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Ecological Systems of Texas' High Plains

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by

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This subset of the International Ecological Classification Standard covers terrestrial ecological systems attributed to the Texas. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to [Judy Teague <judy_teague@natureserve.org>].



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TABLE OF CONTENTS

SHRUBLAND 3

- CES302.731 Chihuahuan Creosotebush Desert Scrub..... 3
- CES302.017 Chihuahuan Mixed Salt Desert Scrub..... 3
- CES302.737 Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub 3
- CES303.041 Edwards Plateau Limestone Shrubland..... 3
- CES303.668 Western Great Plains Mesquite Woodland and Shrubland..... 4
- CES303.671 Western Great Plains Sandhill Steppe 4

HERBACEOUS 5

- CES303.659 Central Mixedgrass Prairie..... 5
- CES302.061 Chihuahuan Loamy Plains Desert Grassland 5
- CES302.736 Chihuahuan Sandy Plains Semi-Desert Grassland 6
- CES303.670 Western Great Plains Sand Prairie 6
- CES303.672 Western Great Plains Shortgrass Prairie 7
- CES303.673 Western Great Plains Tallgrass Prairie 7

WOODY WETLAND 9

- CES303.678 Western Great Plains Floodplain 9

HERBACEOUS WETLAND 10

- CES303.666 Western Great Plains Closed Depression Wetland..... 10
- CES303.675 Western Great Plains Open Freshwater Depression Wetland..... 10
- CES303.669 Western Great Plains Saline Depression Wetland..... 10

MIXED UPLAND AND WETLAND 12

- CES302.746 Chihuahuan-Sonoran Desert Bottomland and Swale Grassland 12
- CES303.956 Western Great Plains Riparian..... 12
- CES303.680 Western Great Plains Wooded Draw and Ravine..... 12

BARREN 14

- CES303.725 LLano Estacado Caprock Escarpment and Breaks Shrubland and Steppe..... 14
- CES302.744 North American Warm Desert Active and Stabilized Dune 14
- CES303.665 Western Great Plains Cliff and Outcrop 14

SHRUBLAND

CES302.731 CHIHUAHUAN CREOSOTEBUSH DESERT SCRUB

This ecological system is the common lower elevation desert scrub that occurs throughout much of the Chihuahuan Desert and has recently expanded into former desert grasslands in the northern portion of its range. Stands typically occur in flat to gently sloping desert basins and on alluvial plains, extending up into lower to mid positions of piedmont slopes (bajada). Substrates range from coarse-textured loams on gravelly plains to finer-textured silty and clayey soils in basins. Soils are alluvial, typically loamy and non-saline, and frequently calcareous as they are often derived from limestone, and to a lesser degree igneous rocks. The vegetation is characterized by a moderate to sparse shrub layer (<10% cover on extremely xeric sites) that is typically strongly dominated by *Larrea tridentata* with *Flourensia cernua* often present to codominant. A few scattered shrubs or succulents may also be present, such as *Agave lechuguilla*, *Parthenium incanum*, *Jatropha dioica*, *Koeberlinia spinosa*, *Lycium* spp., and *Yucca* spp. Additionally, *Flourensia cernua* will often strongly dominate in silty basins that are included in this ecological system. In general, shrub diversity is low as this ecological system lacks codominant thornscrub and other mixed desert scrub species that are common on the gravelly mid to upper piedmont slopes. However, shrub diversity and cover may increase locally where soils are deeper and along minor drainages with occasional *Atriplex canescens*, *Gutierrezia sarothrae*, or *Prosopis glandulosa*. Herbaceous cover is usually low and composed of grasses. Common species may include *Bouteloua eriopoda*, *Dasyochloa pulchella* (= *Erioneuron pulchellum*), *Muhlenbergia porteri*, *Pleuraphis mutica*, *Scleropogon brevifolius*, and *Sporobolus airoides*. Included in this ecological system are *Larrea tridentata*-dominated shrublands with a sparse understory that occur on gravelly to silty, upper basin floors and alluvial plains. A pebbly desert pavement may be present on the soil surface.

This ecological system is the common lower elevation desert scrub that occurs throughout much of the Chihuahuan Desert and has recently expanded into former desert grasslands in the northern portion of its range. Stands typically occur in flat to gently sloping, desert basins and on alluvial plains, extending up into the lower to mid positions of piedmont slopes (bajada). Substrates range from coarse-textured loams on gravelly plains to finer-textured silty and clayey soils in basins. Soils are alluvial, typically loamy and non-saline, and frequently calcareous as they are often derived from limestone, and to a lesser degree igneous rocks (Brown 1982, MacMahon and Wagner 1985, Henrickson and Johnston 1986, MacMahon 1988, Dick-Peddie 1993).

CES302.017 CHIHUAHUAN MIXED SALT DESERT SCRUB

This ecological system includes extensive open-canopied shrublands of typically saline basins in the Chihuahuan Desert. Stands often occur on alluvial flats and around playas, as well as in floodplains along the Rio Grande and Pecos rivers, possibly also extending into the San Simon of Southeastern Arizona. Substrates are generally fine-textured, saline soils. Vegetation is typically composed of one or more *Atriplex* species such as *Atriplex canescens*, *Atriplex obovata*, or *Atriplex polycarpa* along with species of *Allenrolfea*, *Flourensia*, *Salicornia*, *Suaeda*, or other halophytic plants. Graminoid species may include *Sporobolus airoides*, *Pleuraphis mutica*, or *Distichlis spicata* at varying densities.

This system includes extensive open-canopied shrublands of typically saline basins in the Chihuahuan Desert. Stands often occur on alluvial flats, around playas and floodplains of the Rio Grande and Pecos rivers, possibly also extending into the San Simon of southeastern Arizona. Sites are flat to gently sloping with slopes up to 3%. Elevation ranges from 1000-1300 m (3300-4300 feet). Substrates are generally fine-textured, saline soils but may include moderately coarse-textured alluvium in the floodplains. Water tables are generally shallow but fluctuate within reach of deep-rooted plants, and in most places are high enough that salts accumulate on the surface of the soil.

