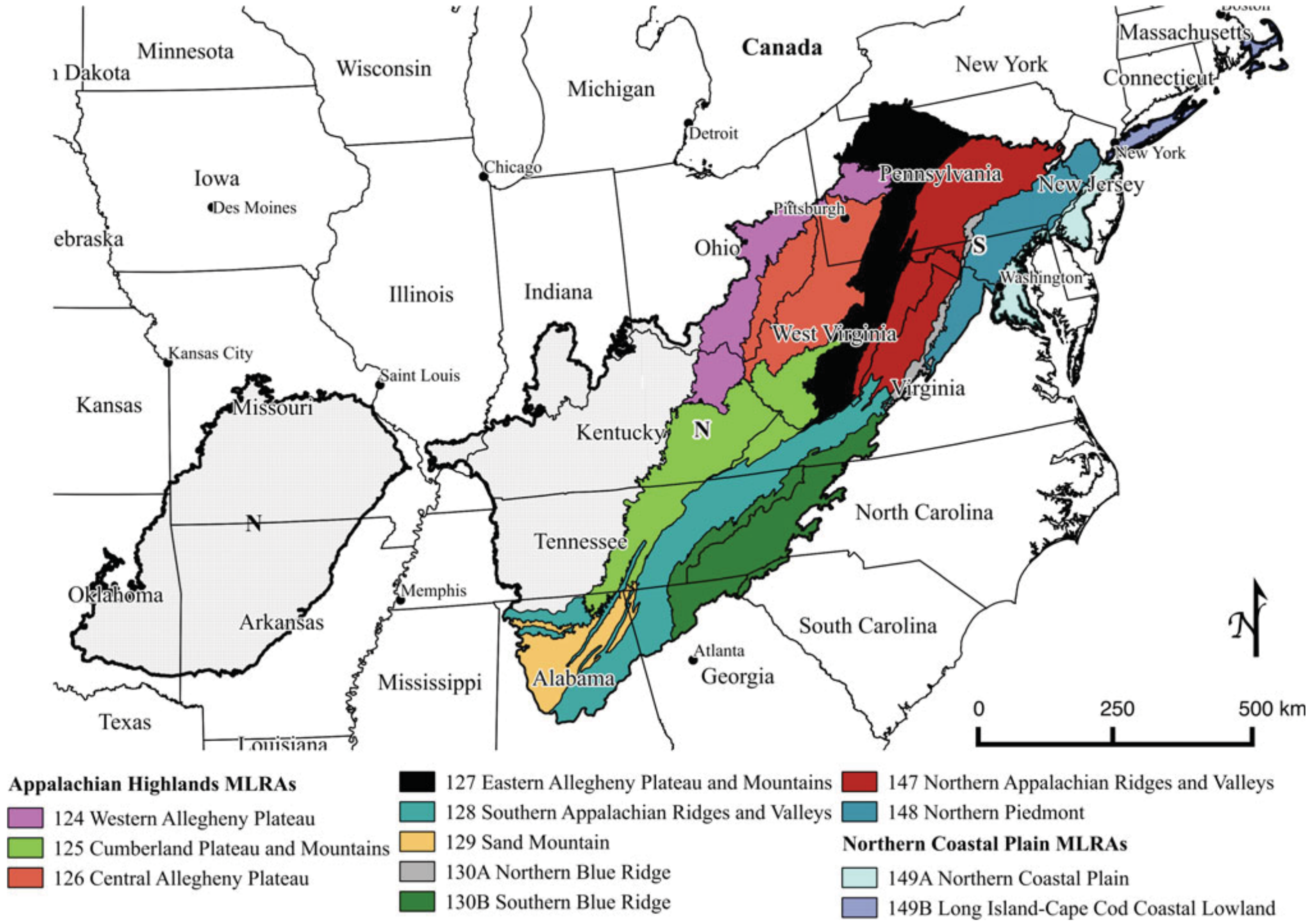

Fig. 12.12 Extent and distribution of MLRAs in the Appalachian Highlands (MLRAs 124, 125, 127, 128 130A, 130B, 128, 147, 148) and the Northern Coastal Plains (MLRAs 149A and 149B) within LRRs N and S

