

------ Level III ecoregion boundary ---- County boundary

Level IV ecoregion boundary -State boundary \_----



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Oklahoma State University), David V. Peck (U.S. Environmental Protection Agency), and Dale Splinter (Boone Pickens School of Geology, Oklahoma State University). CITING THIS POSTER: Woods, A.J., Omernik, J.M., Butler, D.R., Ford, J.G., Henley, J.E., Hoagland, B.W., Arndt, D.S., and Moran, B.C., 2005, Ecoregions of Oklahoma (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,250,000). This project was supported in part by funds from USEPA Region 6, Water Quality Cooperative Agreement under the provisions of Section 104(b) (3) of the Clean Water Act to the Oklahoma Water Resources Board (through the Office of the Secretary of Environment, State of Oklahoma). Assistance from the private sector is acknowledged in the form of

Ron Jarman, Ph.D., on loan from Apex Environmental, Inc. Electronic versions of ecoregion maps and posters as well as other ecoregion resources are available at http://www.epa.gov/wed/pages/ecoregions.htm



In Oklahoma, Ecoregion 25 consists of smooth to irregular, semiarid plains that are studded with playas and stock ponds, widely mantled by loess or sand, and underlain by semiconsolidated sand and gravel deposits. Elevations range from 2,400 to 4,800 feet, and are highest in the west. Overall, Ecoregion 25 is less dissected than the Southwestern Tablelands (26) and higher in elevation than the Central Great Plains (27). Precipitation increases eastward, averages only 17 to 20 inches annually, and is erratic. Natural vegetation is mostly short grass prairie, but sagebrush-bluestem prairie is native on scattered sand plains and sand hills. Overall, natural regetation is distinct from the mixed grass and tall grass prairies of moister ecoregions to the east. Today, cropland (mostly winter wheat and grain sorghum) is xtensive. Rangeland (widely overgrazed) is found in areas that are too sandy or steep for farming. Both cropland and rangeland require proper management to limit vind erosion. Groundwater irrigation, drawing down the Ogallala Aquifer, has become increasingly common in recent decades. This has caused many streams to go y, some to the point that no defined channels remain. The remaining streams and pools are shallow and have sandy substrates. Conditions in these intermittent reams are intensely stressful for many species of fish. As a result, both the diversity and richness of fish species are lower than in any other ecoregion in Oklahoma. he most common fishes in Ecoregion 25 are the red shiner and the plains killifish. The Rolling Sand Plains ecoregion consists of plains, sand hills, depressions, and scattered, mostly stabilized, dunes. Small interdune wetlands occur and are important habitat for many wetland species, including migrating shorebirds and waterfowl. Soils have developed from sand and silt deposits laid by rivers and ter reworked by wind. They naturally support sand sagebrush-bluestem prairie. Ecoregion 25b is lithologically, physiographically, and floristically unlike the rest of coregion 25 in Oklahoma. Today, native range is found in areas too sandy or too steep for farming. Elsewhere, irrigated cropland growing grain sorghum occurs. gricultural conversion and heavy grazing have imperiled animals dependent on the native sand sagebrush–prairie habitat, such as the lesser prairie chicken. The Moderate Relief Plains ecoregion is composed of irregular, rolling to broken plains. Slopes are greater than in the cropland-dominated Canadian/Cimarron High Plains (25e). Natural vegetation is short grass prairie; it is unlike the sand sagebrush-bluestem prairie of the lithologically and raphically distinct Rolling Sand Plains (25b). Today, less rugged areas have been widely overgrazed. The nearly level, semiarid Canadian/Cimarron High Plains are studded with playas, underlain by semiconsolidated sediments, and widely mantled by loess. Drainage is not well established, and is often internal. Rainfall is either absorbed by the soil or flows via ephemeral, shallow channels to playas where it evaporates or percolates into the ground. Natural vegetation is short grass prairie; it is adapted to the ecoregion's limited, erratic precipitation and high evaporation rates. Today, groundwater-irrigated cropland, mainly growing wheat and grain sorghum, is extensive. Rangeland is found on land that is too sandy or too rugged for farming; it has been widely overgrazed. Concentrated hog feeding operations occur. Playa wetlands are important habitat for wetland species including migratory waterfowl.

## 26. Southwestern Tablelands Ecoregion 26 is made up of dissected plains, hills, canyons, escarpments, plains, breaks, buttes, mesas, and terraces. It is more rugged than neighboring ecoregions. Rangeland and grassland occur but, unlike adjacent ecoregions, there is little cropland. In Oklahoma, mean annual rainfall ranges from 16 to 28 inches and is highly variable from year to year. Natural vegetation in this semiarid to dry-subhumid area is mostly short grass prairie; there is also mesquite-buffalograss in the southwest, sand



27. Central Great Plains

sagebrush-bluestem prairie on dunes, and juniper-pinyon woodland in the western Panhandle. Small streams are often dry except after storms, but short, spring-fed runs occur. The diversity and richness of fish species is greater than in the High Plains **26a** The **Canadian/Cimarron Breaks** are rugged and used for grazing. Dissected canyons, escarpments, hills, buttes, terraces, and dunes occur. Ecoregion 26a in Oklahoma is widely underlain by easily eroded, semiconsolidated sediments of the Tertiary Ogallala Formation; lithology contrasts with the Permian-age red le, sandstone, and siltstone that dominates the less rugged Central Great Plains (27). Natural vegetation is mostly short grass prairie, but dunes along major streams poprt sand sagebrush-bluestem prairie. Canyons provide shelter and water that is missing from the High Plains (25). Springs occur in canyons and are fed by the allala Aquifer; recent drawdown of the aquifer has caused many springs to disappear, thereby reducing stream flow and wetland size. The Flat Tablelands and Valleys ecoregion consists of nearly level land that is surrounded by the prominent buttes, badlands, and escarpments of neighboring ecoregions. It is a mosaic of cropland and rangeland that contrasts with the rangeland of the more rugged Canadian/Cimarron Breaks (26a) and lling Red Hills (27q). In the Oklahoma portion of the Flat Tablelands and Valleys (26b), the main crops are wheat, grain sorghum, and alfalfa. The Caprock Canyons, Badlands, and Breaks ecoregion extends eastward into Oklahoma from the eroded edge of the High Plains (25) in Texas. Hills, buttes, ledges, canyons, and badlands are characteristic. Rangeland is common. Both physiography and land use are different from adjacent, less rugged coregions in the Central Great Plains (27). Ecoregion 26c is underlain by Permian red shale, gypsum, sandstone, siltstone, dolomite, and salt. Soils derived from ypsum support a distinctive flora, including Pinchot juniper, that is adapted to drought and high concentrations of salt. Rivers are saline and shallow. The Mesa de Maya/Black Mesa ecoregion includes nearly flat, basalt-capped mesas as well as deep canyons, knobs, dissected plains, and breaks that have been cut into sandstone, shale, and thin limestone. It includes Black Mesa, Oklahoma's highest point at 4,973 feet. Spring-fed perennial streams occur and are more common than in other parts of Ecoregions 25 and 26 in Oklahoma; they usually disappear into alluvium before reaching the Cimarron River. Black Mesa



(27k) protrude through adjacent portions of treams in the Wichita Mountains (27k) Pleistocene Sand Dunes (271) occur on the ave courser substrates, higher gradients, and north side of the North Canadian River and less turbidity than elsewhere in the Central other major rivers flowing through the Great Plains (27). As a result, they support a Central Great Plains (27). Sandy channels distinctive group of fish species, including with intermittent flow occur. the logperch, Oklahoma's largest darter.