CES302.737 CHIHUAHUAN STABILIZED COPPICE DUNE AND SAND FLAT SCRUB

This ecological system includes the open desert scrub of vegetated coppice dunes and sandsheets found in the Chihuahuan Desert. Stands are usually dominated by *Prosopis glandulosa* or *Artemisia filifolia* but also include *Atriplex canescens*, *Ephedra torreyana*, *Ephedra trifurca*, *Poliomintha incana*, and *Rhus microphylla* coppice and sand flat scrub usually with 10-30% total vegetation cover. *Yucca elata*, *Gutierrezia sarothrae*, *Bouteloua eriopoda*, and *Sporobolus flexuosus* are commonly present. In northern stands, *Artemisia filifolia* dominates and *Prosopis glandulosa* become less uncommon or absent. This system include degraded sandy desert plains grasslands now dominated by *Artemisia filifolia*.

CES303.041 EDWARDS PLATEAU LIMESTONE SHRUBLAND

This ecological system occurs as a matrix on relatively thin-soiled surfaces of plateaus of the massive limestones such as the Edwards limestone. These short to tall shrublands are variable in density depending on the relative amount of, and depth to, bedrock. *Quercus sinuata* var. *breviloba* is an important component of the system, with some areas dominated by *Quercus fusiformis*. *Juniperus ashei* is often an important component of this system. In the west, *Pinus remota* may also contribute to a scattered emergent overstory. Other shrub species may include *Rhus virens*, *Rhus lanceolata*, *Cercis canadensis* var. *texensis*, *Forestiera pubescens*, *Forestiera reticulata*, *Fraxinus texensis*, *Ungnadia speciosa*, *Sophora secundiflora*, *Diospyros texana*, *Salvia ballotiflora*, *Mimosa borealis*, *Condalia hookeri*, *Rhus trilobata*, *Opuntia engelmannii*, and *Mahonia trifoliolata*. This system also includes *Quercus mohriana*- or *Quercus vaseyana*-dominated shrublands that are more common to the west, often sharing dominance with *Juniperus pinchotii*. Herbaceous cover may be patchy and is generally graminoid with species including *Schizachyrium scoparium*, *Bouteloua curtipendula*, *Bouteloua rigidiseta*, *Bouteloua trifida*, *Hilaria belangeri*, *Bothriochloa laguroides* ssp. *torreyana*, *Nassella leucotricha*, *Erioneuron pilosum*, *Aristida* spp., and others. Disturbances such as fire may be important processes maintaining this system. However, it appears to persist on thin-soiled sites. In the western portions of the Edwards Plateau, more xeric conditions lead to the slow succession of sites to woodlands, resulting in long-persisting shrublands. This system occurs on thin soils over limestone in the Edwards Plateau of Texas.

This system occurs in a steady state on thin-soiled xeric sites. Shrub cover can be 100% in patches, but overall cover may be 40-50%. Patches of dense shrubs may be interspersed with bare rock and grasslands over shallow soil. Farther west this system grades into other shallow-soiled shrubland systems.

CES303.668 WESTERN GREAT PLAINS MESQUITE WOODLAND AND SHRUBLAND

This system is found primarily in the southern portion of the Western Great Plains Division, primarily in Texas, Oklahoma and eastern New Mexico. It is dominated by *Prosopis glandulosa* with shortgrass species in the understory. *Ziziphus obtusifolia* and *Atriplex canescens* can codominate in some examples, as can *Opuntia* species in heavily grazed areas. Shortgrass species *Bouteloua gracilis* or *Buchloe dactyloides* are typically present. Other grasses may include *Aristida purpurea*, *Bouteloua curtipendula*, *Bouteloua eriopoda*, *Bouteloua hirsuta*, *Muhlenbergia torreyi*, *Pleuraphis jamesii*, *Sporobolus airoides*, and *Sporobolus cryptandrus*. Historically this system probably occurred as a natural component on more fertile soils and along drainages, but it has expanded its range into prairie uplands in recent decades. This system occurs naturally on deeper or more fertile soils and along drainages.

CES303.671 WESTERN GREAT PLAINS SANDHILL STEPPE

This system is found mostly in south-central areas of the Western Great Plains Division ranging from southwestern Wyoming and southwestern Nebraska up into the Nebraska Sandhill region, south through eastern Colorado, and New Mexico to central Texas, although some examples may reach as far north as the Badlands of South Dakota. The climate is semi-arid to arid for much of the region in which this system occurs. This system is found on somewhat excessively to excessively well-drained, deep sandy soils that are often associated with dune systems and ancient floodplains. In some areas, this system may actually occur as a result of overgrazing in Western Great Plains Tallgrass Prairie (CES303.673) or Western Great Plains Sand Prairie (CES303.670). Typically, this system is characterized by a sparse to moderately dense woody layer dominated by *Artemisia filifolia*, but other characteristic species may be present, including *Amorpha canescens*, *Prosopis glandulosa* (southern stands), *Prunus angustifolia*, *Prunus pumila* var. *besseyi* (northern stands), *Rhus trilobata*, and *Yucca glauca*. Associated herbaceous species can vary with geography, amount and season of precipitation, disturbance, and soil texture. The herbaceous layer typically has a moderate to dense canopy but may include stands with sparse understory. Several mid- to tallgrass species characteristic of sand substrates are usually present to dominant, such as *Andropogon hallii*, *Calamovilfa gigantea*, *Calamovilfa longifolia*, *Schizachyrium scoparium*, *Sporobolus cryptandrus*, *Sporobolus giganteus*, or *Hesperostipa comata*.