12.3.9 Physiography

Within the western part of this region, the Appalachian Plateau has narrow, level valley floors, rolling ridgetops, and hilly to steep ridge slopes. Elevations range from 200 m on the Ohio River flood plain to 1200 m in the mountains. Local relief is about 50–100 m. To the east, the Allegheny Front marks the termination of the plateau on the edge of the Appalachian Ridge and Valley Province. The Valley and Ridge Province is an area of folded and faulted parallel ridges and valleys that are carved in anticlines, synclines, and thrust blocks. Parallel sandstone and shale ridges are separated by narrow to moderately broad limestone and shale valleys. The ridges are strongly sloping to extremely steep and have narrow, rolling crests. The valleys are mainly level to strongly sloping. Elevations range from 100 m in the valleys to 800 m on the ridges and mountains. The Blue Ridge Mountains are rugged with steep slopes, sharp crests and narrow valleys. Streams have deeply dissected the landscape, flowing through gorges and gaps in the mountains. Broad valleys, basins, and rolling hills are extensive throughout the area. Elevations range from 250 m along the Potomoc River to 2010 m on Mt. Mitchell at the crest of the Great Smoky and Black Mountain Ranges (USDA 2006).

12.3.10 Geology

The Appalachian Highlands resulted from tectonic activity through the collision of tectonic plates from 480 to 220 million years ago. At about 480 million years ago, the oceanic plate began sinking underneath the North American continental plate below the current location of the Appalachian Mountains. Mountain building collisions continued including collisions of continental masses ancestral to North America and Africa about 270 million years ago. As a result, there is considerable metamorphism of the rocks, and in some places, igneous plutons formed and are scattered throughout the region. These igneous plutons are more resistant to weathering than surrounding rocks and are elevated relative to the surrounding less resistant metamorphic or sedimentary rocks at the surface (e.g., Looking Glass Rock).

The bedrock geology in the Blue Ridge Mountains consists mostly of Precambrian metamorphic rock formations with a few small bodies and of igneous and sedimentary rocks. The degree of metamorphism varies but generally decreases westward from gneiss, schist, and amphibolite to interbedded metasandstone, slate, phyllite, metasiltstone, and metaconglomerate. To the west of the Blue Ridge Mountains, the Valley and Ridge Province formed from tilted, Cambrian to Pennsylvanian aged sedimentary strata with varying resistance to erosion. The differential erosion resistance of the parent rocks is reflected in the topography with resistant sandstone and conglomerate bedrock on ridges, and less resistant shale and limestone underlying the valleys. The topographic orientation of the Valley and Ridge Province is dominantly northeast to southwest. West of the Valley and Ridge Province lies the Cumberland Plateau to the south and Allegheny Plateaus to the north. Both are underlain by relatively planar cyclic beds of sandstone, siltstone, clay, shale, and coal of Pennsylvanian age. The major river valleys are filled with unconsolidated deposits of clay, silt, sand, gravel, with outwash and glaciofluvial deposits in the northwestern part of the area in Pennsylvania. The lower slope positions of most hills are covered with a layer of colluvium.

The northern Piedmont geology includes an ancestral Atlantic Ocean basin with Triassic sandstone, shale, and conglomerates similar to those found in the western British Isles. The Piedmont geology is the result of the mountain building processes associated with a subduction zone where the oceanic crust slid under the continental crust. The resulting rocks in the Piedmont are metamorphic and are less resistant to erosion than some of the igneous rocks found in the Blue Ridge Mountains to the west. The northern boundary of the northern Piedmont marks the terminus of the Wisconsinan glaciers, but earlier periods of glaciation extend further south into New Jersey and eastern Pennsylvania.