Photo: ! Noel Burkhead

stops or nearly stops in the summer, but scattered pools endure and serve as summer refuges for aquatic fauna. Salt or gypsum deposits and leaching produce high mineral concentrations in many streams and rivers. Numerous streams have been channelized and/or impounded resulting in the loss of riparian forest, unnatural flow regimes, entrenchment, bank erosion, substrate alteration, and fauna modification. In Ecoregion 27, the plains killifish occurs in large numbers in some streams. The most common minnows include the red shiner, sand shiner, suckermouth minnow, and the plains minnow; the endemic (and threatened) Arkansas River shiner also ccurs. Slenderhead darters are widespread in Ecoregion 27. Freckled madtoms and isolated pockets of orangethroat and dusky darters also occur. The Red River pupfish is found in pools and backwaters of sandy-bottomed streams and rivers where temperature, salinity, and alkalinity are high. 27d The Prairie Tableland ecoregion is nearly level, dominated by cropland, and underlain by Permian red shale, soft sandstone, and siltstone. Natural vegetation is mixed grass prairie; it is distinct from the sand sagebrush-bluestem prairie of Ecoregion 271 and the oak savanna of Ecoregion 29. Ecoregion 27d has greater natural vegetation density, less rainfall variability, less evaporation, and receives more precipitation than Ecoregions 27h and 27m. Rainfall is generally sufficient for mall grains. This is the wheat belt of Oklahoma: deep, fertile soils are used to produce winter wheat, grain sorghum, alfalfa, and in the east where rainfall is greatest. bybeans. Ecoregion 27d is as flat as the Red River Tablelands (27m), but grows fewer row crops. Land use and terrain are distinct from neighboring Ecoregions 27l, n, 270, 27q, 28a, and 29. Soils are not as sandy as Ecoregions 29b, 29c, or 29h. Broad, shallow, low gradient channels with silty bottoms are common. They often go during the late summer and autumn. At other times, turbid water over one meter deep may occur in larger streams. Uncommon, short stream reaches with gravel, cobble, or bedrock substrates support a few darter species, freckled madtoms, and suckermouth minnows. Most wildlife is confined to the borders of streams. The **Red Prairie** is nearly level to rolling and underlain by Permian sandstone, shale, gypsum, and siltstone. It is physiographically distinct from the flatter **27h** The **Ked Frairle** is hearly level to forming and undertain by Fermian statistical, Syptems, and the more irregular Broken Red Plains (27i). Ecoregion 27h has greater rainfall variability, warmer summer temperatures, less ipitation, and more evaporation than the topographically similar Prairie Tableland (27d). Upland native vegetation is mostly mesquite-buffalograss, but shinnery is tive on sandy areas; natural vegetation is distinct from Ecoregions 27d, 27l, 27o, 27q, and 29. Gypsum ledges and escarpments occur and have distinctive flora.

oday, cropland is extensive, but rangeland is found in less favorable areas. Wheat is the main crop, grain sorghum is found on sandier soils, and alfalfa is grown for se as winter feed. Overall, cropland is more common than in Ecoregion 27q, but irrigated cotton is not as extensive as in Ecoregion 27m. Highly mineralized springs re locally common. Streams originating in or flowing through the Flowerpot Shale have very high sodium chloride concentrations, whereas those from the gypsum arst of the Blaine Formation are high in calcium sulfate. The fauna and microflora of the two spring types are distinctly different. The Red River pupfish is adapted to ve in the saline, warm, slowly moving water of southwestern Oklahoma; through accidental introduction, it is spreading northward through western Oklahoma. The grass- and shrub-covered Broken Red Plains ecoregion is mostly underlain by Permian-age sandstone and shale. It is more irregular than Ecoregions 7d, 27h, and 27m, but has much less relief than Ecoregion 27k. Upland natural vegetation is mesquite-buffalograss. The density of mesquite increases outhward into Texas, where its prevalence may be the result of grazing pressure and climate. Ecoregion 27i lacks the upland tree cover found on sandier soils in Ecoregions 270, 29b, and 29c; native vegetation is also distinct from Ecoregions 27d, 27k, 27l, 27q, and 29h. Today, Ecoregion 27i is a mosaic of rangeland and the Central Great Plains (27). Physiography, cropland; rangeland is more common than in Ecoregions 27d, 27h, and 27m. Its growing season is longer than north of the Wichita Mountains in Ecoregion 27d. lithology, water quality, and flora and fauna assemblages are unlike other parts of the common Higher peaks are steep boulder-strewn and have many rock outcrops. Summits are sparsely wooded. South-facing slopes with thin story soil common. Higher peaks are steep, boulder-strewn, and have many rock outcrops. Summits are sparsely wooded. South-facing slopes with thin, stony soil support scrubby woodlands dominated by post oak and blackjack oak; many glades occur. North-facing slopes are less xeric and have denser tree cover than south-facing slopes. Short grasses and scattered prickly pear are found on overgrazed lowlands. Stream substrates typically consist of very coarse sand, gravel, or cobble. Streams support a distinctive group of species not widely found elsewhere in Ecoregion 27, including the bigeye shiner, southern redbelly dace, stoneroller, black and golden redhorses, spotted bass, logperch, and orangethroat darter. Physiography, lithology, water quality, and flora and fauna assemblages are distinct from nearby ecoregions in the Central Great Plains (27). Today, Ecoregion 27k is used for recreation, military purposes, and grazing. It includes Wichita Mountains National Wildlife Refuge. 271 Active, barren, or stabilized **Pleistocene Sand Dunes** are found along, and usually to the north of, most major rivers in the Central Great Plains (27); they lack well developed drainage networks and are physiographically and lithologically unlike the rest of Ecoregion 27. Deep, loose, permeable to rapidly meable, sandy soils are characteristic. They widely support sand sagebrush-bluestem prairie, but where moisture is sufficient, oak savanna stabilizes dunes. Small erdune wetlands occur where the water table is high; they are important habitat for migrating shorebirds and waterfowl. Grazing is the most common land use, but ated cropland is found on soils that can retain sufficient moisture. Local overgrazing has occurred, promoting wind erosion. Springs are abundant, especially at the act between sand and the underlying Permian redbeds. Ecoregion 271 consistently supports large populations of rodents, rabbits, and birds; it is one of the most important areas for game in Ecoregion 27. During prolonged cold and wet periods, the Pleistocene Sand Dunes (271) ecoregion provides important shelter to wildlife.