In the southern range of this system, *Quercus havardii* may also be present to dominant and represents one succession pathway that develops over time following a disturbance. *Quercus havardii* is able to resprout following a fire and thus may persist for long periods of time once established forming extensive clones. Edaphic and climatic factors are the most important dynamic processes for this type, with drought and extreme winds impacting this system significantly in some areas. Because *Quercus havardii* is able to resprout rapidly following fire, fire tends to cause structural changes in the vegetation, and compositional shifts are less significant in most cases. Overgrazing can lead to decreasing dominance of some of the grass species such as *Andropogon hallii*, *Calamovilfa gigantea*, and *Schizachyrium scoparium*. In the western extent of this system in the shortgrass prairie, more xeric mid- and shortgrass species such as *Hesperostipa comata*, *Sporobolus cryptandrus* and *Bouteloua gracilis* often dominate the herbaceous layer. This system is found primarily in semi-arid to arid areas of the Western Great Plains Division. It occurs on somewhat excessively to excessively well-drained and deep sandy soils. This system is often found associated with dune systems and/or ancient floodplains but may occur in soils derived from sandstone residuum.

HERBACEOUS

CES303.659 CENTRAL MIXEDGRASS PRAIRIE

This mixedgrass prairie system ranges from South Dakota into the Rolling Plains and the western Edwards Plateau of Texas. It is bordered by the shortgrass prairie on its western edge and the tallgrass prairie to the east. The loessal regions in west-central Kansas and central Nebraska, the Red Hills region of south-central Kansas and northern Oklahoma are all located within this system. Because of its proximity to other ecoregions, this system contains elements from both shortgrass and tallgrass prairies, which combine to form the mixedgrass prairie ecological system throughout its range. The distribution, species richness and productivity of plant species within the mixedgrass ecological system is controlled primarily by environmental conditions, in particular soil moisture and topography. Grazing and fire are important dynamic processes in this system. The relative dominance of the various grass and forb species within different associations in the system also can strongly depend on the degree of natural or human disturbance. This system can contain grass species such as *Bouteloua curtipendula*, *Schizachyrium scoparium*, *Andropogon gerardii*, *Hesperostipa comata*, *Sporobolus heterolepis*, and *Bouteloua gracilis*, although the majority of the associations within the region are dominated by *Pascopyrum smithii* or *Schizachyrium scoparium*. Numerous forb and sedge species (*Carex* spp.) can also occur within the mixedgrass system in the Western Great Plains. Although forbs do not always significantly contribute to the canopy, they can be very important. Some dominant forb species include *Ambrosia psilostachya*, *Echinacea angustifolia*, and *Lygodesmia juncea*. Oak species such as *Quercus macrocarpa* can occur also in areas protected from fire due to topographic position. This can cause an almost oak savanna situation in certain areas, although fire suppression may allow for a more closed canopy and expansion of bur oak beyond those sheltered areas. In those situations, further information will be needed to determine if those larger areas with a more closed canopy of bur oak should be considered part of Western Great Plains Dry Bur Oak Forest and Woodland (CES303.667). Likewise, within the mixedgrass system, small seeps may occur, especially during the wettest years. Although these are not considered a separate system, the suppression of fire within the region has enabled the invasion of both exotics and some shrub species such as *Juniperus virginiana* and also allowed for the establishment of *Pinus ponderosa* in some northern areas. This system is found primarily in the Central Mixed-grass Prairie (TNC Ecoregion 33); it becomes more restricted to mesic lowlands sites to the west and southwest in the shortgrass prairie region of Texas (S. Menard pers. comm. 2005). This is probably a reference to the Llano Estacado region rather than the Southern Shortgrass Prairie (TNC Ecoregion 28) (J. Teague pers. obs 2005). The Central Mixed-grass Prairie (TNC Ecoregion 33) should be extended south to include the Rolling Plains of Texas; being separated from the Southern Shortgrass Prairie (TNC Ecoregion 28) by the Caprock Escarpment (L. Elliott pers. comm. 2005).

Differences in topography and soil characteristics also occur across the range of this system. It is often characterized by rolling to extremely hilly landscapes with soils developed from loess, shale, limestone or sandstone parent material. Mollisol soils are most prevalent and range from silt loams and silty clay loams with sandy loams possible on the western edge of the range. The Red Hills region of Kansas and Oklahoma, which contains examples of this system, contains somewhat unique soil characteristics and has developed from a diversity of sources including red shale, red clay, sandy shale, siltstone, or sandstone. These soils have developed a characteristic reddish color from the primary material. These soils can consist of silt, loam, or clay and can have textures ranging from a fine sandy loam to a more clayey surface.

CES302.061 CHIHUAHUAN LOAMY PLAINS DESERT GRASSLAND

This ecological system occurs in the northern Chihuahuan Desert and extends into limited areas of the southern Great Plains on alluvial flats, loamy plains, and basins sometimes extending up into lower piedmont slopes. Sites are typically flat or gently sloping so precipitation does not run off and may be somewhat mesic if they receive runoff from adjacent areas, but these are not wetlands. Soils are non-saline, finer textured loams or clay loam. Vegetation is characterized by perennial grasses and is typically dominated by *Pleuraphis mutica* (tobosa) or with *Bouteloua eriopoda* codominant (more historically) or *Bouteloua gracilis*. In degraded stands, *Scleropogon brevifolius*, *Dasyochloa pulchella* (= *Erioneuron pulchellum*), or *Aristida* spp. may codominate. *Pleuraphis jamesii* may become important in northern stands and *Bouteloua gracilis* in the Great Plains and on degraded stands. If present, mesic graminoids such as *Pascopyrum smithii*, *Panicum obtusum*, *Sporobolus airoides*, and *Sporobolus wrightii* typically have low cover and are restricted to drainages and moist depressions (inclusions). Scattered shrubs such as *Ephedra torreyana*, *Flourensia cernua*, *Gutierrezia sarothrae*, *Larrea tridentata*, *Opuntia imbricata*, *Prosopis glandulosa*, and *Yucca* spp. may be present, especially on degraded sites.

