



# Vegetation Inventory Project

## *Big Bend National Park*

Natural Resource Report NPS/CHDN/NRR—2021/2275



**ON THE COVER**

View down lower Boot Canyon toward Crown Mountain in the Chisos Mountains in Big Bend National Park.

Photograph by: Jeff Renfrow



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## Executive Summary

Big Bend National Park (BIBE) is located in south Texas on the Rio Grande River as it flows, or bends northeast on its path to the Gulf Mexico. The park covers approximately 801,163 acres (324,219 hectares) directly across the river from Mexico on the United States (U.S.) international boundary. In 1935, through an act of Congress, BIBE was established as the first National Park in Texas. BIBE is located in the Chihuahuan Desert ecoregion and has a rugged topography consisting of the Chisos, Rosillos, Deadhorse, and Mariscal Mountains, many foothills, mesas, river canyons, and broad desert plains dissected by an intricate network of washes, arroyos and drainages. To better understand and document the vegetation occurring on these formations, the National Park Service (NPS), the NPS National Vegetation Inventory Program (NVIP) and the NPS Chihuahuan Desert Inventory and Monitoring Network (CHDN) started a BIBE vegetation inventory effort.

An eight-year, six-phase project was begun in 2010 to complete the inventorying and mapping of the vegetation at BIBE. In phase one, Cogan Technology, Inc. (CTI) reviewed the existing vegetation data, summarized the previous classification efforts, and created a new sampling plan. In phase two, NPS, Rio Grande Institute (RGI), and Lady Bird Johnson Wildflower Center (LBJWC) ecologists used the sampling plan to collect 499 classification plots and one observation point across the landscape. Field data was then entered into the NVIP-specific PLOTS database and reviewed by CHDN staff. In phase three, CTI analyzed the PLOTS data to classify 55 plant associations using the revised U.S. National Vegetation Classification (rUSNVC) standard. During phase four, CTI created rUSNVC-type map units to produce a detailed digital vegetation map layer for the project area that included 810,482 acres (327.991 hectares) in and around BIBE. In the accuracy assessment (AA) phase, contracted field crews collected data at 1,113 AA point locations that were randomly placed by map class throughout the project area. The final phase, CTI finalized the classification, reported the AA results, revised the final vegetation map, and delivered the final products to the NVIP.

The resulting spatial database and vegetation map layer for BIBE was created from high-resolution 2015 Texas Orthoimagery Program (TOP) imagery and ancillary data. By comparing the signatures on the imagery to field data, 72 map units (62 vegetated and 10 land-use/land-cover) were developed and used to delineate the vegetation. The interpreted vegetation polygons were then digitized into a Geographic Information System (GIS) layer that was field-tested, reviewed, and revised. The final BIBE vegetation map was assessed for overall thematic accuracy at 81.8% (79.2% raw accuracy) with a Kappa value of 78.4%.

Products developed for BIBE are described and presented in this report, as well as stored in the accompanying project digital files. Project deliverables include the final BIBE Vegetation Inventory Report, the BIBE Spatial GIS Geodatabase, Digital Field Photos, Metadata, Vegetation Descriptions, and Field Key to the Vegetation Associations. For a full listing of the BIBE products available to download please visit the National Park Vegetation Inventory Product website at: <https://www.nps.gov/im/vmi-products.htm>.

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# Introduction

## National Vegetation Inventory Program

The National Vegetation Inventory Program (NVIP) was started as a cooperative effort between the National Park Service (NPS) and the United States Geological Survey (USGS) to classify, describe, and map existing vegetation communities in more than 270 national park units across the United States. The primary objective of the NVIP is to produce high-quality plant community classifications, standardized maps, and associated data sets of the vegetation. This information fills data gaps and complements a wide variety of resource assessments, park management, and conservation needs. Among its many uses, the NVIP products have helped park managers better identify and conserve plant biodiversity; manage non-native and rare species, monitor insect and disease effects; and provide a baseline to examine wildlife habitat relationships and the effects of wildland fires.

In 1999, the Director of the NPS approved the Natural Resource Challenge to encourage National Parks to focus on the preservation of the nation's natural heritage through science, natural resource inventories, and expanded resource monitoring. The Natural Resource Challenge provided funding for 12 baseline inventories to be completed in each of 270 park units that contain significant natural resources. The NVIP is considered one of these 12 baseline inventories.

The NVIP follows well-established procedures that are compatible with other agencies and organizations. The inventory uses the revised National Vegetation Classification Standard Version 2 (rUSNVC) (FGDC 2008), a system that is integrated with the major scientific efforts in the taxonomic classification of vegetation, and is a Federal Geographic Data Committee (FGDC) standard (FGDC 1997 and FGDC 2008). In addition, stringent quality control procedures ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases at multiple scales.

A complete vegetation mapping project for a NPS unit follows a standard 12-step procedure (NPS 2009) and includes the following products:

- Detailed Vegetation Report
- Digital Vegetation Map
- Vegetation Plot Data
- Accuracy Assessment Data and Analysis
- Dichotomous Vegetation Key
- Photo-interpretation Key

Maps and other spatial data products for NPS units in the Continental U.S. are normally produced in the Universal Transverse Mercator (UTM) projection, the North America Datum (version 1983 = NAD 83), uses meters for map and distance units, and have a nominal 1:24,000-scale with a minimum mapping unit (MMU) of 0.5 hectare (1.2 acres). The vegetation maps must meet the National Map Accuracy Standards for positional accuracy (TNC and ESRI 1994a & Lea and Curtis



2010), and the recently revised minimum map class accuracy goal across all vegetation and land cover classes of 60% percent (NPS 2009).

### **National Vegetation Classification Standard**

In 1994, the NPS formed the NVIP to catalog and map the vegetation within all of the 270 NPS units with a natural resource component. Shortly thereafter, the USGS joined this effort and formed a partnership. In the same year, the NVIP also adopted the U.S. National Vegetation Classification (USNVC) (Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. NatureServe has since revised the USNVC and in 2008, the FGDC formally endorsed the rUSNVC (FGDC 2008).

Use of a standardized vegetation classification system, such as the rUSNVC helps ensure data compatibility throughout the NPS and other agencies (FGDC 2008). A standard system is critical for a systematic inventory and classification of the nation's biological resources, assist with efficient stewardship, and help prioritize conservation efforts. The rUSNVC is being used for vegetation classification and mapping projects throughout the Chihuahuan Desert Inventory and Monitoring Network (CHDN) and all of the other 32 NPS inventory and monitoring networks in the U.S. The USNVC has been in existence for over two decades and has evolved from the original classification systems first developed jointly by The Nature Conservancy (TNC), NatureServe, and various other state Natural Heritage Programs (TNC and ESRI 1994a, Grossman et al. 1998).

The rUSNVC is a hierarchical system that allows for vegetation classification at multiple scales (FGDC 2008). There are eight levels with specific criteria set for each level (Table 1). The upper three levels are based on climate and physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels focus largely on broad sets of diagnostic plant species and habitat factors along regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels (as in the original USNVC) are the plant alliance and association (i.e. plant community) and are distinguished by differences in the local floristic composition (Grossman et al. 1998).

The broader alliances are physiognomically distinct groups (e.g. forests, woodlands, shrublands, herbaceous vegetation, etc.) of plant associations sharing one or more differential or diagnostic species (Mueller-Dombois and Ellenberg 1974). These are commonly the dominant(s) found in the uppermost strata of vegetation. The plant association is the base unit of the classification, and following Jennings et al. (2009) is “a vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy”. In the winter of 2016, the NVC for the Conterminous United States was formally released. In the spring of 2017, version 2.01 was made available through the USNVC Explorer. Currently work is being done to revise the classification for plant communities found in Alaska, Hawai'i, and for the U.S. territories in the Caribbean and Pacific islands.

Content for the rUSNVC is currently maintained by NatureServe and is being peer reviewed through collaboration with federal agencies and the Ecological Society of America (ESA) (Faber-Langendoen et al. 2009). The content is available to the public and is regularly updated through NatureServe

Explorer (2018) (<https://explorer.natureserve.org/>) and on the official USNVC website: <http://www.usnvc.org>.

**Table 1.** Summary of USNVC Revised Hierarchy Levels.

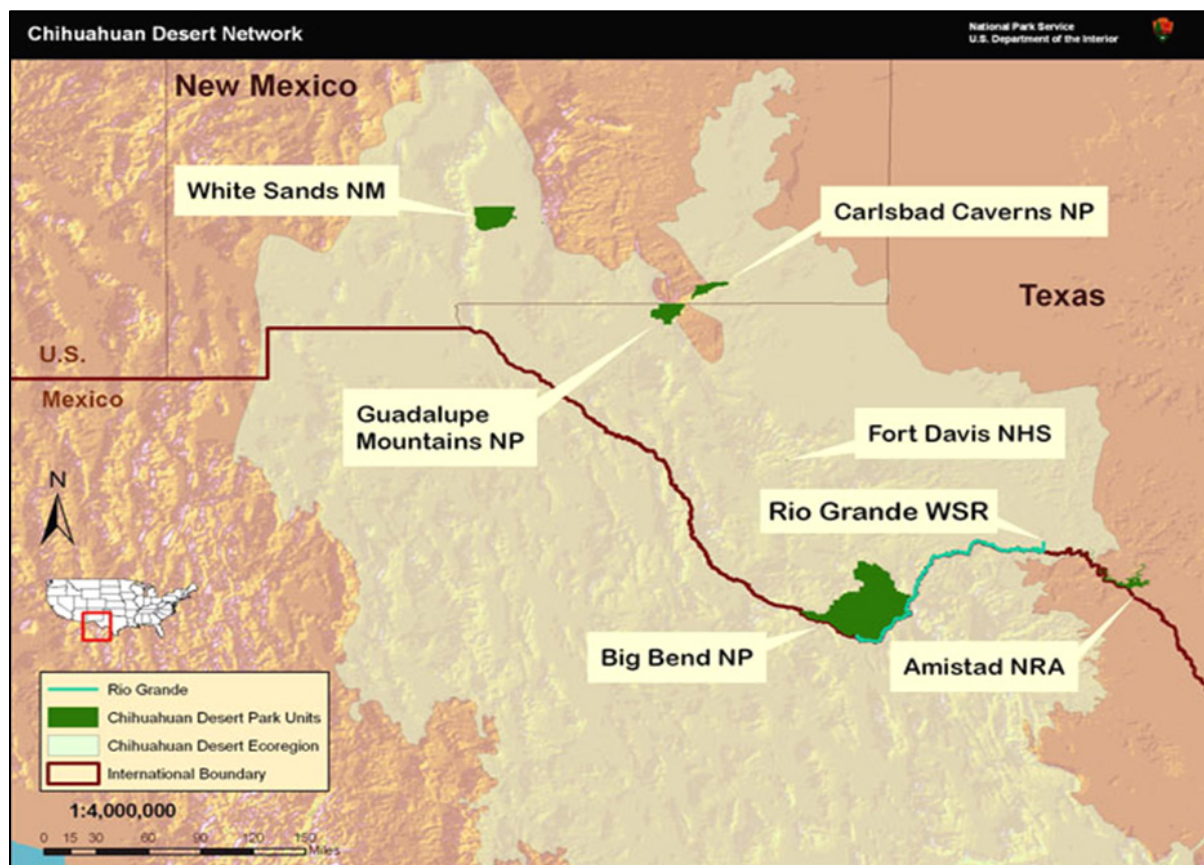
Hierarchy Level	Description	Criteria
Upper: Physiognomy plays a predominant role.	L1 – Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions.
	L2 – Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate/aquatic conditions.
	L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
Middle: Floristics and physiognomy play predominant roles	L4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
	L5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms, that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
	L6 – Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology and disturbance regimes.
Lower: Floristics plays a predominant role	L7 – Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
	L8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

All of the rUSNVC associations and alliances (or equivalents) are commonly used for map units or classes in the NVIP to insure compatibility throughout the NPS as well as with other federal and state agencies. Vegetation maps and supporting ecological information based on the rUSNVC allows for efficient comparisons of similar types in other areas and at the same location through time. Referencing the rUSNVC assures that map units are not based on confusing local (common) plant names or site-specific habitats. Future researchers using the vegetation map and data can always reference the rUSNVC descriptions for timely and accurate information on the common species and habitat characteristics. Having the ability to cross-reference the vegetation map units with the

rUSNVC types also allows for comparison to other studies relating to a wide variety of resource assessment, park management, and planning needs.

### Chihuahuan Desert Inventory and Monitoring Network

CHDN is composed of seven NPS park units in the desert and mountain landscapes of west Texas and southeastern New Mexico (Figure 1). CHDN park units include: BIBE, Amistad National Recreation Area (AMIS), Carlsbad Caverns National Park (CAVE), Fort Davis National Historic Site (FODA), Guadalupe Mountains National Park (GUMO), Rio Grande Wild and Scenic River (RIGR), and White Sands National Monument (WHSA). This network of park units occurs within the 230,000 square-mile Chihuahuan Desert Ecoregion that covers much of Northern Mexico and extends into Southwest Texas and Southern New Mexico. The biota contained in the CHDN park units is extremely diverse and specialized, with many animal and plant species only found in this region of the world.



**Figure 1.** The Chihuahuan Desert Inventory and Monitoring Network Map (BIBE highlighted in red). Source: NPS – CHDN.

The CHDN was organized to inventory and monitor status and trends for selected natural resources and provide a network organization that facilitates collaboration, information sharing, and economies of scale across all the park units in the Chihuahuan ecoregion. The inventory and monitoring information created and collected by this network is used for many purposes including: guiding park

level management decisions, informing and fostering scientific research, and providing outreach and education to the general public. One goal of the CHDN is to collect and serve data on the dynamic nature and condition of park-managed ecosystems and to provide reference points for comparisons with other management types and possibly with altered environments. The development of a vegetation classification to the vegetation alliance/plant association level and associated GIS map and database for each park is viewed as a high priority in reaching this goal. To help achieve this requirement, the CHDN has collaborated with the NVIP to get all of their park units inventoried and mapped. The products presented here, along with those for AMIS and RIGR, represent the last park units to be completed within the CHDN.

For more information about CHDN please visit their website at:

<https://www.nps.gov/im/chdn/index.htm> and to view examples of other completed NVIP projects in CHDN please access either the NPS Integrated Resource Management Application Data Store website at: <https://irma.nps.gov/DataStore> or the National Park Vegetation Inventory Product website at: <https://www.nps.gov/im/vmi-products.htm>.

### **Big Bend National Park**

The Rio Grande River (or the Rio Bravo—its Mexican name) forms part of a natural boundary between the United States (U.S.) and Mexico. This important and historical river meanders southeast from the high Rocky and San Juan Mountains through New Mexico and lower Texas before reaching its terminus at the Gulf of Mexico. Along its path, it cuts through the heart of the Chihuahuan Desert ecoregion and for about 118 miles (190 km) it forms the southern border of BIBE. BIBE is aptly named after the path of the Rio Grande River as occurs exactly in the middle of a large bend where the river dramatically shifts from a southeastern trek towards a more northeastern route. Within this bend is a vast landscape that has been described as the focal point for the Chihuahuan Desert, “one of three most biologically rich and diverse desert ecoregions in the world” (WWF 2019). Labeling BIBE a desert does not do it justice as it is much more diverse than that. Within its borders are geologic wonders, life-sustaining riparian corridors, high refuges for pre-desert flora and fauna, mountain oases of cool springs and streams, rugged canyons, and vivid wildernesses that are awesome in size and stunning to behold (NPS 2004).

With the underlying importance of protecting the natural history and generating public interest in the Big Bend Area, BIBE was established as the first National Park in Texas by an act of Congress in 1935. BIBE is geographically located in the western panhandle of Texas in the southern portion of Brewster County. Brewster County is a large county (6,204 square miles – 16,068 sq km) that is sparsely populated (about 13,000 residents). BIBE is located south and southeast of the towns of Marathon and Alpine (Figure 2). The small towns of Study Butte, Terlingua, and Lajitas are located just outside of BIBE to the west and the Mexican border town of Bouquillas del Carmen is situated to the southeast of the park just across the border.





**Figure 2.** Big Bend National Park Regional Map. Source: NPS.

The boundary of BIBE has changed over the years due to both the meandering and twisting of the Rio Grande River and by land acquisitions. The southern boundary of the park is officially the U.S. – Mexico international boundary and is defined as the midpoint of the deepest depth in the Rio Grande River channel (which can change depending on the direction and flow of the river). The park has also recently acquired the Harte Family Ranch as part of a donation from The Nature Conservancy in the northwest corner of the park near the Rosillos Mountains (where other private inholdings still exist). According to the NPS website, BIBE currently encompasses 801,163 acres (324,219 ha) (NPS 2019) (Figure 3) and is surrounded by a mix of privately owned ranches and state managed/protected lands (both U.S. and Mexican). In 1978, through an act of Congress a 315-kilometer (196-mile) section of the Rio Grande River was designated as a wild and scenic river effectively creating the Rio Grande Wild and Scenic River (RIGR) park unit that starts in BIBE and extends eastward. A hundred and eleven kilometers (69 miles) of RIGR are actually contained within the eastern portion of BIBE and both units are jointly administered and managed by BIBE staff.

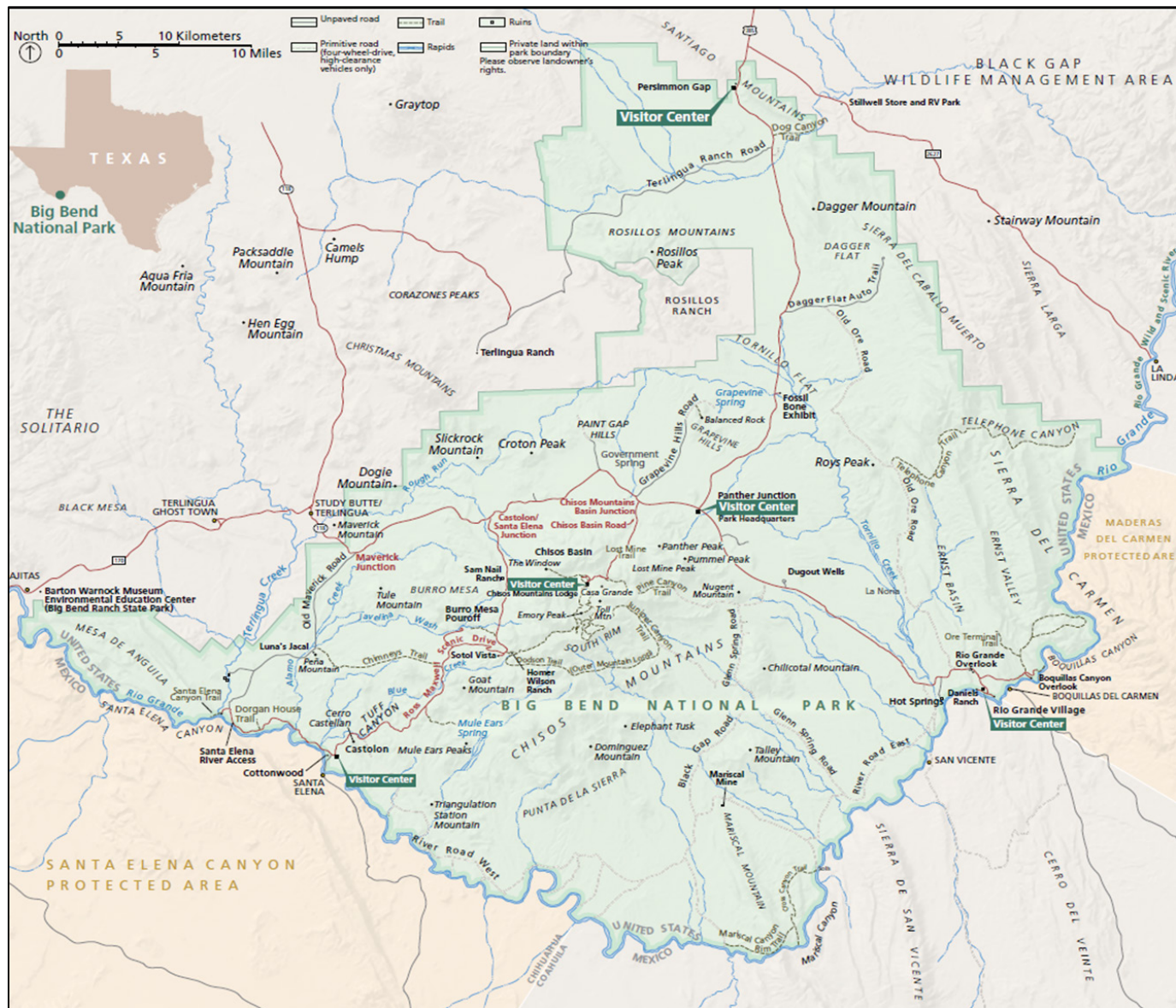


Figure 3. Big Bend National Park Map. Source: NPS.

### **Natural Setting**

BIBE is located in the north central portion of the Chihuahuan Desert region that extends north from Mexico into southwest Texas and northeast New Mexico. It is a land of extremes from the low Rio Grande River to the high Chisos Mountains, from hot arid deserts to cool mountains, and from sparse desert scrublands to the thick mesic forests. Broadly speaking, BIBE has a rugged topography with many dramatic vistas including deep river canyons, rugged mountains, large mesas, rolling foothills, and broad desert plains/basins all dissected by an intricate network of washes and drainages. Within this distinctive physiography and across its broad elevational gradient, BIBE has many distinct geologic formations including calcareous limestones and clays, sandstones and siltstones, alluvial and colluvial gravels, hard igneous outcrops and intrusions, talus and scree fields, and volcanics and basalts (Gray and Page 2008). Soils in BIBE are all derived from these various parent materials and are heavily influenced by various erosion processes. The most recently updated soil survey for BIBE (Salinas 2011) divides the soils into 5 broad vegetative zones (Table 2).

**Table 2.** Soil Survey for BIBE Summarized by Vegetative Zone.

<b>Vegetative Soil Zone</b>	<b>Major Soils</b>	<b>Soil Characteristics</b>	<b>Common Plant Species</b>	<b>Percentage of BIBE</b>
Hot Desert Shrub	Corazones, Geefour, Ninepoint, Solis, Studybutte, Terlingua, and Tornillo Series (Rock Outcrops)	Shallow or Very Shallow  Loamy or Gravelly Surfaces	Drought Tolerant Short & Mid Grasses and Shrubs	49%
Desert Grassland	Bissett, Chilicotal, Leyva, Lingua, and Paisano Series (Rock Outcrops)	Very Deep, Shallow, or Very Shallow  Loamy or Gravelly Surfaces	Short and Mid Grasses and Shrubs	26%
Southern Edwards Plateau	Blackgap, Mariscal, Stillwell, Strawhouse, and Terlingua Soils (Rock Outcrops)	Very Deep, Shallow, or Very Shallow  Loamy, Gravelly, or Very Gravelly Surfaces	Drought Tolerant Short Grasses and Frequent Woody Shrubs	22%
Mixed Prairie	Altuda and Brewster Soils (Rock Outcrops)	Shallow or Very Shallow  Loamy or Extremely Gravelly Surfaces	Short and Mid Grasses and Scattered Shrubs	2%
Mountain Savannah	Madrone and Puerta Series	Shallow or Moderately Deep  Cobbly or Gravelly Loamy Surfaces	Evergreen and Deciduous Tree Woodlands  Mid and Tall Grasses in the Understory and in Canopy Openings	1%

In the center of BIBE are the imposing Chisos Mountains. The Chisos are the southernmost mountain range in the continental U.S. and are completely contained within BIBE. They rise to over 7,825 feet

(2,385 m) above sea level at Emory Peak and these mountains provide a refuge for unique relict forests, woodland, and chaparral communities. In the heart of the Chisos is a depression known as the Chisos Basin, a dramatic vista popular with tourists. Another unique area is the limestone fault-block mountain range called the Sierra del Caballo Muerto or the Dead Horse Mountains. Located along the eastern boundary of the park, it is a remote and rugged place. Elevations here range from 2,700 feet (850 m) to 5,200 feet (1,600 m) and support unique environments not found elsewhere in the park. Other lesser mountain ranges include the Rosillos, Chalk, and Christmas Mountains in the north, the Mariscal Mountains in the south, Santiago and Sierra Del Caballo Mountains in the northeast, and the large Mesa de Anguilla formation in the southwest. Various single mountains or peaks and hills are also scattered throughout BIBE or occur along the park boundary. These include Pena, Slickrock, Dogie, Maverick, Rattlesnake and Talley Mountains, Grapevine Hills, and Roy's, Tule, and Croton Peaks.

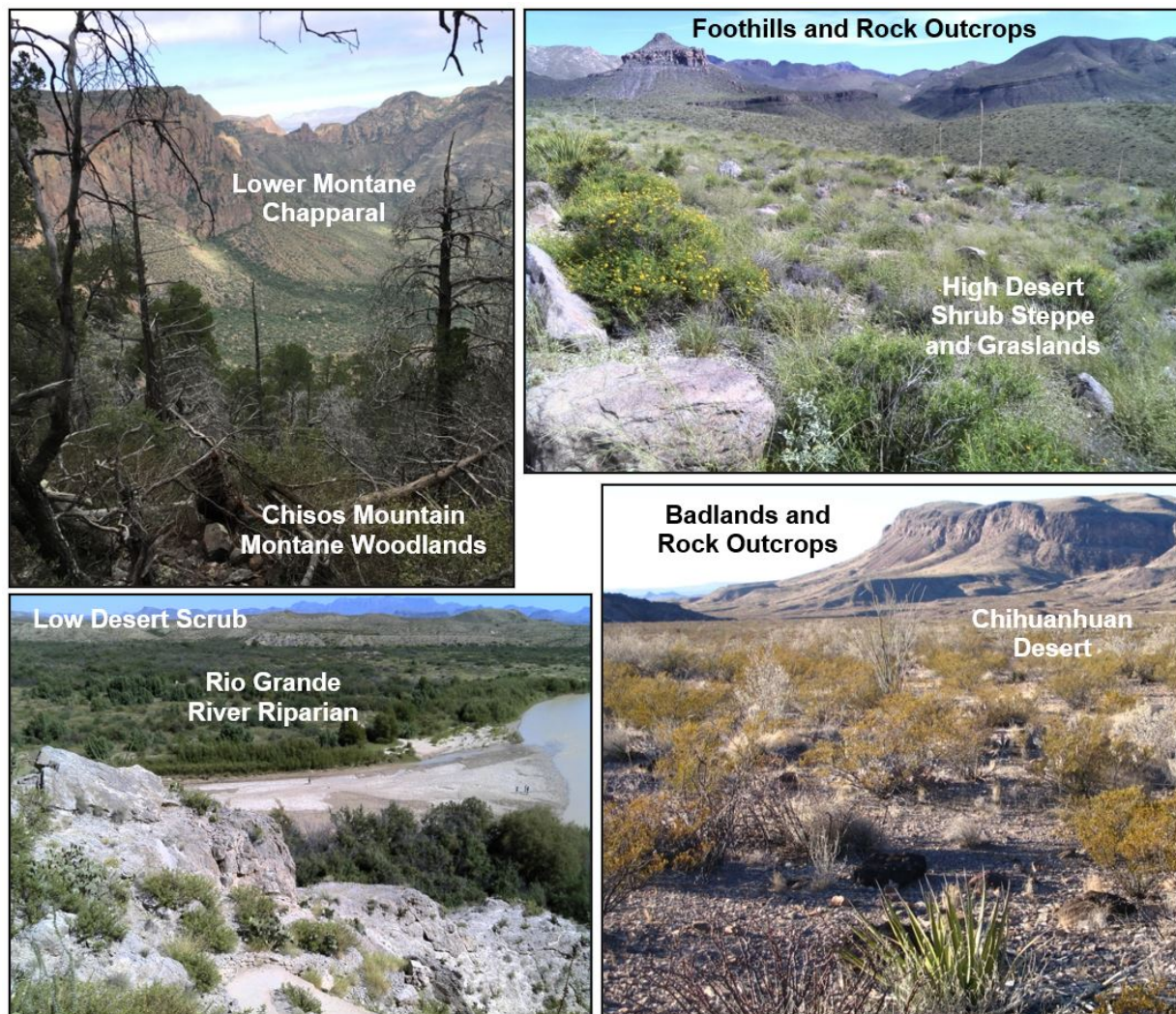
The Rio Grande River is the dominant water feature in the park and at 1,470 feet (448 m) above sea level represents its lowest elevation. As the river continues its journey from west to east along the southern boundary, it has shaped much of the landscape including creating the Santa Elena (west), Mariscal (middle), and Boquillas Canyons (east). The river has constantly altered its path over the years, leaving behind meandering floodplain channels and dry riverbeds. The river has also cut numerous riverbanks, formed ever-changing large flats, and has deposited tons of sediment on new alluvial plains and riverbeds. Flowing into the Rio Grande at BIBE are numerous flash flood-prone dry washes and semi-annual creeks and tributaries. Among the largest and longest are the Terlingua, Alamo, Smoky, and Tornillo Creeks. The presence of water and mesic soils in these streams and along the Rio Grande River has created riparian grass, shrub and woodland habitats important for birds and other wildlife. Unfortunately, like most rivers in the Western U.S., the Rio Grande has lost most of its water to dams, pumping, irrigation, and diversion projects. It is estimated that only 20% of its original water actually makes it to the Gulf of Mexico. On most days in BIBE, the river may only be knee deep and may actually be completely dried up in some locations (NPS 2019).

As part of the Chihuahuan Desert, BIBE has a hot and dry climate. Summers are usually hot and temperatures can easily reach over 100 degrees Fahrenheit (38 degrees Celsius). Spring and fall are milder with average temperatures closer to 70 °F (21° C). Winters are mild with 50 °F (10° C) days and slightly colder nights. Freezing events at BIBE are rare but do occur. The winter season also brings the most moisture to the area although thunderstorms are common in the spring and summer and can be heavy. Average annual precipitation varies from about 19 inches (48 centimeters) in the Chisos Basin to about 10 in (25 cm) along the Rio Grande River. As you travel up in elevation, the climate also changes. Higher areas in the Chisos and other mountains may be 20 degrees cooler and receive significantly more rain and snowfall. As a rule, air temperatures in the park drop 5 degrees and precipitation levels increase about 2.5 in (6 cm) for every 1,000 ft (30 m) of elevation you gain (NPS 2019).

BIBE's extreme climate, rapid changes in elevation, geologic variety, isolated basin and range physiography, and long-term climate trends (from cool/wet to hot/dry) all produce a wide range of ecological niches and unique habitats (Figure 4). Nearby ecoregions also influence BIBE's



biodiversity and play a major role in the formation of plant communities. Notably plants from the Edwards Plateau, Tamaulipan, Sinaloan, Sonoran, Sierra Madre, Meseta Central, Colorado Plateau, and the Arizona and Rocky Mountain regions can all be found within the park. This unique assemblage of species and habitats includes relic plant communities hanging on in higher elevations and more recently adapted species able to survive in hot and dry conditions. The high diversity and uniqueness of BIBE's vegetation has brought it national recognition as the largest protected area of Chihuahuan Desert in the U.S. Further, as part of the larger protected landscape with nearby Texan and Mexican managed lands, BIBE is part of one of the largest trans-boundary protected areas in North America. Contained in this area are approximately 1,000 endemic plant species and about one-fifth of all the world's cacti (WWF 2019).