The Red River Tablelands ecoregion is nearly level, dominated by irrigated cropland, and underlain by Permian-age shale, dolomite, and gypsum. This is 27m The ked kiver fablelands ecolegion is hearly level, dominated by inighted crophand, and discretion of the cotton belt of Oklahoma. Ecoregion 27m is flatter, and has more crophand and less rangeland than Ecoregions 26c, 27h, 27i, 27k, 27l, 27o, and 27q. Irrigation water is largely derived from solution cavities in underlying gypsum beds. Overuse of these aquifers has caused serious depletion problems during droughts. Ecoregion 27m has greater rainfall variability, warmer summer temperatures, more evaporation, and receives less precipitation than the Prairie Tableland (27d). Jpland native vegetation is mostly mesquite-buffalograss, but mixed grass prairie also occurs; natural vegetation is distinct from Ecoregions 27d, 27l, 27o, 27q, and 29. Ecoregion 27m has a higher proportion of southwestern flora than elsewhere in Oklahoma; lotebush, ephedra, tobosa grass, agarita, and pencil cholla occur. The Gypsum Hills ecoregion includes breaks, escarpments, gorges, ledges, caves, and canyons that were formed by the differential erosion of underlying gypsum, shale, dolomite, fine sand, and rock salt. Gypsum is widely exposed and especially significant; it is prone to chemical erosion, forms karst features uch as solution caves and cavities, and impacts both soil and vegetation. Solution caves are important shelter and hibernating sites for wildlife and serve as summer bosts for bats. Gypsum-fed springs strongly affect surface water quality and quantity. No other part of Ecoregion 27 in Oklahoma is impacted as much by gypsum ind none has the same mix of landform, lithology, vegetation, water quality, and water availability. Soils derived from gypsum support a distinctive flora adapted to gorous conditions typified by drought and high concentrations of salt. Uplands are covered by mixed grass prairie and scattered trees; eastern redcedars are becoming reasingly common. Stream substrates are composed of bedrock, cobble, or gravel. The diversity of fish and macroinvertebrate populations in small, spring-fed,

The Cross Timbers Transition consists of rough plains that are covered by prairie grasses and eastern redcedar, scattered oaks, and elms. Terrain and vegetation are transitional between the less rugged, grass-covered ecoregions to the west and the hilly, oak savanna of Ecoregions 29a and 29h to the east. Since the early 19th century, both the abundance of upland trees and the number of tree species have greatly increased due, in part, to fire suppression. During the same period, natural riparian forests and wetlands have been degraded or lost due to channelization and land use changes. Today, land use is a mixture of rangeland and cropland. Rangeland is more common than in the Prairie Tableland (27d) and Red Prairie (27h). The growing season is shorter than in the Broken Red Plains (27i). Stream substrates are more rocky and less muddy than in Ecoregions 27d, 27h, and 27i.





25b 25b

# Ecoregions of Oklahoma

KANSAS

Oklahoma C

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Medicine Lodge

supports many end-of-range flora and fauna species. Here, Great Plains vegetation intergrades with foothill flora of the Rocky Mountains. Mesa tops are covered with

The Central Great Plains (27), in Oklahoma, are largely underlain by red, Permian-age sedimentary rocks and include scattered hills, breaks, salt plains, low mountains, gypsum karst, sandy flats, and sand dunes. Landform diversity is greater and and grain sorghum. In addition, soybeans are grown in the east, where rainfall is greatest, and cotton occurs, especially on irrigated, nearly flat land in the south. Rangeland and grassland are found in more rugged areas and are being invaded by eastern redcedar. Extensive oil and gas fields occur. Typically, after heavy rains, streams flow strongly and are laden with suspended sediment. Streams draining rangeland carry less sediment load than those that are downstream of cropland. Flow

yon tributaries to the Cimarron River is greater than in nearby ecoregions. Disjunct populations of the Arkansas darter notably occur near gypsum springs.

27. Central Great Plains (continued) The **Salt Plains** ecoregion is composed of salt flats, scattered hummocky 27p mounds, islands, and lakes. High surface and subsurface salinity, extensive barren areas, and halophytic vegetation differentiate it from other ecoregions. Plant life is poor, both in number of species and number of plants; seapurslane, western seepweed, and an algae species are the only plants on the salt plains proper, whereas little bluestem occurs on isolated mounds. Animal life on the salt plains is limited to a few species of insects, birds, and fish. Amphibians and reptiles are restricted to grass-covered islands and mounds. Ecoregion 27p includes the Salt Plains National Wildlife Refuge, and provides nesting and foraging habitat for shorebirds including the least tern, federally listed as an endangered species. The Rolling Red Hills ecoregion includes gently to steeply sloping hill 27q breaks, and gypsum karst features (e.g., solution caves). It is mostly used as rangeland, but cropland occurs on suitable, nearly level sites. In contrast, Ecoregions The Rolling Red Hills (27q) ecoregion is mostly underlain by red, Permian-age

## 28. Flint Hills Ecoregion 28 includes the western edge of tall grass prairie in Oklahoma; natural vegetation is unlike the oak savanna of

the Cross Timbers (29) and the mixed grass prairie that dominates the Central Great Plains (27). Its grass-covered, open, low hills, cuestas, and plains are underlain by cherty limestone and shale. Ecoregion 28 is used for grazing. Cropland is restricted to river valleys and stonefree uplands; it is far more limited than in Ecoregion 27. Mean annual precipitation is 38 to 42 inches. Springs are common enough to increase summer base flow in some streams. Ecoregions 28 and 29 share many of the same fish species. The grass-covered **Flint Hills** are underlain by cherty limestone and **28a** The grass-covered Fint finds are common and unsuited to farming. Rangeland and grassland predominate. Extensive cropland and major hydrological modifications do not occur. As a result, many natural channels remain nearly intact. Nonarable soils derived from cherty limestone dominate the Flint Hills (28

## 29. Cross Timbers

poor assemblages of aquatic fauna. Two types of streams are common. The first is characterized by a mixture of shaded riffles, runs, and pools that have gravel or cobble substrates. The second stream type has lower gradients and is found downstream of the first; it is characterized by wide, shallow, sand-choked channels. In the summer, surficial flow is often absent from wide, sandy, lower reaches. Erratic stream flow has led to the construction of many reservoirs. Generally, stream conditions in Ecoregion 29 are more stressful for fish than in eastern Oklahoma, but less rigorous than in the west. As a result, Ecoregion 29 lacks many sensitive eastern fish species as well as some river species. Other species are shared with adjacent regions. Common minnows include the red, sand, and redfin shiners and the suckermouth minnow. The redfin and orangethroat darters, smallmouth buffalo, river carpsucker, black and golden redhorses, and channel and flathead catfishes occur in many streams. **29a** The hills, cuestas, and ridges of the Northern Cross Timbers are naturally covered by a mosaic of oak savanna, scrubby oak forest, eastern redcedar, and tall grass prairie. Native on porous, course-textured soils derived from sandstone are post oak, blackjack oak, and understory grasses. Tall grass prairie naturally occurs on fine-textured soils derived from limestone or shale. Overall, far more oak savanna occurs than in the Central Great Plains (27), Flint Hills (28), or Central Irregular Plains (40). Floristic variety is less, vegetation is sparser, and growing season is shorter than in the Eastern Cross Timbers (29b). Today, livestock farming is the main land use; cropland is less extensive than in Ecoregions 27 and 40, but rangeland is less widespread than in Ecoregion 28. Soils are highly erodible when disturbed. Large oilfields were developed in the early 20th century; associated brine, drilling mud, and petroleum waste products have increased salinity in many streams. Streams are typically shallow and have sandy substrates; they are habitatpoor and have lower fish and macroinvertebrate species richness than Ecoregion 37e. However, some stream reaches have deep pools, riffles, and bedrock, boulder, cobble. or gravel substrates; these reaches have greater species richness and more