This upland grassland is similar to the bottomland/depressional wetland system Chihuahuan-Sonoran Desert Bottomland and Swale Grassland (CES302.746) and grades into Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735) in the foothills and piedmont desert grasslands. In similar loamy plains land positions in the Great Plains, *Bouteloua gracilis*, *Buchloe dactyloides*, or *Pleuraphis jamesii* are dominant grasses in Western Great Plains Shortgrass Prairie (CES303.672). This grassland system is found from the northern to central Chihuahuan Desert and extends across the Trans-Pecos and into areas of the southwestern Great Plains. It

extends from western Texas across New Mexico and into southeastern Arizona. Stands are described from Jornada del Muerto Basin, Marfa grasslands and Marathon Basin, south to central Chihuahua and Coahuila, Mexico.

Examples of this system are found on alluvial flats, loamy plains, and basins sometimes extending up into lower piedmont slopes. Sites are typically flat or gently sloping so precipitation does not run off and may be somewhat mesic if they receive runoff from adjacent areas, but these are not wetlands. Soils are non-saline, finer textured loams or clay loam.

CES302.736 CHIHUAHUAN SANDY PLAINS SEMI-DESERT GRASSLAND

This ecological system occurs across the Chihuahuan Desert and extends into the southern Great Plains where soils have a high sand content. These dry grasslands or steppe are found on sandy plains and sandstone mesas. The graminoid layer is typically dominated or codominated by *Bouteloua eriopoda* and *Sporobolus flexuosus* with characteristic Chihuahuan species. Other common species are *Achnatherum hymenoides*, *Aristida purpurea*, *Bouteloua gracilis*, *Hesperostipa neomexicana* (minor), *Muhlenbergia arenicola*, *Pleuraphis jamesii*, *Sporobolus airoides*, *Sporobolus constrictus*, and *Sporobolus cryptandrus*. Typically, there are scattered desert shrubs and stem succulents present, such as *Ephedra torreyana*, *Ephedra trifurca*, *Opuntia imbricata*, *Yucca baccata*, *Yucca elata*, and *Yucca torreyi*, that are characteristic of the Chihuahuan Desert. The widespread shrub *Artemisia filifolia* is also frequently present, especially in the northern extent.

CES303.670 WESTERN GREAT PLAINS SAND PRAIRIE

The sand prairies constitute a very unique system within the western Great Plains. These sand prairies are often considered part of the tallgrass or mixedgrass regions in the western Great Plains but can contain elements from Western Great Plains Shortgrass Prairie (CES303.672), Central Mixedgrass Prairie (CES303.659), and Northwestern Great Plains Mixedgrass Prairie (CES303.674). The largest expanse of sand prairies (approximately 5 million ha) can be found in the Sandhills of north-central Nebraska and southwestern South Dakota. These areas are relatively intact. The primary use of this system has been grazing (not cultivation), and areas such as the Nebraska Sandhills can experience less degeneration than other prairie systems. Although greater than 90% of the Sandhills region is privately owned, the known fragility of the soils and the cautions used by ranchers to avoid poor grazing practices have allowed for fewer significant changes in the vegetation of the Sandhills compared to other grassland systems. The unifying and controlling feature for this system is that coarse-textured soils predominate and the dominant grasses are well-adapted to this condition. Soils in the sand prairies can be relatively undeveloped and are highly permeable. Soil texture and drainage along with a species' rooting morphology, photosynthetic physiology, and mechanisms to avoid transpiration loss are highly important in determining the composition of the sand prairies. In the northwestern portion of its range, stand size corresponds to the area of exposed caprock sandstone, and small patches predominate, but large patches are also found embedded in the encompassing Northwestern Great Plains Mixedgrass Prairie (CES303.674). Another important feature is their susceptibility to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, particularly the Nebraska Sandhills. In most of eastern Montana, substrates supporting this system have weathered in place from sandstone caprock; thus the solum is relatively thin, and the wind-sculpted features present further east, particularly in Nebraska, do not develop. Graminoid species dominate the sand prairies, although relative dominance can change due to impacts of wind disturbance. *Andropogon hallii* and *Calamovilfa longifolia* are the most common species, but other grass and forb species such as *Hesperostipa comata*, *Carex inops ssp. heliophila*, and *Panicum virgatum* may be present. Apparently only *Calamovilfa longifolia* functions as a dominant throughout the range of the system. In the western extent, *Hesperostipa comata* becomes more dominant, and *Andropogon hallii* is less abundant but still present. Communities of *Artemisia cana ssp. cana* are included here in central and eastern Montana. Patches of *Quercus havardii* can also occur within this system in the southern Great Plains. Fire and grazing constitute the other major dynamic processes that can influence this system. This system was edited to expand the concept to include sandy portions of the mixedgrass prairie of the Montana plains. Although in terms of potentially dominant graminoids there is virtually a complete overlap between the eastern and western extremities of the system, there is a distinct shift from west to east from midgrass species dominance, most notably *Hesperostipa comata*, to tallgrass species dominance, including prominently *Andropogon gerardii* and *Andropogon hallii*. Prevailing patch size also shifts from smaller to larger moving west to east. Current thinking is to include this variation within this system, but with more information and input from other Great Plains ecologists in the U.S. and Canada, this concept is subject to change, including the possibility of creating a new system.

This system is found throughout the Western Great Plains Division. The largest and most intact example of this system is found within the Sandhills region of Nebraska and South Dakota. However, it is also common (though occurring in predominantly small patches) farther west into central and eastern Montana. Its western extent in Wyoming is still to be determined, but it does occur in mapzone 29 on weathered-in-place sandy soils, where *Calamovilfa longifolia* is found, along with *Artemisia cana*.