**Figure 4.** Examples of Unique Ecological Habitats at BIBE. Source: CTI.

## **Vegetation**

BIBE is a diverse and rugged place with a steep elevational gradient. Along this gradient various riparian, desert scrub, grass/shrub steppe, chaparral, and relic montane plant communities have become established. This unique blending of types along with possible future threats posed by climate change, insect infestation, fire, and other anthropogenic events have led to various past vegetation studies at BIBE. Starting in 1901 (Bray), the vegetation at BIBE has been inventoried, investigated, and described. Most of this work has been centered on identifying (inventorying) native plant species (Bowman 1911, Worthington 2002, and Fenstermacher et al. 2008), documenting non-native vegetation (Young et al. 2007), locating and preserving rare plant species and habitats (Young et al. 2006), monitoring and documenting changes to the vegetation (Warnock et al. 1955, 1968, Moir 1980, Muldavin et al. 2002, and Wondzell et al. 2007), and/or stratifying the vegetation by plant communities or other ecological groupings for the purposes of mapping or environmental analysis (Cochran and Rives 1985, Plumb 1991, 1992, 1993, Muldavin et al. 2014, Whitefield 1990, Brown 1994, Wood et al. 1999, and Salinas 2011).

Vegetation communities across large landscapes lend themselves to be stratified by elevation (Merriam 1895 & Billings 1951) and the resulting life zones can be a valuable tool for understanding the vegetation diversity in complex environments. BIBE is no exception as the vegetation has been grouped by dominant overstory species by elevation into many different classifications over the years. As previously stated in this report, the most recent soil survey used five vegetative soil zones. Plumb in his studies used six broad map classes; they included (1) Floodplain/Upland Riparian, (2) Scrub Desert, (3) High Desert Grasslands, (4) Shrub Woodland, (5) Grassy Woodlands, and (6) Forests. Plumb (1992) also identified 20 plant specific cover types based on extensive ground based sampling. These and other studies have documented the importance of life zones and ecological units for inventorying, modeling, monitoring, and making park management decisions (General Management Plan 2004 and Fire Management Plan 2005).

Using the existing vegetation classifications and the preliminary work for this study, a detailed vegetative pattern based on elevation and location can be created for BIBE. The park's vegetation gradient starts at the lowest point along the Rio Grande River with riparian flora, goes up through three levels of desert (scrub, shrub, and grass steppe) dominated vegetation, into the lower mountain and foothills region (dominated by chaparral, taller shrubs, and short trees), and finally ends in the highest montane (forests, woodlands and grassy meadows) zone. Included within these broad categories are subtle changes in the species composition based on the parent geology. Specifically the limestone or calcareous portions of BIBE contain slightly different dominant species consisting of mainly yucca and other shrubs. Using this model, the general life zones are presented in Table 3 and can be visually examined in Figure 5.

**Table 3.** General BIBE Vegetated Life Zones (from high to low elevation).

Life Zone	Elevation*	Vegetation Type
1. Upper Montane – High Chisos Mountains	2,300–1,800 meters (7,500–6,000 feet)	<ul style="list-style-type: none"> <li>a) Closed Canopy Woodlands and Forests – Protected Slopes and Canyons (Mixed Oaks, Arizona Cypress, Mixed Pines and Juniper Trees)</li> <li>b) Open Canopy Woodlands – Exposed Slopes (Mixed Pines, Mixed Junipers, and Mixed Deciduous Trees)</li> <li>c) High Montane Chaparral and Grasslands (Short Trees, Mixed Shrubs, Mixed Grasses)</li> <li>d) Rock Outcrops and Talus (Igneous and Sedimentary Rocks)</li> </ul>
2. Lower Montane – Low Mountains and Foothills	1,800–1,500 meters (6,000–5,000 feet)	<ul style="list-style-type: none"> <li>a) Forests and Woodlands – Protected Slopes and Canyons (Mixed Oaks, Mixed Junipers, and Pinyon Pines Trees)</li> <li>b) Scrub Woodlands and Mixed Chaparral – Exposed Slopes (Short Juniper and Oak Trees, Mixed Shrubs, and Mixed Grasses)</li> <li>c) Foothill Washes (Mixed Deciduous Shrubs)</li> <li>d) Montane Grasslands, Rock Outcrops, and Talus (Mixed Grasses and Sparse Vegetation)</li> </ul>
3a. High Desert Steppe (Non-Calcareous)	1,500–1,200 meters (5,000–4,000 feet)	<ul style="list-style-type: none"> <li>a) Low Chaparral and Shrublands (Mixed Trees, Shrubs, and Grasses)</li> <li>b) Shrub Steppe (Sotol, Lechuguilla, Mesquite, and Mariola Shrubs and Mixed Grasses)</li> <li>c) Mixed Tall Shrub Washes (Mixed Deciduous Shrubs and Grasses)</li> <li>d) High Desert Grasslands (Chino Grama and Other Grasses)</li> <li>e) Non-Calcareous Exposed Rock Outcrops and Talus (Sparse Vegetation)</li> </ul>
4a. Mid-Desert Scrub (Non-Calcareous)	1,200–800 meters (4,000–2,500 feet)	<ul style="list-style-type: none"> <li>a. Desert Shrublands (Creosotebush, Ocotillo, and Lechuguilla Shrubs)</li> <li>a) Desert Washes and Tall Shrublands (Acacias, Mesquites, and Mixed Deciduous Shrubs)</li> <li>b) Desert Grasslands (Chino Grama and Other Grasses)</li> <li>c) Non-Calcareous Exposed Rock Outcrops and Talus (Sparse Vegetation)</li> </ul>
5a. Low Desert Scrub (Non-Calcareous)	800–500 meters (2,500–1,500 feet)	<ul style="list-style-type: none"> <li>a. Low Desert Scrub (Creosotebush and Ocotillo Shrubs and Sparse Understories)</li> <li>a) Low Desert Washes (Creosotebush, Acacias and Mesquite Shrubs)</li> <li>b) Low Desert Sparse Vegetation (Sparse Vegetation on Badlands, Basalt Outcrops, Clay, and Gypsum Flats)</li> </ul>

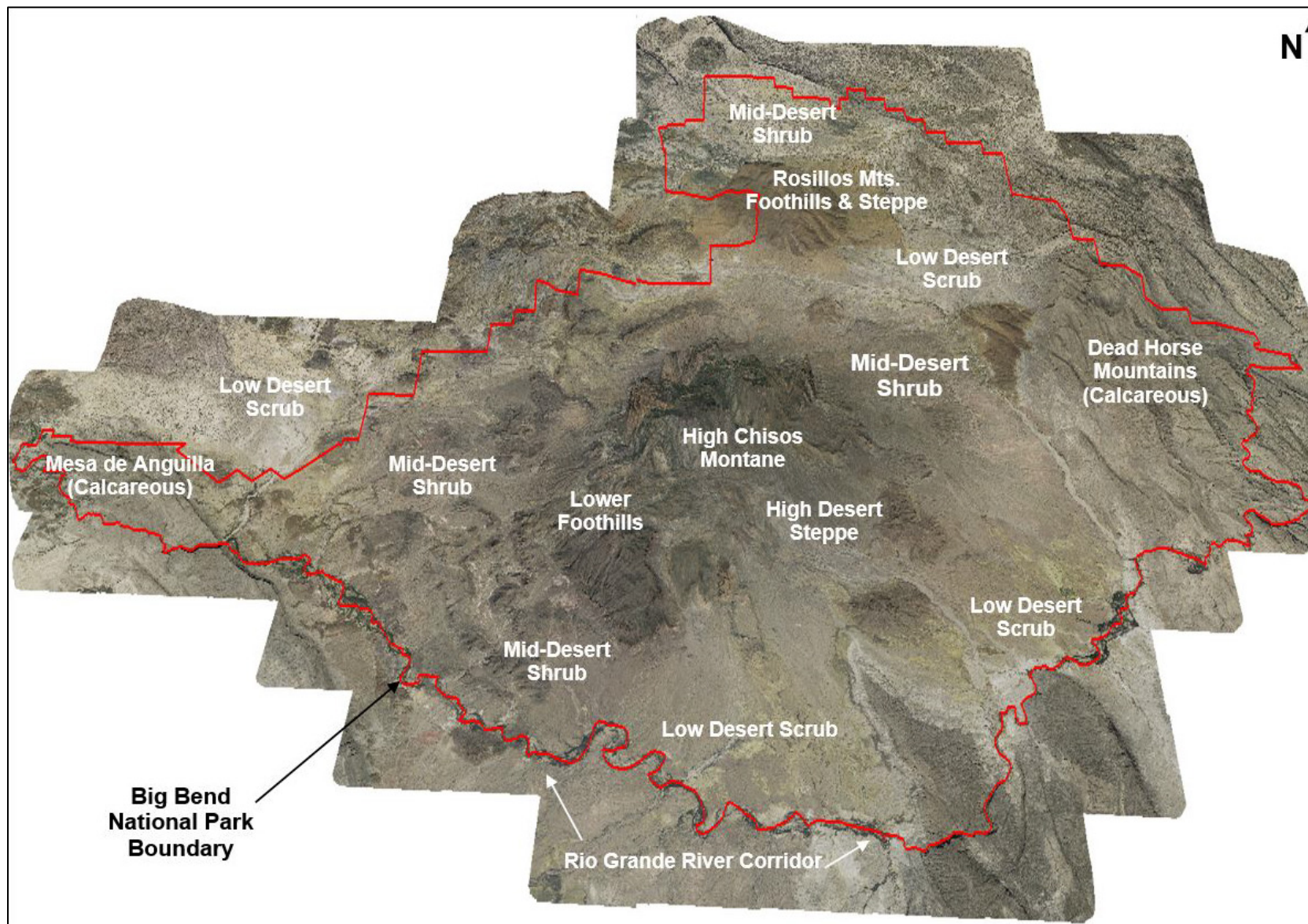
\* all elevations are estimates only and can vary by location.

**Table 3 (continued).** General BIBE Vegetated Life Zones (from high to low elevation).

Life Zone	Elevation*	Vegetation Type
3b. High Desert Steppe (Calcareous)	1,900–1,500 meters (6,000–5,000 feet)	a) Calcareous Chaparral – Protected Slopes (Mixed Tall Yuccas, Mixed Shrubs, and Mixed Grasses) b) Calcareous Shrub Steppe and Grasslands – Exposed Slopes (Mixed Short Yuccas and Sotol Shrubs and Chino Grama Grass) c) Calcareous Exposed Rock Outcrops and Talus (Sparse Vegetation)
4b. Mid-Desert Scrub (Calcareous)	1,500–900 meters (5,000–3,000 feet)	a. Calcareous Mixed Desert Shrublands (Mixed Short Yuccas, Candelilla Shrubs, Mixed Grasses) a) Calcareous Desert Washes (Mixed Yucca and Sotol Shrubs and Mixed Grasses) b) Calcareous Exposed Rock Outcrops and Talus (Sparse Vegetation)
5b. Low Desert Scrub (Calcareous)	900–500 meters (3,000–1,500 feet)	a. Calcareous Mixed Desert Scrub (Mixed Short Yuccas, Candelilla Shrubs and Sparse Understories) a) Calcareous Desert Washes (Yucca Shrubs) b) Low Calcareous Sparse Vegetation (Sparse Vegetation)
6. Low Elevation Rio Grande River Riparian Corridor	700–500 meters (2,300–1,500 feet)	a. Riparian Woodlands = (Cottonwood, Willows, and Restored/Planted Tree) a) Riparian Shrublands = (Mesquite) [Weedy Riparian Shrublands = (Tamarisk, Tree Tobacco, Rooseveltweed] b) Riparian Herbaceous Vegetation = (Common Reed, Spikerush, and Bulrush) [Weedy Riparian Herbaceous Vegetation = (Arundo/Giant Cane and Bermuda Grass)]

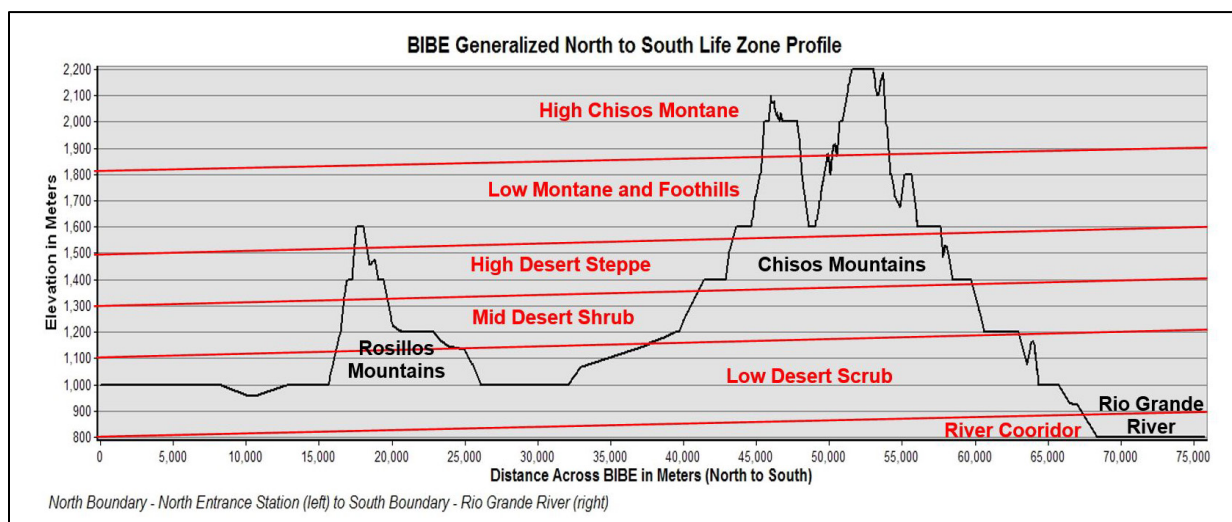
\* all elevations are estimates only and can vary by location.





**Figure 5.** Overview of BIBE Showing Vegetation Patterns. Source: CTI, USGS 10-meter DEM, and 2015 TOP Orthophotography.

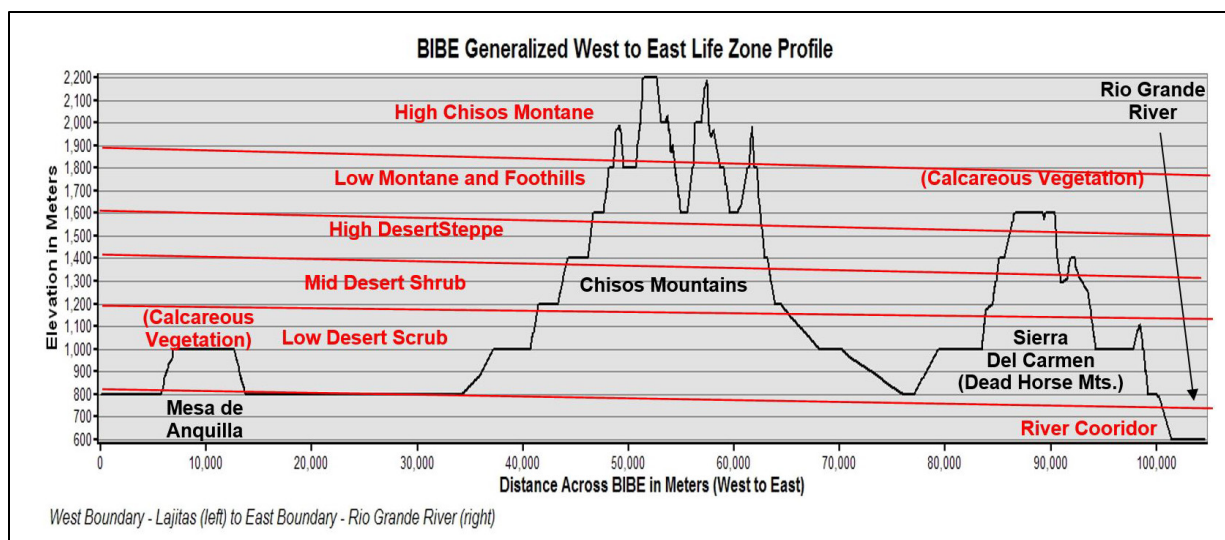
Further investigation shows other vegetation patterns including a general elevational range and aspect difference between plant communities located on north and east vs. south and west slopes (Figure 6 and Table 4; Figure 7 and Table 5). For instance, vegetation communities occur at slightly different elevations all the way around the Chisos Mountain range. As a result, life zones on the southern and western slopes of BIBE likely extend 325 to 650 feet (100–200 m) further upslope as compared to their counterparts on the cooler and more mesic northern and eastern sides. Aspect variations likely occur due to the differences in moisture regimes and solar insulation with the south and west slopes receiving more sunlight and are slightly drier and warmer than those on the other sides of the mountains are. This trend is likely only well defined for the montane, foothills and upper desert zones and may not be indicative of the generally open high, mid, and low desert and the Rio Grande riparian corridor portions of BIBE—or in other areas with little or no slope.



**Figure 6.** Representative North to South Cross-Section.

**Table 4.** Life zone differences in elevation based on north or south aspect.

Life Zone	North-Slope		South-Slope	
	Highest Elevation	Lowest Elevation	Highest Elevation	Lowest Elevation
High Chisos Montane	2,300	1,800	2,300	1,900
Low Montane and Foothills	1,800	1,500	1,900	1,600
High Desert Steppe	1,500	1,300	1,600	1,400
Mid Desert Shrub	1,300	1,100	1,400	1,200
Low Desert Scrub	1,100	< 800	1,200	< 900
Rio Grande River Corridor	< 800	< 800	< 900	< 900



**Figure 7.** Representative West to East Cross-Section.

**Table 5.** Life zone differences in elevation based on east or west aspect.

Life Zone	West-Slope		East-Slope	
	Highest Elevation	Lowest Elevation	Highest Elevation	Lowest Elevation
High Chisos Montane	2,300	1,900	2,300	1,800
Low Montane and Foothills	1,900	1,600	1,800	1,500
High Desert Steppe	1,600	1,400	1,500	1,300
Mid Desert Shrub	1,400	1,200	1,300	1,100
Low Desert Scrub	1,200	< 900	1,100	< 800
Rio Grande River Corridor	< 800	< 800	< 800	< 800

To understand better BIBE's vegetation distribution and diversity each of the life zones can be examined individually using a combination of elevation, landscape position, and dominant plant species. The following are brief descriptions for each life zone at BIBE.

#### High Montane:

Starting at the highest point in the Chisos Mountains, BIBE's high montane zone is a cool, rugged area with numerous rock outcrops and talus fields. Around these rock formations a variable mix of Grave's oak or Chisos red oak (*Quercus gravesii*), other oaks (*Quercus* spp.), Mexican pinyon pine (*Pinus cembroides*), and juniper (*Juniperus* spp.) trees occur. Understories, if present, contain a variety of shrubs, large succulents, and semi-succulents species. Unique areas may also contain relic communities of Arizona pine (*Pinus arizonica*) and Arizona cypress (*Hesperocyparis arizonica*) trees. In slightly lower elevations, the oak trees tend to drop out and the resulting mixed pinyon pine – juniper woodlands extend both into mesic (protected) areas and into drier (exposed) locations. Along with Mexican pinyon pine, alligator juniper (*Juniperus deppeana*) and weeping juniper (*Juniperus flaccida*) trees are prevalent. Mesic areas contain closed canopies with limited

understories or a mix of shrubs and sparse grasses. In contrast, drier areas have open canopies with a moderate to high cover of various grasses and larger shrubs. Both Pinochet's or redberry juniper (*Juniperus pinchotii*) and Emory oak (*Quercus emoryi*) trees may be locally abundant. Montane mixed shrublands also occur on some of the moderately steep slopes within the Chisos Mountains and to a lesser extent in the Sue Peaks vicinity of the Dead Horse Mountains. Sclerophyllus tree-like shrubs are dominant, where they form closed and nearly closed canopies along drainages and at the base of rock escarpments. Grave's oak, gray oak (*Quercus grisea*), coahuila (dwarf) oak (*Quercus intricata*), and Arizona white oak (*Quercus arizonica*) and their hybrids are the dominant species. Throughout the high elevations are the occasional grassy meadows in low-relief areas dominated by moderate to high cover of graminoids including finestem needlegrass (*Nassella tenuissima*), bull muhly grass (*Muhlenbergia emersleyi*), and grama grasses (*Bouteloua* spp.) (Figure 8)

#### Lower Montane and Foothills:

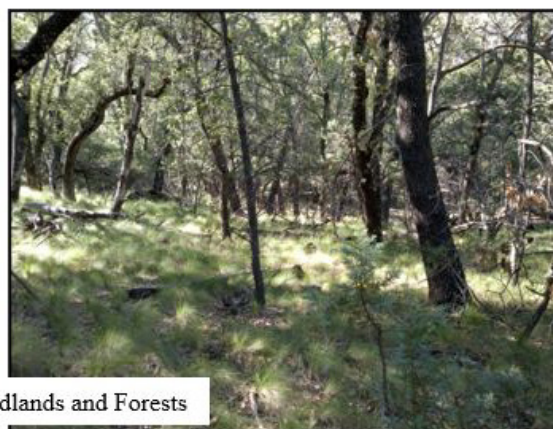
The lower portions of the Chisos Mountains, its foothills, and other taller peaks in BIBE contain mixes of short trees, shrubs, and grasses. The range of this zone extends into the highest desert plains and along many of the minor washes. Species diversity is high and communities of short trees and tall shrubs may be locally abundant. Dominant species include Pinchot juniper and Emory oak trees and mixed broad-leaved shrubs such as alderleaf mountain mahogany (*Cercocarpus montanus*), skunkbush sumac (*Rhus trilobata*), and Apache plume (*Fallugia paradoxa*). As trees become less abundant, more shrub steppe and grass-like communities occur. These include areas with moderate to dense cover of lechuguilla (*Agave lechuguilla*), resinbush, (*Viguiera stenoloba*), and Texas barometer bush (*Leucophyllum* spp.) shrubs and sideoats grama (*Bouteloua curtipendula*) and chino grama (*Bouteloua ramosa*) grasses (Figure 9).



High - 2,300 meters



Closed Canopy Woodlands and Forests



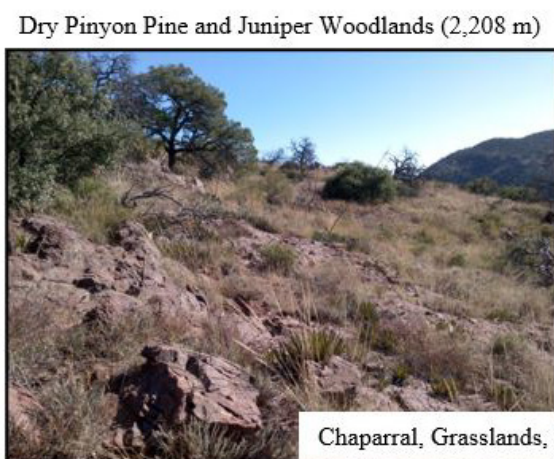
High Chisos Mixed Oak and Pine Forest (2,065 m)



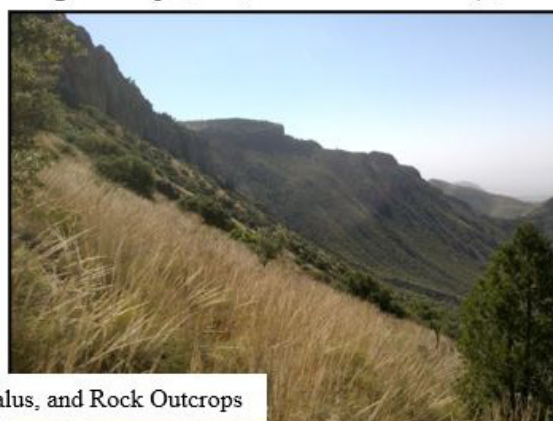
Open Canopy Woodlands



Alligator Juniper, Pine, and Oak Woodlands (2,101 m)



Chaparral, Grasslands, Talus, and Rock Outcrops



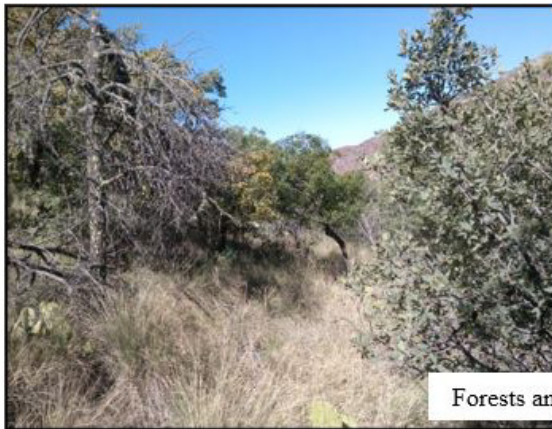
High Montane Chaparral and Grasslands (2,090 m)

↓ Mixed Grasses, Rocks, and Talus (2,218 m)  
1,800 meters

**Figure 8.** Common BIBE High Chisos Montane Vegetation Types. Source: LBJWC, CTI, and NPS Photos.



1,800 meters



Forests and Woodlands

Mesic Pine, Oak, and Juniper Woodlands (1,783 m)

Grave's Oak and d Emory Oak Canyon Forest (1,666 m)



Scrub Woodlands & Mixed Chaparral

Mixed Montane Chaparral (1,843m)

Oak Scrub Woodlands (1,640 m)



Grasslands and Sparse Vegetation

↓ Spikemoss Rocky Shrub Herbaceous Veg. (1,710 m)  
1,500 meters

Mesic Montane Talus and Rock Outcrops (1,650 m)

**Figure 9.** Common BIBE Lower Montane and Foothills Vegetation Types. Source: LBJWC, CTI, and NPS Photos.

### High Desert Steppe:

Transitioning from the lower montane and foothills region of BIBE to the more desert-like areas, lechuguilla becomes more pronounced and steppe-like communities dominated by green sotol (*Dasyilirion leiophyllum*) and chino grama grass are common. Grasses in this region can have moderate to high cover in protected areas and can be sparse or absent on rockier and exposed soils. On moderate slopes adjacent to the Chisos Mountains, beargrass (*Nolina erumpens*) may be locally abundant. Trees and broad-leaved shrubs including Gregg's ash (*Fraxinus greggii*), Lacey oak (*Quercus laceyi*), Texas persimmon (*Diospyros texana*), evergreen sumac (*Rhus virens*), Mexican buckeye (*Ungnadia speciosa*), Texas swampprivet (*Forestiera angustifolia*), little walnut (*Juglans microcarpa*), and whitethorn acacia (*Acacia constricta*) are mostly limited to the drainages and washes in these areas (Figure 10). High desert communities occurring in the Dead Horse Mountains and on other limestone formations in the park vary slightly in species composition. On these calcareous deposits, mesic and protected areas support chaparral like communities consisting of Torrey's yucca (*Yucca torreyi*), Thompson's yucca (*Yucca thompsoniana*), and candelilla (*Euphorbia antisiphilitica*) with a high cover of dwarf shrubs and grasses (mainly chino grama) in the understory. Drier areas on exposed limestone usually have the same species but with less cover and the understories are rocky and sparse (Figure 11).

### Mid Desert Shrub:

Middle elevations in the park have widespread shrub, succulent and grass communities that occur on the rolling low hills and upper desert plains of the park. The higher limits of this type mark the transition from green sotol/yucca/lechuguilla/chino grama sites to more creosotebush (*Larrea tridentata*) dominated shrublands. The most prevalent cover type is creosotebush with lechuguilla, and ocotillo (*Fouquieria splendens*). Variants include rocky slopes with little creosotebush and more cacti, a mix of creosotebush, yuccas, and chino grama grass in the northeastern corner of the park, pricklypear (*Opuntia* spp.) and other cacti dominated slopes in the Rosillos Mountains, rocky areas with resurrection plants (*Selaginella pilifera*), and scattered areas with moderate cover of creosotebush and mariola (*Parthenium incanum*) shrubs. Washes, drainages, roadsides, and other mesic areas usually contain a mix of tall shrubs including catclaw acacia (*Acacia greggii*), soaptree yucca (*Yucca elata*), roundflower catclaw (*Acacia roemeriana*), whitebrush (*Aloysia gratissima*), spiny hackberry (*Celtis ehrenbergiana*), and littleleaf sumac (*Rhus microphylla*). Cottonwoods (*Populus* spp.), willows (*Salix* spp.), and other deciduous tree/shrubs may be present near the major man-made wells and larger natural springs. Sparse rock outcrops, talus slopes, badlands, and basalt/volcanic formations are also common (Figure 12). Areas with similar elevations occurring on limestone formations also have a slightly different mix of dominant species. These include lechuguilla, candelilla, short yuccas, rough jointfir (*Ephedra aspera*), Texas false agave (*Hechtia texensis*), leatherstem (*Jatropha dioica*), and spiny hedgehog cactus (*Echinocereus dasyacanthus*) shrubs/succulents with chino grama grass in the understory (Figure 11).



1,500 meters



Low Chaparral and Shrublands



Redberry Juniper and Sotol Shrublands (1,536m)



Shrub Steppe and Washes

Sotol and Mixed Shrub Steppe (1,514 m)



Mixed Tall Wash and Chaparral Shrubs (1,485 m)



High Desert Grasslands and Sparse Vegetation

High Chino Grama Shrub Grassland (1,500 m)  
1,200 meters



Talus and Rock Outcrops (1,413 m)

**Figure 10.** Common BIBE High Desert Steppe Vegetation Types. Source: LBJWC, CTI, and NPS Photos.



High - 1,900 meters



High Desert Steppe



Calcareous Chaparral (1,704 m)

1,500 meters

Yucca and Sotol Calcareous Shrub Grassland (1,714m)



Mid Desert Shrub



Yucca Calcareous Wash Channel (870 m)

900 meters

Calcareous Mixed Desert Shrublands (980 m)



Low Desert Scrub



Low Calcareous Sparse Vegetation (590 m)

Calcareous Mixed Desert Scrub (650 m)

Low - 500 meters

**Figure 11.** Summary of Common BIBE Calcareous Vegetation Types. Source: LBJWC, CTI, and NPS Photos.



1,200 meters



Desert Shrublands



Sotol and Lechuguilla Shrub Steppe (1,275 m)

Creosotebush, Ocotillo, and Lechuguilla Scrub (1,232 m)



Desert Washes and Tall Shrublands



Desert Wash Channel (1,256 m)

Tall Desert Wash Shrublands (1,354 m)



Desert Grasslands and Sparse Vegetation



▼ Chino Grama and Sparse Shrub Grasslands (1,125 m)  
800 meters

Lower Talus and Rock Outcrops (1,266 m)

**Figure 12.** Common BIBE Mid Desert Shrub Vegetation Types. Source: LBJWC, CTI, and NPS Photos.

#### Low Desert Scrub:

The lowest areas in BIBE, outside of the Rio Grande River corridor, contain sparse shrub and succulent plant communities. In these areas, lechuguilla and ocotillo mostly drop out and are replaced with high cover of creosotebush, mesquite (*Prosopis glandulosa*), and various other succulents and cacti. Creosotebush in this region can form extensive communities on dry flat plains, desert pavement surfaces, and low basins. The cover of this type is sparse and diversity is low, with many sites only containing creosotebush and the occasional succulent, forb, or grass species. Slightly higher, and areas with gentle relief, may contain creosotebush with moderate grass cover, mainly false grama (*Cathestecum erectum*) and woollygrass (*Erioneuron pulchella*) species. Mesquite can occur in similar settings as creosotebush, where mesquite shrubs form sparse to moderate upland communities in low basins that may have been previously disturbed. Washes and mesic areas in this region can contain the occasional cottonwood or willow tree and ribbons or patches of desert willow (*Chilopsis linearis*), Seepwillow/mule-fat (*Baccharis salicifolia*), and singlewhorl burrobrush (*Hymenoclea monogyra*). Sparse rock outcrops, badlands, barren washes, and clay flats are also common (Figure 13). Low desert scrub types on limestone formations contain slightly different sparse shrub/dwarf shrub assemblages including communities containing creosotebush, devilshead (*Echinocactus horizonthalonius*), and Texas false agave (*Hechtia texensis*) species (Figure 11).