The rolling hills, cuestas, and ridges of the **Eastern Cross Timbers** are naturally covered by oak savanna, scrubby oak forest, eastern redcedar, and tall grass prairie and are underlain by sand, shale, clay, sandstone, calcareous shale, and limestone. Ecoregion 29b is lithologically and physiographically distinct from the Grand Prairie (29d) and Arbuckle Mountains (29i). It is both floristically and lithologically unlike the Cretaceous Dissected Uplands (35d) to the east. Post oak and blackjack oak are dominant on sandy soils; finer soils support grasses. Tree height and density are typically greater than in the drier Western Cross Timbers (29c) and Northwestern Cross Timbers (29h). Floristic variety, vegetation density, and growing season is greater than in the Northern Cross Timbers (29a). Today, livestock farming is the main land use, but some cropland also occurs. Abandoned farmland is common. The rolling hills, cuestas, and ridges of the Western Cross Timbers are Ecoregion 29. Westward, in the plains, they with pastureland in Ecoregion 29a. naturally covered by oak savanna, scrubby oak forest, and prairie and are are restricted to wooded riparian areas underlain by interbedded sandstone, shale, and clay. Blackjack oak and post oak are dominant on sandy soils, but finer soils support grasses. Ecoregion 29c is physiographically and floristically unlike the Grand Prairie (29d) and Broken Red Plains (27i), and lithologically and physiographically distinct from the Arbuckle Mountains (29i). Tree height and density are less than in the moister Eastern Cross Timbers (29b). Today, land use is a mixture of livestock farming and cropland. Main crops are small grains, sorghum, and peanuts. Growing season is longer than to the north of the Arbuckle Mountains (29i). Oil production occurs. **29d** The **Grand Prairie** ecoregion is nearly level to rolling and has incised, meandering streams. Its clayey, very slowly permeable soils developed

eroded away to expose underlying clays, American elm, hackberry, and pecan are have bedrock or gravel substrates. streams, ravines, ledges, and waterfalls occur. and more common than in Ecoregion 29g.

of woodland, pastureland, and rangeland. It separates moister, more forested, eastern pollution- and habitat-intolerant species than shallower streams in Ecoregion 29a. ecoregions from drier, prairie-dominated, western areas. Many impoundments occur. Fox squirrels and other forest animals inhabit Scrubby forests and woodlands containing Oklahoma's wooded uplands as far west as post and blackiack oaks presently alternate from the residuum of Cretaceous-age limestone, marl, clay, and shale. On uplands, The spring-fed, cool, clear, perennial Limestone, dolomite, and sandstone underlie natural vegetation is tall grass prairie. In riparian areas, where limestone has been streams of the Arbuckle Mountains (29i). Perennial Today, post oak-blackjack oak-winged elm woodland is widespread on uplands,

35. South Central Plains Ecoregion 35 is an irregular, forested plain cut by shallow valleys and underlain by poorly-consolidated deposits; it is lithologically and physiographically distinct from Ecoregion 36. Mean annual rainfall in this humid region varies from 45 to 55 inches, and increases eastward. Ecoregion 35 occupies the edge of the southern coniferous forest belt; farther west, scrubby oak savanna and prairies occur. Natural vegetation is oak-hickory-pine forest on uplands and southern floodplain forest on bottomlands. Prairies once occurred on soils derived from limestone, marl, and calcareous shale. Today, uplands are largely pastureland or forest dominated by shortleaf pine, loblolly pine, oaks, and hickories. Poorly-drained floodplains support bottomland forests and wetlands. Cropland is most extensive along the Red River. Streams in forested watersheds typically have low concentrations of suspended solids whereas the Red River is continuously turbid. streams is limited or nonexistent, but enduring, deep pools usually occur. Species richness markedly increases towards the east as more fauna from the Mississippi Valley are encountered. In addition, downstream influences of the Ouachita Mountains on aquatic flora and fauna occur far into Ecoregion 35. Sunfishes, catfishes, gars, crappies, grass pickerels, orangebelly darters, and bigeye, ribbon, striped, and redfin shiners are common. Redhorses and creek chubsuckers are numerous in small and medium size streams. The smallmouth bass is an important game species. In Oklahoma, the dollar sunfish naturally occurs only in the South Central Plains (35), whereas the pirate perch is limited to the ecoregion's ponds, swamps, oxbows, and 35b The Floodplains and Low Terraces ecoregion is nearly level, susceptible to flooding, and veneered by alluvium; it includes natural levees, swales, terraces, and slowly moving streams in meandering, low gradient

channels. Oxbow lakes and forested wetlands are common; they provide critical habitat for waterfowl and have distinct flora and fauna. Ecoregion 35b is physiographically and lithologically different from adjacent, higher ecoregions. Cropland is much less extensive than in the Red River Bottomlands (35g). **35c** The **Pleistocene Fluvial Terraces** ecoregion is nearly level, periodically wet, and characteristically veneered by unconsolidated Pleistocene terrace deposits. A vertical sequence of stream terraces occurs; age and dissection increase with increasing elevation. The lowest terrace is clayey and supports hardwood wetlands. Higher ones are dominated by pine flatwoods, but pastureland and hayland also occur. Ecoregion 35c is less dissected and more poorly-drained than the Cretaceous Dissected Uplands (35d), and is floristically unlike the Floodplains and Low Terraces (35b). Some streams tend to be mildly acidic and stained by organic matter, whereas others, draining the Ouachitas, retain upstream water quality and most of the Ouachita Mountains' characteristic aquatic flora and fauna. The level to hilly Cretaceous Dissected Uplands are mostly underlain

by calcareous sands, clays, and gravels of Cretaceous age. Lithology is distinct from the other, less dissected parts of Ecoregion 35. Natural vegetation is Water quality in forested watersheds tends to be good, and is better than forest is native. Today, forests and pastureland are common. downstream of pastureland. Surface waters usually have lower total organic







33. East Central Texas Plains Ecoregion 33 is composed of plains with fine-textured soils and claypans. Substrates of large streams are typically

ws. These grasslands have persisted since settlement. Photo: Bruce Hoagland



response to disturbance (Bryce, Omernik, and Larsen, 1999). Ecoregions are general purpose regions that are critical for structuring and implementing ecosystem management strategies across federal agencies, state agencies, and nongovernment organizations that are responsible for different types of resources in the same geographical areas (Omernik and others, 2000). A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I is the coarsest level, dividing North America into 15 ecological regions. Level II divides the continent into 52 regions (Commission for Environmental Cooperation Working Group, 1997). At level III, the continental United States contains 104 regions whereas the conterminous United States has 84 (U.S. Environmental Protection Agency, 2005). Level IV ecoregions are further subdivisions of level III ecoregions. Methods used by the U.S. Environmental Protection Agency (USEPA) to define the ecoregions are explained in Omernik (1995, 2004), Omernik and others (2000), and Literature Cited Gallant and others (1989). The Oklahoma ecoregion map was compiled at a scale of 1:250,000; it

originally compiled at a smaller scale (Omernik, 1987; U.S. American Midland Naturalist, v. 20, no. 2, p. 425-454. can be identified through the analysis of the spatial patterns and the differences in ecosystem quality and integrity (Wiken, 1986; Omernik, 1987, 1995). These characteristics include physiography, geology, climate, soils, land use, wildlife, fish, hydrology, and vegetation (including "potential natural vegetation", defined by K!chler (p. 2, 1964) as "vegetation that would exist today" if human influence ended and "the resulting plant succession" was "telescoped into a single moment"). The relative importance of each characteristic varies from one ecoregion to another regardless of ecoregion hierarchical level. In Oklahoma, there are 12 level III ecoregions and 46 level IV ecoregions; all but twelve of these level IV ecoregions continue into ecologically similar parts of adjacent states (Chapman and others, 2001,