12.3.11 Vegetation

This vast area supports deciduous forest vegetation. White oak, red oak, black oak, hickories (*Carya* spp.), and associated upland hardwoods are the major species. Scarlet oak, chestnut oak (*Quercus montana*), hickories along with scattered Virginia pine (*Pinus virginiana*), shortleaf pine, and white pine (*Pinus strobus*) grow on dry ridges and on the shallower soils. Yellow-poplar, black walnut (*Juglans nigra*), northern red oak, red maple (*Acer rubrum*), and other species requiring abundant water grow in sheltered coves, on footslopes and on north-facing slopes. Shagbark hickory, bitternut hickory, pignut hickory, and mockernut hickory (*Carya tomentosa*) also occur on these landforms. Oaks, blackgum (*Nyssa sylvatica*), flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), Virginia pine, pitch pine (*Pinus rigida*), and shortleaf pine grow mostly on ridgetops. Willows (*Salix* spp.), sycamore, sweetgum, and river birch (*Betula nigra*) grow on flood plains. In the Northern Piedmont, black walnut and black cherry (*Prunus serotina*) grow on the well-drained floodplain soils.

At higher elevations in the Blue Ridge Mountains, above 1525 m, red spruce and Fraser fir are the dominant tree species. In some areas at high elevation, grassy and heath "balds" are evident. These large meadows are dominated by grass species and are home to rare shade-intolerant plant species. Heath balds which often have organic, low pH or excessively drained soils support many shrubs including mountain laurel (*Kalmia latifolia*), rhododendron (*Ericaceae* spp.), hawthorn (*Crataegus* spp.), blueberry (*Vaccinium* spp.), and sandmyrtle (*Kalmia buxifolia*).

12.3.12 Soils

Most of the region's soils have a mesic temperature regime. However, the soils in the Blue Ridge Mountains above 1280 m have a frigid soil temperature regime. The soil moisture regime is udic, and the soils have mixed or siliceous mineralogy. Most of the soils are shallow in the uplands and deep to very deep in the valleys. Many are excessively drained due to coarse textures and fractured parent materials while others are somewhat poorly drained with fine textures and are skeletal. Erosion is a concern throughout the region on steep slopes. Most of the soils in the region are Ultisols (50 %), Inceptisols (28 %), and Alfisols (18 %). Entisols, Mollisols, Spodosols, Vertisols, and Histosols make up the remaining 4 % of the soils in this region. Hapludults are most common (33 %) and found in a variety of environments ranging from rolling and steep terrain on the Cumberland Plateau to valley floors in the Valley and Ridge Province. More deeply developed Paleudults (7 %) are common throughout the region, particularly in the Appalachian Ridges and Valleys where they form on areas underlain by limestone, on the lower footslopes, and in valleys. Fragiudults (6 %) are found throughout this region, particularly in the Eastern Allegheny Plateau and Northern Appalachian Ridges and Valleys.

Dystrudepts (26 %) formed from residuum or colluvium are common on hills, mountains, and ridges and can also be found on alluvium along major streams. Hapludalfs (15 %) formed on hillsides from parent materials with a high base saturation including limestone, calcareous shales, and colluvium.

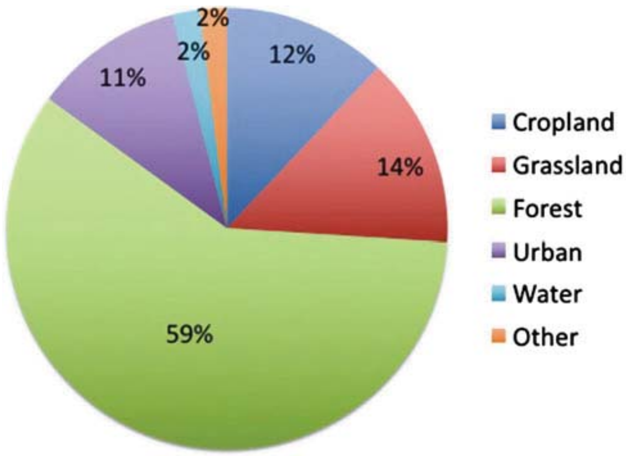

Fig. 12.13 Land use in the Appalachian Highlands

12.3.13 Land Use

Land use in the Appalachian Highlands is predominantly forest (59 %) (Fig. 12.13). Cropland and managed grasslands make up 26 % of the land area. A small amount of land is being used for coal extraction via subsurface and surface mining operations. The northern part of this region includes three of the top five coal producing states that produce 25 % of the coal produced in the USA (US Energy Information Administration 2013). With recent advances in horizontal well drilling coupled with hydraulic fracking, gas production from shale deposits in the northeastern part of this region is projected to be 115,000 m^3 day^{-1} in 2020 (Considine et al. 2009).