#### Riparian Corridor:

The Rio Grande River is at the lowest elevations in BIBE. This riparian zone includes floodplains, large tributaries, riverbanks, alluvial deposits, benches, and old river channels. Mesquite shrubs are common here and can form large thickets or bosque woodlands ranging in cover from moderately sparse to dense and impenetrable stands. Understory and associated species are mostly limited to creosotebush and prickly pear cacti. Other native riparian shrubs are limited in distribution and rarely form large communities. These include Thuber's willow (*Salix thuberi*), coyote/narrowleaf willow (*Salix exigua*), Rooseveltweed (*Baccharis neglecta*), black willow (*Salix nigra*), and seepwillows. Native riparian tree species also are limited and include the occasional cottonwood, huisache/sweet acacia (*Acacia farnesiana*), or Goodding willow (*Salix gooddingii*) stands. Riparian herbaceous vegetation is dynamic in the river corridor and can change during or after flooding, or after long drought events. Common native species include common reed (*Phragmites australis*), alkali sacaton (*Sporobolus airoides*), and desert seepweed (*Suaeda suffrutescens*) (Figure 14).



800 meters



Low Desert Scrub



Mesquite and Creosotebush Desert Scrub (813 m)

Creosotebush Desert Scrub (649 m)



Low Desert Washes



Lowlands Wash Channel Shrubland (870 m)

Acacia - Mesquite Wash Shrubland (685 m)



Low Desert Sparse Vegetation



Flats, Benches, and Rocky Areas (634 m)

Badlands, Eroding Slopes, and Hillsides (848 m)

500 meters

**Figure 13.** Common BIBE Low Desert Scrub Vegetation Types. Source: LBJWC, CTI, and NPS Photos.



700 meters



Riparian Woodlands

Cottonwood Spring Woodland (680 m)

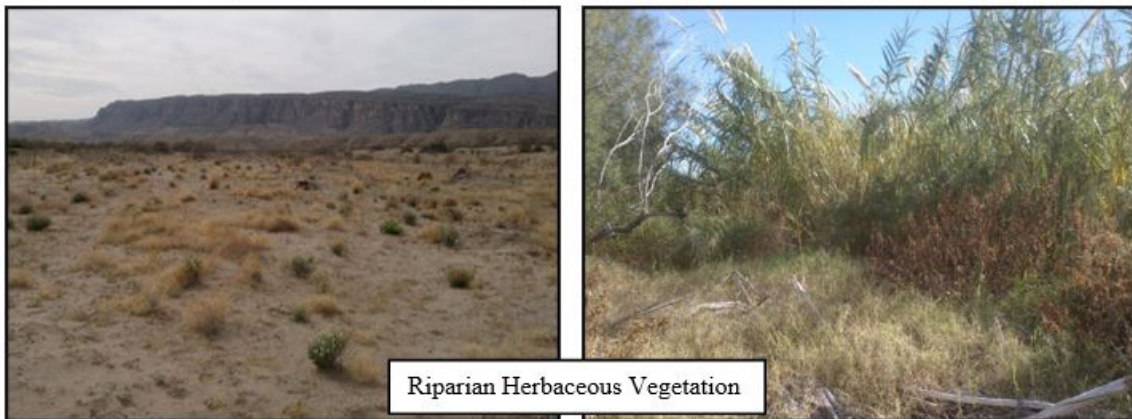
Restored/Planted Riparian Woodland (570 m)



Riparian Shrublands

Rio Grande Mesquite Riparian Bosque (630 m)

Tamarisk - (Tree Tobacco) Riparian Shrubland (576 m)



Riparian Herbaceous Vegetation

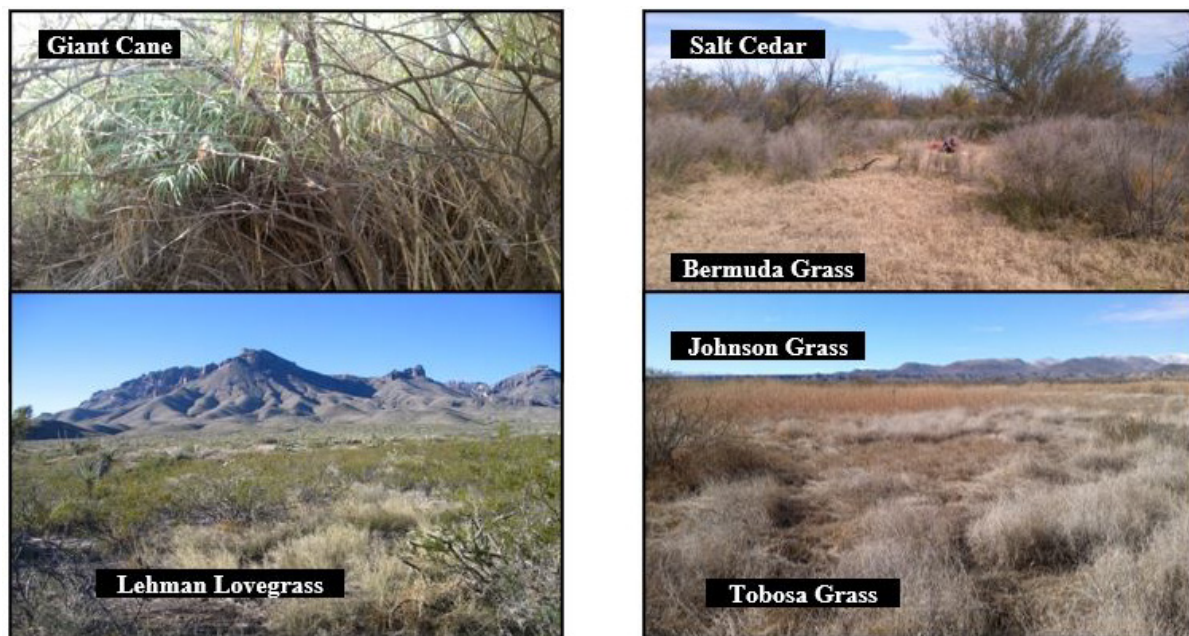
500 meters (or river level)  
 Rio Grande Alluvial Bar Sparse Vegetation (585 m)

Bermuda Grass (fore) and Arundo (back) H.V. (660 m)

**Figure 14.** Common BIBE Rio Grande River Corridor Vegetation Types. Source: LBJWC, CTI, and NPS Photos.

### Non-native Species:

Like many areas in the West, past ranching, mining, and other human activities have removed or altered native plant communities and have introduced non-native species. At BIBE, non-native species are common along the Rio Grande River and in the desert uplands. Although actively managed by the park, large riparian areas still contain thick stands of tamarisk or salt cedar (*Tamarix* spp.) shrubs/trees and giant/river cane or arundo (*Arundo donax*) grass thickets. Both species negatively affect the natural ecology by crowding out native vegetation, creating high salt concentrations, and consuming large amounts of water. Other, less pronounced non-native species such as tree tobacco (*Nicotiana glauca*) and Bermuda grass (*Cynodon dactylon*) also occur here. Recently ranched areas in the desert uplands at BIBE have high amounts of Johnson (*Sorghum halepense*) and tobosa grasses (*Pleuraphis mutica*) and Russian thistle (*Salsola tragus*) forbs. Other aggressive grasses including Lehmann lovegrass (*Eragrostis lehmanniana*) and California or Arizona cottontop (*Digitaria californica*) grass have been recently identified and are spreading through some of the low and mid desert regions of the park, especially around the park headquarters and nearby park roads (Figure 15). Buffelgrass (*Pennisetum cillare*), a species from Africa is also found throughout the park.



**Figure 15.** Examples of Non-native and Recent Aggressive Species at BIBE. Source: LBJWC, CTI, and NPS Photos.

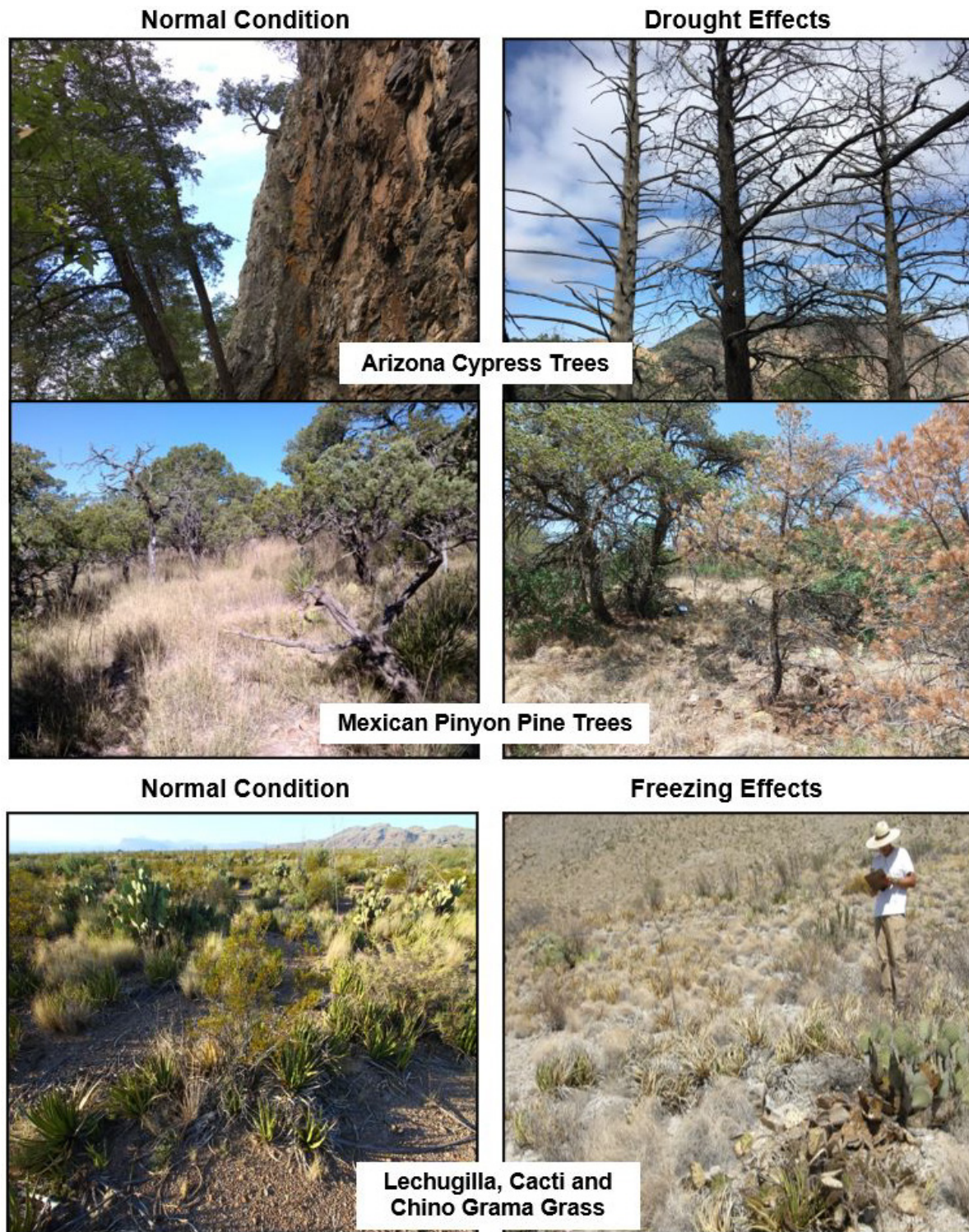
### Disturbances and Changes to the Vegetation:

Similar to the challenges presented by the introduction of non-native species is the fragile and disturbed nature of the desert grasslands at BIBE. Areas in the park, including the former Harte Ranch in the north, have experienced excessive grazing, building of water holding/diversion projects, and vegetation clearing in the past. The removal of vegetative cover in these areas has promoted soil loss and excessive erosion leaving mostly large, barren areas containing only mesquite and

creosotebush shrubs and non-native or aggressive grasses. With various levels of success, the park has actively tried to restore these areas using innovative ways to plant and maintain native species (Rinas 2000). Similarly, the park has also engaged in actively planting new native riparian trees and shrubs along the Rio Grande River and in the campgrounds, picnic areas, and other low-laying facilities.

Another challenge to the survival of the native and natural vegetation at BIBE is the effects of short and long-term climate change. Recent and prolonged droughts at BIBE have killed off some of the less adapted species such as trees and shrubs in the montane zones of the park (Figure 16). This leftover dead material can then create high fuel loads that may result in severe and uncontrollable wildfires. The loss of tree cover can also dramatically alter the biodiversity in these areas by creating erosion-prone and barren areas, promoting rapid understory regrowth, opening areas for non-native species, encouraging insect infestations on weakened plants, and limiting the overall ability for woodlands and forests to regenerate. Another recent phenomenon has been the hard frosts and freezing events in the desert portions of the park. These cold events have killed off many succulents (especially lechuguilla and cacti) and bunches of chino grama grass (Figure 16). Long term changes to the climate may create even more lasting and devastating impacts to the vegetation at BIBE. As the climate heats up, this could effectively expand or create more arid and warm zones. As species die-off, lower elevation or better adapted species may migrate upwards in the park. High desert species may move into the Chisos Mountains and the rare mountain types may die off or be phased out completely (NPS 2016).





**Figure 16.** Examples of BIBE Climate Influenced Vegetation. Source: LBJWC, CTI, and NPS Photos.

Finally, dry vegetation tied with frequent human-caused and natural thunderstorm activity can present many opportunities for wildfire ignition. Since 1980, BIBE has averaged just over 15 unplanned fires per year with 1 or 2 of those usually over 100 acres (40 ha) in size (NPS 2005). BIBE



staff has also engaged in prescribed burning to help minimize large fire fuel loads, protect people and property, help promote healthy vegetation, and achieve natural resource management goals. Fire events can vary in severity, ranging from small pockets of dead grasses and trees to large areas of blackened earth. The age and severity of the burn directly affects the vegetation response and can leave a site with little vegetation or in an early state of succession with weedy species, native forbs/grasses, or seedling/sapling trees re-populating the burned area.

### **Vegetation Inventory Project**

The decision to inventory, classify, and map the vegetation at BIBE was made in response to guidelines set forth by the NVIP (NPS 2009) and the CHDN (NPS 2001). Work was started at BIBE in 2011, when CTI was contracted to complete three preliminary studies that including a review of the existing (legacy) vegetation data (Von Loh & Cogan 2011), an update to the vegetation classification (Von Loh & Cogan 2011), and a sampling approach for a plant community inventory (Cogan & Von Loh 2011). Using the preliminary list of plant communities and the recommend sampling strategies found in these reports, the NVIP contracted with the Lady Bird Johnson Wildflower Center (LBJWC) to collect sample plot data in representative vegetation associations at BIBE starting in 2012.

After the plot data was collected at BIBE, CTI was again contracted to begin work on both the final vegetation classification (using the LBJWC data) and the vegetation map. CTI delivered the draft BIBE classification, field key, and vegetation map layer to the NVIP in 2016 CTI sub-contracted field crews completed the accuracy assessment (AA) data collection in 2017. Data from the AA effort was then used to evaluate the draft products by CTI and the results were sent to the NVIP for review and approval in 2018.

Overall the NVIP, CHDN, CTI, LBJWC, and other contracted professionals (with critical support from BIBE staff), worked together to meet all of the project objectives and ultimately produce all of the final products that met the NVIP's mandates as outlined in their 12 Step Guidance for NPS Vegetation Inventories (NPS 2009). Important directives from the NVIP that were addressed by the team include the following:

- **Vegetation Information**
  - The vegetation classification will be based on the rUSNVC;
  - A dichotomous field key of vegetation associations will be created;
  - Formal descriptions for each of the vegetation association will be included;
  - Representative ground photos will be attached for all vegetation associations;
  - All of the field data will be presented in the PLOTS database format.
- **Spatial Data**
  - The map classification will be based on the rUSNVC and will include BIBE-specific requirements;
  - Descriptions and a key will be created for each of the map units;
  - A spatial geodatabase will be created for all of the vegetation data;

- Digital and hardcopy maps of the vegetation will be created;
- Metadata will be included for all spatial database layers;
- An accuracy assessment of the vegetation spatial data will be performed and presented in a detailed final report.

### Scope of Work

All vegetation inventory work for BIBE occurred within the administrative boundary as provided in digital form by the NVIP and the NPS Land Resource Division. The final BIBE vegetation inventory project boundary also contained some small inholdings in the northern portions of the park along with the larger Rosillos Ranch area. Mapping was done within the BIBE project boundary and all fieldwork was conducted on the U.S. side of the border, on NPS managed lands, and no privately or Mexican owned lands were accessed (Figure 17). During the course of the project, the project boundary was updated and a final version was delivered to CTI in July 2018. The final BIBE project boundary (Figure 18) contains 810,482 acres (327.991 ha).



**Figure 17.** Examples of the Private Lands and Fieldwork on the U.S. Border at BIBE. Source: Carpenter Real Estate and NPS Photos.



## Vegetation Inventory Project Area



**Figure 18.** Map of the BIBE Vegetation Inventory Project Boundary. Source: CTI.

## Methods

All protocols and methods for this project as outlined in the following sections of this report can be found in the original program documents produced by The Nature Conservancy and Environmental Research Systems Institute (1994a, 1994b, and 1994c) and in later revisions (Lea 2011 and Lea and Curtis 2010). The standard vegetation inventory tasks were implemented for BIBE as outlined in the 12 Step Guidance for NPS Vegetation Inventories (NPS 2009). The six major project categories are summarized below and the following report sections give detailed descriptions for each:

1. Plan, gather legacy and historical data, and coordinate tasks;
2. Survey BIBE to understand and inventory the vegetation using sample plots and observation points;
3. Classify the vegetation using the resulting field data to rUSNVC standard associations and alliances and crosswalk these to recognizable map units;
4. Acquire current digital imagery and interpret the vegetation from the imagery using the rUSNVC and a map unit crosswalk table;
5. Assess the accuracy of the final map product;
6. Summarize the project findings in a final report, create the final vegetation spatial database, and produce all of the other standard deliverables.

All protocols for this project as outlined in the following sections can be found on the NVIP website: <https://www.nps.gov/im/technical-guidance.htm>.

### Planning, Data Gathering, and Coordination

Planning for this project got underway in 2009 and numerous on-site meetings and conference calls were attended by representatives from CTI, NVIP, BIBE, and LBJWC. The goals of these efforts were to:

- Discuss the overall project and review the necessary requirements,
- Discuss availability of existing data,
- Learn about the management issues and concerns,
- Discuss procedural issues and data management,
- Develop a project scope of work and project timeline,
- Discuss future project needs and funding.

After the initial meeting and calls, individual work responsibilities were assigned, tasked, or contracted with various entities to create an experienced vegetation inventory team. The participants in the vegetation inventory project and their responsibilities include the following:

***NPS-NVIP Staff***

- Provide project guidance, contract facilitation, oversight, and funding;
- Provide project management;
- Review draft and final products;
- Finalize the project.

***NPS BIBE and CHDN Staffs***

- Provide copies of the existing data, provide local expertise, and other resources;
- Supply digital boundary files and ancillary spatial data files;
- Assist with all fieldwork and provide logistical support;
- Review and help develop the vegetation classification;
- Review draft and final products.

***Rio Grande Institute (RGI) and Lady Bird Johnson Wildflower Center (LBJWC) (Contractors)***

- Collect and manage plot and observation point data;
- Write the plot data collection report;
- Help develop the vegetation classification;
- Enter the plots and observation point data into the PLOTS database and review for quality assurance purposes;
- Provide sections for the final report;
- Review draft and final products.

***Cogan Technology, Inc. (CTI) and Coast to Coast Botany (CCB) (Contractor and Sub-contractor)***

- Help with overall project planning, facilitation and coordination;
- Summarize the legacy data and conduct gradsect planning;
- Develop the vegetation classification (CCB);
- Write the field key and local descriptions for the vegetation types (CCB);
- Map and delineate the vegetation and land use types;
- Ground-truth vegetation and land use/land cover signatures on the imagery;
- Develop map units linked to the rUSNVC;
- Create the draft vegetation map for the AA;
- Collect and manage the AA data (CCB);
- Enter the AA data into the PLOTS database and review for quality (CCB);
- Write the AA data collection report (CCB);
- Review AA point field determinations, generate contingency tables, and suggest post-AA modifications to the vegetation layer;

- Finalize the vegetation layer;
- Create the final deliverables including a summary report, vegetation classification appendices, a spatial geo-database with all of the new spatial layers, FGDC-compliant metadata, field and map guides, a vegetation map layout, graphics, and hyperlink all ground photos to the database.

## Field Surveys

The field methods used for developing the classification at BIBE followed the methodology outlined by the NVIP methods (TNC and ESRI 1994b and Lea 2011). BIBE was considered to be in the “very large park” category based on the project area size. The field methods for this type of park suggested using multiple gradsects per ecoregion (TNC and ESRI 1994b). However, because of the sheer size of the park and logistical and safety concerns a gradsect planning and preliminary study was preformed (Cogan & Von Loh 2011). The western portion of RIGR co-located in BIBE was also included in the field sampling approach at this time.

The gradsect study combined two spatial databases. The first database was a biophysical unit (BPU) map created from GIS layers provided by the park. The layers in the BPU map included 10-meter digital elevation models (DEMs) derived aspect categories (e.g. flat, north, east, south and west), hydrology, and the general vegetation polygons as contained in the existing BIBE vegetation map created by Plumb (1993). The existing Plumb vegetation map contained nine general vegetation classes that included: (1) Bare, (2) Closed Canopy Woodland, (3) Creosote Scrub, (4) High Desert Grassland, (5) Lechuguilla Scrub, (6) Open Canopy Woodland, (7) Riverine Riparian, (8) Scrub Woodland, and (9) Upland Riparian. BPU vegetation polygons were created by first converting the original raster map to vectors and then cleaning these to remove all polygons below 25 acres (10 ha) in size. Next, new general vegetation polygons were created for the missing portions of the project area in the northwest corner of the park (Rosillos Area) and combined with Plumb’s polygons. Since moisture availability is critical in this arid landscape, the upland riparian class was modified to include additional areas within 160 feet (50 m) of major, perennial streams and the riverine riparian type was expanded to include additional areas within 820 feet (250 m) of the Rio Grande River.

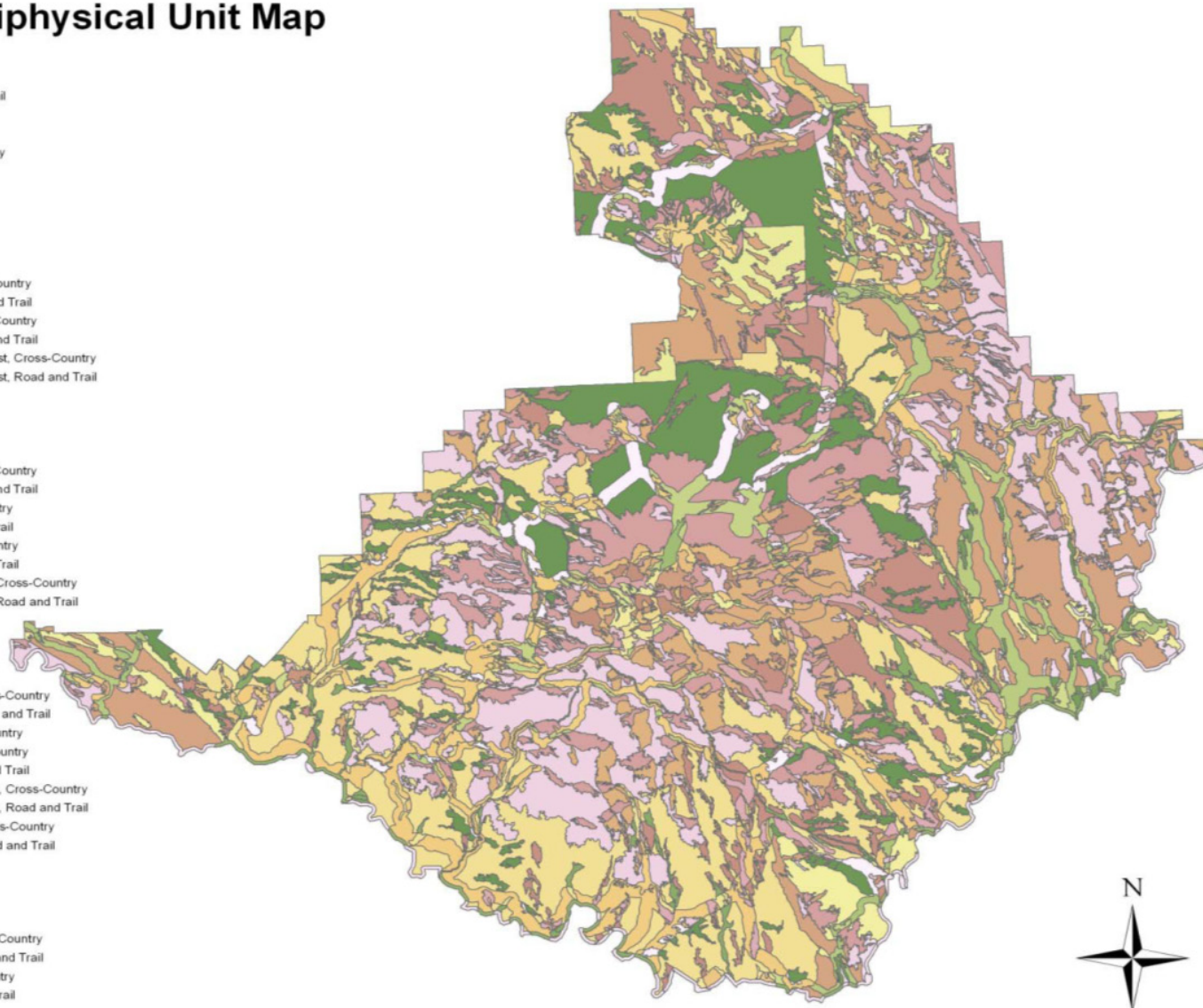
The second database was a cost surface analysis that factored the time to travel to each potential sampling site and the cost of navigating from roads and trails based on steepness. The locations of known roads and trails were merged into one layer and then buffered to create polygons. The roads were buffered 0.5 miles (1 km) from their centers and the trails were buffered 0.3 miles (0.5 km) on both sides. Areas within the cost surface were then relabeled by whether they could be accessed from roads and trails or only by cross-country navigation. The resulting polygons were joined to the first database to create the final biophysical units for BIBE (Figure 19). Polygons in the combined BPU and cost surface area were tagged by their respective vegetation type, general aspect, and access location (e.g. Upland Scrub Woodland, South and West, Road and Trail) and field maps were printed based on BIBE’s management use areas.



## BIBE/RIGR Biophysical Unit Map

### BIBE/RIGR BPUs

- Unknown, South and West, Road and Trail
- Unknown, East, Cross-Country
- Unknown, North, Cross-Country
- Unknown, South and West, Cross-Country
- Bare, East, Cross-Country
- Bare, East, Road and Trail
- Bare, North, Cross-Country
- Bare, North, Road and Trail
- Bare, South and West, Cross-Country
- Bare, South and West, Road and Trail
- Closed Canopy Woodland, East, Cross-Country
- Closed Canopy Woodland, East, Road and Trail
- Closed Canopy Woodland, North, Cross-Country
- Closed Canopy Woodland, North, Road and Trail
- Closed Canopy Woodland, South and West, Cross-Country
- Closed Canopy Woodland, South and West, Road and Trail
- Creosote Scrub, East, Cross-Country
- Creosote Scrub, East, Road and Trail
- Creosote Scrub, North, Cross-Country
- Creosote Scrub, North, Road and Trail
- Creosote Scrub, South and West, Cross-Country
- Creosote Scrub, South and West, Road and Trail
- High Desert Grassland, East, Cross-Country
- High Desert Grassland, East, Road and Trail
- High Desert Grassland, North, Cross-Country
- High Desert Grassland, North, Road and Trail
- High Desert Grassland, South and West, Cross-Country
- High Desert Grassland, South and West, Road and Trail
- Lechuguilla Scrub, East, Cross-Country
- Lechuguilla Scrub, East, Road and Trail
- Lechuguilla Scrub, North, Cross-Country
- Lechuguilla Scrub, North, Road and Trail
- Lechuguilla Scrub, South and West, Cross-Country
- Lechuguilla Scrub, South and West, Road and Trail
- Open Canopy Woodland, East, Cross-Country
- Open Canopy Woodland, North, Cross-Country
- Open Canopy Woodland, North, Road and Trail
- Open Canopy Woodland, South and West, Cross-Country
- Open Canopy Woodland, South and West, Road and Trail
- Riverine Riparian, Flat River Bottom, Cross-Country
- Riverine Riparian, Flat River Bottom, Road and Trail
- Scrub Woodland, East, Cross-Country
- Scrub Woodland, East, Road and Trail
- Scrub Woodland, North, Cross-Country
- Scrub Woodland, North, Road and Trail
- Scrub Woodland, South and West, Cross-Country
- Scrub Woodland, South and West, Road and Trail
- Upland Riparian, Flat Upland, Cross-Country
- Upland Riparian, Flat Upland, Road and Trail



**Figure 19.** Biophysical Unit Map with Travel Categories for BIBE. Source: CTI.

Working with the gradsect and BPU data, the plot and observation data was collected during four sampling sessions or phases. The first session at BIBE collected about 60 plots from September to December 2010. The field team consisted of two persons (a botanist and an assistant) from the Rio Grande Institute (RGI) and BIBE. Their focus was to guide the BPU sampling by collecting data from as many different BPU polygons (i.e. vegetation types) as they could locate within easy to reach areas as dictated by the BPU access criteria (i.e. targets next to roads and trails). The 60 plots they collected represented 35 to 45 potential plant associations. The second phase of plot data collection followed in 2011 (from June to December) using multiple teams from the Lady Bird Johnson Wildflower Center (LBJWC) and BIBE. Their efforts concentrated on getting replicate plots across the park for the initial types identified by the RGI/BIBE group and locating new plant associations. A coordinator monitored the plot accumulation, set a goal of collecting ten replicates per type, and then adjusted the group's priorities to balance the sampling. This phase accumulated data for nearly 400 additional plots and added perhaps 10–15 potentially new associations. While most of the plots from these phases were from BIBE, some were collected in RIGR as well.