2002; Griffith and others, 2004; Woods and others, 2004). Oklahoma's ecological diversity is strongly related to its varied climate, terrain, geology, soil, and land use. Oklahoma contains vast plains, elevated karst plateaus, hills, and folded, low mountains. Precipitation increases eastward, rainfall variability increases westward, and both mean annual temperature and the length of the growing season increase southward. Soils influence the effectiveness and availability of moisture for plant life. Forests cover most of the Ozark Plateau and the Ouachita Mountains; they become progressively Gulf Coastal Plain, occur in the southeast. Tall grass prairie, mixed grass prairie, and short grass prairie are native to central and western southwest. Elevations drop from about 5,000 feet on Black Mesa in the northwestern Panhandle to about 300 feet in southeastern Oklahoma. Rivers follow regional topographic trends. Impoundments are common, and impact hydrology and the abundance and distribution of fish. The strong east-west zonation of vegetation and climate in Oklahoma nammals, and insects (Blair and Hubbell, 1938; Webb, 1970). The western boundary of deciduous forest limits the westward extension of many eastern species. Southern Rocky Mountain fauna species intergrade with Great Plains species on Black Mesa in the western Panhandle. Great Plains fauna are found in intervening districts. Much of Oklahoma's natural vegetation has been lost to overgrazing, burning, logging, erosion, and cultivation. Today, the state is a mosaic of grazing land, cropland, woodland, forests, and abandoned farmland. Wheat and alfalfa are the main crops. Grain sorghum is well adapted to sandy soils. Soybeans are becoming increasingly common on eastern

plains and on moister parts of the prairie. Cotton is now concentrated on irrigated farmland in the southwest. Corn, once a major Oklahoma crop, has declined in importance due to soil depletion and periodic droughts. This poster is part of a collaborative project between the USEPA Region 6, USEPA-National Health and Environmental Effects Research

is mostly mixed grass prairie. In addition, shinnery grows on sand flats and hills in the west, and short grass prairie is found on higher elevation, sandy sites in the northwest. Eastern redcedar is becoming increasingly widespread on uplands. avines are wooded and provide cover for wildlife. Rainfall is limited and variable. During the 1930s, drought and poor soil conservation practices contributed to widespread farm abandonment. Subsequently, many areas have been planted with ntroduced forage grasses and converted into managed grasslands. Extensive flood control projects are found throughout the Washita River Basin in Ecoregion 27q and have modified regional hydrology. Most streams are now entrenched and have sandy, unstable substrates and eroding banks. However, scattered reaches have cut into rock layers, increasing gradients and improving stream habitat. The **Limestone Hills** ecoregion is steep, stony, grass-covered, and is used as rangeland. It lacks the cropland that dominates Ecoregions 27d, 27h, and wooded Wichita Mountains (27k). Many springs, but no perennial streams, occur.

composed of mud and very fine sand. Mean annual rainfall in this moist-subhumid region ranges from 42 to 45 inches. 33a The Northern Post Oak Savanna ecoregion is characterized by level to rolling plains, extensive clay flats, and slowly to very slowly permeable soils that were derived from Cretaceous-age plastic shale, marl, limestone, sand, and gravel. Tall grass prairie and oak savanna are native, and contrast with the oak-hickory-pine forest of the neighboring South Central Plains (35). Cropland and pastureland are now common. Main crops are peanuts, soybeans, grain sorghum, small grains, hay, and cotton. all grass prairie and oak savanna are native on the level to the rolling plains of gion 33a. This image, taken near Durant, shows one of Ecoregion 33a's many hay

A mix of savanna, woodland, and prairie is native to the low hills, cuestas, ridges, and plains of Ecoregion 29, and separates the forests of eastern ecoregions from the prairies of drier, western ecoregions. The boundary between the Cross Timbers (29) and the nearly treeless Central Great Plains (27) coincides with the western limit of many mammals and insects. Post oak-blackjack oak woodland and savanna are native on porous, course-textured soils derived from sandstone; the percentage of blackjack oak increases westward. Tall grasses are native on fine-textured, moisture deficient soils derived from limestone, shale, or marl. Recent fire suppression has increased forest density and allowed eastern redcedar to invade many areas. Today, woodland, rangeland, pastureland, and several extensive, but declining, oil fields occur. Abandoned, depleted farmland is common. The remaining cropland is largely restricted to valleys near channelized streams whose degraded habitat supports very native. Today, cropland is common and pastureland occurs, especially on steeper sites. The mosaic of natural vegetation, physiography, lithology, soils, and land use is unlike that of the neighboring Eastern Cross Timbers (29b) and Western Cross Timbers (29c) Tall grass prairie and oak savanna are native to the rolling hills and plains of the Arbuckle Uplift, and developed over a unique mosaic of imestone, granite, dolomite, sandstone, and shale. Upland soils that were derived rom limestone are usually shallow, moisture deficient, and erodible if disturbed:

they are extensive and are now used as grazing land. Upland soils that developed

com granite are sufficiently deep to permit farming. Cropland is common on podplains. Stream substrates are typically composed of gravel, cobble, bedrock, r, particularly in the east, coarse sand. Most streams have some spring influence and many are dominated by spring flow, especially in the summer. Perennial, clear, cool streams are common. Springs are especially common in limestone. Streams typically have low turbidity and support a fish fauna that is distinct from neighboring Ecoregions 29a, 29b, 29c, and 37e. Fish and macroinvertebrate species richness is higher than elsewhere in the Cross Timbers (29), but less than in the Lower Canadian Hills (37e). Granite does not influence water quality or water quantity nearly as much as limestone in the Arbuckle Uplift (29g), but, where it is at the surface, vernal pools occur and contain primitive arthropods. The rolling hills of the **Northwestern Cross Timbers** are underlain by Permian-age sandstone, siltstone, and shale. Blackjack oak-post oak savanna occurs on sandy soils, tall grass prairie is native on fine-textured soils, and forests dominated by sugar maple grow in the shelter of larger canyons. Eastern redcedar is native to fire-protected areas; it is now common due to the combined effects of grazing and fire suppression. Ecoregion 29h is drier than other parts of he Cross Timbers (29). Tree density and height are less than in the Northern Cross mbers (29a), but greater than in the Cross Timbers Transition (27o). Cultivation and overgrazing has largely destroyed the native prairie. Ecoregion 29h includes the canyons of Caddo and Canadian counties and their permanent, spring-fed streams. Most of these streams are highly modified by upstream flood control, channelization, and erosion; they mostly have fine sandy substrates and tend to be entrenched, wide, and shallow. Unmodified reaches occur; they have greater habitat diversity and more sensitive species than modified reaches. The Arbuckle Mountains contain mesic ravines, ledges, caves sinkholes, and springs, and protrude through the Cross Timbers (29) by up to 650 feet. Local relief is greater than elsewhere in Ecoregion 29. The Arbuckle Mountains (29i) ecoregion is mostly underlain by folded limestone,

dolomite, and sandstone. Valleys are cut into shale. Cool, clear, fast-flowing, pring-fed streams, with rock or gravel bottoms are common; longitudinal radients are steeper than in the Arbuckle Uplift (29g). In the early 19th century, prairie or savanna covered the uplands, whereas forests were confined to ravines.