12.4 Northern Coastal Plain

The Northern Coastal Plains occur in the eastern portion of LRR S and include two MLRAs: Northern Coastal Plains (MLRA 149A) and Long Island-Cape Cod Coastal Lowland (MLRA 149B). Much of this area is in eastern Maryland, southwest and central New Jersey, Long Island, New York, and Cape Cod, Massachusetts (Fig. 12.12).

12.4.1 Climate

Average annual precipitation ranges from 1015 to 1220 mm. Most of the precipitation falls as high-intensity thunderstorms during summer. In the coastal plain, the seasonal snowfall ranges from little to none in the southern part of the region to as much as 750 mm in the northern part. The average temp is 10–14 °C. Due to the low elevation, areas adjacent to the coast and in river valleys are subject to storm surges associated with hurricanes.

12.4.2 Physiology

The Coastal Plain is low and partially submerged with many islands and marshes along the coast. The province consists of a series of south easterly dipping layers of unconsolidated sands and clays. Eroding streams have dissected the area, leaving a series of terraces across the landscape, which are most prevalent away from the coast where the terrain is more rolling. Nearest the coast the area is nearly level. Elevation ranges from sea level to 100 m, but local relief is 2–10 m. The north and west boundary between the Coastal Plain and the Piedmont Plateau has been identified as the fall line. This is an ill-defined boundary between the crystalline rocks of the Piedmont and the unconsolidated sediments of the Northern Coastal Plain. At the fall line, streams descend into the easily eroded unconsolidated sand and clay sediments of the Northern Coastal plains (Maryland Department of State Planning 1973).

12.4.3 Geology

Unconsolidated sediments deposited in the near-shore environment of late Cretaceous seas as they transgressed and regressed underlie most of this area. These materials overlay the rocks of the eastern Piedmont and extend submerged for another 125 km across the Atlantic Continental Shelf. In the northern part of this region, the southern extent of the Wisconsinan glacial advance is marked by remnants of moraines in the central lowlands of New Jersey, Long Island, and Cape Cod and sandy outwash plains that extend into the Atlantic Ocean. Sand dunes and tidal marshes are extensive along the coastline.

12.4.4 Vegetation

This area has a mixture of oak-hickory (*Quercus*-*Carya*) and other hardwoods, white pine-red pine (*Pinus strobus*-*Pinus resinosa*) forest, and pine-oak woodlands. Of particular interest in the region is the "pine barrens," which is an expansive area that is dominated by pitch pine. These forests are found in Long Island on sandy outwash and on undeveloped stretches of the bay side of barrier islands on the Atlantic shore. Upland forests in this region are characterized by a continuous gradient from pure pitch pine stands where the soils are sandy and nutrient poor at one end that grade into pure oak stands at the opposite end where soils are loamy and have a greater nutrient supply (McCormick 1979). Under the forest overstory, well-developed understories are dominated by scrub oak (various species of *Quercus*), mountain laurel, huckleberry (*Gaylussacia* spp.), and blueberry.

12.4.5 Soils

Over half of the soils in this region are Ultisols (58 %) while the majority of the remaining soils are Entisols (19 %), Inceptisols (15 %), and Histosols (5 %) with minor amounts of Spodosols (2 %) and Alfisols (1 %). The soils have a mesic soil temperature regime, and aquic or udic soil moisture regime, and mixed, siliceous, or glauconitic mineralogy. The soils are very deep, excessively to very poorly drained, and primarily loamy or sandy in texture. Hapludults are the most abundant Great Group found in the region and have formed in fluviomarine deposits on terraces, flats, near-shore marine deposits, sandy eolian deposits and silty loess deposits. Quartzipsamments occur on landscapes with thick eolian or marine sand deposits on dunes and flats along streams on sandy outwash plains. Dystrudepts, very deep and well-drained soils, are common in the glacial, coarse-textured outwash deposits. Haplosaprists formed in freshwater bogs and along stream corridors while Sulfihemists formed in organic deposits in estuarine and tidal marshes.