The BIBE/RIGR Rio Grande River was the focus of the last two remaining sessions. Beginning in April of 2013 a different LBJWC team collected data from about 30 additional plots in the RIGR portion of BIBE. These data were collected after the quantitative analysis of plots collected in 2010 and 2011 was completed. This data uncovered two potentially new vegetation types and augmented the understanding of the previously discovered types. The fourth and final phase was conducted in May of 2013 by the same LBJWC field team. This session used a canoe-assisted river trip through the RIGR Lower Canyons section (just east of BIBE) to collect observation points. Observation points involve collecting less comprehensive floristic data than plots but are faster and easier to set-up and record. While this session took place outside the geographic scope of BIBE, the observation points mostly confirmed the riparian vegetation associations that also occurred in BIBE.

During all of the sampling sessions, the sampling plot size and shape requirements were consistent with NVIP guidelines (TNC and ESRI 1994b) and were determined by the physiognomy of the plant community being sampled (Table 6). Measuring tapes were used to establish the circular, square, or rectangle sampling area and the plot size and shape was adjusted as needed to sample linear bands of vegetation in washes, riparian corridors, or other confined sites. In general, most of the BIBE plots were rectangular in shape, were 400 square meters in size, and were 16 meters wide by 25 meters long in dimension. In contrast, observation points were not delineated on the ground but were recorded around a single point location. Geo-referenced coordinates were recorded as a waypoint in the center of each plot or observation point using Global Positioning System (GPS) receivers and then recorded by hand onto the field forms. Ground reference photographs of the sampling site were taken using digital cameras in the various cardinal directions (North, South, East, and West) or as the vegetation and landscape allowed. Ground photos were later labeled after each plot/observation point using a unique numbering system (e.g. BIBE\_007N = BIBE plot number 7 with the ground photo taken in the northern direction).



**Table 6.** Plot Sizes Used for Classification Sampling at BIBE.

Dominant physiognomy	Plot size	Plot area
<b>Forest:</b> trees have their crowns overlapping, usually forming 60–100% cover, and <b>Woodland:</b> open stands of trees with crowns usually not touching. Canopy tree cover 25–60%, OR exceeds shrub, dwarf-shrub, herb, and nonvascular cover.	Circular 11.28 m radius Square 20m x 20 m	400 m <sup>2</sup>
<b>Shrubland:</b> shrubs greater than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeding tree, dwarf-shrub, herb, and nonvascular cover, and <b>Dwarf-shrubland</b> (e.g., heath): Shrubs less than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeds tree, shrub, herb, and nonvascular cover.	Circular 11.28 m radius Square 20m x 20 m	400 m <sup>2</sup>
<b>Herbaceous</b> (e.g., grassland, meadow, marsh): Grasses or forbs dominant, usually forming more than 25% cover OR exceeds tree, shrub, dwarf-shrub, and nonvascular cover.	Circular 11.28 m radius Square 20m x 20 m	400 m <sup>2</sup> or 100 m <sup>2</sup>
<b>Nonvascular</b> (e.g., fen, bog, cliff, scree slopes: nonvascular cover dominant, usually forming more than 25% cover.	Circular 11.28 m radius Square 20m x 20 m	400 m <sup>2</sup> or 100 m <sup>2</sup>
<b>Sparse vegetation</b> (e.g., rock outcrops, talus slopes, and fell-fields): less than 10% total vegetation cover.	Circular 11.28 m radius Square 20m x 20 m	400 m <sup>2</sup> or 100 m <sup>2</sup>

Following the establishment of each BIBE plot or observation point it was given a unique label/number and environmental data were recorded on the plot field forms (Appendix A). Environmental data included elevation, slope, aspect, landform, topographic position, soil texture and drainage, hydrologic (flooding) regime, and evidence of disturbance or wildlife use. The unvegetated surface was estimated and recorded as percent cover of bedrock, litter/duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2 to 10 cm), sand (0.1 to 2 mm), lichens, and mosses. Next, the vegetation was visually divided into strata, with the height and canopy cover of the dominant vegetation estimated for each stratum. Within each stratum, all taxa within the plot area (grid) or observed at a point location (no grid) were identified and the foliar cover of each taxon was estimated using cover classes (Table 7).

**Table 7.** Cover Classes and Vegetation Strata used at BIBE.

Cover scales	Vegetation strata
T 0–1%	T1 Emergent Canopy:
P >1–5%	T2 Main Canopy
1 >5–15%	T3 Subcanopy
2 >15–25%	S1 Tall Shrubs
3 >25–35%	S2 Short Shrubs
4 >35–45%	S3 Dwarf-shrubs
5 >45–55%	H1 Herbaceous (Graminoids)
6 >55–65%	H2 Herbaceous (Forbs)
7 >65–75%	H3 Herbaceous (Ferns)
8 >75–85%	H4 Herbaceous (Tree seedlings)
9 >85–95%	A1 Floating-leaved aquatics
10 >95%	A2 Submerged-leaved aquatics

Additional species within the vegetation unit that occurred outside of sampled plots were sometimes listed to assist with creation of local descriptions. Species that were not identifiable in the field were collected for later identification and specimens were typically destroyed after being identified. Species were recorded by scientific name familiar to researchers and a provisional vegetation type was assigned to the plot/observation point. Appendix B contains a list of all of the plant species found during the BIBE fieldwork portion of this project.

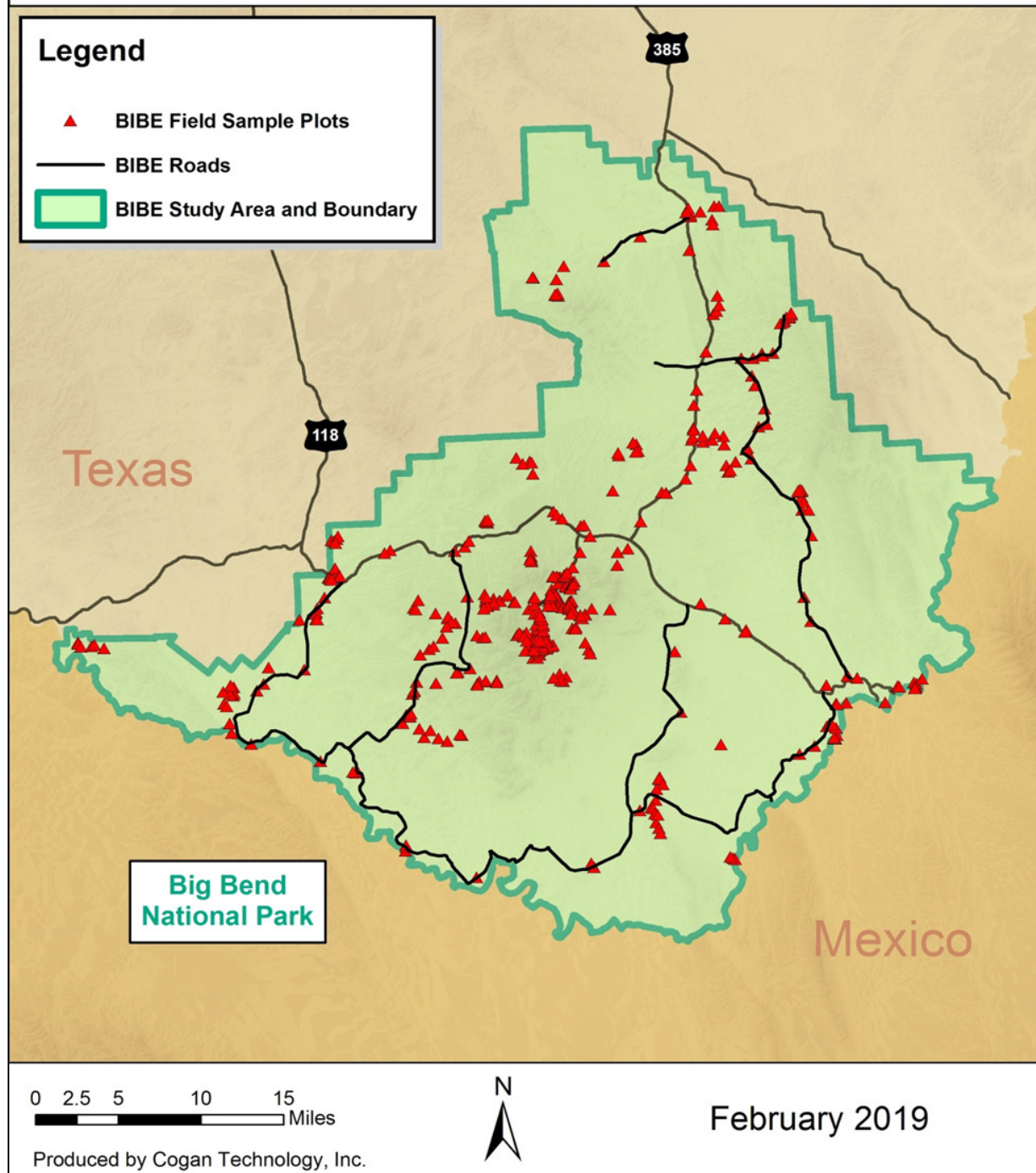
The various RGI, LBJWC, and BIBE field crews from 2010 through 2013 sampled vegetation at a total of 500 sites (Figure 20). These included 499 full releve-style plots and 1 observation point. Each sampled area was assigned a provisional community name from the preliminary plant associations list (Von Loh and Cogan 2011). All data was then transferred from the field datasheets to the PLOTS database (version 3.2) and reviewed for content and quality assurance by LBJWC staff. LBJWC working with the CHDN certified the plant species data that was collected. Upon receipt of the final PLOTS database for BIBE, CTI extracted the geo-referenced coordinates for each unique plot and created a GIS spatial layer (Figure 21).



**Figure 20.** Photo Examples of the Plot Data Collection at BIBE. Source RGI, LBJWC, and NPS Photos.



## Plot Location Map



**Figure 21.** Map of the Vegetation Plots Collected at BIBE. Source: CTI.

## **Vegetation Classification**

To classify the BIBE/RIGR plot data, a CCB NVCS specialist (sub-contracted to CTI) first edited and reviewed all of the data in the PLOTS database and then ran it through a series of analytical steps to classify the potential plant associations. The plot data represented both the original 500 or so plots collected within BIBE that were analyzed in 2012 and then supplemented in 2018 with the additional 38 plots collected in RIGR. Initial efforts included converting the plot data by individual species and stratum abundance into a species by plot abundance matrix using the data conversion formula given by Jennings et al. (2009). Individual species by plot abundance values were then scaled using the cover classes applied during the field data collection.

The second step involved taking the species by plots matrix and conducting a primary cluster analysis (McCune and Grace 2002) using a flexible beta value of  $-0.5$  (Bray and Curtis 1957). Dissimilarity distances were derived using PC-ORD version 6.0 software (McCune and Mefford 2011). The results were placed into a dendrogram that was inspected to determine an “average” level at which the individual clusters were ecologically interpretable. A level of clustering that left about 70% information remaining was selected. Additional clusters were also recognized if they were close to the threshold. This step provided 55 initial clusters to be considered as putative vegetation types.

The third classification step was to evaluate the initial clusters for common environmental conditions. Clusters that had common environmental conditions and few interpretable floristic differences were merged and clusters that seemed overly heterogeneous were split further. At this time, the Bray-Curtis distance matrix was also converted to a plot-by-plot similarity matrix. The cells in this matrix that represented plot similarities were color-coded to better visualize tabular sorting. Finally, individual plots were moved around and sorted from cluster to cluster to optimize the balance between (1) interpretability and ecological consistency of the clusters (particularly at mapping scales) with (2) maximizing within-cluster similarities and between-cluster dissimilarities.

The effect of splitting, lumping, and sorting the individual plots between clusters provided 47 initial interpretable fine-scale or provisional association types for BIBE. Subsequent classification work based off ancillary RIGR observation point data, BIBE AA data, and the master’s degree thesis of Fenstermacher (2007) (from the higher elevations in the Dead Horse Mountains) added four new types and removed two others that were local variants. Finally, six preliminary associations representing sparse and managed vegetation types were added, yielding a total of 55 rUSNVC plant associations for BIBE.

## ***Plant Associations and Fine Scale Units***

Of the 55 preliminary plant associations for BIBE, 14 were determined to be a reasonable match with an existing unit published by the USNVC (2018). The remaining types were not directly relatable to the USNVC at this time for one or more of the following reasons:

- General lack of detailed vegetation data from the Trans-Pecos region of Texas;
- Existing USNVC associations were too broad and were only defined at the state level;
- No similar USNVC association concept was found;
- A possible match was found, but the USNVC lacked sufficient data for comparison;



- The existing USNVC type matched in concept but did not match the dominant plant species at BIBE;
- The dominant plant species in one USNVC association occurred in multiple potential BIBE types;
- A partial match was found, but the published USNVC concept had significant conceptual conflicts with the BIBE type;
- A partial match was found, but the published USNVC association concept was placed in a higher level that left the potential BIBE type inappropriately distant in the hierarchy.

Those associations that were documented from BIBE with no certain USNVC counterpart were given a suitable Latin (floristic) name and NPS unique identifier (in lieu of a USNVC identifier), in accordance with the NPS classification guidelines (Lea 2011). Additionally, both the matched USNVC and new BIBE-specific associations were given a park or vernacular name. Alternative names are useful in that they include the environmental context, helps with confusing Latin and scientific plant names, and makes them easier to understand.

### ***Plant Alliances and Coarse Scale Units***

At the next higher or coarser level of the USNVC, 54 of the 55 BIBE associations fell within a total of 25 USNVC alliances (24 of them described and one of them not covered by current content). The associations were also nested within 20 Groups, 15 Macrogroups, eight Divisions and Formations, seven Subclasses, and five Classes (including one Cultural Vegetation unit at each of these levels) (USNVC 2018). These thematically and taxonomically coarser groupings of the associations represent broader levels in the hierarchy that might be more suitable for some management objectives. Despite their relatively new status, the USNVC Groups have fairly complete concept descriptions and, unlike published USNVC associations, seem to be more comprehensive for vegetation patterns that can be extracted from the BIBE PLOTS data.

The final products of the classification task included field keys and local plant association descriptions. The dichotomous field key to the BIBE plant associations was developed to assist users in identifying plant associations and their corresponding map units in the field, particularly during the AA portion of the project (Appendix C). The list of plant associations within the USNVC and their local descriptions provide a summary of the classification efforts at BIBE and include unique characteristics found for each plant associations at BIBE (Appendix D).

### **Digital Imagery and Vegetation Mapping**

The enormous size of the BIBE project area warranted the use of a modified or hybrid mapping approach. Early discussions determined the need to have an approach that included a coarse-level automated or machine-logic image processing stage and a fine-level stage that included vegetation signature interpretation and manual polygon delineation. Based on similar mapping work done by CTI in other desert environments, the automated stage would use multiresolution image segmentation routines to capture high contrast landforms and drainage/wash features, greatly reducing the time needed to delineate these by hand. The second phase would build off these segmented polygons to delineate the fine-level plant alliance/association based map units.

### ***Coarse-Level Mapping***

To complete the automated phase, CTI subcontracted with Photo Science (based in Lexington, KY) to create a BIBE landform layer and a drainage/wash layer. Photo Science reviewed and acquired all National Elevation Dataset (NED) 10-meter DEMs for the project area and mosaiced them into a seamless coverage. The DEM data was then manipulated to create the following derived spatial layers: aspect, slope, three hillshade datasets (different azimuth angles), a contour range layer, and a compound topographic index (or wetness index) that models water flow and accumulation.

Similarly, Photo Science also acquired the 2012 National Agriculture Imagery Program (NAIP) imagery for the entire project area as high-resolution (1-meter pixels) digital ortho quarter quadrangles (doqqs). The NAIP doqqs were mosaiced and resampled from 1-meter to 10-meter pixels to match the DEM resolution. Erdas Imagine software was then used to derive a normalized difference vegetation index (NDVI) and a near infrared (NIR) band texture layer from the imagery using a 9x9 moving window.

**Landform Layer:** To create the landform spatial model, the NIR band, red band, NDVI, slope, contours, and hillshade layers were imported into Trimble eCognition software. eCognition was used to segment the derived layers in a stepwise fashion until obvious landform patterns were observed. For the purposes of this effort, a landform was defined as a repeatable landscape feature (i.e. mountain, hill, basin, etc.) that contained unique geographic and vegetation patterns. The completed segments were then exported as shapefiles into ArcGIS software. In ArcGIS, the segments were classified into preliminary landforms using a combination of modeling and manual labeling. For modeling, segments were classified using attribute thresholds such as elevation, slope, aspect, band values, or a combination of thresholds. All preliminary segments were manually reviewed and attributes changed if needed. Once all segments were correctly classified, common boundaries were dissolved resulting in the final BIBE landform polygons.

**Drainage and Wash Layer:** To delineate the intricate network of drainages and washes at BIBE, the final landform shapefile was imported back into eCognition using a chessboard segmentation process that divided the landforms into individual or grouped features. Next, a Canny Brightness index using the NIR and red bands and a Zabud index (using image band ratios) were created for each landform. Through a series of multiresolution segmentation routines preliminary drainage/wash segments were created and classified using thresholds obtained from the mean band values, NDVI, elevation, slope, the Canny Brightness, Zabud, and wetness indices and by general landscape position. All classified segments were then manually reviewed and edited to correct any commission and omission errors. Once completed, all riparian/wash polygons were combined into a single layer and the polygon boundary lines were smoothed to remove the stair-step effect from pixel boundaries and jagged edges.

### ***Fine-Level Mapping***

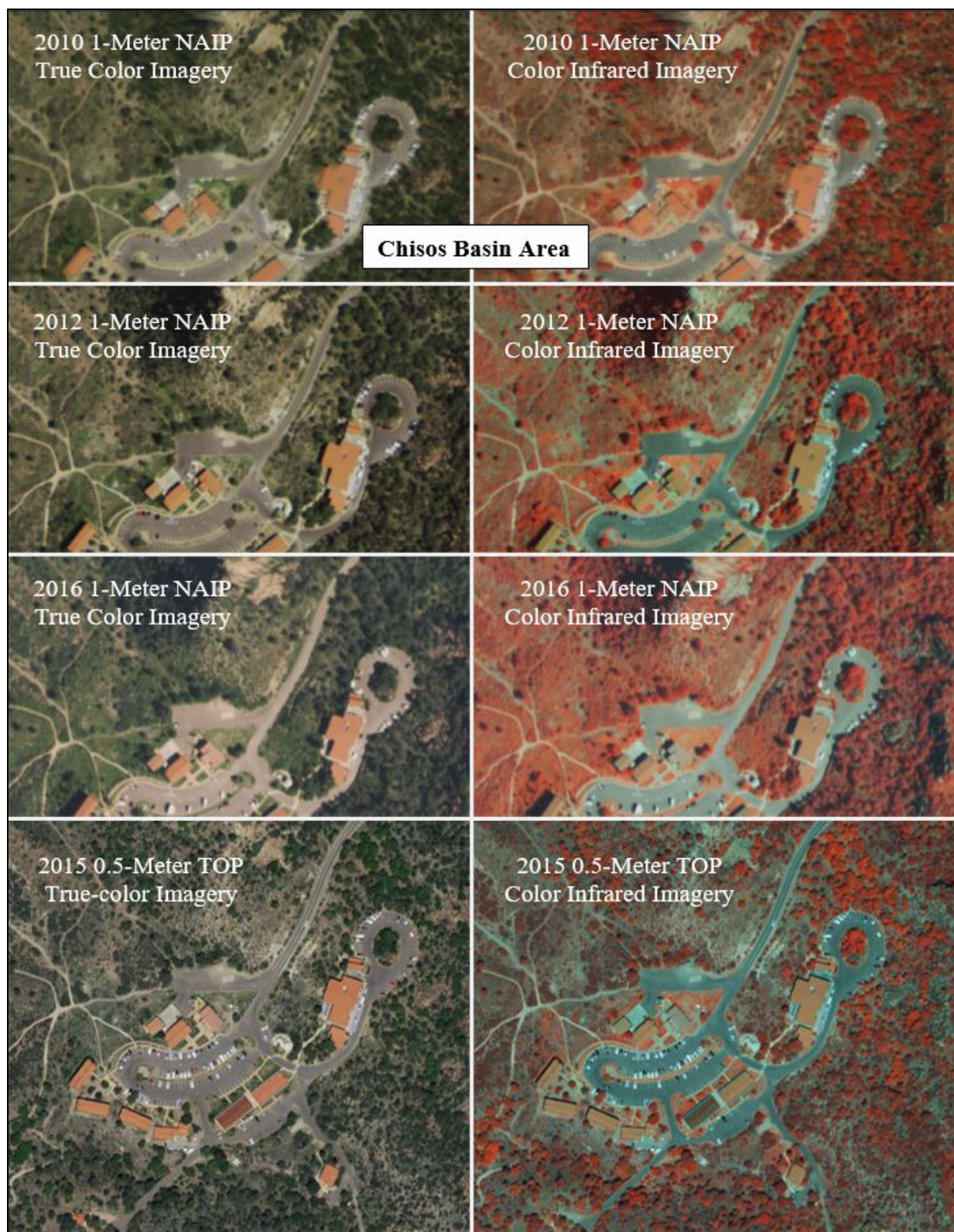
During the planning and coordination phase, CTI staff reviewed all available digital imagery for its potential use as the BIBE basemap. The most promising, and easiest to access, was the imagery available on the Texas Natural Resource Information System (TNRIS) website (<https://data.tnris.org>). Navigating to the orthoimagery-statewide web page, the list of existing

imagery covering BIBE included multiple NAIP products. The corresponding 2010 and 2012 NAIP 1-meter doqqs for BIBE were downloaded and used during the early planning stages of this project and to produce field maps and interim products.

Since 2012, other orthoimagery products covering RIGR were made available by TNRIS and were downloaded by CTI. This included the 2015 Texas Orthoimagery Program (TOP) 50-cm quarter quads and the 2016 version of the NAIP products (Figure 22). Both datasets contained an infrared band that is useful for vegetation mapping as it highlights active growth patterns. However after a thorough review, the 2015 TOP imagery was found to be superior to the 2016 NAIP product due to its finer resolution and sharper contrast. Based on this decision, the 2015 TOP imagery was selected as the primary basemap for this project and the NAIP 2016 product was used as ancillary data to back-up the 2015 TOP imagery (for mapping in shadows, at recent disturbed sites, etc.). Once digital copies of the imagery were acquired and compiled, interpretation and mapping of the vegetation began using a four-step process that included: (1) importing and updating the coarse-level mapping, (2) photo-interpretation and digitizing, (3) ground-truthing the mapped data, and (4) map refinement and finalization. Figure 23 shows a summary of the mapping stages and spatial layers used or produced.

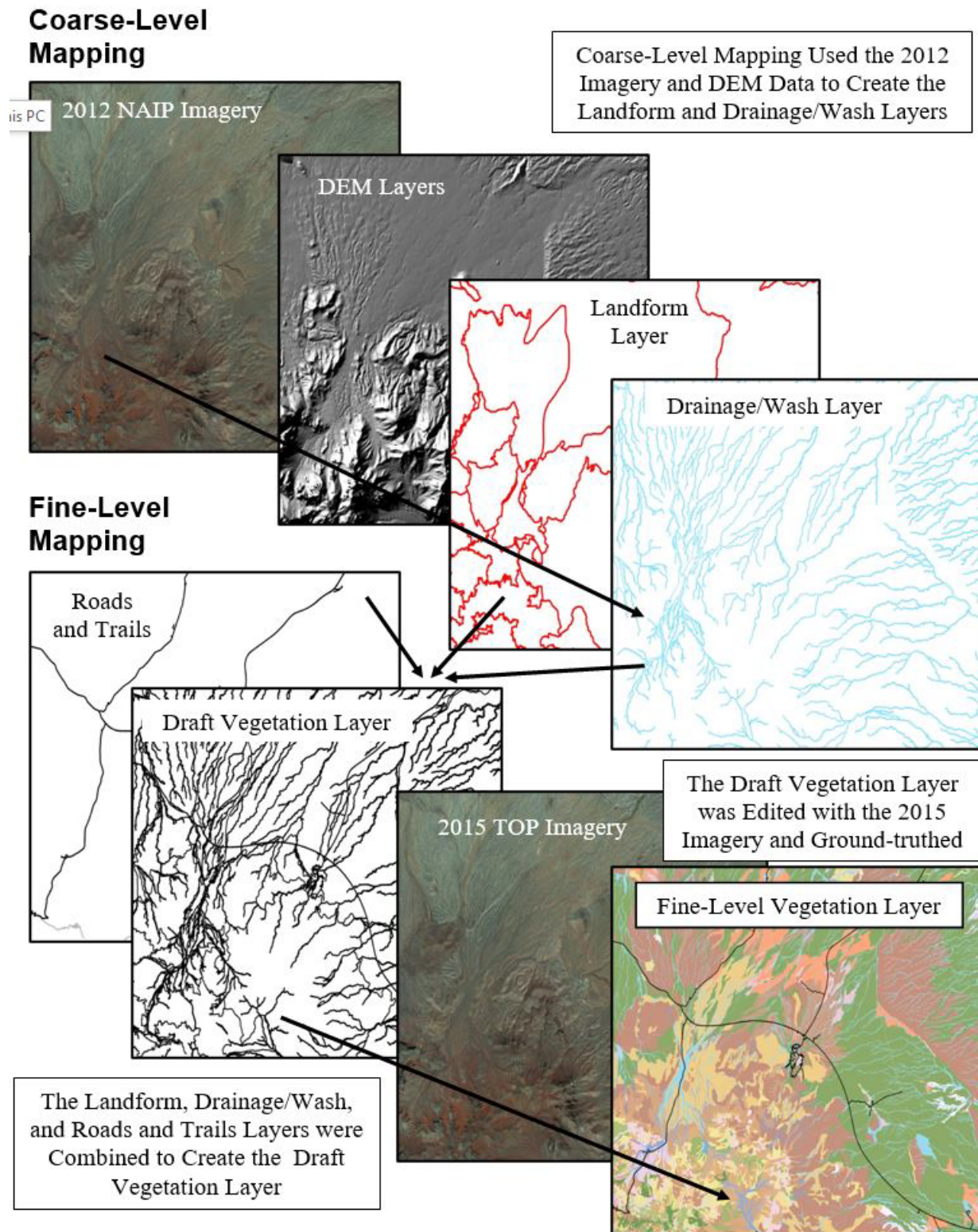
In the first step, all of the final coarse-level landform and drainage/wash polygons were combined and edited into one layer. Next, the existing BIBE roads and trails layer was converted from lines to polygons using buffering routines and added to the polygon map. Once the preliminary polygon layer was cleaned and smoothed, manual editing was used to remove unnecessary and small polygons, update polygon lines compared to the 2015 TOP imagery, and new polygons were added in areas that were not adequately delineated. Cleaning was considered complete when all resulting polygons matched homogenous stands of vegetation apparent on the TOP 2015 imagery. The result was a draft vegetation layer with no attributes.

During the next stage of mapping, the coarse-level vegetation map was exported as shapefiles and converted to ArcGIS coverages. At this stage the mapping shifted to photo-interpretation, on-screen digitizing, and other manual mapping techniques. All vegetation delineations were visually inspected and manually moved, edited and updated as needed. Any obvious problems in the mapping (such as shifting and sliver polygons) were edited and resolved. Once the preliminary lines were completed temporary map unit names and placeholder codes were used to attribute each vegetation polygon. The vegetation layer was then loaded into a mobile GIS laptop computer for ground-truthing purposes at BIBE.



**Figure 22.** Examples of the NAIP and TOP Imagery for BIBE.





**Figure 23.** BIBE Vegetation Mapping Flow Diagram.

Ground-truthing or verifying the vegetation for BIBE by the mapping team occurred during three field trips. The first started after the conclusion of the initial planning meeting in 2009 and two others were conducted in October 2014 (after the plot data collection) and in October of 2016 (prior to the AA fieldwork). During these trips, the preliminary BIBE vegetation layer, orthoimagery, plots, observation points, roads, and ancillary digital data was loaded onto a portable computer linked to a GPS receiver. Once at BIBE, CTI staff visited representative polygons and verified the map lines and labels against the actual vegetation on the ground. Polygons with mixed or confusing vegetation signatures were targeted along roads and trails to maximize efficiency. Systematic checking of the mapping was also done by rapidly verifying map class polygons that contained homogeneous and consistent vegetation communities. Adjustments were made on both a site by site basis and park wide if polygons were mislabeled, too heterogeneous, or too finely split. Site specific changes included changing the polygon label, merging neighboring polygons, or creating new polygons from larger ones. Park-wide changes included adding new map classes, merging similar map classes, or expanding/restricting the extent of map classes based on field observations. All observations were later used to help write descriptions and create the final list of BIBE map units. Additional ground-truthing was also conducted on some specific designated sites in 2015 by BIBE staff and contracted biologists at the request of the mapping team.

The fine-level BIBE vegetation map was considered ready for the AA in 2017 after the verification was completed and when the vegetation classification was finalized. In most cases, the preliminary, placeholder map unit names and labels were simply changed to reflect the current rUSNVC association or equivalent name. Due to the limitations of the imagery and the complex mixing of the vegetation some map units contained multiple associations. This issue was addressed by grouping similar associations into broader map units. Some park special map units were also created especially for BIBE to define rare tree types, disturbed vegetation, and separate broad associations into finer scale units. At this time it was determined that part of the vegetation at BIBE occurred in mixed settings or ecotones. To better capture the full spectrum of the vegetation in these polygons a second set of vegetation attributes were added to capture the secondary or alternative vegetation. To round-out the mapping scheme, additional map units were added for land use types based on a mapping system developed by Anderson et al. (1976). This included land-use and land-cover types not in the rUSNVC, such as roads and facilities.

In addition to the final map unit names and codes other polygon specific information or modifiers were added to the vegetation layer (Table 8). Polygon modifiers included physical quantifiers such as average height of the vegetation, average density of the dominant vegetation strata, and the general pattern/shape of the vegetation in each polygon. Topographic and landscape modifiers (i.e. landform, biophysical location, geology, etc.) were also added for each vegetation polygon by extracting data from existing spatial datasets through GIS analysis routines (i.e. zonal statistics and spatial joining). BIBE also requested that any areas with dead trees/shrubs (especially in the Chisos Mountains) and any areas with non-native grasses be flagged or attributed in the GIS layer. Finally the vegetation layer was converted to a Geodatabase and all of the common rUSNVC data contained in the final BIBE plant classification was joined using relationship-classes.