arbon values and slightly higher turbidity, total suspended solids, and hardness values than Ecoregion 35c. Streams lying in the Muddy Boggy Creek and Blue River watersheds often originate in, and share many aquatic species with, Ecoregion 29g; alkalinity, hardness, and conductivity values are influenced by local springs, and increase westward. Streams in the eastern part of Ecoregion 35d drain the more rugged, lithologically distinct Ouachita Mountains (36); aquatic flora and fauna ssemblages are influenced by the Ouachitas and are distinct from western streams. The nearly flat **Red River Bottomlands** are veneered with Holocene alluvium and have been widely cleared and drained for agriculture. Ecoregion 35g contains floodplains, low terraces, oxbow lakes, meander scars, backswamps, levees, drainage ditches, and the meandering, low gradient Red River. The Red River carries high silt loads and is almost continuously turbid. Natural vegetation is southern floodplain forest; it is unlike the oak-hickory-pine forest of higher, better drained, and lithologically distinct Ecoregions 35c, 35d, and 36. Cropland is more extensive than in other parts of Ecoregion 35 in Oklahoma. The main crops are soybeans, grain sorghum, alfalfa, corn, and wheat. 35h The level to rolling Blackland Prairie has deep, dark soils derived from underlying limestone, marl, and calcareous shale. Prairie was common uring, and shortly after, the Hypsithermal Period in the middle of the Holocene Epoch. By the late 18th century, Ecoregion 35h was a mosaic of woodland and savanna; prairies were limited to droughty, thin soils on cuesta scarps. Today, the fertile soils of the Blackland Prairie (35h) are mostly used for pastureland,

woodland, and havland

36. Ouachita Mountains 36a The Athens Plateau ecoregion is composed of open hills and low ridges that are widely underlain by Mississippian Stanley Shale; lithology contrasts with the sandstone, shale, and chert of the Central Mountain Ranges (36b), the sandstone and shale of the more rugged Fourche Mountains (36d), and the unconsolidated sediments of the lower, less rugged South Central Plains (35). Today, commercial pine plantations are widespread, and pastureland and hayland also occur. Logging, as in the Western Ouachitas (36e), is an important land use that impacts stream quality. Cattle and broiler chickens are important farm products. The Central Mountain Ranges are underlain by sandstone, chert, conglomerate, and shale; resistant chert is more extensive than elsewhere in Ecoregion 36. Shallow, stony soils are common and support oak-hickory-pine forest. Ridges are steep enough to limit logging. Ecoregion 36b in Oklahoma contains the largest remaining tract of unlogged, old growth oak-shortleaf pine habitat in the United States. Its pine woodlands are managed to increase the population of the redcockaded woodpecker, which is federally-listed as endangered. Perennial springs and seeps are common, and support diverse vegetation; they are not large enough to strongly contribute to summer stream flow. Thus, all except the largest streams stop flowing during the driest parts of the summer. Constricted valleys between ridges have waterfalls and rapids. Streams have very low nutrient, mineral, and biochemical water quality parameter concentrations. Surface waters are more oligotrophic, and have less kaolin and less turbidity, than the rest of Ecoregion 36. Bottomland forests along the Mountain Fork River were drowned by Broken Bow Lake. The Fourche Mountains ecoregion is composed of east to west trending, folded, sandstone-capped ridges and intervening shale valleys. It is more rugged than Ecoregions 36a and 36f. Ridges are longer, and habitat continuity is greater than in other parts of Ecoregion 36. Natural vegetation is oak-hickory-pine forest. Forests on steep, north-facing slopes are more mesic than on southern aspects. Steepest, south-facing slopes with shallow, moisture deficient soils support shrubs and rocky glades. Pastureland and hayland are restricted to broad valleys. Logging is not as intensive as in the commercial pine plantations of Ecoregions 36a and 36e. Surface waters usually have low nutrient, mineral, and biochemical water quality parameter concentrations, but turbidity can be high. Although most streams stop flowing during the driest part of the summer, enduring deep pools, high quality habitat, and good water quality allow sensitive aquatic species to survive through the summer. The low mountains, hills, and valleys of the Western Ouachitas are covered with oak-hickory-pine forest, and largely underlain by sandstone and shale. Ecoregion 36 is not as rugged as Ecoregion 36d or adjacent parts of Ecoregion 36b. Ridgetop elevations and forest density generally decline westward. Logging, recreation, and woodland grazing are the main land uses; commercial pine plantations occur. Ecoregion 36e (when aggregated with interfingering parts of Ecoregion 36f), contains one of the greatest concentrations of imperiled or critically imperiled, aquatic and terrestrial species in mid-North America (as classified as by the Natural Heritage Network). forest on uplands and bottomland forest on floodplains and low terraces. Prairies occurred in Ecoregion 36f prior to the 20th century, but were lacking from the other, the north. more mountainous parts of Ecoregion 36. Today, pastureland, woodland, and hayland are common; poultry, cattle, and hogs are the main farm products.

37. Arkansas Valley

37a The Scattered High Ridges and Mountains ecoregion is more rugged and wooded than Ecoregions 37b, 37c, or 37d. Ecoregion 37a is covered by savannas, open woodlands, or forests dominated or codominated by upland oaks, hickory, and shortleaf pine; loblolly pine occurs, but is not native. It is gely underlain by Pennsylvanian sandstone and shale; calcareous rocks, such as those that dominate the Ozark Highlands (39), are absent. 37h The Arkansas River Floodplain is veneered with alluvium and includes natural levees, meander scars, oxbow lakes, point bars, swales, and backswamps. Reservoir, channel, and levee construction has reduced the frequency, magnitude, and duration of natural flood cycles. Ecoregion 37b has been widely cleared r agriculture, but remnants of the native bottomland forest remain in frequently flooded, poorly-drained areas. Today, cropland is more extensive than elsewhere in coregion 37. The Arkansas River is continuously turbid. Ecoregion 37b is lithologically, physiographically, and floristically different from nearby uplands. 37d The Arkansas Valley Plains ecoregion is underlain by Pennsylvanian-age shale, sandstone, and coal. It was once covered by a distinctive mosaic of savanna, woodland, forest, and prairie. Prairie was most extensive on fire-prone sites with moisture deficient soils derived from shale. Today, its undulating plains are mostly pastureland or havland, whereas its scattered hills and ridges remain wooded; cropland is much less extensive than in the Arkansas River Floodplain (37b), and wooded areas are less extensive than in Ecoregions 36, 37a, and 38. Poultry farming and surface coal mining are other important land uses. Some of the larger streams in Ecoregion 37d still possess sufficient habitat and water quality to support exceptional assemblages of aquatic fauna. Flow in the Poteau River system varies widely; during droughts, tributaries stop or nearly stop flowing, but after heavy precipitation, both flow and turbidity increase, and flooding commonly occurs.