The distribution, species richness and productivity of plant species within the sand prairie ecological system are controlled primarily by environmental conditions, in particular the temporal and spatial distribution of soil moisture and topography. Soils in the sand prairies can be relatively undeveloped and are highly permeable. Soil texture and drainage along with a species' rooting morphology, photosynthetic physiology, and mechanisms to avoid transpiration loss are highly important in determining the composition and

distribution of communities/associations within the sand prairies. Another important aspect of soils in the sand prairies is their susceptibility to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, particularly the Nebraska Sandhills, which can profoundly impact vegetation composition and succession within this system. This tallgrass system is found primarily on sandy and sandy loam soils that can be relatively undeveloped and highly permeable as compared to Western Great Plains Tallgrass Prairie (CES303.673), which occurs on deeper loams. This system is usually found in areas with a rolling topography and can occur on ridges, midslopes and/or lowland areas within a region. It often occurs on moving sand dunes, especially within the Sandhills region of Nebraska and South Dakota. In Montana, occurrences are intimately associated with Northwestern Great Plains Mixedgrass Prairie (CES303.674), usually occupying higher positions in local landscapes due to the fact that sandy members of some formations (that are predominantly marine shales) constitute the highest (and most weathering-resistant) points in the landscape.

CES303.672 WESTERN GREAT PLAINS SHORTGRASS PRAIRIE

This system is found primarily in the western half of the Western Great Plains Division in the rainshadow of the Rocky Mountains and ranges from the Nebraska Panhandle south into Texas and New Mexico, although grazing-impacted examples may reach as far north as southern Canada where it grades into Northwestern Great Plains Mixedgrass Prairie (CES303.674). This system occurs primarily on flat to rolling uplands with loamy, ustic soils ranging from sandy to clayey. In much of its range, this system forms the matrix system with *Bouteloua gracilis* dominating this system. Associated graminoids may include *Aristida purpurea*, *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Buchloe dactyloides*, *Hesperostipa comata*, *Koeleria macrantha* (= *Koeleria cristata*), *Pascopyrum smithii* (= *Agropyron smithii*), *Pleuraphis jamesii*, *Sporobolus airoides*, and *Sporobolus cryptandrus*. Although mid-height grass species may be present, especially on more mesic land positions and soils, they are secondary in importance to the sod-forming short grasses. Sandy soils have higher cover of *Hesperostipa comata*, *Sporobolus cryptandrus*, and *Yucca elata*. Scattered shrub and dwarf-dwarf species such as *Artemisia filifolia*, *Artemisia frigida*, *Artemisia tridentata*, *Atriplex canescens*, *Eriogonum effusum*, *Gutierrezia sarothrae*, and *Lycium pallidum* may also be present. Also, because this system spans a wide range, there can be some differences in the relative dominance of some species from north to south and from east to west. Large-scale processes such as climate, fire and grazing influence this system. High variation in amount and timing of annual precipitation impacts the relative cover of cool- and warm-season herbaceous species.

In contrast to other prairie systems, fire is less important, especially in the western range of this system, because the often dry and xeric climate conditions can decrease the fuel load and thus the relative fire frequency within the system. However, historically, fires that did occur were often very expansive. Currently, fire suppression and more extensive grazing in the region have likely decreased the fire frequency even more, and it is unlikely that these processes could occur at a natural scale. A large part of the range for this system (especially in the east and near rivers) has been converted to agriculture. Areas of the central and western range have been impacted by the unsuccessful attempts to develop dryland cultivation during the Dust Bowl of the 1930s. The short grasses that dominate this system are extremely drought- and grazing-tolerant. These species evolved with drought and large herbivores and, because of their stature, are relatively resistant to overgrazing. This system in combination with the associated wetland systems represents one of the richest areas for mammals and birds. Endemic bird species to the shortgrass system may constitute one of the fastest declining bird populations. In Texas, this system occurs on the Llano Estacado and ranges to but does not include the Stockton Plateau.

This system is located on primarily flat to rolling uplands. Soils typically are loamy and ustic and range from sandy to clayey. Climate is continental with mean annual precipitation generally about 300 mm ranging to 500 mm to the south in Texas. Most of the annual precipitation occurs during the growing season as thunderstorms. Precipitation events are mostly <10 cm with occasional larger events.

CES303.673 WESTERN GREAT PLAINS TALLGRASS PRAIRIE

This system can be found throughout the Western Great Plains Division. It is found primarily in areas where soil characteristics allow for mesic conditions more typical of the Eastern Great Plains Division and thus are able to sustain tallgrass species. This system may be small patches interspersed within Northwestern Great Plains Mixedgrass Prairie (CES303.674) or Western Great Plains Shortgrass Prairie (CES303.672) and may also be associated with upland terraces above a floodplain system where these more mesic conditions persist. Soils are primarily loamy Mollisols that are moderately deep and rich. Those areas that contain more sandy soils should be considered part of Western Great Plains Sand Prairie (CES303.670). This system is dominated primarily by *Andropogon gerardii* and may also include *Sorghastrum nutans*, *Schizachyrium scoparium*, *Pascopyrum smithii*, *Hesperostipa spartea*, and *Sporobolus heterolepis*. *Andropogon gerardii* often dominates the lowland regions, although *Pascopyrum smithii* can be prolific if conditions are favorable. Forbs in varying density may also be present. The primary dynamics for this system include fire, climate and grazing. Fire suppression in these areas has allowed for the invasion of woody species such as *Juniperus virginiana* and *Prunus* spp. Grazing also has contributed to these changes and likewise led to a decrease of this system as overgrazing favors shortgrass and mixedgrass systems. Conversion to agriculture likewise has probably decreased the range of this system. Thus, this system likely only occurs in

small patches and in scattered locations throughout the division. Large-patch occurrences are mostly isolated to slopes and swales of rolling uplands where either grazing or cultivation are more problematic. A granitic woodland association of the Wichita Mountains of Oklahoma (*Quercus fusiformis* - (*Quercus stellata*) / *Schizachyrium scoparium* Granite Woodland (CEGL004937)), formerly included here, now is included in Crosstimbers Oak Forest and Woodland (CES205.682).