**Table 8.** Polygon Attribute Items and Descriptions used in the BIBE GIS Vegetation Layer.

Attribute	Description
AREA*	Surface area of the polygon in meters squared
PERIMETER*	Perimeter of the polygon in meters
BIBEVEG*	Unique code for each polygon
BIBEVEG_ID*	Unique identification code for each polygon
MAP_CODE	Final Map Unit Codes – Project specific
MAP_DESC	Map Unit Scientific Description Name – Project Specific
MAP_CDESC	Map Unit Common Description Name – Project Specific
ALT_DESC	Map Unit Scientific Alternative Description Name – Project Specific
ALT_CDESC	Map Unit Scientific Alternative Description Name – Project Specific
DENS_MOD	Modifier – Percent Density or Cover of the Upper Stratum Layer in the Polygon. <u>Percent Density Classes:</u> <ul style="list-style-type: none"> <li>• Sparse = &lt; 10%,</li> <li>• Open = 10–25%,</li> <li>• Intermediate = 25–50%,</li> <li>• Discontinuous = 50–75%,</li> <li>• Closed = 75–100%</li> </ul>
PTRN_MOD	Modifier – Vegetation Pattern within the Polygon. <u>Vegetation Pattern Classes:</u> <ul style="list-style-type: none"> <li>• Evenly Dispersed = Homogeneous,</li> <li>• Grouped Stands of Vegetation = Bunched / Clumped,</li> <li>• String of Vegetation = Linear,</li> <li>• Varying densities and gradients of vegetation = Gradational</li> </ul>
HT_MOD	Modifier – Height Range of the Dominant Vegetation Layer. <u>Height Classes:</u> < 1, 1–3, 3–5, 5–15, and 15–30 Meters
ASPECT	General Aspect (Direction) of the Polygon in Degrees
ASPECT_DIR	General Aspect Direction of the Polygon
SLOPE	General Slope of the Polygon in Degrees
ELEV_FT	Average Elevation in the Polygon (Feet)
ELEV_MTRS	Average Elevation in the Polygon (Meters)
LANDFORM	General Landforms: 1) Valley flats, 2) Gently sloping toe slopes, bottoms, and swales, 3) Gently sloping ridges, fans, and hills, 4) Nearly level terraces and plateaus, 5) Very moist steep slopes, 6) Moderately moist steep slopes, 7) Moderately dry steep slopes, 8) Very dry steep slopes, 9) Cool aspect scarps, cliffs, canyons, 10) Hot aspect scarps, cliffs, canyons.
PHYS_VEG	General Physical Vegetation – Based on the Plumb 1993 Vegetation Map: 1) Land-use, 2) Open Water, 3) Sparse Vegetation, 4) Herbaceous Vegetation, 5) Shrubland, 6) Tall Shrubs and Woodlands

\* ArcInfo© default items

**Table 8 (continued).** Polygon Attribute Items and Descriptions used in the BIBE GIS Vegetation Layer.

Attribute	Description
BPS_VEG	General Biophysical Vegetation: Foothills Vegetation, High Desert Shrub Grassland, High Desert Shrubland, Wetland, Limestone Scrub, Limestone Shrubland, Low Desert Scrub, Low Ruderal Grasslands and Desert Scrub, Montane, Riverine Riparian, Upland Riparian, and Land-use.
GEOLOGY	Dominant Geological Formation for each Polygon
SOIL	General Soil Type in the Polygon (USDA 2019)
MORTALITY	Evidence of Mortality in the Polygon – Dead Trees and Shrubs
INTRO_GRSS	Common Non-native or Introduced Grass Species Name Present in the Polygon
PARK_NAME	Local or Common Name of the BIBE Plant Association
ASSN, ELMNT_CODE, ALLIANCE, GROUP, MACROGROUP, DIVISION, FORMATION, SUBCLASS, CLASS	rUSNVC (or local equivalent) Hierarchy Names for the BIBE Vegetation Types (See Appendix D for more information on the rUSNVC)
ANDERSON_1_2	Anderson Level One and Two Land-use and Land-cover Types (Anderson <i>et. al</i> 1976)
COMMENTS	Additional Comments about the Vegetation for Individual Polygons
ACRES	Surface Area of the Polygon in Acres
HECTARES	Surface Area of the Polygon in Hectares

\* ArcInfo® default items

## Accuracy Assessment

Once the vegetation layer was completed, the accuracy assessment (AA) was conducted. Typically, in mapping exercises both thematic or attribute map accuracy as well as the positional or polygon line accuracy are considered. In the case of the NVIP however, the positional accuracy is usually omitted since rarely does vegetation split on discrete edges that can be positively located in the field. The subjectivity involved in this effort plus the high resolution and accuracy of TOP imagery allows for the assumption that all products derived from them are well within National Map Accuracy Standards for 1:12,000-scale maps ( $\pm 30$  feet).

The thematic accuracy of the vegetation map was assessed using the methodology provided by the NVIP (TNC and ESRI 1994c and Lea and Curtis 2010). The revised protocols included a four step AA process consisting of a (1) sample design, (2) sample site selection, (3) data collection, and (4) data analysis. The design of the AA process followed the three possible scenarios provided in the field manual with stratified random targets placed in each map class based on their respective frequency and abundance (Table 9).



**Table 9.** Standard Sample Size Allocations for Accuracy Assessment Points Based on Map Unit Area.

Map Class Total Area*	Number of Observations Per Map Class
> 50 hectares	30**
8.33 to 50 hectares	0.6 per hectare**
< 8.33 hectares	5**

\* as measured before buffering for cost surface (access buffer) or for map class boundary buffer.

\*\* or as many spatially independent (non-overlapping) observation sites as map class area, MMU size and other considerations will allow.

The AA sample size parameters were loaded into a custom GIS program along with the vegetation layer to perform the sample site selection. The program picked the random target locations and also buffered them 10 meters (33 ft) away from any polygon boundary and 50 meters (165 ft) away from any other data point. Being able to choose minimum distance to polygon boundaries helped to minimize confusion and accounted for the horizontal error typically encountered in common GPS receivers ( $\pm 5$  m). In addition, target locations were generally restricted to no more than 1 mile (2 km) from any existing BIBE road and trail except for rare types where no polygons occurred within this buffered area. The buffering generally restricted the sampling to about 50% of the project area. Unique and diverse areas outside of the AA sampling buffer were identified including the Deadhorse Mountains and Mesa de Anguilla regions of the park. Some targets were located in the Dead Horse Mountains with the field work being contingent on getting pack animals and other support from BIBE. Additional target points were also added to long linear riparian polygons that were missed. The resulting target locations covered most of the project area except for some remote areas in the north, northwest, southeast, and areas south of the Chisos Mountains. Potential AA targets were reviewed, edited, removed, and replaced if they were located too close to previously collected plots or observation points.

At this time, an additional set of independent back-up AA targets were also created in case the original targets could not be reached while in the field. Difficult or hazardous target points were replaced with easier to reach backup targets for safety and economical reasons as determined by the field crews.

The BIBE AA data collection process was started once the draft vegetation layer, the AA target point locations, the key to the associations and their corresponding map units, and all associated digital GIS files were turned over to Coast to Coast Botany (CCB) (a CTI sub-contractor) on August of 2017. CCB used these materials to create a thorough AA study design with precise planning of field team deployments to maximize the use of NPS provided facilities. To ensure efficiency, CCB also selected AA targets no farther than 500 meters from park roads, lowland trails, and from most sections of trails in the Chisos Mountains. Other AA site selection parameters included no AA targets farther than 200 meters from the ordinary high water mark on the U.S. bank of the Rio Grande River (as defined by USGS hydrologic data) and obvious steep dangerous areas were removed for safety reasons. CCB then created custom field maps, coordinated with BIBE staff for logistics and site access, hired, and trained field crews on the AA methodology.

The AA fieldwork was split into three trips or rotations in BIBE with multiple work sessions per rotation (Table 10). CCB field teams were made-up of local botanists, ecologists, and experienced field people who had done hiking at BIBE and conducted river trips in the past. The teams were divided into two person teams and were supported throughout by a camp cook/commissary person. Due to the overlapping of the BIBE and RIGR boundaries some AA work was also conducted in RIGR during the same river trips. After the data from the first three rotations was analyzed it was determined that a large amount of RIGR was not fully sampled and a subsequent fourth RIGR-specific AA trip was conducted.

**Table 10.** Summary of the BIBE Accuracy Assessment Field Data Collection Trips.

Rotation	Session	Dates (# Days)	# Teams	Primary Areas Covered	# AA Sites
1	1	10/15/17– 10/20/17 (5)	4	Chisos Basin, Green Gulch	105
	2	10/23/17– 10/28/17 (6)	3	High Chisos backcountry, Juniper Canyon, Blue Creek	129
	3	10/31/17– 11/5/17(5)	4	Pine Canyon, Chisos Basin, Green Gulch, Oak Springs Road, Ward Springs Trail, Dodson Trail	138
2	4	11/27/17– 12/13/17 (6)	4	Old Maverick Road, Ross Maxwell Scenic Drive Area, Paint Gap Road, Main Park Road, Dodson Trail	203
	5	12/5/17– 12/12/17 (6)	4	Sue Peaks, River Road, Old Ore Road, Grapevine Hills Road, Glenn Springs Road, Main Park Road, Rio Grande Village Area	259
3	6	2/21/18– 3/1/18 (9)	4	Rio Grande (Mouth of Terlingua Creek to Rio Grande Village), Rio Grande (Lower Canyons)	103
	7	3/4/18– 3/9/18 (5)	4	Terlingua Ranch Road, Dagger Flat Road, Old Ore Road, Panther Junction Area, Main Park Road, Chisos Basin, Sue Peaks	176
TOTAL					1,113

On average, each field crew sampled four or five target points each day in the field and attempted to access one or more additional target points if possible. After reaching a target site, the two observers completed a paper copy of the AA Form (Appendix A). The navigator recorded the waypoint indicated on a Garmin Oregon 650i (or similar) GPS receiver and photographed the vegetation in opposing directions to each other and perpendicular to the major slope present at the site (for washes, an upstream and downstream photo are taken from the center point). At most AA points, the observation area was a circle with a radius of 40 meters (131 feet) that was equal to the MMU of 0.5 hectare. Smaller observation areas of 0.25 hectare or 0.1 hectare were used for smaller stands of vegetation as appropriate. The botanist on the field crew recorded the dominant vegetation by cover class and used the vegetation key to determine the primary and secondary association, if needed. After determining the association(s), the botanist noted the level of fitness for the vegetation key and collected supplemental data about the species composition. At the end of each field day, the field

teams met to identify unknown plant species and checked the AA forms for completeness. Appendix B contains all of the plant species identified during the AA point data collection.

BIBE and NPS support was critical for all of the AA fieldwork. Park staff joined the AA teams when possible, provided housing and campsites, conducted shuttles for river trips, and assisted with the trips into the Dead Horse Mountains by providing pack animals (Figure 24). Together the NPS and CCB field teams collected 1,113 AA points at BIBE and 105 RIGR AA points, with some AA points used for both projects.



**Figure 24.** Photo Examples of the Accuracy Assessment Data Collection at BIBE. Source CCB and NPS Photos.

The CCB crews sampled 1,113 target points and all of the BIBE AA data was later entered into the PLOTS database. The AA data was then exported into a GIS point layer by CTI for analyzing purposes (Figure 25). The AA point layer was overlain on the BIBE vegetation map and the field call to the vegetation association was visually compared to its corresponding vegetation polygon map unit name during two stages of review.

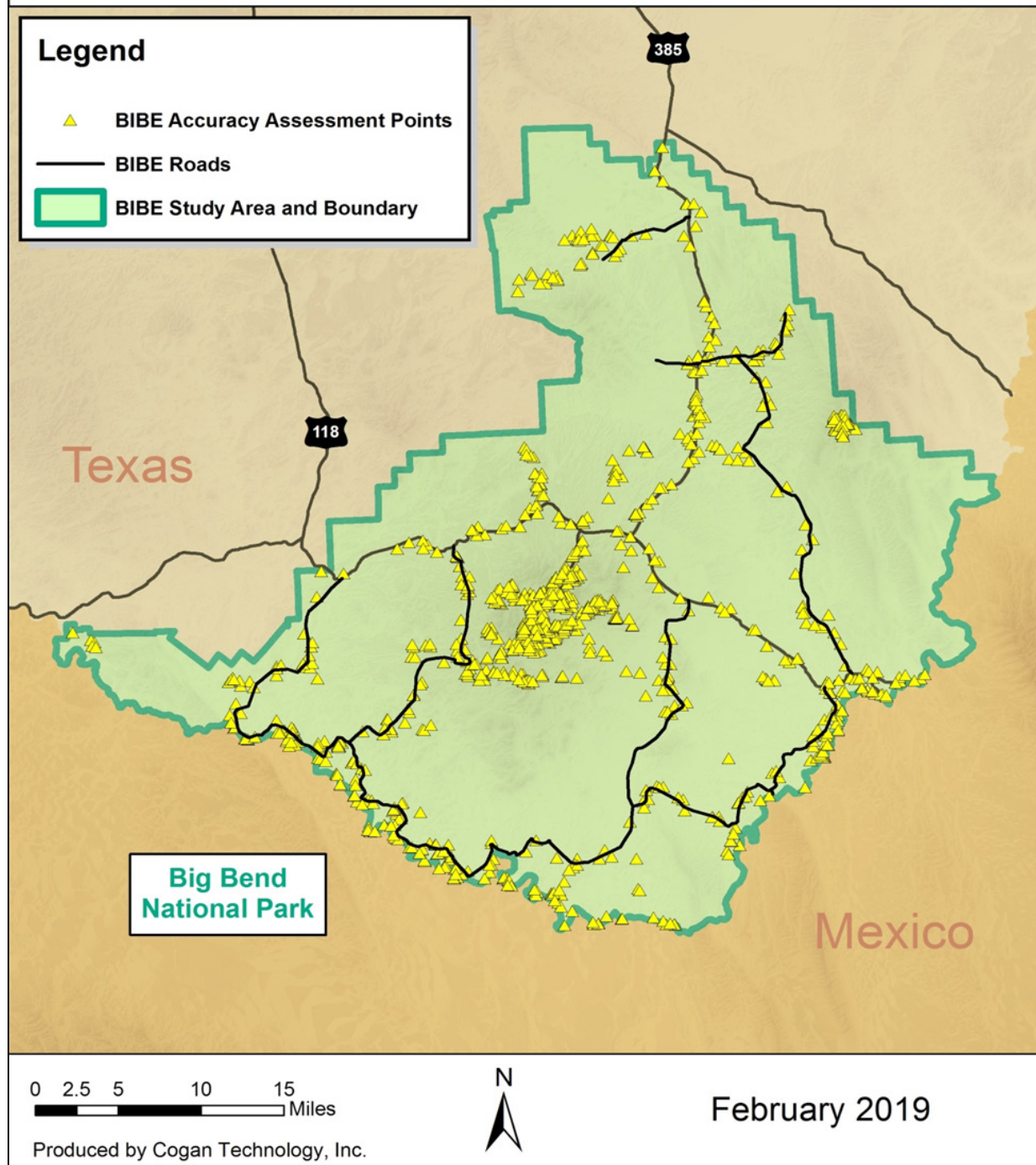
In the first review stage, the original AA point data was matched by its rUSNVC association name to the corresponding map unit. If more than one association was listed on the AA form or the map unit contained more than one possible association the best map unit determination was made based on location, geology/substrate, dominant species, and foliar cover values. A preliminary contingency table was then generated to highlight any errors. Points that differed from the predicted polygon label were examined by reviewing the field forms in question. After the initial examination, many of the

general errors in the data were corrected. Common errors included: (1) incorrect UTM coordinates (handwriting/transcription errors on the datasheet vs. the actual GPS waypoint location), (2) incomplete and/or incorrect field calls (corrected based on actual species and cover data), (3) discrepancies in the field key (i.e. wrong couplet was used), or (4) data was collected in a polygon that was obviously labeled incorrectly (e.g. a vegetated polygon labeled as a road). Changes were made and recorded in the comments field of the AA point layer.





## Accuracy Assessment Point Location Map



**Figure 25.** Map of the Accuracy Assessment Points Collected at BIBE. Source: CTI.

The second review step involved deciding between the primary or secondary field call for the plant association. This was done by first adding a “Final\_Code” attribute to the AA point layer and then comparing the assigned field names of the point with its corresponding location on the digital imagery. In most cases, the primary map unit name assigned by the field crew was used. However, some points were assigned their secondary field call based on one of the following reasons: (1) it appeared that the second call was the better choice due to the overhead perspective (e.g. a stand judged to be a sparse shrubland on the imagery versus herbaceous vegetation in the field), (2) the data were actually recorded in a stand that was too small (i.e. inclusion below MMU size), or (3) the second call more appropriately matched the ecological context (e.g. riparian vegetation along a stream versus dry, upland vegetation).

Once the data were reviewed, the final AA analysis was conducted. This was accomplished by using CTI custom GIS programs and AA templates supplied by the NVIP. Through this automated process, the final map units in the AA layer were compared to the map unit designations for their corresponding polygons. All of the statistics and calculations used to analyze these data are described at length in the program manuals (TNC and ESRI 1994c and Lea and Curtis 2010). Final percent accuracy for each of the map classes was recorded using contingency tables (error matrices).

# Results

## Vegetation Classification

The BIBE classification of the 499 plot and one observation point data resulted in 55 plant associations. Fourteen of which matched an existing rUSNVC association and 41 did not fit a current rUSNVC type at this time. The new associations represent local plant communities that differ from existing rUSNVC association concepts. The new BIBE types were linked however to an Alliance or higher rUSNVC level for classification and mapping purposes. With additional data and analysis, some of the new plant associations may become official rUSNVC types or may be subsumed into existing rUSNVC associations. The new BIBE plant associations can be distinguished by their rUSNVC element codes as current rUSNVC associations begin with the C EGL prefix versus NPSBIBE for park specials.

All BIBE plant associations were named using standardized protocols including adding parentheses (“( )”) to indicate a species may or may not be present in a given stand. A dash (“–”) between species names to indicate that the dominant species occur in the same vegetation layer (i.e. stratum) and a slash (“/”) to separate the dominant species that occur by strata (i.e. canopy/subcanopy/understory). All plant associations found at BIBE in this study are listed in Table 11 along with their common or park-specific name and element code.

Summarized by physiognomic class and topographic locations, this study found nine montane forest and woodland, two riparian woodland, six chaparral and shrub steppe, 13 desert shrubland, steppe, and shrub grasslands, five riparian bosque and shrubland, seven riparian herbaceous vegetation, five upland herbaceous vegetation, and eight sparse vegetation types. The vast majority of the BIBE associations were dominated by native species with only 7 associations considered to be dominated by either non-native or recently planted species. The seven semi-natural or disturbed vegetation types represented mostly riparian types along the Rio Grande River or upland locations that were recently ranched, cleared, or otherwise disturbed.

**Table 11.** Summary of rUSNVC Associations for BIBE.

Category	BIBE Association [BIBE Park Name]	rUSNVC Element Code
Montane Forest and Woodlands	<i>Pinus cembroides</i> – <i>Quercus grisea</i> – <i>Quercus emoryi</i> – <i>Juniperus flaccida</i> / <i>Salvia regia</i> / <i>Bouteloua curtipendula</i> Woodland Association [Alligator Juniper – Pinyon Pine – Gray Oak Woodland]	CEGL004596
	<i>Pinus cembroides</i> – <i>Quercus grisea</i> – <i>Juniperus flaccida</i> / <i>Salvia regia</i> / <i>Muhlenbergia emersleyi</i> Woodland Association [Dry Pinyon Pine Woodland]	CEGL004596
	<i>Pinus cembroides</i> – <i>Quercus gravesii</i> – <i>Juniperus flaccida</i> / <i>Salvia regia</i> / <i>Piptochaetium fimbriatum</i> Woodland Association [Dry – Mesic Pinyon Pine – Oak – Juniper Forest]	CEGL004600
	<i>Quercus laceyi</i> Madrean Woodland Association [Lacey's Oak Woodland]	NPSBIBE012

**Table 11 (continued).** Summary of rUSNVC Associations for BIBE.

Category	BIBE Association [BIBE Park Name]	rUSNVC Element Code
Montane Forest and Woodlands (continued)	<i>Quercus emoryi</i> / <i>Muhlenbergia emersleyi</i> Scrub Woodland Association [Emory Oak Woodland]	CEGL000685
	<i>Acer grandidentatum</i> – <i>Quercus gravesii</i> Forest Association [Graves' Oak – Bigtooth Maple Forest]	CEGL004548
	<i>Quercus gravesii</i> – <i>Quercus emoryi</i> / <i>Arbutus xalapensis</i> / <i>Garrya ovata</i> ssp. <i>goldmanii</i> Forest Association [Graves' Oak – Emory Oak Canyon Forest]	NPSBIBE007
	<i>Quercus gravesii</i> – <i>Pinus (cembroides, arizonica)</i> / <i>Quercus grisea</i> Forest Association [High Chisos Oak – Pine Forest]	NPSBIBE004
	<i>Hesperocyparis arizonica</i> / <i>Quercus gravesii</i> – <i>Pinus cembroides</i> / <i>Piptochaetium fimbriatum</i> Forest Association [Arizona Cypress – Graves' Oak – Pinyon Pine Forest]	NPSBIBE002
Riparian Woodlands	<i>Populus fremontii</i> – <i>Salix gooddingii</i> Woodland Association [Cottonwood – Goodding Willow Spring Woodland]	CEGL000944
	<i>Populus</i> spp. – <i>Fraxinus</i> spp. Planted Woodland Cultural Type [Mixed Ornamental and Planted Woodland]	NPSBIBE045
Chaparral and Shrub Steppe	<i>Quercus intricata</i> – <i>Dasyllirion leiophyllum</i> Shrubland Association [Coahuila Scrub Oak Chaparral]	CEGL004530
	<i>Quercus grisea</i> – <i>Cercocarpus montanus</i> Shrubland Association [High Chisos Gray Oak – Mountain Mahogany Chaparral]	NPSBIBE022
	<i>Quercus (pungens, mohriana)</i> – <i>Fraxinus greggii</i> – <i>Rhus virens</i> – ( <i>Yucca faxoniana</i> ) Shrubland Association [Calcareous Chaparral]	NPSBIBE009
	<i>Rhus virens</i> – <i>Quercus</i> spp. / <i>Viguiera stenoloba</i> – <i>Nolina erumpens</i> Shrubland Association [Montane Mixed Chaparral]	NPSBIBE005
	<i>Juniperus (coahuilensis, pinchotii)</i> / <i>Dasyllirion leiophyllum</i> – <i>Nolina erumpens</i> – <i>Bouteloua curtipendula</i> Shrubland Association [Redberry Juniper – Sotol Shrubland]	NPSBIBE021
	<i>Fraxinus greggii</i> – <i>Diospyros texana</i> – <i>Rhus virens</i> – <i>Senegalia</i> spp. Shrubland Association [Persimmon – Littleleaf Ash Foothills Shrubland]	NPSBIBE013
Desert Shrublands, Steppe, and Shrub Grasslands	<i>Suaeda suffrutescens</i> / <i>Sporobolus pyramidatus</i> Shrubland Association [Alkaline Clay Flat Shrubland]	NPSBIBE027
	<i>Larrea tridentata</i> – <i>Fouquieria splendens</i> – <i>Agave lechuguilla</i> – <i>Leucophyllum frutescens</i> Shrubland Association [Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub]	NPSBIBE044
	<i>Larrea tridentata</i> – <i>Cylindropuntia leptocaulis</i> / <i>Dasyochloa pulchella</i> – <i>Cathastecum erectum</i> Shrubland Association [Big Bend Lowlands Creosotebush Desert Scrub]	NPSBIBE031



**Table 11 (continued).** Summary of rUSNVC Associations for BIBE.

Category	BIBE Association [BIBE Park Name]	rUSNVC Element Code
Desert Shrublands, Steppe, and Shrub Grasslands (continued)	<i>Prosopis glandulosa</i> – <i>Larrea tridentata</i> – ( <i>Flourensia cernua</i> , <i>Parthenium incanum</i> ) Shrubland Association [Mesquite – Creosotebush Desert Scrub]	NPSBIBE025
	<i>Larrea tridentata</i> – <i>Agave lechuguilla</i> – <i>Hechtia texensis</i> – <i>Echinocactus horizonthalonius</i> Shrubland Association [Boquillas Basin Calcareous Creosotebush Desert Scrub]	NPSBIBE011
	<i>Agave lechuguilla</i> – <i>Euphorbia antisiphilitica</i> – <i>Ephedra aspera</i> / <i>Bouteloua ramosa</i> Shrubland Association [Calcareous Mixed Desert Scrub]	NPSBIBE010
	<i>Hymenoclea monogyra</i> – <i>Chilopsis linearis</i> – <i>Porophyllum scoparium</i> Shrubland Association [Big Bend Lowlands Wash Channel Shrubland]	NPSBIBE014
	<i>Chilopsis linearis</i> – <i>Yucca torreyi</i> – ( <i>Brickellia laciniata</i> ) Shrubland Association [Foothills Wash Channel Shrubland]	NPSBIBE042
	<i>Dasyllirion leiophyllum</i> – <i>Agave lechuguilla</i> / <i>Bouteloua curtipendula</i> – <i>Heteropogon contortus</i> Shrub Grassland Association [Sotol – Lechuguilla Foothills Shrub Grassland]	NPSBIBE030
	<i>Dasyllirion leiophyllum</i> – <i>Viguiera stenoloba</i> – <i>Agave lechuguilla</i> / <i>Bouteloua ramosa</i> Shrubland Association [Chino Grama Shrub Grassland]	CEGL004604
	<i>Diospyros texana</i> – <i>Forestiera angustifolia</i> – <i>Prosopis glandulosa</i> – ( <i>Rhus microphylla</i> ) Shrubland Association [Mixed Tall Shrubs Wash Shrubland]	NPSBIBE029
	<i>Vachellia</i> spp. – <i>Senegalia greggii</i> – <i>Prosopis glandulosa</i> – <i>Yucca elata</i> Shrubland Association [Acacia – Mesquite Wash Shrubland]	NPSBIBE043
Riparian Bosque and Shrublands	<i>Yucca faxoniana</i> – <i>Yucca thompsoniana</i> – <i>Dasyllirion leiophyllum</i> / <i>Nolina erumpens</i> – <i>Bouteloua curtipendula</i> Shrub Grassland Association [Yucca – Sotol Calcareous Shrub Grassland]	NPSBIBE040
	<i>Tamarix</i> spp. Temporarily Flooded Semi-natural Shrubland Association [Tamarisk – (Tree Tobacco) Riparian Shrubland]	CEGL003114
	<i>Salix exigua</i> – <i>Baccharis salicifolia</i> Shrubland Association [Thurber's Willow Spring Shrubland]	CEGL005980
	<i>Salix (gooddingii, thurberi)</i> Rio Grande Woodland Association [Rio Grande Willow Riparian Bosque]	NPSBIBE019
	<i>Baccharis salicifolia</i> / ( <i>Phragmites australis</i> ) Chihuahuan Riparian Shrubland Association [Rio Grande Seepwillow Riparian Shrubland]	NPSBIBE047
	<i>Prosopis glandulosa</i> Wet Scrub Association [Rio Grande Mesquite Riparian Bosque]	CEGL004934

**Table 11 (continued).** Summary of rUSNVC Associations for BIBE.

Category	BIBE Association [BIBE Park Name]	rUSNVC Element Code
Riparian Herbaceous Vegetation	<i>Arundo donax</i> Riverbank Herbaceous Vegetation Association [Giant Cane Riparian Herbaceous Vegetation]	CEGL004101
	<i>Phragmites australis</i> Chihuahuan Desert Riparian Herbaceous Vegetation Association [Common Reed Riparian Herbaceous Vegetation]	NPSBIBE023
	<i>Cynodon dactylon</i> Arid Southwest Herbaceous Vegetation Association [Bermuda Grass Herbaceous Vegetation]	NPSBIBE017
	<i>Schoenoplectus pungens</i> Herbaceous Vegetation Association [Wet Riverbank Herbaceous Vegetation]	CEGL001587
	<i>Schoenoplectus californicus</i> Chihuahuan-Tamaulipan Riparian Herbaceous Vegetation Association [California Bulrush Herbaceous Vegetation]	NPSBIBE050
	<i>Baccharis salicifolia</i> / <i>Andropogon glomeratus</i> Shrub Herbaceous Vegetation Association [Seepwillow – Bushy Bluestem Spring Vegetation]	NPSBIBE016
	<i>Atriplex canescens</i> – <i>Suaeda suffrutescens</i> / <i>Sporobolus airoides</i> Shrub Herbaceous Vegetation Association [Alkali Sacaton Riparian Grassland]	NPSBIBE026
Upland Herbaceous Vegetation	<i>Muhlenbergia emersleyi</i> – <i>Bommeria hispida</i> – <i>Cheilanthes bonariensis</i> Herbaceous Vegetation Association [Bull Muhly Montane Grassland]	NPSBIBE008
	<i>Nassella tenuissima</i> Herbaceous Vegetation Association [Finestem Needlegrass Montane Grassland]	NPSBIBE003
	<i>Pleuraphis mutica</i> Monotype Herbaceous Vegetation Association [Tobosa Grass Desert Grassland]	CEGL001637
	<i>Sorghum halepense</i> Chihuahuan Desert Herbaceous Vegetation Association [Johnson Grass – Russian Thistle Desert Grassland]	NPSBIBE018
	( <i>Heteropogon contortus</i> , <i>Pennisetum ciliare</i> , <i>Eragrostis lehmanniana</i> ) – Mixed Forbs Chihuahuan Ruderal Herbaceous Vegetation Association [Upland Ruderal Herbaceous Vegetation]	NPSBIBE046
Sparse Vegetation	Arid West Alluvial Shrub Herbaceous Vegetation Association [Rio Grande Alluvial Sparse Vegetation]	NPSBIBE024
	Chihuahuan Desert Non-calcareous Outcrop Lichen Vegetation Association [Low Elevation Non-calcareous Outcrop Lichen Vegetation]	NPSBIBE038
	Chihuahuan Desert Calcareous Outcrop Lichen Vegetation Association [Calcareous Outcrop Lichen Vegetation]	NPSBIBE039
	<i>Atriplex obovata</i> / <i>Tidestromia carnososa</i> Dwarf-shrubland Association [Badlands Sparse Vegetation]	CEGL004575
	<i>Jatropha dioica</i> – <i>Opuntia rufida</i> Sparse Vegetation Association [Low Elevation Talus and Dune Sparse Vegetation]	NPSBIBE036

**Table 11 (continued).** Summary of rUSNVC Associations for BIBE.

Category	BIBE Association [BIBE Park Name]	rUSNVC Element Code
Sparse Vegetation (continued)	<i>Agave lechuguilla</i> – <i>Viguiera stenoloba</i> / <i>Selaginella peruviana</i> – <i>Bommeria hispida</i> – <i>Muhlenbergia emersleyi</i> Shrub Herbaceous Vegetation Association [Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation]	NPSBIBE006
	<i>Fouquieria splendens</i> – <i>Dasyllirion leiophyllum</i> / <i>Bouteloua curtipendula</i> – <i>Notholaena standleyi</i> Rocky Sparse Shrubland Association [Montane Talus and Cliff Rocky Sparse Shrubland]	NPSBIBE020
	Madrean Igneous Outcrop Lichen Vegetation Association [Montane Igneous Outcrop Lichen Vegetation]	NPSBIBE037

### Digital Imagery and Mapping

The 55 rUSNVC plant associations (and equivalents) were used as the basis for the BIBE mapping scheme. BIBE map classes represent a compromise between the details of the rUSNVC, new types found in the park (not currently in the rUSNVC), the needs of the resource management staff, and the limitations of the imagery used for mapping. As a result, the mapping legend does not always match the rUSNVC (or equivalent) at the plant association level. From the final association list, 45 association were directly cross-walked or linked to one map unit, three were combined into a single map unit, and six were expanded into 16 map units for a total of 62 individual vegetated map classes. Ten additional land-use/land-cover) were also included to describe non-vegetated areas.