12.4.6 Land Use

The largest land use in this area is urban development (40 %, Fig. 12.14) in and surrounding large cities including Washington D.C., Baltimore, and New York City. Outside of these urban areas, much of the cropland (9 % of region) supports these urban areas by growing vegetables, corn, soybeans, small grains, and fruits. Turf farms and nurseries also serve the expanding urban sector. Forests occupy 23 % of the area. In the larger forested areas, pine pulpwood and hardwood lumber are the principle forest products. The coastal plain sediments are a source of groundwater for the most urbanized region of the USA. Erosion and nutrient runoff related to urban development and agriculture have degraded streams and subsequently the Chesapeake Bay.

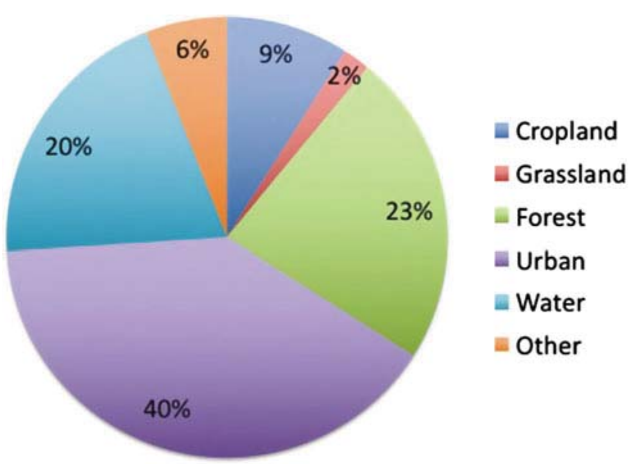

Fig. 12.14 Land use in the Northern Coastal Plains

12.5 Summary

The East and Central Farming and Forest Region (Land Resource Region N) and the Atlantic Basin Diversified Farming Region (Land Resource Region S) comprise 718, 550 km^2 in the central and eastern USA and include the Interior Highlands, Interior Plains, Appalachian Highlands, and the Northern Coastal Plains. These regions include nearly level to gently rolling plains in the Interior Plains and the Northern Coastal Plains and rugged hills and mountains in the Interior Highlands and Appalachian Highlands. The climate is mild with mean annual temperature ranging from 8 to 17 °C and rainfall is ample ranging from 915 to 3015 mm, with the greatest amount of precipitation occurring in the mountains in the Appalachian Highlands. The underlying bedrock consists of sedimentary rocks including limestone, dolostone, sandstone, siltstone, and shale in the Interior Highlands and in the Interior Plains, metamorphic rocks including gneiss, schist, amphibolite, and slate in the Appalachian Highlands, and unconsolidated coastal plain sediments and lesser amounts of glacial till and outwash in the Northern Coastal Plains. Diverse hardwood forests comprising several species of oaks and hickories occur throughout these regions. Yellow-poplar, black walnut, and northern red oak occur in sheltered coves and north-facing slopes of the Interior Plains and Appalachian Highlands. Pines occur on the drier slope positions or on coarse-textured soils except in the Interior Plains. Ultisols are the single most extensive soils of Land Resource Regions N and S comprising more than 40 % of the land area. Alfisols are the second most extensive soils (29 %) in Land Resource Region N and Inceptisols are the second most extensive soils (34 %) of Land Resource Region S. Other important soil orders include Entisols and Mollisols. Forests are the single most important land use followed by cropland and grassland. Urban land is more extensive near major metropolitan areas of Washington D.C., Baltimore, and New York City in the Northern Coastal Plains.

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