This system is found primarily on loam, moderately deep, and rich Mollisols throughout the Western Great Plains Division. These soils tend to be more mesic and deep than the majority of soils within the Western Great Plains and are more typical of the Eastern Great Plains Division.

WOODY WETLAND

CES303.678 WESTERN GREAT PLAINS FLOODPLAIN

This ecological system is found in the floodplains of medium and large rivers of the western Great Plains. It occurs on the lower reaches of the North and South Platte, Platte, Arkansas, and Canadian rivers. Alluvial soils and periodic, intermediate flooding (every 5-25 years) typify this system. These are the perennial big rivers of the region with hydrologic dynamics largely driven by snowmelt in the mountains, instead of local precipitation events. Dominant communities within this system range from floodplain forests to wet meadows to gravel/sand flats; however, they are linked by underlying soils and the flooding regime. Dominant species include *Populus deltoides* and *Salix* spp. Grass cover underneath the trees is an important part of this system and is a mix of tallgrass species, including *Panicum virgatum* and *Andropogon gerardii*. *Tamarix* spp. and less desirable grasses and forbs can invade degraded areas within the floodplains, especially in the western portion of the province. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded. Another factor is that groundwater depletion and lack of fire have created additional species changes. In most cases, the majority of the wet meadow and prairie communities may be extremely degraded or extirpated from the system. All the riparian/floodplain/alluvial systems of the Great Plains region need to be revisited for naming conventions, along with better definitions of conceptual boundaries. There is much apparent overlap in their concepts and distribution, and the names add to the confusion. In particular, the difference between "riparian" and "floodplain" usage in the names needs revisiting and possible changing. These systems include Northwestern Great Plains Floodplain (CES303.676), Northwestern Great Plains Riparian (CES303.677), Western Great Plains Floodplain (CES303.678), and Western Great Plains Riparian (CES303.956). Need to review if there needs to be another split of this system into a Central Great Plains floodplain system and a Southern Great Plains floodplain system. Will need to review in conjunction with Northwestern Great Plains Floodplain (CES303.676).

This system is found along major river floodplains in the southern and central portions of the Western Great Plains Division. This system occurs on the middle to lower reaches of the North and South Platte, Platte, Arkansas, and Canadian rivers. Major river floodplains of eastern Wyoming and Montana are included in Northwestern Great Plains Floodplain (CES303.676) and not this system.

HERBACEOUS WETLAND

CES303.666 WESTERN GREAT PLAINS CLOSED DEPRESSION WETLAND

Communities associated with the playa lakes in the southern areas of this province and the rainwater basins in Nebraska characterize this system. They are primarily upland depressional basins. This hydric system is typified by the presence of an impermeable layer such as a dense clay, hydric soil and is usually recharged by rainwater and nearby runoff. They are rarely linked to outside groundwater sources and do not have an extensive watershed. Ponds and lakes associated with this system can experience periodic drawdowns during drier seasons and years, and are often replenished by spring rains. *Eleocharis* spp., *Hordeum jubatum*, along with common forbs such as *Coreopsis tinctoria*, *Symphyotrichum subulatum* (= *Aster subulatus*), and *Polygonum pensylvanicum* (= *Polygonum bicorne*) are common vegetation in the wetter and deeper depression, while *Pascopyrum smithii* and *Buchloe dactyloides* are more common in shallow depressions in rangeland. Species richness can vary considerably among individual examples of this system and is especially influenced by adjacent land use, which is often agriculture, and may provide nutrient and herbicide runoff. Dynamic processes that affect these depressions are hydrological changes, grazing, and conversion to agricultural use. Open and emergent marshes may be a separate system from wet meadows and wet prairies. This system needs to be more clearly distinguished from the similar open depressional wetlands of the western Great Plains, as well as from Great Plains Prairie Pothole (CES303.661).

This system is typified by upland depressional basins with an impermeable layer such as dense clay, hydric soils. Rainwater and runoff primarily recharge this system and it is rarely linked to outside groundwater sources.

CES303.675 WESTERN GREAT PLAINS OPEN FRESHWATER DEPRESSION WETLAND

This Great Plains emergent marsh ecological system is composed of lowland depressions; it also occurs along lake borders that have more open basins and a permanent water source through most of the year, except during exceptional drought years. These areas are distinct from Western Great Plains Closed Depression Wetland (CES303.666) by having a large watershed and/or significant connection to the groundwater table. A variety of species are part of this system, including emergent species of *Typha*, *Carex*, *Eleocharis*, *Juncus*, *Spartina*, and *Schoenoplectus*, as well as floating genera such as *Potamogeton*, *Sagittaria*, *Stuckenia*, or *Ceratophyllum*. The system includes submergent and emergent marshes and associated wet meadows and wet prairies. These types can also drift into stream margins that are more permanently wet and linked directly to the basin via groundwater flow from/into the pond or lake. Some of the specific communities will also be found in the floodplain system and should not be considered a separate system in that case. These types should also not be considered a separate system if they are occurring in lowland areas of the prairie matrix only because of an exceptional wet year.

This system occurs widely throughout the western Great Plains, but in the arid shortgrass region, it is replaced by North American Arid West Emergent Marsh (CES300.729). Open and emergent marshes may be a separate system from wet meadows and wet prairies. More clarification needs to be made between this system and other depressional wetlands occurring in Wyoming and Montana, such as the Inter-Mountain Basins Alkaline Closed Depression (CES304.998), Great Plains Prairie Pothole (CES303.661), and the other western Great Plains depressional wetland systems.

This system is found within lowland depressions and along lakes that have more permanent water sources throughout the year. These areas typically have a large watershed and are connected to the groundwater sources. Examples may also drift into stream margins that are more permanently wet and linked to a basin via groundwater flow from/into a pond or lake. Those areas that are found within larger prairie matrix that are only lowland or wet because of an exceptional wet year are not part of this system.