The following types represent the possible mapping scenarios encountered in the BIBE project:

1. **One-to-one relationship** = When a plant association had an unique photo signature and could be readily delineated on the imagery, the map unit adopted the plant association name or similar synonym name (45 map units at BIBE).
2. **One-to-many relationship** = When related plant associations shared the same signature and could not be distinguished on the imagery, several plant associations were combined into a single map unit.
  - *Baccharis salicifolia* / (*Phragmites australis*) Chihuahuan Riparian Shrubland (NPSBIBE047)
  - *Schoenoplectus californicus* Chihuahuan-Tamaulipan Riparian Herbaceous Vegetation (NPSAMIS030)
  - *Schoenoplectus pungens* Herbaceous Vegetation (CEGL001587)
    - Map Code = **H\_RIO**
    - Map Unit = Rio Grande Alluvial Herbaceous Vegetation
    - Reason = Riparian herbaceous vegetation along the Rio Grande River was patchy, small, intermixed, and could not be reliably delineated.

3. **Many-to-one relationship** = Some of the BIBE associations occurred in more than one map unit and include the following:

- *Populus fremontii* – *Salix gooddingii* Woodland (CEGL000944)
  - Map Codes = **W\_CWD** and **W\_GWIL**
  - Map Units = Cottonwood – Goodding Willow Spring Woodland and Goodding Willow Spring Woodland
  - Reason = Cottonwood tree stands were split from Goodding willow tree stands in an effort to provide more riparian detail.
- *Quercus gravesii* – *Pinus (cembroides, arizonica)* / *Quercus grisea* Forest (NPSBIBE004)
  - Map Codes = **W\_APOAK** and **W\_HOAK**
  - Map Units = Arizona Pine – Graves’ Oak Forest and High Chisos Oak – Pine Forest
  - Reason = Areas with Arizona Pine trees were split from the mixed High Chisos Oak – Pine woodland type in an effort to provide more detail on the location of Arizona pine trees.
- *Juniperus (coahuilensis, pinchotii)* / *Dasyllirion leiophyllum* – *Nolina erumpens* / *Bouteloua curtipendula* Shrubland (NPSBIBE021)
  - Map Codes = **S\_LMIX** and **S\_RJUN**
  - Map Units = Low Montane Mixed Shrub / Sideoats Grama Shrubland and Redberry Juniper – Sotol Shrubland
  - Reason = Areas with high cover of Redberry Juniper trees/shrubs were split from the mixed Low Montane Shrub type in an effort to provide more detail on the location of redberry juniper trees.
- *Agave lechuguilla* – *Euphorbia antisiphilitica* – *Ephedra aspera* / *Bouteloua ramosa* Shrubland (NPSBIBE010)
  - Map Codes = **S\_CDS** and **S\_CTAL**
  - Map Units = Calcareous Mixed Desert Scrub and Calcareous Talus Mixed Shrubland
  - Reason = Calcareous areas with shrubs growing on talus and rocky slopes were split from the mixed Calcareous Scrub type in an effort to provide more detail.
- *Yucca faxoniana* – *Yucca thompsoniana* – *Dasyllirion leiophyllum* – *Nolina erumpens* / *Bouteloua curtipendula* Shrub Grassland (NPSBIBE040)
  - Map Codes = **S\_YUC** and **S\_YWASH**
  - Map Units = Yucca – Sotol Calcareous Shrub Grassland and Yucca Calcareous Wash Channel Shrubland
  - Reason = Washes on limestone and calcareous geological formations were split from other wash map units and the yucca – sotol type to provide more detail.



- *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathestecum erectum* Shrubland (NPSBIBE031)
    - Map Codes = **S\_CB**, **SP\_LDES1**, **SP\_LDES2**, and **SP\_LDES3**
    - Map Units = Creosotebush Desert Scrub, Big Bend Lowlands (Flats, Benches, and Plateaus), Big Bend Lowlands (Eroding Slopes, Hillsides, and Badlands), and Big Bend Lowlands (Basalt, Lava, and Volcanic Rocks)
    - Reason = The widespread Creosotebush Desert Scrub type was split into four map units to provide more detail on low desert areas with high creosotebush cover (S\_CB) and areas with sparse creosotebush cover that occurred on different soils and geologic formations (SP\_LDES types).
  - *Hymenoclea monogyra* – *Chilopsis linearis* – *Porophyllum scoparium* Shrubland (NPSBIBE014)
    - Map Codes = **S\_WASH** and **SP\_WASH**
    - Map Units = Big Bend Lowlands Wash Channel Shrubland and Big Bend Lowlands Sparsely Vegetated Wash Channel
    - Reason = Washes with little or no vegetation were split from vegetated washes to provide more detail.
4. **Land Use – Land Cover** = Non-vegetated areas and vegetation types not recognized by the rUSNVC received Anderson et al. (1976, updated 2002) map unit designations.

Table 12 contains the final list of map units and their cross-walk to associations/alliances or map unit description information and Appendix E contains descriptions and representative photographs for all the vegetation map units used at BIBE. To maintain consistency with previous vegetation mapping and classification efforts at BIBE, the resulting new map units were also cross-walked to other recent and similar studies at BIBE (Table 13).

**Table 12.** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Woodlands	W_ACYP	<i>Hesperocyparis arizonica</i> – <i>Quercus gravesii</i> – <i>Pinus cembroides</i> Forest	Arizona Cypress – Graves' Oak – Pinyon Pine Forest	<i>Hesperocyparis arizonica</i> / <i>Quercus gravesii</i> – <i>Pinus cembroides</i> / <i>Piptochaetium fimbriatum</i> Forest – NPSBIBE002
	W_APJ	<i>Juniperus deppeana</i> – <i>Pinus cembroides</i> – <i>Quercus grisea</i> Woodland	Alligator Juniper – Pinyon Pine – Gray Oak Woodland	<i>Pinus cembroides</i> – <i>Quercus grisea</i> – <i>Quercus emoryi</i> – <i>Juniperus flaccida</i> / <i>Salvia regla</i> / <i>Bouteloua curtipendula</i> Woodland – CEGL004597
	W_APOAK	<i>Pinus arizonica</i> – <i>Quercus gravesii</i> Forest	Arizona Pine – Graves' Oak Forest	<i>Quercus gravesii</i> – <i>Pinus (cembroides, arizonica)</i> / <i>Quercus grisea</i> Forest – NPSBIBE004
	W_CWD	<i>Populus fremontii</i> – <i>Salix gooddingii</i> Spring Woodland	Cottonwood – Goodding Willow Spring Woodland	<i>Populus fremontii</i> – <i>Salix gooddingii</i> Woodland – CEGL000944
	W_EOAK	<i>Quercus emoryi</i> Woodland	Emory Oak Woodland	<i>Quercus emoryi</i> / <i>Muhlenbergia emersleyi</i> Scrub Woodland – CEGL000685
	W_FOR	Mixed Ornamental and Planted Woodland	Mixed Ornamental and Planted Woodland	<i>Populus</i> spp. – <i>Fraxinus</i> spp. Planted Woodland Cultural Type – NPSBIBE045
	W_GWIL	<i>Salix gooddingii</i> Spring Woodland	Goodding Willow Spring Woodland	<i>Populus fremontii</i> – <i>Salix gooddingii</i> Woodland – CEGL000944
	W_HOAK	<i>Quercus gravesii</i> – <i>Pinus</i> spp. Forest	High Chisos Oak – Pine Forest	<i>Quercus gravesii</i> – <i>Pinus (cembroides, arizonica)</i> / <i>Quercus grisea</i> Forest – NPSBIBE004
	W_LOAK	<i>Quercus laceyi</i> Woodland	Lacey's Oak Woodland	<i>Quercus laceyi</i> Madrean Woodland – NPSBIBE012
	W_MPJ	Dry – Mesic <i>Pinus cembroides</i> – <i>Quercus</i> spp. – <i>Juniperus</i> spp. Woodland	Dry – Mesic Pinyon Pine – Oak – Juniper Woodland	<i>Pinus cembroides</i> – <i>Quercus gravesii</i> – <i>Juniperus flaccida</i> / <i>Salvia regla</i> / <i>Piptochaetium fimbriatum</i> Woodland – CEGL004600
	W_PJ	Dry <i>Pinus cembroides</i> Woodland	Dry Pinyon Pine Woodland	<i>Pinus cembroides</i> – <i>Quercus grisea</i> – <i>Juniperus flaccida</i> / <i>Salvia regla</i> / <i>Muhlenbergia emersleyi</i> Woodland – CEGL004596

**Table 12 (continued).** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Woodlands (continued)	W_ROKBM	<i>Quercus gravesii</i> – <i>Acer grandidentatum</i> Forest	Graves' Oak – Bigtooth Maple Forest	<i>Acer grandidentatum</i> – <i>Quercus gravesii</i> Forest – CEGL004548
	W_ROKEOK	<i>Quercus gravesii</i> – <i>Quercus emoryi</i> Canyon Forest	Graves' Oak – Emory Oak Canyon Forest	<i>Quercus gravesii</i> – <i>Quercus emoryi</i> / <i>Arbutus xalapensis</i> / <i>Garrya ovata</i> ssp. <i>goldmanii</i> Forest – NPSBIBE007
Shrublands	S_ACAMEQ	<i>Vachellia</i> spp. – <i>Senegalia greggii</i> – <i>Prosopis glandulosa</i> Wash Shrubland	Acacia – Mesquite Wash Shrubland	<i>Vachellia</i> spp. – <i>Senegalia greggii</i> – <i>Prosopis glandulosa</i> – <i>Yucca elata</i> Shrubland – NPSBIBE043
	S_CB	<i>Larrea tridentata</i> Desert Scrub	Creosotebush Desert Scrub	<i>Larrea tridentata</i> – <i>Cylindropuntia leptocaulis</i> / <i>Dasyochloa pulchella</i> – <i>Cathastecum erectum</i> Shrubland – NPSBIBE031
	S_CBO	<i>Larrea tridentata</i> – <i>Fouquieria splendens</i> – <i>Agave lechuguilla</i> Mixed Desert Scrub	Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub	<i>Larrea tridentata</i> – <i>Fouquieria splendens</i> – <i>Agave lechuguilla</i> – <i>Leucophyllum frutescens</i> Shrubland – NPSBIBE044
	S_CDS	Calcareous Mixed Desert Scrub	Calcareous Mixed Desert Scrub	<i>Agave lechuguilla</i> – <i>Euphorbia antisyphilitica</i> – <i>Ephedra aspera</i> / <i>Bouteloua ramosa</i> Shrubland – NPSBIBE010
	S_CHAP	Calcareous Chaparral	Calcareous Chaparral	<i>Quercus (pungens, mohriana)</i> – <i>Fraxinus greggii</i> – <i>Rhus virens</i> – ( <i>Yucca faxoniana</i> ) Shrubland – NPSBIBE009
	S_CLAY	Alkaline Clay Flat Shrubland	Alkaline Clay Flat Shrubland	<i>Suaeda suffrutescens</i> / <i>Sporobolus pyramidatus</i> Shrubland – NPSBIBE027
	S_CTAL	Calcareous Talus Mixed Shrubland	Calcareous Talus Mixed Shrubland	<i>Agave lechuguilla</i> – <i>Euphorbia antisyphilitica</i> – <i>Ephedra aspera</i> / <i>Bouteloua ramosa</i> Shrubland – NPSBIBE010
	S_CWIL	<i>Salix thurberi</i> Spring Shrubland	Thurber's Willow Spring Shrubland	<i>Salix thurberi</i> – <i>Baccharis salicifolia</i> Shrubland – CEGL005980

**Table 12 (continued).** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Shrublands (continued)	S_FWASH	Foothills Wash Channel Shrubland	Foothills Wash Channel Shrubland	<i>Chilopsis linearis</i> – <i>Yucca torreyi</i> – ( <i>Brickellia laciniata</i> ) Shrubland – NPSBIBE042
	S_GOAK	High Chisos <i>Quercus grisea</i> – <i>Cercocarpus montanus</i> Chaparral	High Chisos Gray Oak – Mountain Mahogany Chaparral	<i>Quercus grisea</i> – <i>Cercocarpus montanus</i> Shrubland – NPSBIBE022
	S_LMIX	Low Montane Mixed Shrub / <i>Bouteloua curtipendula</i> Shrubland	Low Montane Mixed Shrub / Sideoats Grama Shrubland	<i>Juniperus (coahuilensis, pinchotii)</i> / <i>Dasyllirion leiophyllum</i> / <i>Nolina erumpens</i> – <i>Bouteloua curtipendula</i> Shrubland – NPSBIBE021
	S_MEQ	<i>Prosopis glandulosa</i> – <i>Larrea tridentata</i> Desert Scrub	Mesquite – Creosotebush Desert Scrub	<i>Prosopis glandulosa</i> – <i>Larrea tridentata</i> – ( <i>Flourensia cernua</i> , <i>Parthenium incanum</i> ) Shrubland – NPSBIBE025
	S_MMIX	Montane Mixed Chaparral	Montane Mixed Chaparral	<i>Rhus virens</i> – <i>Quercus spp.</i> / <i>Viguiera stenoloba</i> – <i>Nolina erumpens</i> Shrubland – NPSBIBE005
	S_MRIP	Rio Grande <i>Prosopis glandulosa</i> Riparian Bosque	Rio Grande Mesquite Riparian Bosque	<i>Prosopis glandulosa</i> Wet Scrub – CEGLO04934
	S_PERS	<i>Diospyros texana</i> – <i>Fraxinus greggii</i> Foothills Shrubland	Persimmon – Littleleaf Ash Foothills Shrubland	<i>Fraxinus greggii</i> – <i>Diospyros texana</i> – <i>Rhus virens</i> – <i>Senegalia</i> spp. Shrubland – NPSBIBE013
	S_RJUN	<i>Juniperus (coahuilensis, pinchotii)</i> – <i>Dasyllirion leiophyllum</i> Shrubland	Redberry Juniper – Sotol Shrubland	<i>Juniperus (coahuilensis, pinchotii)</i> / <i>Dasyllirion leiophyllum</i> – <i>Nolina erumpens</i> – <i>Bouteloua curtipendula</i> Shrubland – NPSBIBE021
	S_RWIL	Rio Grande <i>Salix</i> spp. Riparian Bosque	Rio Grande Willow Riparian Bosque	<i>Salix (gooddingii, thurberi)</i> Rio Grande Shrubland – NPSBIBE019
	S_SOAK	<i>Quercus intricata</i> Chaparral	Coahuila Scrub Oak Chaparral	<i>Quercus intricata</i> – <i>Dasyllirion leiophyllum</i> Shrubland – CEGLO04530
	S_SOT	<i>Dasyllirion leiophyllum</i> – <i>Agave lechuguilla</i> Foothills Shrub Grassland	Sotol – Lechuguilla Foothills Shrub Grassland	<i>Dasyllirion leiophyllum</i> – <i>Agave lechuguilla</i> / <i>Bouteloua curtipendula</i> – <i>Heteropogon contortus</i> Shrub Grassland – NPSBIBE030

**Table 12 (continued).** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Shrublands (continued)	S_TAM	<i>Tamarix</i> spp. – ( <i>Nicotiana glauca</i> ) Riparian Shrubland	Tamarisk – (Tree Tobacco) Riparian Shrubland	<i>Tamarix</i> spp. Temporarily Flooded Semi-natural Shrubland – CEGl003114
	S_TMX	Mixed Tall Shrubs Wash Shrubland	Mixed Tall Shrubs Wash Shrubland	<i>Diospyros texana</i> – <i>Forestiera angustifolia</i> – <i>Prosopis glandulosa</i> – ( <i>Rhus microphylla</i> ) Shrubland – NPSBIBE029
	S_WASH	Big Bend Lowlands Wash Channel Shrubland	Big Bend Lowlands Wash Channel Shrubland	<i>Hymenoclea monogyra</i> – <i>Chilopsis linearis</i> – <i>Porophyllum scoparium</i> Shrubland – NPSBIBE014
	S_YUC	<i>Yucca</i> spp. – <i>Dasyllirion leiophyllum</i> Calcareous Shrub Grassland	<i>Yucca</i> – Sotol Calcareous Shrub Grassland	<i>Yucca faxoniana</i> – <i>Yucca thompsoniana</i> – <i>Dasyllirion leiophyllum</i> – <i>Nolina erumpens</i> / <i>Bouteloua curtipendula</i> Shrub Grassland – NPSBIBE040
	S_YWASH	<i>Yucca</i> spp. Calcareous Wash Channel Shrubland	<i>Yucca</i> Calcareous Wash Channel Shrubland	<i>Yucca faxoniana</i> – <i>Yucca thompsoniana</i> – <i>Dasyllirion leiophyllum</i> – <i>Nolina erumpens</i> / <i>Bouteloua curtipendula</i> Shrub Grassland – NPSBIBE040
Herbaceous Vegetation	H_ASAC	<i>Sporobolus airoides</i> Riparian Grassland	Alkali Sacaton Riparian Grassland	<i>Atriplex canescens</i> – <i>Suaeda suffrutescens</i> / <i>Sporobolus airoides</i> Shrub Herbaceous Vegetation – NPSBIBE026
	H_BERM	<i>Cynodon dactylon</i> Herbaceous Vegetation	Bermuda Grass Herbaceous Vegetation	<i>Cynodon dactylon</i> Arid Southwest Herbaceous Vegetation – NPSBIBE017
	H_CANE	<i>Arundo donax</i> Riverbank Herbaceous Vegetation	Giant Cane Riverbank Herbaceous Vegetation	<i>Arundo donax</i> Riverbank Herbaceous Vegetation – CEGl004101
	H_FINE	<i>Nassella tenuissima</i> Montane Grassland	Finestem Needlegrass Montane Grassland	<i>Nassella tenuissima</i> Herbaceous Vegetation – NPSBIBE003
	H_GRAM	<i>Bouteloua ramosa</i> Shrub Grassland	Chino Grama Shrub Grassland	<i>Dasyllirion leiophyllum</i> – <i>Viguiera stenoloba</i> – <i>Agave lechuguilla</i> / <i>Bouteloua ramosa</i> Shrubland – CEGl004604



**Table 12 (continued).** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Herbaceous Vegetation (continued)	H_GRS	<i>Sorghum halepense</i> – <i>Salsola tragus</i> Desert Grassland	Johnson Grass – Russian Thistle Desert Grassland	<i>Sorghum halepense</i> Chihuahuan Desert Herbaceous Vegetation – NPSBIBE018
	H_MUHL	<i>Muhlenbergia emersleyi</i> Montane Grassland	Bull Muhly Montane Grassland	<i>Muhlenbergia emersleyi</i> – <i>Bommeria hispida</i> – <i>Cheilanthes bonariensis</i> Herbaceous Vegetation – NPSBIBE008
	H_REED	<i>Phragmites australis</i> Riparian Herbaceous Vegetation	Common Reed Riparian Herbaceous Vegetation	<i>Phragmites australis</i> Chihuahuan Desert Riparian Herbaceous Vegetation – NPSBIBE023
	H_RIO	Rio Grande Alluvial Herbaceous Vegetation	Rio Grande Alluvial Herbaceous Vegetation	<i>Baccharis salicifolia</i> / ( <i>Phragmites australis</i> ) Chihuahuan Riparian Shrubland – NPSBIBE047  <i>Schoenoplectus californicus</i> Chihuahuan-Tamaulipan Riparian Herbaceous Vegetation – NPSBIBE050  <i>Schoenoplectus pungens</i> Herbaceous Vegetation – CEGLO01587
	H_SPIK	<i>Agave lechuguilla</i> – <i>Selaginella</i> spp. Rocky Shrub Herbaceous Vegetation	Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation	<i>Agave lechuguilla</i> – <i>Viguiera stenoloba</i> / <i>Selaginella peruviana</i> – <i>Bommeria hispida</i> – <i>Muhlenbergia emersleyi</i> Shrub Herbaceous Vegetation – NPSBIBE006
	H_SWIL	<i>Baccharis salicifolia</i> – <i>Andropogon glomeratus</i> Spring Vegetation	Seepwillow – Bushy Bluestem Spring Vegetation	<i>Baccharis salicifolia</i> / <i>Andropogon glomeratus</i> Shrub Herbaceous Vegetation – NPSBIBE016
	H_TOB	<i>Pleuraphis mutica</i> Desert Grassland	Tobosa Grass Desert Grassland	<i>Pleuraphis mutica</i> Monotype Herbaceous Vegetation – CEGLO01637

**Table 12 (continued).** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Herbaceous Vegetation (continued)	H_UPG	Upland Ruderal Herbaceous Vegetation	Upland Ruderal Herbaceous Vegetation	( <i>Heteropogon contortus</i> , <i>Pennisetum ciliare</i> , <i>Eragrostis lehmanniana</i> ) – Mixed Forbs Chihuahuan Ruderal Herbaceous Vegetation – NPSBIBE046
Sparse Vegetation	SP_BAD	Badlands Sparse Vegetation	Badlands Sparse Vegetation	<i>Atriplex obovata</i> / <i>Tidestromia carnosus</i> Dwarf-shrubland – CEGLO04575
	SP_CAL	Calcareous Outcrop Lichen Vegetation	Calcareous Outcrop Lichen Vegetation	Chihuahuan Desert Calcareous Outcrop Lichen Vegetation – NPSBIBE039
	SP_IGN	Montane Igneous Outcrop Lichen Vegetation	Montane Igneous Outcrop Lichen Vegetation	Madrean Igneous Outcrop Lichen Vegetation – NPSBIBE037
	SP_LCAL	Boquillas Basin Calcareous <i>Larrea tridentata</i> Desert Scrub	Boquillas Basin Calcareous Creosotebush Desert Scrub	<i>Larrea tridentata</i> – <i>Agave lechuguilla</i> – <i>Hechtia texensis</i> – <i>Echinocactus horizonthalonius</i> Shrubland – NPSBIBE011
	SP_LDES1	Big Bend Lowlands (Flats, Benches, and Plateaus)	Big Bend Lowlands (Flats, Benches, and Plateaus)	<i>Larrea tridentata</i> – <i>Cylindropuntia leptocaulis</i> / <i>Dasyochloa pulchella</i> – <i>Cathastecum erectum</i> Shrubland – NPSBIBE031
	SP_LDES2	Big Bend Lowlands (Eroding Slopes, Hillsides, and Badlands)	Big Bend Lowlands (Eroding Slopes, Hillsides, and Badlands)	<i>Larrea tridentata</i> – <i>Cylindropuntia leptocaulis</i> / <i>Dasyochloa pulchella</i> – <i>Cathastecum erectum</i> Shrubland – NPSBIBE031
	SP_LDES3	Big Bend Lowlands (Basalt, Lava, and Volcanic Rocks)	Big Bend Lowlands (Basalt, Lava, and Volcanic Rocks)	<i>Larrea tridentata</i> – <i>Cylindropuntia leptocaulis</i> / <i>Dasyochloa pulchella</i> – <i>Cathastecum erectum</i> Shrubland – NPSBIBE031
	SP_MTAL	Montane Talus and Cliff Rocky Sparse Shrubland	Montane Talus and Cliff Rocky Sparse Shrubland	<i>Fouquieria splendens</i> – <i>Dasyllirion leiophyllum</i> / <i>Bouteloua curtipendula</i> – <i>Notholaena standleyi</i> Rocky Sparse Shrubland – NPSBIBE020
	SP_NCAL	Low Elevation Non-Calcareous Outcrop Lichen and Sparse Vegetation	Low Elevation Non-Calcareous Outcrop Lichen and Sparse Vegetation	Chihuahuan Desert Non-calcareous Outcrop Lichen Vegetation – NPSBIBE038
	SP_RIO	Rio Grande Alluvial Sparse Vegetation	Rio Grande Alluvial Sparse Vegetation	Arid West Alluvial Shrub Herbaceous Vegetation – NPSBIBE024

**Table 12 (continued).** BIBE Map Classes and Relationships to the Plant Associations (or Map Class Descriptions).

Category	Map Code	Map Class Name	Map Class Common Name	rUSNVC Unit Assigned to Map Class – or – (Map Class Description)
Sparse Vegetation (continued)	SP_TAL	Low Elevation Talus And Dune Sparse Vegetation	Low Elevation Talus And Dune Sparse Vegetation	<i>Jatropha dioica</i> – <i>Opuntia rufida</i> Sparse Vegetation – NPSBIBE036
	SP_WASH	Big Bend Lowlands Sparsely Vegetated Wash Channel	Big Bend Lowlands Sparsely Vegetated Wash Channel	<i>Hymenoclea monogyra</i> – <i>Chilopsis linearis</i> – <i>Porophyllum scoparium</i> Shrubland – NPSBIBE014
Land-Use and Land-Cover	L_AGRI	Agricultural Business / Ranches	Agricultural Business / Ranches	(Ranch and Farm Areas)
	L_COMM	Communications and Utilities	Communications and Utilities	(Substations, Water Towers, and Communication Facilities)
	L_FACL	NPS and Other Facilities	NPS and Other Facilities	(Visitor Center, Maintenance Yard, Picnic Areas, Boat Ramps, and Campgrounds)
	L_FIELD	Planted / Cultivated Fields	Planted / Cultivated Fields	(Fallow and Tilled Agricultural Fields)
	L_PITS	Quarries / Strip Mines / Gravel Pits	Quarries / Strip Mines / Gravel Pits	(Disturbed Sites for Sand, Gravel, or Rock)
	L_POND	Small Lake / Pond	Small Lake / Pond	(Natural Catchments and Small Human-made Water Impoundments)
	L_ROAD	Main Roads and Transportation Structures	Main Roads and Transportation Structures	(Paved and Gravel Roads)
	L_STRM	Stream / River	Stream / River	(Perennial Streams and Rivers)
	L_TRAN	Transitional Area	Transitional Area	(Recently Disturbed Area)
	L_TRL	Trails and 2-Track Roads	Trails and 2-Track Roads	(Dirt Roads, Hiking, and Social Trails)

**Table 13.** Crosswalk to Other Recent BIBE Vegetation Studies.

<b>National Vegetation Inventory (2019) (Map Classes)</b>	<b>Muldavin et al. (2014) BIBE Alliance Group</b>	<b>Brown et al. (1979 &amp; 1998) American SW (U.S. &amp; México)</b>	<b>Plumb (1991 &amp; 1993) BIBE (Map Classes)</b>
Arizona Cypress – Graves' Oak – Pinyon Pine Forest; Arizona Pine – Graves' Oak Forest; High Chisos Oak – Pine Forest	Madrean Upper Montane Conifer Forest	Madrean Montane Conifer Forest (Mixed Conifer Series)	<i>Pinus-Quercus-Juniperus</i> ; Oak-Ponderosa-Cypress; (Closed Canopy Woodland)
Alligator Juniper – Pinyon Pine – Gray Oak Woodland; High Chisos Oak – Pine Forest	Madrean Lower Montane Conifer Forest	Madrean Montane Conifer Forest (Pine Series); Madrean Evergreen Woodland (Oak-Pine Series)	<i>Pinus-Quercus-Juniperus</i> ; Oak-Ponderosa-Cypress; (Closed Canopy Woodland)
Graves' Oak – Bigtooth Maple Forest; High Chisos Oak – Pine Forest	Madrean Upper Montane Oak Forest	Madrean Evergreen Woodland (Encinal)	Mixed <i>Quercus</i> ; Mixed Oak; (Closed Canopy Woodland)
Graves' Oak – Emory Oak Canyon Forest	Madrean Lower Montane Oak Woodland	Madrean Evergreen Woodland (Encinal)	Mixed <i>Quercus</i> ; Mixed Oak; (Closed Canopy Woodland)
Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation; Montane Igneous Outcrop Lichen Vegetation; Montane Talus and Cliff Rocky Sparse Shrubland; Non-calcareous Outcrop Lichen Vegetation; Calcareous Outcrop Lichen Vegetation	(N/A)	(N/A)	(Bare)
Dry – Mesic Pinyon Pine – Oak – Juniper Forest;	Madrean Pinyon – Juniper Woodland	(N/A)	<i>Pinus-Juniperus-Gramineae</i> ; Pinyon-Juniper-Grass; (Open Canopy Woodland)
Dry Pinyon Pine Woodland Redberry Juniper – Sotol Shrubland;	Madrean Juniper Savanna Woodland	(N/A)	<i>Pinus-Juniperus-Gramineae</i> ; Pinyon-Juniper-Grass; (Open Canopy Woodland)
Bull Muhly Montane Grassland; Finestem Needlegrass Montane Grassland	Madrean Mesa-Foothill Grassland	(N/A)	<i>Stipa Meadow</i> ; (Open Canopy Woodland)

**Table 13 (continued).** Crosswalk to Other Recent BIBE Vegetation Studies.

<b>National Vegetation Inventory (2019) (Map Classes)</b>	<b>Muldavin et al. (2014) BIBE Alliance Group</b>	<b>Brown et al. (1979 &amp; 1998) American SW (U.S. &amp; México)</b>	<b>Plumb (1991 &amp; 1993) BIBE (Map Classes)</b>
Emory Oak Woodland; Coahuila Scrub Oak Chaparral; High Chisos Gray Oak – Mountain Mahogany Chaparral; Montane Mixed Chaparral	Madrean Montane Scrub	Madrean Montane Scrub	<i>Quercus</i> scrub; Oak Scrub; (Scrub Woodland)
Low Montane Mixed Shrub / Sideoats Grama Shrubland; Lacey's Oak Woodland; Persimmon – Littleleaf Ash Foothills Shrubland; Foothills Wash Channel Shrubland	Chihuahuan Interior Chaparral	Chihuahuan Interior Chaparral	Mixed Scrub; (Scrub Woodland)
Calcareous Chaparral; Yucca – Sotol Calcareous Shrub Grassland; Calcareous Mixed Desert Scrub; Calcareous Talus Mixed Shrubland; Yucca Calcareous Wash Channel Shrubland; Calcareous Outcrop Lichen Vegetation	(N/A)	(N/A)	<i>Agave-Bouteloua-Euphorbia</i> ; (Lechuguilla Scrub)
Sotol – Lechuguilla Foothills Shrub Grassland Chino Grama Shrub Grassland	Chihuahuan Foothill-Piedmont Desert Grassland	Semi-desert Grassland	<i>Dasyllirion-Agave-Bouteloua</i> ; <i>Dasyllirion-Nolina</i> ; <i>Agave-Bouteloua-Viguiera</i> ; <i>Agave-Bouteloua</i> ; (High Desert Grassland)
Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub	Chihuahuan Creosotebush Desert Scrub	Chihuahuan Desert Scrub (Creosotebush-Tarbush Series; Whitethorn Series)	<i>Agave-Flourensia</i> ; <i>Agave-Bouteloua-Opuntia</i> ; <i>Larrea-Yucca-Bouteloua</i> (Creosote Scrub)
Mixed Tall Shrubs Wash Shrubland; Acacia – Mesquite Wash Shrubland; Mesquite – Creosotebush Desert Scrub	Chihuahuan Mixed Desert Scrub	Chihuahuan Desert Scrub (Creosotebush-Tarbush Series; Whitethorn Series)	<i>Larrea-Agave</i> <i>Larrea-Gramineae</i> (Creosote Scrub)



**Table 13 (continued).** Crosswalk to Other Recent BIBE Vegetation Studies.

<b>National Vegetation Inventory (2019) (Map Classes)</b>	<b>Muldavin et al. (2014) BIBE Alliance Group</b>	<b>Brown et al. (1979 &amp; 1998) American SW (U.S. &amp; México)</b>	<b>Plumb (1991 &amp; 1993) BIBE (Map Classes)</b>
Big Bend Lowlands Creosotebush Desert Scrub; Boquillas Basin Calcareous Creosotebush Desert Scrub; Low Elevation Non-calcareous Outcrop Lichen Vegetation; Alkaline Clay Flat Shrubland; Badlands Sparse Vegetation; Low Elevation Talus and Dune Sparse Vegetation; Low Elevation Non-calcareous Outcrop Lichen Vegetation	Chihuahuan Dwarf Desert Scrub	Chihuahuan Desert Scrub (Creosotebush-Tarbush Series; Whitethorn Series)	<i>Larrea</i> Flats (Creosote Scrub)
Big Bend Lowlands Wash Channel	Chihuahuan Dwarf Desert Scrub	Chihuahuan Desert Scrub (Creosotebush-Tarbush Series; Whitethorn Series)	<i>Chloopsis</i>
Tobosa Grass Desert Grassland; Johnson Grass – Russian Thistle Desert Grassland; Upland Ruderal Herbaceous Vegetation	(N/A – No Introduced Grasslands)	(N/A – No Introduced Grasslands)	(N/A – No Introduced Grasslands)
Cottonwood – Goodding Willow Spring Woodland; Mixed Ornamental and Planted Woodland; Thuber's Willow Spring Shrubland; Seepwillow – Bushy Bluestem Spring Vegetation	(N/A)	(N/A)	<i>Populus</i> Grove (Upland Riparian)
Rio Grande Mesquite Riparian Bosque; Rio Grande Willow Riparian Bosque; Tamarisk – (Tree Tobacco) Riparian Shrubland; Bermuda Grass Herbaceous Vegetation; Alkali Sacaton Riparian Grassland; Giant Cane Riverbank Herbaceous Vegetation; Common Reed Riparian Herbaceous Vegetation; Rio Grande Alluvial Herbaceous Vegetation; Rio Grande Alluvial Sparse Vegetation	(N/A)	(N/A)	<i>Prosopis</i> Thicket (Riverine Riparian)

### **Vegetation Map**

The BIBE vegetation map consists of 44,454 polygons at the association level totaling 810,482 acres (327,991 hectares) (Appendix F) with an average polygon size of about 18 acres (7 hectares) (Table 14). The relatively small polygons are due in part to the detailed (association-level) mapping, the importance of delineating rare and non-native vegetation types, and the arbitrary splitting of continuous polygons into smaller areas due to roads, trails, washes, and the park boundary. The mapping is also finely detailed since the 2015 TOP imagery was of high resolution allowing for very small stands of vegetation to be accurately mapped. Figure 26 shows an example of the detailed BIBE vegetation mapping centered on the Chisos Basin.