**37e** The Lower Canadian Hills ecoregion is underlain by Pennsylvanian-age shale, sandstone, and coal. It acts as a transition between the drier Cross Timber (29) to the west and moister parts of the Arkansas Valley (37) to the east. Native vegetation is a mixture of oak woodland, tall grass prairie, oak-hickory

38. Boston Mountains

inches, and increases eastward. Ecoregions 38 and 39 are dominated by many of the same fish species. Common fishes include minnows, darters, and sunfishes. Many sensitive species occur. Spring-fed streams are not as common as in Ecoregion 39. Summer flow in small streams is limited or nonexistent, but isolated, enduring pools and high quality aquatic communities may occur. During low flows, streams in both Ecoregions 36 and 38 usually run clear. However, during high flow onditions, turbidity in Ecoregion 38 tends to be greater than in Ecoregion 36. **38b** The Lower Boston Mountains ecoregion is mostly covered by a mosaic of forest and woodland, and is largely underlain by Pennsylvanian-age sandstone and shale. It lacks the complexly folded, well-defined ridges of the Ouachita Mountains (36), and is lithologically distinct from the limestone-dominated pringfield Plateau (39a) and Dissected Springfield Plateau-Elk River Hills (39b). Natural vegetation is mostly oak-hickory forest; it contrasts with the oak-hickory-pine forest of the Ouachita Mountains (36). Flatter areas are used as pastureland or hayland. Logging and recreation are important land uses.

macroinvertebrate species richness is greater than in the Cross Timbers (29), but less than in the rest of the Arkansas Valley (37

39. Ozark Highlands

and limited oak-hickory-pine forests are native on uplands; ecoregions to the west, and the South Central Plains (35) and Ouachita Mountains (36) to the south, have different natural vegetation than Ecoregion 39. Today, rugged areas are wooded and nearly level sites are pastureland or hayland. The main land uses are logging, recreation, and especially, poultry and livestock farming. Rapid suburbanization, intensive grazing, and fields receiving waste from poultry farms have significantly increased fecal coliform, phosphorus, and nitrite-nitrate concentrations in receiving waters. Where nutrient input is high, the central stoneroller is often common. Bank erosion has choked many channel reaches with cherty gravel, causing the reaches to become braided and dominated by unstable run habitat; in the process, many natural pools have been lost. In the Ozark Highlands (39), both habitat diversity and species richness are high and sensitive fish species are common. Minnows, sunfishes, and darters are plentiful. The banded sculpin and slender madtom occur in small streams, especially where aquatic macrophytes are present, and the southern redbelly dace inhabits headwaters. The shadow bass is nearly limited to the Ozark Highlands (39). Other common fishes include the orangethroat darter, stippled darter, greenside darter, fantail darter, northern hogsucker, white sucker, Ozark minnow, cardinal shiner, and bigeye shiner. The most important game species is the smallmouth bass. **39a** The **Springfield Plateau** is underlain by cherty limestone of the Mississippian Boone Formation; dissection, relief, and forest density are less than in neighboring Ecoregions 38 and 39b. Karst features, such as sinkholes and caves, are common. Cool, perennial, spring-fed streams occur. Prior to the 19th century, uplands were dominated by oak-hickory forest; savannas and tall grass prairies also occurred and were maintained by fire. Today, much of the forest, and nearly all of the prairie, has been replaced by agriculture or expanding residential areas. Poultry and livestock farming are the main land uses. Application of poultry litter to agricultural fields and cattle farming have impaired downstream water quality. Streams in the Springfield Plateau (39a) have lower gradients, contain more clay, and are less clogged with gravel from bank erosion than in the Dissected Springfield Plateau-Elk River Hills (39b). Total dissolved solids and hardness values are higher than in the Ouachita Mountains (36), but are lower than in many other parts of Oklahoma. Total suspended solids and turbidity values in streams are usually low. The wooded, rugged, **Dissected Springfield Plateau–Elk River Hills** ecoregion is composed of narrow ridgetops and intervening, steep V-shaped valleys. Carbonate rocks, along with associated karst features, are characteristic. Springs abound in valleys and contribute cool water to perennial streams. Cherty limestone of the Mississippian Boone Formation is extensive, but older shales, limestone, and dolomite are also exposed in valley bottoms. Ecoregion 39b is more rugged and wooded than either the lithologically similar Ecoregion 39a or the lithologically dissimilar Ecoregion 40b. Upland natural vegetation is oak-hickory and The Ozark Highlands (39) are largely oak-hickory-pine forests and woodlands. Livestock and poultry farming, woodland grazing, logging, recreation, and quarrying are the main land uses. Bank and hillslope underlain by flat-lying, cherty limestone. uses include poultry and livestock farming. erosion has choked many channels and filled many pools with cherty gravel. As a result, braided streams and unstable run habitat have become common. The lower Underground drainage, karst features,

40. Central Irregular Plains Ecoregion 40 in Oklahoma is a belt of prairie that separates the Cross Timbers (29) from the forests of the Boston Mountains (38) and Ozark Highlands (39). Interbedded Pennsylvanian-age shale, sandstone, limestone, and coal occur; the alternating hard-soft strata dip westward, forming nearly flat to irregular plains, low hills, and east-facing cuestas. The landform mosaic is distinct from the Flint Hills (28), Arkansas Valley (37), and Ozark Highlands (39). Natural vegetation is mostly tall grass

prairie, but forests and woodlands, dominated by post oak, blackjack oak, and black hickory, are native on stony hilltops. Today, Ecoregion 40 is a mix of rangeland, grassland, woodland, floodplain forests, and farmland; cropland is most extensive on nearly level plains, and overall, is more common than in Ecoregions 29, 37, 38, or 39. Rivers and streams typically have low gradients, slowly moving water, muddy banks, and meander in wide valleys. Stream substrates and habitats vary from a high quality, variable mix of conditions to silt- and mud-choked channels. Runoff from bituminous coal mining has degraded water quality and affected aquatic biota in a few streams. The redfin shiner, suckermouth minnow, redfin and orangethroat darters, smallmouth buffalo, river carpsucker, black and golden redhorses, spotted suckers, yellow and black bullheads, and flathead catfish occur; diversity and richness of aquatic fauna is markedly lower than in Ecoregions 38 and 39. The Osage Cuestas ecoregion is an irregular to undulating plain that is underlain by interbedded, westward-dipping sandstone, shale, and limestone. East-facing cuestas and low hills occur. Topography is distinct from the nearby Flint Hills (28), Ozark Highlands (39), and Cherokee Plains (40d). Natural vegetation is mostly tall grass prairie, but a mix of tall grass prairie and oak-hickory forest is native to eastern areas. Overall, the mosaic of natural vegetation is unlike the Cross Timbers (29) and Ozark Highlands (39). Today, rangeland, cropland, riparian forests, and on rocky hills, oak woodland or oak forest occur; cropland is not as common as in Ecoregion 40d. **40d** The **Cherokee Plains** ecoregion is a nearly flat erosional plain that is dominated by clayey, slowly to very slowly permeable soils; it is less irregular and more poorly-drained than the Osage Cuestas (40b). Claypans occur and impede drainage. After rainfall, water may accumulate on the surface. However, in dry weather, soils are deficient in moisture. Natural vegetation is mostly tall grass prairie. Today, Ecoregion 40d is mostly cropland; rangeland occurs on steeper slopes and