CES303.669 WESTERN GREAT PLAINS SALINE DEPRESSION WETLAND

This ecological system is very similar to Western Great Plains Open Freshwater Depression Wetland (CES303.675) and Western Great Plains Closed Depression Wetland (CES303.666). However, strongly saline soils cause both the shallow lakes and depressions and the surrounding areas to be more brackish. Salt encrustations can occur on the surface in some examples of this system, and the soils are severely affected and have poor structure. Species that typify this system are salt-tolerant and halophytic species such as *Distichlis spicata*, *Sporobolus airoides*, and *Hordeum jubatum*. Other commonly occurring taxa include *Puccinellia nuttalliana*, *Salicornia rubra*, *Schoenoplectus maritimus*, *Schoenoplectus americanus*, *Suaeda calceoliformis*, *Spartina* spp., *Triglochin maritima*, and shrubs such as *Sarcobatus vermiculatus* and *Krascheninnikovia lanata*. During exceptionally wet years, an increase in precipitation can dilute the salt concentration in the soils of some examples of this system which may allow for less salt-tolerant species to occur. Communities found within this system may also occur in floodplains (i.e., more open depressions) but probably should not be considered a separate system unless they transition to areas outside the immediate floodplain. Open and emergent saline

marshes may be a separate system from saline wet meadows and prairies. This system is often intimately associated (in space) with greasewood flats, and there is some overlap in the associations between the two. This system tends to be more of an herbaceous wetlands, whereas Inter-Mountain Basins Greasewood Flat (CES304.780) is more strongly shrub-dominated with patches of herb-dominance.

This system is distinct from the freshwater depression systems by its brackish nature caused by strongly saline soils. Salt encrustations could occur near the surface in some examples of this system.

MIXED UPLAND AND WETLAND

CES302.746 CHIHUAHUAN-SONORAN DESERT BOTTOMLAND AND SWALE GRASSLAND

This ecological system occurs in relatively small depressions or swales and along drainages throughout the northern and central Chihuahuan Desert and adjacent Sky Islands and Sonoran Desert, as well as limited areas of the southern Great Plains on broad mesas, plains and valley bottoms that receive runoff from adjacent areas. Occupying low topographic positions, these sites generally have deep, fine-textured soils that are neutral to slightly or moderately saline/alkaline. During summer rainfall events, ponding is common. Vegetation is typically dominated by *Sporobolus airoides*, *Sporobolus wrightii*, *Pleuraphis mutica* (tobosa swales), or other mesic graminoids such as *Pascopyrum smithii* or *Panicum obtusum*. With tobosa swales, sand-adapted species such as *Yucca elata* may grow at the swale's edge in the deep sandy alluvium that is deposited there from upland slopes. *Sporobolus airoides* and *Sporobolus wrightii* are more common in alkaline soils and along drainages. Other grass species may be present, but these mesic species are diagnostic. Scattered shrubs such as *Atriplex canescens*, *Prosopis glandulosa*, *Ericameria nauseosa*, *Fallugia paradoxa*, *Krascheninnikovia lanata*, or *Rhus microphylla* may be present. This bottomland/depressional wetland system can be similar to the upland Chihuahuan Loamy Plains Desert Grassland (CES302.061) but is restricted to moist depressions and intermittently flooded drainage terraces and adjacent flats. Alkali sacaton (*Sporobolus airoides*) is often associated with more alkaline (to gypsic), poorly drained areas and giant sacaton (*Sporobolus wrightii*) with less alkaline better drained areas. *Distichlis spicata*, *Allenrolfea occidentalis*, and *Suaeda* spp. are characteristic of more saline and alkaline sites.

This ecological system occurs in relatively small depressions or swales and along drainages on broad mesas, plains and valley bottoms that receive runoff from adjacent areas. These sites occupy low topographic positions and generally have deep, fine-textured soils that are neutral to slightly or moderately saline/alkaline.

CES303.956 WESTERN GREAT PLAINS RIPARIAN

This ecological system is found in the riparian areas of medium and small rivers and streams throughout the western Great Plains. It is likely most common in the Shortgrass Prairie and Northern Great Plains Steppe but extends west as far as the Rio Grande in New Mexico and into the Wyoming Basins in the north. Major rivers include the North and South Platte, portions of the Arkansas, Cimarron, Canadian and upper Pecos rivers and tributaries to where they extend into Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821). It is found on alluvial soils in highly variable landscape settings, from deep cut ravines to wide, braided streambeds. Hydrologically, these sites tend to be more flashy with less developed floodplains than on larger rivers that are classified as floodplain systems, and may dry down completely for some portion of the year. Water sources for this riparian system are largely snowmelt near the Rocky Mountains, but it will respond to summer rains. This system includes numerous smaller prairie rivers and streams that are often groundwater-fed, such as the Arikaree River, a tributary of the Republican River. Dominant vegetation shares much with generally drier portions of larger floodplain systems downstream, but overall abundance of vegetation is generally lower. Communities within this system range from riparian forests and shrublands to gravel/sand flats. Dominant species include *Populus deltoides*, *Salix* spp., *Artemisia cana* ssp. *cana*, *Pascopyrum smithii*, *Panicum virgatum*, *Panicum obtusum*, *Sporobolus cryptandrus*, and *Schizachyrium scoparium*. On the North Platte in southeastern Wyoming, *Fraxinus pennsylvanica* may be present to dominant. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded. *Tamarix* spp., *Elaeagnus angustifolia*, and less desirable grasses and forbs can invade degraded examples up through central Colorado. Groundwater depletion and lack of fire have resulted in additional species changes. All the riparian/floodplain/alluvial systems of the Great Plains region need to be revisited for naming conventions, along with better definitions of conceptual boundaries. There is much apparent overlap in their concepts and distribution, and the names add to the confusion. In particular, the difference between "riparian" and "floodplain" usage in the names needs revisiting and possible changing. These systems include Northwestern Great Plains Floodplain (CES303.676), Northwestern Great Plains Riparian (CES303.677), Western Great Plains Floodplain (CES303.678), and Western Great Plains Riparian (CES303.956).