Based on the final vegetation layer, less than 1% (3,015 acres) was developed and 99.6% (807,467 acres) were vegetated. Of the vegetated total, 1% (8,428 acres) was forested or wooded, 53% (429,476 acres) were shrublands, 13% (105,658 acres) were dominated by herbaceous species, and 33% (263,906 acres) contained sparse vegetation. The largest single map unit was the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub (S\_CBO) covering 13% (102,345 acres) of the park. General trends include 21% (171,088 acres) of the project area was mapped as a calcareous (limestone) formation type, 13% (101,456 acres) was mapped as either badlands or a similar badland-like formation, 12% (94,517 acres) was mapped as an upland wash, drainage, or mesic shrub type, 3% (25,853 acres) was located in the Chisos Mountain and foothills, and about 1% (7,834 acres) consisted of native riparian vegetation along the Rio Grande River. Non-native vegetation map units were split between 1.4% (11,067 acres) for the upland grasses, and 0.3% (2,251 acres) for riparian shrubs and grasses.

For further vegetation analysis, the full vegetation spatial database can be explored and manipulated using the additional linked databases and the additional polygon attributes such as density, height, pattern, landform, geology, soils and biophysical settings in a GIS program. The extensive data created for BIBE in this project are difficult to convey in a table or on a two-dimensional map, but it should be understood that the different attributes can be combined in many ways and at different scales and resolutions to produce additional products. For example, coarse-scale maps can be produced by scaling up the NVCS hierarchy to the Alliance, Group, or Macrogroup level (Figure 27) or by selecting the General Physical Vegetation or General Biophysical Vegetation attributes. The selection of a broader vegetation class would produce a less-detailed vegetation map that might be more applicable for reports or park-wide assessments. Conversely, fine-scale mapping efforts can focus on individual associations by selecting the appropriate map unit in both the Map Description (primary) and the Alternative Description (secondary). This would produce a map highlighting all known areas for a specific vegetation type. Habitat studies can also be performed by querying the spatial database for various indicators such as canopy densities and heights of the vegetation, types in or close to washes/drainages, or map units that occur on certain geologic or soil formations.

**Table 14.** Summary Statistics for the BIBE Map Class Polygons.

Category	Map Code	Map Unit Common Name	BIBE Project Area		
			# of Polygons	Acres	Hectares
Woodlands	W_ACYP	Arizona Cypress – Graves' Oak – Pinyon Pine Forest	8	131.4	53.2
	W_APJ	Alligator Juniper – Pinyon Pine – Gray Oak Woodland	92	1,212.1	490.6
	W_APOAK	Arizona Pine – Graves' Oak Forest	7	44.3	17.9
	W_CWD	Cottonwood – Goodding Willow Spring Woodland	85	112.3	45.5
	W_EOAK	Emory Oak Woodland	6	81.3	32.9
	W_FOR	Mixed Ornamental and Planted Woodland	29	37.5	15.2
	W_GWIL	Goodding Willow Spring Woodland	36	61.3	24.8
	W_HOAK	High Chisos Oak – Pine Forest	104	579.1	234.4
	W_LOAK	Lacey's Oak Woodland	4	30.6	12.4
	W_MPJ	Dry – Mesic Pinyon Pine – Oak – Juniper Woodland	206	1,877.3	759.8
	W_PJ	Dry Pinyon Pine Woodland	200	2,752.5	1,113.9
	W_ROKBM	Graves' Oak – Bigtooth Maple Forest	73	412.0	166.7
	W_ROKEOK	Graves' Oak – Emory Oak Canyon Forest	176	1,096.4	443.7
	Subtotal Woodlands	–	1,026	8,428.25	3,410.88
Shrublands	S_ACAMEQ	Acacia – Mesquite Wash Shrubland	2,133	21,965.1	8,889.1
	S_CB	Creosotebush Desert Scrub	1,466	25,124.7	10,167.4
	S_CBO	Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub	4,087	102,345.1	4,1417.6
	S_CDS	Calcareous Mixed Desert Scrub	2,275	86,769.7	35,114.4
	S_CHAP	Calcareous Chaparral	159	3,471.8	1,404.9
	S_CLAY	Alkaline Clay Flat Shrubland	1,814	19,064.2	7,715.0
	S_CTAL	Calcareous Talus Mixed Shrubland	334	4,235.0	1,713.8
	S_CWIL	Thurber's Willow Spring Shrubland	18	24.1	9.8
	S_FWASH	Foothills Wash Channel Shrubland	191	3,404.6	1,377.8
	S_GOAK	High Chisos Gray Oak – Mountain Mahogany Chaparral	15	121.1	49.0
	S_LMIX	Low Montane Mixed Shrub / Sideoats Grama Shrubland	228	4,253.8	1,721.5

**Table 14 (continued).** Summary Statistics for the BIBE Map Class Polygons.

Category	Map Code	Map Unit Common Name	BIBE Project Area		
			# of Polygons	Acres	Hectares
Shrublands (continued)	S_MEQ	Mesquite – Creosotebush Desert Scrub	1,330	23,521.4	9,518.9
	S_MMIX	Montane Mixed Chaparral	416	5,582.3	2,259.1
	S_MRIP	Rio Grande Mesquite Riparian Bosque	418	4,246.9	1,718.7
	S_PERS	Persimmon – Littleleaf Ash Foothills Shrubland	43	650.4	263.2
	S_RJUN	Redberry Juniper – Sotol Shrubland	30	439.8	178.0
	S_RWIL	Rio Grande Willow Riparian Bosque	38	75.3	30.5
	S_SOAK	Coahuila Scrub Oak Chaparral	6	122.7	49.7
	S_SOT	Sotol – Lechuguilla Foothills Shrub Grassland	899	28,243.8	11,429.9
	S_TAM	Tamarisk – (Tree Tobacco) Riparian Shrubland	230	1,365.6	552.6
	S_TMIK	Mixed Tall Shrubs Wash Shrubland	1,510	14,803.0	5,990.6
	S_WASH	Big Bend Lowlands Wash Channel Shrubland	4,048	42,940.4	17,377.5
	S_YUC	Yucca – Sotol Calcareous Shrub Grassland	1,053	28,790.7	11,651.3
	S_YWASH	Yucca Calcareous Wash Channel Shrubland	460	7914.8	3,203.0
	Subtotal Shrublands	–	23,201	429,476	173,803
Herbaceous Vegetation	H_ASAC	Alkali Sacaton Riparian Grassland	11	9.0	3.6
	H_BERM	Bermuda Grass Herbaceous Vegetation	81	198.9	80.5
	H_CANE	Giant Cane Riverbank Herbaceous Vegetation	197	687.4	278.2
	H_FINE	Finestem Needlegrass Montane Grassland	3	2.9	1.2
	H_GRAM	Chino Grama Shrub Grassland	1,859	91,088.1	36,862.1
	H_GRS	Johnson Grass – Russian Thistle Desert Grassland	494	2,903.3	1,174.9
	H_MUHL	Bull Muhly Montane Grassland	151	1,040.6	421.1
	H_REED	Common Reed Riparian Herbaceous Vegetation	27	37.0	15.0
	H_RIO	Rio Grande Alluvial Herbaceous Vegetation	185	860.2	348.2
	H_SPIK	Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation	90	637.4	258.0
	H_SWIL	Seepwillow – Bushy Bluestem Spring Vegetation	20	13.5	5.5

**Table 14 (continued).** Summary Statistics for the BIBE Map Class Polygons.

Category	Map Code	Map Unit Common Name	BIBE Project Area		
			# of Polygons	Acres	Hectares
Herbaceous Vegetation (continued)	H_TOB	Tobosa Grass Desert Grassland	546	8,164.4	3,304.0
	H_UPG	Upland Ruderal Herbaceous Vegetation	1	15.1	6.1
	Subtotal Herbaceous Vegetation	—	3,665	105,658	42,758
Sparse Vegetation	SP_BAD	Badlands Sparse Vegetation	2,227	53,055.0	21,470.6
	SP_CAL	Calcareous Outcrop Lichen Vegetation	1,177	17,365.2	7,027.5
	SP_IGN	Montane Igneous Outcrop Lichen Vegetation	557	3,519.9	1,424.4
	SP_LCAL	Boquillas Basin Calcareous Creosotebush Desert Scrub	1,443	22,540.9	9,121.9
	SP_LDES1	Big Bend Lowlands (Flats, Benches, and Plateaus)	4,405	7,2916.7	29,508.5
	SP_LDES2	Big Bend Lowlands (Eroding Slopes, Hillsides, and Badlands)	2,807	48,401.5	19,587.5
	SP_LDES3	Big Bend Lowlands (Basalt, Lava, and Volcanic Rocks)	953	19,743.5	7,989.9
	SP_MTAL	Montane Talus and Cliff Rocky Sparse Shrubland	310	1,265.3	512.0
	SP_NCAL	Low Elevation Non-Calcareous Outcrop Lichen Vegetation	1,463	17,919.2	7,251.5
	SP_RIO	Rio Grande Alluvial Sparse Vegetation	252	329.8	133.5
	SP_TAL	Low Elevation Talus And Dune Sparse Vegetation	216	3,358.1	1,359.0
	SP_WASH	Big Bend Lowlands Sparsely Vegetated Wash Channel	180	3,489.8	1,412.3
	Subtotal Sparse Vegetation	—	15,990	26,3905	106,799
Land-Use and Land-Cover	L_AGRI	Agricultural Business / Ranches	6	18.2	7.4
	L_COMM	Communications and Utilities	4	1.6	0.7
	L_FACL	NPS and Other Facilities	191	83.3	33.7
	L_FIELD	Planted / Cultivated / Fallow Fields and Pastures	8	62.3	25.2
	L_PITS	Quarries / Strip Mines / Gravel Pits	1	0.7	0.3
	L_POND	Small Lake / Pond / Watering Catchments	70	22.0	8.9
	L_ROAD	Main Roads and Transportation Structures	6	1,533.6	620.6
	L_STRM	Stream / River	23	701.3	283.8

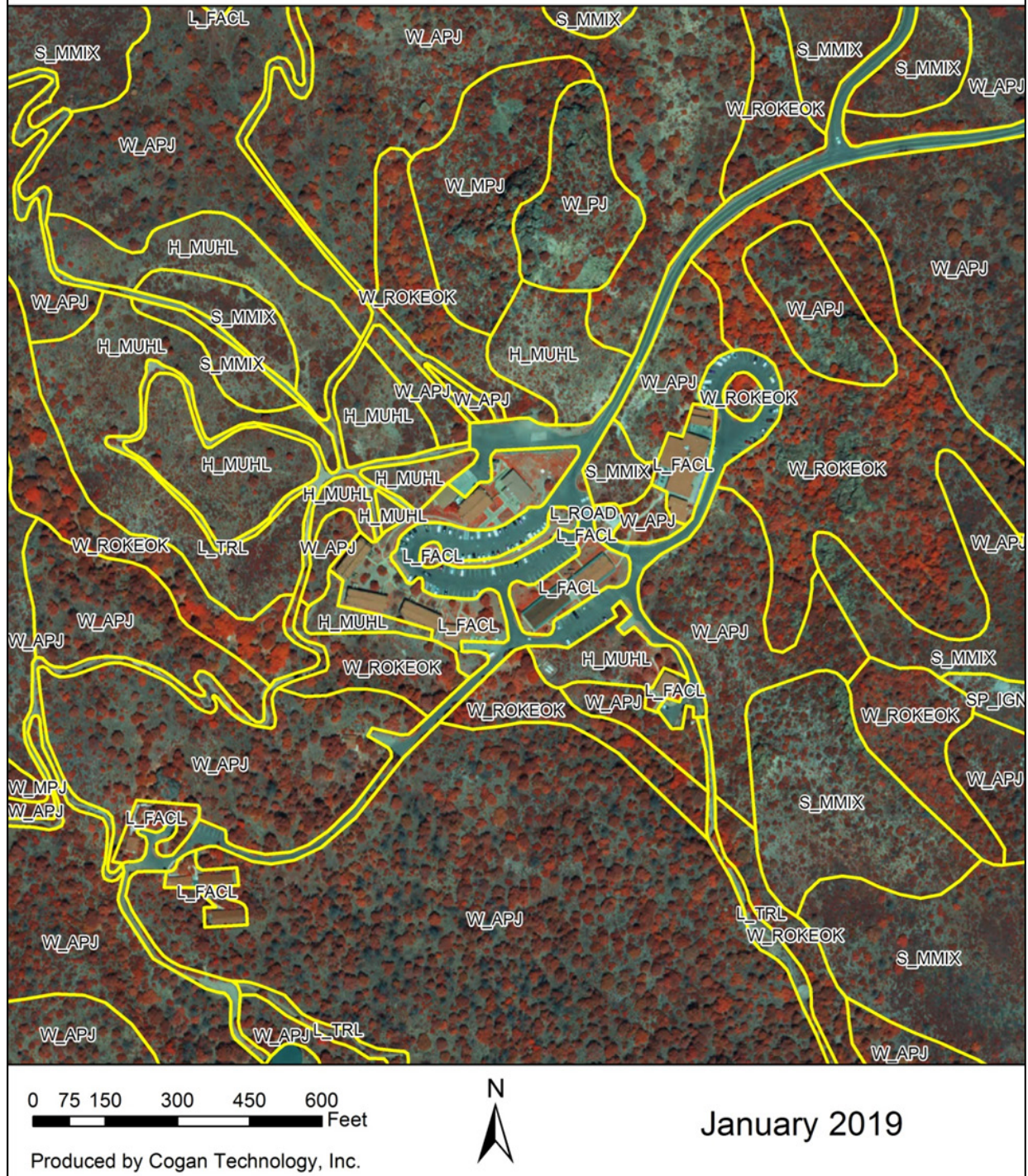


**Table 14 (continued).** Summary Statistics for the BIBE Map Class Polygons.

Category	Map Code	Map Unit Common Name	BIBE Project Area		
			# of Polygons	Acres	Hectares
Land-Use and Land-Cover (continued)	L_TRAN	Transitional Area	151	135.1	54.7
	L_TRL	Trails and 2-Track Roads	112	456.9	184.8
	Subtotal Land-Use and Land-Cover	—	572	3,015.02	1,219.98
Subtotal All Vegetation and Sparse Areas	—	—	43,882	807,467	326,771
TOTALS	—	—	44,454	810,482	327,991



## Association Level Vegetation and Land-Use Map Example



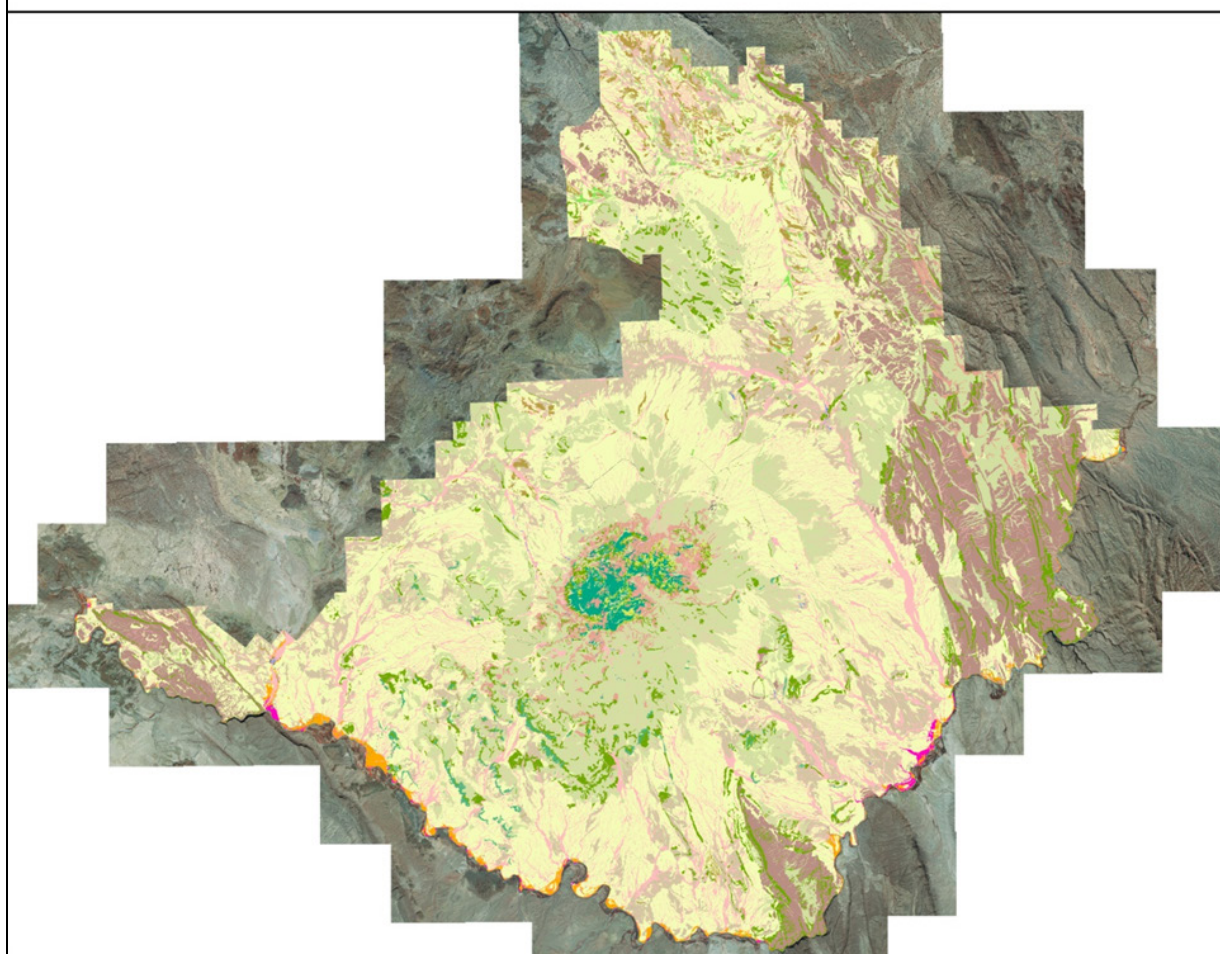
**Figure 26.** Example of the BIBE Fine-Scale Vegetation Map Layer. Source: CTI and 2015 TOP Imagery (Color Infrared Band).





## Group Level Vegetation Map Example

GROUP	
Arid West Interior Freshwater Marsh (G531)	Madrean Lower Montane Pine - Oak Forest & Woodland (G203)
Chihuahuan Creosotebush - Mixed Desert Scrub (G288)	Madrean Pinyon - Juniper Woodland (G200)
Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland (G490)	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Chihuahuan Desert Succulent Scrub (G286)	North American Warm Desert Ruderal Grassland (G677)
Chihuahuan Gypsophilous Grassland (G492)	North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation (G569)
Chihuahuan Lowland Basin Semi-Desert Scrub (G299)	Temperate Tree Developed Vegetation (CSG045)
Chihuahuan Semi-Desert Lowland Grassland (G489)	Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)
Eastern Madrean Chaparral (G280)	Western Interior Riparian Forest & Woodland (G797)
Interior West Ruderal Riparian Forest & Scrub (G510)	Western Interior Riparian Forest & Woodland (G797)
Madrean Encinal (G201)	Western North American Cliff, Scree & Rock Vegetation (G565)
	Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)



0 1.53 6 9 12  
Miles

Produced by Cogan Technology, Inc.



January 2019

**Figure 27.** Example of the BIBE Coarse-Scale Vegetation Map Layer. Source: CTI and 2015 TOP Imagery (Color Infrared Band).

## Accuracy Assessment

A total of 1,113 AA target points were sampled by the CCB field crews and distributed throughout the BIBE project area, including adjacent target sites that share a boundary with RIGR. After the fieldwork, the resulting AA data was entered into the PLOTS database and reviewed. Based on the undescribed vegetation encountered at a few of the remote AA sites, the BIBE classification was updated and finalized to include this new information.

Review of the AA database revealed 27 points were located outside of the BIBE project area (within RIGR) and another 49 AA points were in the wrong location or were too close together (duplicates). These 76 points were removed from analysis yielding a final sample size of 1,037 AA points for analysis. Three vegetation types were not assessed in the field by the CCB field crews. The S\_CTAL (Calcareous Talus Mixed Shrubland) map unit was part of the S\_CDS map unit at the time of the AA and was not targeted for assessment. The H\_REED (Common Reed Riparian Herbaceous Vegetation) and H\_FINE (Finestem Needlegrass Montane Grassland) were both rare types that were already fully sampled during the plot data collection phase. In addition, the SP\_LDES map units were combined for the AA since the field crews did not distinguish them apart while in the field.

Analysis of the AA points involved a point-by-point review in two stages. In stage one, errors in the AA database were corrected, some of the wrong locations were fixed, ambiguous field calls were changed to the correct rUSNVC name, and the primary call was changed to the secondary call based on actual species abundance and cover values. Some AA points were also modified to better address the vegetation as seen from an overhead perspective. This included adding new secondary vegetation types for inclusions, adding additional types for ecotones and transitional areas, and changing field calls to match better the actual recorded species and cover data.

Following the first AA point review, the results were presented to NVIP and BIBE staffs. After their review, BIBE staff requested that all of the map units currently in the vegetation map remain and they would accept any lower than expected accuracy values. The stated reasons for their request included high conservation value for the native types and the importance of knowing the locations of all the rare and non-native vegetation types.

Stage two of the analysis involved re-running the accuracy assessment using the NVIP protocols (Lea and Curtis 2010). The AA points were overlaid on the vegetation map and the field calls were compared to their corresponding polygon labels. The resulting contingency tables (i.e. error matrices) include the observation counts with the predicted values (polygon map labels) as rows and the reference data values (AA field calls) as columns. The individual cell values represent the number of map units mapped in each class (row) that were found to be of a specific class (column) in the field. The values in the shaded cells along the diagonal represent correct map units, whereas those off the diagonal represent mismatched or incorrect types. The results of the sample contingency analysis are presented in Table 15 and are summarized in Table 16. The population contingency analysis is similar to the sample contingency study but these values take into account the proportion of the target area rather than just the raw count of observations. The results of the population table are summarized in Table 17. Due to space considerations, the actual population contingency table (along

with the sample contingency table) but can be viewed directly from the project deliverable files (see BIBE\_AA\_Population\_Contingency\_Table.xlsx).



Table 15. Sample Contingency Table for BIBE.

Map Unit	H_ASAC	H_BERM	H_CANE	H_GRAM	H_GRS	H_MUHL	H_RIO	H_SPIK	H_SWIL
H_ASAC	2	0	0	0	0	0	0	0	0
H_BERM	0	7	0	0	0	0	0	0	0
H_CANE	0	0	20	0	0	0	0	0	0
H_GRAM	0	0	0	26	0	0	0	0	0
H_GRS	0	0	0	0	15	0	0	0	0
H_MUHL	0	0	0	0	0	14	0	0	0
H_RIO	0	1	0	0	0	0	11	0	0
H_SPIK	0	0	0	0	0	0	0	5	0
H_SWIL	0	0	0	0	0	0	0	0	1
H_TOB	0	0	0	0	0	0	0	0	0
H_UPG	0	0	0	0	0	0	0	0	0
SP_BAD	0	0	0	0	0	0	0	0	0
SP_CAL	0	0	0	0	0	0	0	0	0
SP_IGN	0	0	0	4	0	0	0	0	0
SP_LCAL	0	0	0	0	0	0	0	0	0
SP_LDES	0	0	0	0	0	0	0	0	0
SP_MTAL	0	0	0	0	0	0	0	0	0
SP_NCAL	0	0	0	0	0	0	0	0	0
SP_RIO	0	0	0	0	0	0	0	0	0
SP_TAL	0	0	0	0	0	0	0	0	0
SP_WASH	0	0	0	0	0	0	0	0	0
S_ACAMEQ	0	0	0	0	0	0	0	0	0
S_CB	0	0	0	0	2	0	0	0	0
S_CBO	0	0	0	1	0	0	0	0	0
S_CDS	0	0	0	0	0	0	0	0	0
S_CHAP	0	0	0	0	0	0	0	0	0
S_CLAY	0	0	0	0	0	0	0	0	0
S_CWIL	0	0	0	0	0	0	0	0	0
S_FWASH	0	0	0	0	0	0	0	0	0
S_GOAK	0	0	0	0	0	0	0	0	0
S_LMIX	0	0	0	0	0	0	0	0	0
S_MEQ	0	0	0	0	0	0	0	0	0
S_MMX	0	0	0	0	0	0	0	0	0
S_MRIP	0	0	0	0	0	0	0	0	0
S_PERS	0	0	0	0	0	0	0	0	0
S_RJUN	0	0	0	0	0	0	0	0	0
S_RWIL	0	0	1	0	0	0	0	0	0
S_SOAK	0	0	0	0	0	0	0	0	0
S_SOT	0	0	0	8	0	0	0	0	0
S_TAM	0	0	3	0	0	0	0	0	0
S_TMIX	0	0	0	0	0	0	0	0	0
S_WASH	0	0	0	0	0	0	0	0	0
S_YUC	0	0	0	0	0	0	0	0	0
S_YWASH	0	0	0	0	0	0	0	0	0
W_ACYP	0	0	0	0	0	0	0	0	0
W_APJ	0	0	0	0	0	0	0	0	0
W_APOAK	0	0	0	0	0	0	0	0	0
W_CWD	0	0	0	0	0	0	0	0	0
W_EOAK	0	0	0	0	0	0	0	0	0
W_FOR	0	0	0	0	0	0	0	0	0
W_GWIL	0	0	0	0	0	0	0	0	0
W_HOAK	0	0	0	0	0	0	0	0	0
W_LOAK	0	0	0	0	0	0	0	0	0
W_MPJ	0	0	0	0	0	0	0	0	0
W_PJ	0	0	0	0	0	0	0	0	0
W_ROKBM	0	0	0	0	0	0	0	0	0
W_ROKEOK	0	0	0	0	0	0	0	0	0
Column Total	2	8	24	39	17	14	11	5	1
Total Correct	2	7	20	26	15	14	11	5	1
Producer's Accuracy	100%	88%	83%	67%	88%	100%	100%	100%	100%

Table 15 (continued). Sample Contingency Table for BIBE.