Ecoregions denote areas of general similarity in ecosystems and in the Laboratory (Corvallis, Oregon), Oklahoma Water Resources Board, type, quality, and quantity of environmental resources. They are Oklahoma Biological Survey, Oklahoma Climatological Survey, designed to serve as a spatial framework for the research, assessment, Oklahoma Conservation Commission, Oklahoma Department of management, and monitoring of ecosystems and ecosystem components. Agriculture, Food, and Forestry, Oklahoma Department of By recognizing the spatial differences in the capacities and potentials of Environmental Quality, Oklahoma Geological Survey, The Nature ecosystems, ecoregions stratify the environment by its probable Conservancy, U.S. Department of Agriculture–Natural Resources Conservation Service, U.S. Geological Survey (USGS), and USGS National Center for Earth Resources Observation and Science. This project is associated with an interagency effort to develop a common ramework of ecological regions (McMahon and others, 2001). Reaching that objective requires recognition of the differences in the conceptua approaches and mapping methodologies that have been applied to USDAevelop the most common ecoregion-type frameworks, including those eveloped by the U.S. Department of Agriculture–Forest Service (Bailey and others, 1994), the USEPA (Omernik 1987, 1995), and the U.S. Department of Agriculture–Soil Conservation Service (1981). As each of hese frameworks is further refined, their differences are becoming less iscernible. Each collaborative ecoregion project, such as this one in Oklahoma, is a step toward attaining consensus and consistency in ecoregion frameworks for the entire nation.

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The forested low mountains of Ecoregion 36 are characteristically underlain by folded, sedimentary rocks of Paleozoic age. In Oklahoma, mean annual rainfall in this humid ecoregion is 43 to 57 inches. Oak-hickory-shortleaf pine forest is native on uplands; it contrasts with the oak-hickory forest of Ecoregions 38 and 39 and the oak savanna or prairie of drier ecoregions to the west. Ecoregion 36 remains mostly forested, but pastureland and hayland occur in wider valleys. Logging and recreation are major land uses. Most streams have gravel, cobble, boulder, or bedrock substrates but a few have sandy bottoms. Stream gradients are steeper than in Ecoregion 35. Turbidity, total phosphorus, total suspended solids, and biological oxygen demand values are lower, and dissolved oxygen levels are higher, than in the streams of Ecoregions 35 and 37. Common fishes include the longear and green sunfishes, yellow bullhead, brook silverside, blackstripe and blackspotted topminnows, largemouth bass, smallmouth bass, redfin darter, suckers, and the bigeye, Ouachita Mountain, and ribbon shiners. Orangebelly darters, grass pickerels, and tadpole madtoms are also found in Ecoregion 36, but are absent from Ecoregions 38, 39, and 40.

The folded Ouachita Mountains (36) are underlain by Paleozoic sandstone, shale, and The broad Western Ouachita Valleys are etched into Mississippian Stanley Shale and veneered with terrace, alluvial, and colluvial deposits. Ecoregion 36f includes the Kiamichi River, one of the few tributaries to the Red River that has not been heavily impacted by water diversion or major land use changes. The Ouachita Mountains including Ecoregions 36a and 36e. Shortleaf pine and loblolly pine Kiamichi River system is home to more than half of Oklahoma's mussel species, including eight imperiled or vulnerable species. Natural vegetation is oak-hickory-pine are much more common than in the Boston Mountains (38) and Ozark Highlands (39) to

The Arkansas Valley (37) separates the Ozark Plateau from the Ouachita Mountains. It is characteristically transitional and diverse. Plains, hills, floodplains, terraces, and scattered mountains all occur; the terrain is distinct from nearby ecoregions. A mix of oak savanna, prairie, oak-hickory-pine forest, and oak-hickory forest is native on uplands. Bottomland forest is native on floodplains and low terraces. Today, steep slopes are wooded and used for timber, woodland grazing, or recreation. Gently sloping uplands are used as pastureland or hayland. Cropland or pastureland occur on bottomlands. Other main land uses include poultry farming, coal mining, and natural gas production. Land use tends to be the primary factor influencing stream quality in Ecoregion 37. Turbidity, total suspended solids, total organic carbon, total phosphorus, and biochemical oxygen demand values are higher than in Ecoregions 36, 38, or 39, but mean stream gradients and dissolved oxygen levels are lower. Ecoregion 37 has the richest fish fauna in Oklahoma. Fish communities usually contain many sensitive species; a sunfish- and minnow-dominated community exists along with large numbers of darters and catfishes. Common fishes include the bigeye, steelcolor, and redfin shiners, the orangethroat and redfin darters, and suckers including the creek chubsucker, golden and black redhorses, river carpsucker, spotted sucker, and smallmouth buffalo. Summer flow in small streams is often limited or nonexistent.

forest, and oak-hickory-pine forest. In general, wooded hills are more widespread than in the nearby Arkansas Valley Plains (37d) and Osage Cuestas (40b). Prairies The Arkansas Valley (37) is diverse. It is composed of plains, hills, floodplains, terraces, become more extensive in ecoregions to the west. Streams tend to have deeper pools and more habitat diversity than in the Northern Cross Timbers (29a). Fish and and scattered mountains, and is a mosaic of pastureland, wooded areas, hayland, and especially on bottomlands, cropland Ecoregion 38 in Oklahoma is a deeply dissected, mountainous plateau composed of sandstone and shale, and naturally covered by oak-hickory forest; it is lithologically distinct from the limestone- or dolomite-dominated Ozark Highlands (39) to the north, and has different natural vegetation than regions to the south and west. Strata are much less deformed, and ridges are less defined, than in the Ouachita Mountains (36). Mean annual precipitation in this humid ecoregion varies from 44 to 51

The low elevation Boston Mountains (38) are covered in oak-hickory forest, and mostly underlain by flat-lying sandstone and shale.

In Oklahoma, Ecoregion 39 is a level to highly dissected plateau composed of flat-lying, cherty limestone. It is lithologically distinct from surrounding ecoregions and is less rugged than the Ouachita Mountains (36) and Boston Mountains (38). Karst features and clear, cool, spring-fed, perennial streams are common, but small, dry valleys also occur. Total hardness values in streams are higher than in Ecoregion 36. Mean annual rainfall in this humid ecoregion is 41 to 49 inches. Oak-hickory forests

reaches of most streams have aggraded; here, enough gravel has accumulated to promote subsurface flow, except during and immediately after rainfall.

riparian areas are wooded. Main crops are soybeans, wheat, alfalfa hay, and sorghum. Cattle and broiler chickens are important farm products. The mining district near

springs, and perennial streams are common



Picher was a primary source of lead and zinc in the United States during the first half of the twentieth century. It is now abandoned and has become a U.S. The Central Irregular Plains (40) ecoregion is a belt of prairie that divides the hilly Cross Environmental Protection Agency Superfund site; defoliation has occurred, extensive tailings remain, and metal-laden, acidic discharges still pollute streams in the area. Timbers (29) from the forested Boston Mountains (38) and Ozark Highlands (39).



WATER QUALITY DIVISION

OKLAHOMA CONSERVATION