CES303.680 WESTERN GREAT PLAINS WOODED DRAW AND RAVINE

This ecological system is typically found associated with permanent or ephemeral streams and may occur on steep northern slopes or within canyon bottoms that do not experience periodic flooding, although soil moisture and topography allow greater than normal moisture conditions compared to the surrounding areas. Occurrences can be either tree-dominated or predominantly shrubland. *Fraxinus* spp. with *Ulmus rubra* or *Ulmus americana* typically dominate this system, although in some areas of the western Great Plains steppe province, *Juniperus scopulorum* can dominate the canopy. *Populus tremuloides*, *Betula papyrifera*, or *Acer negundo* are commonly present in portions of the northwestern Great Plains, for example in areas of central and eastern Montana. In south-central portions of the Great Plains, *Quercus macrocarpa* can also be present. Component shrubs can include *Cornus sericea*, *Crataegus*

douglasii, *Crataegus chrysocarpa*, *Crataegus succulenta*, *Elaeagnus commutata*, *Prunus virginiana*, *Rhus* spp., *Rosa woodsii*, *Shepherdia argentea*, *Symphoricarpos occidentalis*, or *Viburnum lentago*. Common grasses can include *Calamagrostis stricta*, *Carex* spp., *Pascopyrum smithii*, *Piptatherum micranthum*, *Pseudoroegneria spicata*, or *Schizachyrium scoparium*. This system was often subjected to heavy grazing and trampling by both domestic animals and wildlife and can be heavily degraded in some areas. In addition, exotic species such as *Ulmus pumila* and *Elaeagnus angustifolia* can invade these systems.

Comments: More information from the broader division and from the Rocky Mountain division will be needed to determine if those areas dominated by ash and elm should be separated from areas dominated by *Juniperus scopulorum*. Those areas dominated by *Juniperus* are typically found in the Badlands and the western portions of North Dakota and Nebraska, and should probably be described based on data from the Great Plains Steppe or Rocky Mountain division. However, *Juniperus* can occur in stands with elm and ash in Nebraska and North Dakota.

This system is associated with permanent or ephemeral streams. It also can occur on steep northern slopes or within canyon bottoms that do not experience periodic flooding. Soils are primarily wet to mesic, and more dissected topography allows for greater than normal moisture conditions. This system is most often associated with smaller rivers and/or temporary streams.

BARREN

CES303.725 LLANO ESTACADO CAPROCK ESCARPMENT AND BREAKS SHRUBLAND AND STEPPE

This ecological system occurs on various surfaces that are sufficiently resistant to erosion to form breaks or escarpments along the eastern edge of the Llano Estacado in Texas. This includes sedimentary deposits such as sandstones, limestones, or shales, or less frequently, igneous formations such as basalt. It is sometimes associated with canyons or drainages, but not always. The system occupies slopes, but may continue over transitions to more level sites upslope and downslope. Soils are variable and this system can occur where there is little soil development. Rough Breaks Ecological Sites are characteristic of this system, but other sites such as Rocky Hill and Gravelly Ecological Sites may also be occupied by this system. The physiognomic character of occurrences ranges from sparsely vegetated to shrubland, to sparse woodland. Bare ground is often conspicuous, and herbaceous cover is usually dominated by mid- to shortgrasses such as *Aristida purpurea*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Bouteloua hirsuta*, and *Schizachyrium scoparium*. Forbs, including species such as *Artemisia ludoviciana*, *Calylophus* sp., *Chaetopappa ericoides*, *Krameria lanceolata*, and *Melampodium leucanthum*, may also be present. Shrub canopy may be dense, with some species reaching tree stature, and on some sites forming sparse woodland. Shrub and tree species include *Juniperus pinchotii*, *Juniperus ashei*, *Quercus mohriana*, *Rhus trilobata*, *Dalea formosa*, *Cercocarpus montanus*, *Prosopis glandulosa*, and *Gutierrezia sarothrae*.

CES302.744 NORTH AMERICAN WARM DESERT ACTIVE AND STABILIZED DUNE

This ecological system occurs across the warm deserts of North America and is composed of unvegetated to sparsely vegetated (generally <10% plant cover) active dunes and sandsheets derived from quartz or gypsum sands. Common vegetation includes *Ambrosia dumosa*, *Abronia villosa*, *Artemisia filifolia*, *Atriplex canescens*, *Eriogonum deserticola*, *Larrea tridentata*, *Pleuraphis rigida*, *Poliomintha* spp., *Prosopis* spp., *Psoralea* spp., *Rhus microphylla*, and *Sporobolus flexuosus*. Dune "blowouts" and subsequent stabilization through succession are characteristic processes.

CES303.665 WESTERN GREAT PLAINS CLIFF AND OUTCROP

This system includes cliffs and outcrops throughout the Western Great Plains Division. Substrate can range from sandstone and limestone, which can often form bands in the examples of this system. Vegetation is restricted to shelves, cracks and crevices in the rock. However, this system differs from Western Great Plains Badlands (CES303.663) in that often the soil is slightly developed and less erodible, and some grass and shrub species can occur at greater than 10%. Common species in this system include short shrubs such as *Rhus trilobata* and *Artemisia longifolia* and mixedgrass species such as *Bouteloua curtipendula* and *Bouteloua gracilis* and *Calamovilfa longifolia*. Drought and wind erosion are the most common natural dynamics affecting this system. The granite glades and rock outcrops of the Llano Uplift of Texas have been reclassified to Llano Uplift Acidic Forest, Woodland and Glade (CES303.657). The carbonate glades, barrens, and cliffs of the Edwards Plateau of Texas have been reclassified to Edwards Plateau Carbonate Glade and Barrens (CES303.655) and Edwards Plateau Cliff (CES303.653), respectively.

This system includes cliff and outcrops throughout the Western Great Plains Division with substrate ranging from sandstone to limestone. Areas of shelves, cracks, and crevices accumulated materials and allow soils to develop enough to support more vegetation.