Map Unit	H_TOB	H_UPG	SP_BAD	SP_CAL	SP_IGN	SP_LCAL	SP_LDES	SP_MTAL	SP_NCAL
H_ASAC	0	0	0	0	0	0	0	0	0
H_BERM	0	0	0	0	0	0	0	0	0
H_CANE	0	0	0	0	0	0	0	0	0
H_GRAM	0	0	0	0	0	0	0	0	0
H_GRS	6	0	0	0	0	0	8	0	0
H_MUHL	0	0	0	0	0	0	0	0	0
H_RIO	0	0	0	0	0	0	0	0	0
H_SPIK	0	0	0	0	0	0	0	0	0
H_SWIL	0	0	0	0	0	0	0	0	0
H_TOB	8	0	0	0	0	0	6	0	0
H_UPG	0	1	0	0	0	0	0	0	0
SP_BAD	0	0	15	0	0	0	3	0	0
SP_CAL	0	0	0	1	0	0	0	0	0
SP_IGN	0	0	0	0	3	0	0	1	0
SP_LCAL	0	0	0	0	0	15	0	0	0
SP_LDES	0	0	0	0	0	2	61	0	0
SP_MTAL	0	0	0	0	0	0	0	9	0
SP_NCAL	0	0	0	0	0	0	0	0	1
SP_RIO	0	0	0	0	0	0	0	0	0
SP_TAL	0	0	0	0	0	0	4	0	0
SP_WASH	0	0	0	0	0	0	0	0	0
S_ACAMEQ	0	0	0	0	0	0	0	0	0
S_CB	0	0	0	0	0	0	0	0	0
S_CBO	0	0	0	0	0	0	0	0	0
S_CDS	0	0	0	0	0	6	0	0	0
S_CHAP	0	0	0	0	0	0	0	0	0
S_CLAY	0	0	0	0	0	0	7	0	0
S_CWIL	0	0	0	0	0	0	0	0	0
S_FWASH	0	0	0	0	0	0	0	0	0
S_GOAK	0	0	0	0	0	0	0	0	0
S_LMIX	0	0	0	0	0	0	0	0	0
S_MEQ	1	0	0	0	0	0	3	0	0
S_MMIX	0	0	0	0	0	0	0	2	0
S_MRIP	0	0	0	0	0	0	0	0	0
S_PERS	0	0	0	0	0	0	0	0	0
S_RJUN	0	0	0	0	0	0	0	0	0
S_RWIL	0	0	0	0	0	0	0	0	0
S_SOAK	0	0	0	0	0	0	0	0	0
S_SOT	0	0	0	0	0	0	0	0	0
S_TAM	0	0	0	0	0	0	0	0	0
S_TMIX	0	0	1	0	0	0	0	0	0
S_WASH	0	0	0	0	0	0	1	0	0
S_YUC	0	0	0	0	0	0	0	0	0
S_YWASH	0	0	0	0	0	0	0	0	0
W_ACYP	0	0	0	0	0	0	0	0	0
W_APJ	0	0	0	0	0	0	0	0	0
W_APOAK	0	0	0	0	0	0	0	0	0
W_CWD	0	0	0	0	0	0	0	0	0
W_EOAK	0	0	0	0	0	0	0	0	0
W_FOR	0	0	0	0	0	0	0	0	0
W_GWIL	0	0	0	0	0	0	0	0	0
W_HOAK	0	0	0	0	0	0	0	0	0
W_LOAK	0	0	0	0	0	0	0	0	0
W_MPJ	0	0	0	0	0	0	0	0	0
W_PJ	0	0	0	0	0	0	0	0	0
W_ROKBM	0	0	0	0	0	0	0	0	0
W_ROKEOK	0	0	0	0	0	0	0	0	0
Column Total	15	1	16	1	3	23	93	12	1
Total Correct	8	1	15	1	3	15	61	9	1
Producer's Accuracy	53%	100%	94%	100%	100%	65%	66%	75%	100%

Table 15 (continued). Sample Contingency Table for BIBE.

Map Unit	SP_RIO	SP_TAL	SP_WASH	S_ACAMEQ	S_CB	S_CBO	S_CDS	S_CHAP	S_CLAY
H_ASAC	0	0	0	0	0	0	0	0	0
H_BERM	0	0	0	0	0	0	0	0	0
H_CANE	0	0	0	0	0	0	0	0	0
H_GRAM	0	0	0	0	0	1	1	0	0
H_GRS	0	0	0	0	0	0	0	0	0
H_MUHL	0	0	0	0	0	0	0	0	0
H_RIO	0	0	2	0	0	0	0	0	0
H_SPIK	0	0	0	0	0	0	0	0	0
H_SWIL	0	0	0	0	0	0	0	0	0
H_TOB	0	0	0	0	0	0	0	0	0
H_UPG	0	0	0	0	0	0	0	0	0
SP_BAD	0	0	0	0	0	1	0	0	0
SP_CAL	0	0	0	0	0	0	1	0	0
SP_IGN	0	0	0	0	0	0	0	0	0
SP_LCAL	0	0	0	0	0	0	1	0	0
SP_LDES	0	0	0	0	0	4	0	0	0
SP_MTAL	0	0	0	0	0	0	0	0	0
SP_NCAL	0	0	0	0	0	0	0	0	0
SP_RIO	1	0	0	0	0	0	0	0	0
SP_TAL	0	6	0	0	0	4	0	0	0
SP_WASH	0	0	8	0	0	0	0	0	0
S_ACAMEQ	0	0	0	29	0	0	0	0	0
S_CB	0	0	0	1	12	1	0	0	0
S_CBO	0	0	0	0	1	55	0	0	0
S_CDS	0	0	0	0	0	0	31	0	0
S_CHAP	0	0	0	0	0	0	0	13	0
S_CLAY	0	0	0	0	1	0	0	0	12
S_CWIL	0	0	0	0	0	0	0	0	0
S_FWASH	0	0	0	0	0	0	0	0	0
S_GOAK	0	0	0	0	0	0	0	0	0
S_LMIX	0	0	0	0	0	0	0	0	0
S_MEQ	0	0	1	0	1	4	0	0	0
S_MMX	0	0	0	0	0	0	0	0	0
S_MRIP	0	0	0	0	0	0	0	0	0
S_PERS	0	0	0	0	0	0	0	0	0
S_RJUN	0	0	0	0	0	0	0	0	0
S_RWIL	0	0	0	0	0	0	0	0	0
S_SOAK	0	0	0	0	0	0	0	0	0
S_SOT	0	0	0	0	0	0	2	0	0
S_TAM	0	0	0	0	0	0	0	0	0
S_TMIX	0	0	0	3	1	3	0	0	0
S_WASH	0	0	0	3	0	1	0	0	0
S_YUC	0	0	0	0	0	0	2	3	0
S_YWASH	0	0	0	0	0	0	0	0	0
W_ACYP	0	0	0	0	0	0	0	0	0
W_APJ	0	0	0	0	0	0	0	0	0
W_APOAK	0	0	0	0	0	0	0	0	0
W_CWD	0	0	0	0	0	0	0	0	0
W_EOAK	0	0	0	0	0	0	0	0	0
W_FOR	0	0	0	0	0	0	0	0	0
W_GWIL	0	0	0	0	0	0	0	0	0
W_HOAK	0	0	0	0	0	0	0	0	0
W_LOAK	0	0	0	0	0	0	0	0	0
W_MPJ	0	0	0	0	0	0	0	0	0
W_PJ	0	0	0	0	0	0	0	0	0
W_ROKBM	0	0	0	0	0	0	0	0	0
W_ROKEOK	0	0	0	0	0	0	0	0	0
Column Total	1	6	11	36	16	74	38	16	12
Total Correct	1	6	8	29	12	55	31	13	12
Producer's Accuracy	100%	100%	73%	81%	75%	74%	82%	81%	100%

Table 15 (continued). Sample Contingency Table for BIBE.

Map Unit	S_CWIL	S_FWASH	S_GOAK	S_LMIX	S_MEQ	S_MMIX	S_MRIP	S_PERS	S_RJUN
H_ASAC	0	0	0	0	0	0	0	0	0
H_BERM	0	0	0	0	0	0	0	0	0
H_CANE	0	0	0	0	0	0	0	0	0
H_GRAM	0	0	0	0	0	0	0	0	0
H_GRS	0	0	0	0	1	0	0	0	0
H_MUHL	0	0	0	5	0	6	0	0	0
H_RIO	0	0	0	0	0	0	0	0	0
H_SPIK	0	0	0	0	0	1	0	0	0
H_SWIL	0	0	0	0	0	0	0	0	0
H_TOB	0	0	0	0	0	0	0	0	0
H_UPG	0	0	0	0	0	0	0	0	0
SP_BAD	0	0	0	0	0	0	0	0	0
SP_CAL	0	0	0	0	0	0	0	0	0
SP_IGN	0	0	0	0	0	0	0	0	0
SP_LCAL	0	0	0	0	0	0	0	0	0
SP_LDES	0	0	0	0	0	0	0	0	0
SP_MTAL	0	0	0	0	0	1	0	0	0
SP_NCAL	0	0	0	0	0	0	0	0	0
SP_RIO	0	0	0	0	0	0	0	0	0
SP_TAL	0	0	0	0	0	0	0	0	0
SP_WASH	0	0	0	0	0	0	0	0	0
S_ACAMEQ	0	0	0	0	0	0	0	0	0
S_CB	0	0	0	0	1	0	0	0	0
S_CBO	0	0	0	0	1	0	0	0	0
S_CDS	0	0	0	0	0	0	0	0	0
S_CHAP	0	0	0	0	0	1	0	0	0
S_CLAY	0	0	0	0	0	0	0	0	0
S_CWIL	0	0	0	0	0	0	0	0	0
S_FWASH	0	5	0	0	0	0	0	1	0
S_GOAK	0	0	7	0	0	2	0	0	0
S_LMIX	0	0	0	19	0	1	0	0	1
S_MEQ	0	0	0	0	49	0	1	0	0
S_MMIX	0	0	0	0	0	40	0	0	0
S_MRIP	0	0	0	0	1	0	24	0	0
S_PERS	0	0	0	0	0	0	0	2	0
S_RJUN	0	0	0	0	0	2	0	0	15
S_RWIL	0	0	0	0	0	0	0	0	0
S_SOAK	0	0	0	0	0	0	0	0	0
S_SOT	0	0	0	0	0	0	0	0	0
S_TAM	0	0	0	0	0	0	4	0	0
S_TMIX	0	0	0	0	1	0	0	0	0
S_WASH	0	0	0	0	0	0	0	0	0
S_YUC	0	0	0	0	0	0	0	0	0
S_YWASH	0	0	0	0	0	0	0	0	0
W_ACYP	0	0	0	0	0	0	0	0	0
W_APJ	0	0	0	0	0	2	0	0	0
W_APOAK	0	0	0	0	0	0	0	0	0
W_CWD	0	0	0	0	0	0	0	0	0
W_EOAK	0	0	0	0	0	0	0	0	0
W_FOR	0	0	0	0	0	0	0	0	0
W_GWIL	0	0	0	0	0	0	0	0	0
W_HOAK	0	0	0	0	0	0	0	0	0
W_LOAK	0	0	0	0	0	0	0	0	0
W_MPJ	0	0	0	0	0	0	0	0	0
W_PJ	0	0	0	0	0	2	0	0	1
W_ROKBM	0	0	0	0	0	0	0	0	0
W_ROKEOK	0	0	1	0	0	1	0	0	1
Column Total	0	5	8	24	54	59	29	3	18
Total Correct	0	5	7	19	49	40	24	2	15
Producer's Accuracy	n/a	100%	88%	79%	91%	68%	83%	67%	83%

Table 15 (continued). Sample Contingency Table for BIBE.

Map Unit	S_RWIL	S_SOAK	S_SOT	S_TAM	S_TMIX	S_WASH	S_YUC	S_YWASH	W_ACYP
H_ASAC	0	0	0	0	0	0	0	0	0
H_BERM	0	0	0	0	0	0	0	0	0
H_CANE	1	0	0	1	0	0	0	0	0
H_GRAM	0	0	6	0	1	0	0	0	0
H_GRS	0	0	0	1	0	0	0	0	0
H_MUHL	0	0	0	0	0	0	0	0	0
H_RIO	0	0	0	0	0	0	0	0	0
H_SPIK	0	0	0	0	0	0	0	0	0
H_SWIL	0	0	0	0	0	0	0	0	0
H_TOB	0	0	0	0	0	0	0	0	0
H_UPG	0	0	0	0	0	0	0	0	0
SP_BAD	0	0	0	0	0	0	0	0	0
SP_CAL	0	0	0	0	0	0	0	0	0
SP_IGN	0	0	0	0	0	0	0	0	0
SP_LCAL	0	0	0	0	0	0	0	0	0
SP_LDES	0	0	0	0	0	0	0	0	0
SP_MTAL	0	0	0	0	0	0	0	0	0
SP_NCAL	0	0	0	0	0	0	0	0	0
SP_RIO	0	0	0	0	0	0	0	0	0
SP_TAL	0	0	0	0	0	0	0	0	0
SP_WASH	0	0	0	0	0	0	0	0	0
S_ACAMEQ	0	0	0	0	1	0	0	0	0
S_CB	0	0	0	0	0	0	0	0	0
S_CBO	0	0	3	0	2	0	1	0	0
S_CDS	0	0	0	0	0	0	0	0	0
S_CHAP	0	0	0	0	0	0	1	0	0
S_CLAY	0	0	0	0	0	0	0	0	0
S_CWIL	0	0	0	1	1	0	0	0	0
S_FWASH	0	0	0	0	0	0	0	0	0
S_GOAK	0	0	0	0	0	0	0	0	0
S_LMIX	0	0	0	0	1	0	0	0	0
S_MEQ	0	0	0	0	1	0	0	0	0
S_MMIX	0	0	3	0	0	0	0	0	0
S_MRIP	1	0	0	1	0	0	0	0	0
S_PERS	0	0	3	0	0	0	0	0	0
S_RJUN	0	0	0	0	0	0	0	0	0
S_RWIL	1	0	0	2	0	0	0	0	0
S_SOAK	0	10	0	0	0	0	0	0	0
S_SOT	0	0	45	0	1	0	0	0	0
S_TAM	0	0	0	24	0	0	0	0	0
S_TMIX	0	0	0	0	23	0	0	0	0
S_WASH	0	0	0	0	1	21	0	0	0
S_YUC	0	0	0	0	0	0	23	0	0
S_YWASH	0	0	0	0	0	0	0	3	0
W_ACYP	0	0	0	0	0	0	0	0	8
W_APJ	0	0	0	0	0	0	0	0	0
W_APOAK	0	0	0	0	0	0	0	0	0
W_CWD	0	0	0	0	1	0	0	0	0
W_EOAK	0	0	0	0	0	0	0	0	0
W_FOR	0	0	0	0	0	0	0	0	0
W_GWIL	0	0	0	0	1	0	0	0	0
W_HOAK	0	0	0	0	0	0	0	0	0
W_LOAK	0	0	0	0	0	0	0	0	0
W_MPJ	0	0	0	0	0	0	0	0	0
W_PJ	0	0	0	0	0	0	0	0	0
W_ROKBM	0	0	0	0	0	0	0	0	0
W_ROKEOK	0	0	0	0	0	0	0	0	0
Column Total	3	10	60	30	34	21	25	3	8
Total Correct	1	10	45	24	23	21	23	3	8
Producer's Accuracy	33%	100%	75%	80%	68%	100%	92%	100%	100%



Table 15 (continued). Sample Contingency Table for BIBE.

Map Unit	W_APJ	W_APOAK	W_CWD	W_EOAK	W_FOR	W_GWIL	W_HOAK	W_LOAK	W_MPJ
H_ASAC	0	0	0	0	0	0	0	0	0
H_BERM	0	0	0	0	0	0	0	0	0
H_CANE	0	0	0	0	0	0	0	0	0
H_GRAM	0	0	0	0	0	0	0	0	0
H_GRS	0	0	0	0	0	0	0	0	0
H_MUHL	0	0	0	0	0	0	0	0	0
H_RIO	0	0	0	0	0	0	0	0	0
H_SPIK	0	0	0	0	0	0	0	0	0
H_SWIL	0	0	0	0	0	0	0	0	0
H_TOB	0	0	0	0	0	0	0	0	0
H_UPG	0	0	0	0	0	0	0	0	0
SP_BAD	0	0	0	0	0	0	0	0	0
SP_CAL	0	0	0	0	0	0	0	0	0
SP_IGN	0	0	0	0	0	0	0	0	0
SP_LCAL	0	0	0	0	0	0	0	0	0
SP_LDES	0	0	0	0	0	0	0	0	0
SP_MTAL	0	0	0	0	0	0	0	0	0
SP_NCAL	0	0	0	0	0	0	0	0	0
SP_RIO	0	0	0	0	0	0	0	0	0
SP_TAL	0	0	0	0	0	0	0	0	0
SP_WASH	0	0	0	0	0	0	0	0	0
S_ACAMEQ	0	0	0	0	0	0	0	0	0
S_CB	0	0	0	0	0	0	0	0	0
S_CBO	0	0	0	0	0	0	0	0	0
S_CDS	0	0	0	0	0	0	0	0	0
S_CHAP	0	0	0	0	0	0	0	0	0
S_CLAY	0	0	0	0	0	0	0	0	0
S_CWIL	0	0	0	0	0	0	0	0	0
S_FWASH	0	0	0	0	0	0	0	0	0
S_GOAK	0	0	0	0	0	0	0	0	0
S_LMIX	0	0	0	0	0	0	0	0	0
S_MEQ	0	0	0	0	0	0	0	0	0
S_MMX	0	0	0	0	0	0	0	0	0
S_MRIP	0	0	0	0	0	0	0	0	0
S_PERS	0	0	0	0	0	0	0	0	0
S_RJUN	0	0	0	2	0	0	0	0	0
S_RWIL	0	0	0	0	0	0	0	0	0
S_SOAK	0	0	0	0	0	0	0	0	0
S_SOT	0	0	0	0	0	0	0	0	0
S_TAM	0	0	0	0	0	0	0	0	0
S_TMIX	0	0	0	0	0	0	0	0	0
S_WASH	0	0	0	0	0	0	0	0	0
S_YUC	0	0	0	0	0	0	0	0	0
S_YWASH	0	0	0	0	0	0	0	0	0
W_ACYP	0	0	0	0	0	0	2	0	0
W_APJ	22	0	0	0	0	0	0	0	2
W_APOAK	0	2	0	0	0	0	0	0	0
W_CWD	0	0	3	0	0	1	0	0	0
W_EOAK	0	0	0	2	0	0	0	0	0
W_FOR	0	0	1	0	2	0	0	0	0
W_GWIL	0	0	0	0	0	1	0	0	0
W_HOAK	0	0	0	0	0	0	17	0	0
W_LOAK	0	0	0	0	0	0	0	0	0
W_MPJ	2	0	0	0	0	0	0	0	16
W_PJ	4	0	0	0	0	0	0	0	0
W_ROKBM	0	0	0	0	0	0	2	0	0
W_ROKEOK	0	0	0	0	0	0	0	0	1
Column Total	28	2	4	4	2	2	21	0	19
Total Correct	22	2	3	2	2	1	17	0	16
Producer's Accuracy	79%	100%	75%	50%	100%	50%	81%	n/a	84%

Table 15 (continued). Sample Contingency Table for BIBE.

Map Unit	W_PJ	W_ROKBM	W_ROKEOK	Row Total	Total Correct	User's Accuracy
H_ASAC	0	0	0	2	2	100%
H_BERM	0	0	0	7	7	100%
H_CANE	0	0	0	22	20	91%
H_GRAM	0	0	0	35	26	74%
H_GRS	0	0	0	31	15	48%
H_MUHL	0	0	0	25	14	56%
H_RIO	0	0	0	14	11	79%
H_SPIK	0	0	0	6	5	83%
H_SWIL	0	0	0	1	1	100%
H_TOB	0	0	0	14	8	57%
H_UPG	0	0	0	1	1	100%
SP_BAD	0	0	0	19	15	79%
SP_CAL	0	0	0	2	1	50%
SP_IGN	0	0	0	8	3	38%
SP_LCAL	0	0	0	16	15	94%
SP_LDES	0	0	0	67	61	86%
SP_MTAL	0	0	0	10	9	90%
SP_NCAL	0	0	0	1	1	100%
SP_RIO	0	0	0	1	1	100%
SP_TAL	0	0	0	14	6	43%
SP_WASH	0	0	0	8	8	100%
S_ACAMEQ	0	0	0	30	29	97%
S_CB	0	0	0	17	12	71%
S_CBO	0	0	0	64	55	86%
S_CDS	0	0	0	37	31	84%
S_CHAP	0	0	0	15	13	87%
S_CLAY	0	0	0	20	12	60%
S_CWIL	0	0	0	2	0	0%
S_FWASH	0	0	0	6	5	83%
S_GOAK	0	0	0	9	7	78%
S_LMIX	1	0	0	23	19	83%
S_MEQ	0	0	0	61	49	80%
S_MMX	0	0	0	45	40	89%
S_MRIP	0	0	0	27	24	89%
S_PERS	0	0	0	5	2	40%
S_RJUN	0	0	0	19	15	79%
S_RWIL	0	0	0	4	1	25%
S_SOAK	0	0	0	10	10	100%
S_SOT	0	0	0	56	45	80%
S_TAM	0	0	0	31	24	77%
S_TMIX	0	0	0	32	23	72%
S_WASH	0	0	0	27	21	78%
S_YUC	0	0	0	28	23	82%
S_YWASH	0	0	0	3	3	100%
W_ACYP	0	0	0	10	8	80%
W_APJ	1	0	0	27	22	81%
W_APOAK	0	0	0	2	2	100%
W_CWD	0	0	0	5	3	60%
W_EOAK	0	0	0	2	2	100%
W_FOR	0	0	0	3	2	67%
W_GWIL	0	0	1	3	1	33%
W_HOAK	0	0	1	18	17	94%
W_LOAK	0	0	1	1	0	0%
W_MPJ	2	0	0	20	16	80%
W_PJ	29	0	0	36	29	81%
W_ROKBM	0	1	2	5	1	20%
W_ROKEOK	0	1	25	30	25	83%
Column Total	33	2	30	Total Points	–	1037
Total Correct	29	1	25	Total Correct Points	–	821
Producer's Accuracy	88%	50%	83%	Overall Accuracy	–	79%

**Table 16.** Sample Contingency Table Analysis Results for BIBE.

<b>Map Code</b>	<b>Users Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>	<b>Producers Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>
H_ASAC	100.0%	75%	100%	100%	100%	75%
H_BERM	100.0%	93%	100%	88%	100%	60%
H_CANE	90.9%	78%	100%	83%	100%	67%
H_GRAM	74.3%	58%	90%	67%	84%	50%
H_GRS	48.4%	24%	73%	88%	100%	71%
H_MUHL	56.0%	31%	81%	100%	100%	96%
H_RIO	78.6%	54%	100%	100%	100%	95%
H_SPIK	83.3%	46%	100%	100%	100%	90%
H_SWIL	100.0%	50%	100%	100%	100%	50%
H_TOB	57.1%	22%	92%	53%	89%	18%
H_UPG	100.0%	50%	100%	100%	100%	50%
SP_BAD	78.9%	58%	100%	94%	100%	80%
SP_CAL	50.0%	0%	100%	100%	100%	50%
SP_IGN	37.5%	0%	100%	100%	100%	83%
SP_LCAL	93.8%	80%	100%	65%	89%	42%
SP_LDES	85.7%	78%	94%	66%	77%	55%
SP_MTAL	90.0%	68%	100%	75%	100%	46%
SP_NCAL	100.0%	50%	100%	100%	100%	50%
SP_RIO	100.0%	50%	100%	100%	100%	50%
SP_TAL	42.9%	1%	84%	100%	100%	92%
SP_WASH	100.0%	94%	100%	73%	100%	41%
S_ACAMEQ	96.7%	89%	100%	81%	94%	67%
S_CB	70.6%	45%	96%	75%	100%	50%
S_CBO	85.9%	77%	95%	74%	85%	64%
S_CDS	83.8%	71%	96%	82%	95%	69%
S_CHAP	86.7%	67%	100%	81%	100%	60%
S_CLAY	60.0%	33%	87%	100%	100%	96%
S_CWIL	0.0%	n/a	n/a	n/a	n/a	n/a
S_FWASH	83.3%	46%	100%	100%	100%	90%
S_GOAK	77.8%	45%	100%	88%	100%	60%
S_LMIX	82.6%	66%	100%	79%	97%	61%
S_MEQ	80.3%	70%	91%	91%	99%	83%
S_MMX	88.9%	79%	98%	68%	81%	54%
S_MRIP	88.9%	76%	100%	83%	98%	68%
S_PERS	40.0%	0%	100%	67%	100%	0%

**Table 16 (continued).** Sample Contingency Table Analysis Results for BIBE.

<b>Map Code</b>	<b>Users Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>	<b>Producers Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>
S_RJUN	78.9%	58%	100%	83%	100%	64%
S_RWIL	25.0%	0%	100%	33%	100%	0%
S_SOAK	100.0%	95%	100%	100%	100%	95%
S_SOT	80.4%	70%	91%	75%	87%	63%
S_TAM	77.4%	61%	94%	80%	96%	64%
S_TMIX	71.9%	54%	89%	68%	86%	49%
S_WASH	77.8%	60%	95%	100%	100%	98%
S_YUC	82.1%	67%	97%	92%	100%	81%
S_YWASH	100.0%	83%	100%	100%	100%	83%
W_ACYP	80.0%	50%	100%	100%	100%	94%
W_APJ	81.5%	66%	97%	79%	95%	62%
W_APOAK	100.0%	75%	100%	100%	100%	75%
W_CWD	60.0%	0%	100%	75%	100%	17%
W_EOAK	100.0%	75%	100%	50%	100%	0%
W_FOR	66.7%	0%	100%	100%	100%	75%
W_GWIL	33.3%	0%	100%	50%	100%	0%
W_HOAK	94.4%	0%	100%	81%	100%	62%
W_LOAK	0.0%	n/a	n/a	n/a	n/a	n/a
W_MPJ	80.0%	60%	100%	84%	100%	66%
W_PJ	80.6%	67%	94%	88%	100%	76%
W_ROKBM	20.0%	0%	100%	50%	100%	0%
W_ROKEOK	83.3%	69%	98%	83%	98%	69%

**Table 17.** Population Contingency Table Analysis Results for BIBE.

<b>Map Code</b>	<b>Users Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>	<b>Producers Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>
H_ASAC	100.0%	75.0%	100.0%	100.0%	100.0%	100.0%
H_BERM	100.0%	92.9%	100.0%	76.4%	76.4%	76.4%
H_CANE	90.9%	78.6%	100.0%	80.5%	80.5%	80.6%
H_GRAM	74.3%	60.7%	87.9%	90.1%	88.8%	91.5%
H_GRS	48.4%	32.0%	64.8%	32.2%	32.1%	32.4%
H_MUHL	56.0%	37.7%	74.3%	100.0%	100.0%	100.0%
H_RIO	78.6%	57.0%	100.0%	100.0%	100.0%	100.0%
H_SPIK	83.3%	50.0%	100.0%	100.0%	100.0%	100.0%
H_SWIL	100.0%	50.0%	100.0%	100.0%	100.0%	100.0%
H_TOB	57.1%	31.8%	82.5%	83.1%	82.9%	83.4%
H_UPG	100.0%	50.0%	100.0%	100.0%	100.0%	100.0%
SP_BAD	78.9%	60.9%	97.0%	98.9%	97.9%	99.9%
SP_CAL	50.0%	0.0%	100.0%	100.0%	98.8%	100.0%
SP_IGN	37.5%	3.1%	71.9%	100.0%	99.9%	100.0%
SP_LCAL	93.8%	80.7%	100.0%	53.6%	53.1%	54.1%
SP_LDES	91.0%	84.6%	97.5%	84.8%	83.8%	85.8%
SP_MTAL	90.0%	69.4%	100.0%	62.3%	62.3%	62.4%
SP_NCAL	100.0%	50.0%	100.0%	100.0%	100.0%	100.0%
SP_RIO	100.0%	50.0%	100.0%	100.0%	100.0%	100.0%
SP_TAL	42.9%	17.5%	68.2%	100.0%	99.9%	100.0%
SP_WASH	100.0%	93.8%	100.0%	87.3%	87.3%	87.3%
S_ACAMEQ	96.7%	89.6%	100.0%	73.5%	73.4%	73.7%
S_CB	70.6%	49.5%	91.7%	83.9%	83.3%	84.6%
S_CBO	85.9%	78.0%	93.9%	80.9%	79.9%	81.9%
S_CDS	83.8%	72.5%	95.1%	82.2%	81.0%	83.4%
S_CHAP	86.7%	68.9%	100.0%	49.4%	49.3%	49.5%
S_CLAY	60.0%	39.5%	80.5%	100.0%	99.6%	100.0%
S_CWIL	0.0%	0.0%	25.0%	0.0%	0.0%	0.0%
S_FWASH	83.3%	50.0%	100.0%	100.0%	99.9%	100.0%
S_GOAK	77.8%	49.4%	100.0%	72.0%	72.0%	72.0%
S_LMIX	82.6%	67.4%	97.8%	94.4%	94.3%	94.5%
S_MEQ	80.3%	71.1%	89.5%	83.3%	83.0%	83.6%
S_MMX	88.9%	80.1%	97.7%	79.9%	79.8%	79.9%
S_MRIP	88.9%	77.1%	100.0%	87.0%	87.0%	87.1%
S_PERS	40.0%	0.0%	86.0%	31.4%	31.3%	31.5%
S_RJUN	78.9%	60.9%	97.0%	53.8%	53.8%	53.8%

**Table 17 (continued).** Population Contingency Table Analysis Results for BIBE.

<b>Map Code</b>	<b>Users Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>	<b>Producers Accuracy</b>	<b>90% Confidence Interval –</b>	<b>90% Confidence Interval +</b>
S_RWIL	25.0%	0.0%	73.1%	9.1%	9.0%	9.1%
S_SOAK	100.0%	95.0%	100.0%	100.0%	100.0%	100.0%
S_SOT	80.4%	70.7%	90.0%	51.7%	51.2%	52.3%
S_TAM	77.4%	63.5%	91.4%	76.1%	76.1%	76.1%
S_TMIX	71.9%	57.2%	86.5%	53.5%	53.0%	53.9%
S_WASH	77.8%	62.8%	92.8%	100.0%	99.3%	100.0%
S_YUC	82.1%	68.5%	95.8%	92.8%	92.4%	93.3%
S_YWASH	100.0%	83.3%	100.0%	100.0%	100.0%	100.0%
W_ACYP	80.0%	54.2%	100.0%	100.0%	100.0%	100.0%
W_APJ	81.5%	67.3%	95.6%	66.7%	66.7%	66.7%
W_APOAK	100.0%	75.0%	100.0%	100.0%	100.0%	100.0%
W_CWD	60.0%	14.0%	100.0%	84.3%	84.3%	84.4%
W_EOAK	100.0%	75.0%	100.0%	63.7%	63.7%	63.7%
W_FOR	66.7%	5.2%	100.0%	100.0%	100.0%	100.0%
W_GWIL	33.3%	0.0%	94.8%	47.6%	47.6%	47.6%
W_HOAK	94.4%	82.8%	100.0%	74.1%	74.1%	74.1%
W_LOAK	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%
W_MPJ	80.0%	62.8%	97.2%	92.2%	92.2%	92.3%
W_PJ	80.6%	68.3%	92.8%	84.2%	84.1%	84.2%
W_ROKBM	20.0%	0.0%	59.4%	69.3%	69.2%	69.3%
W_ROKEOK	83.3%	70.5%	96.2%	78.7%	78.6%	78.7%

By reading across the rows of the contingency tables, one can calculate the user's error or percent error of commission. This relates to how many polygons for each map unit were incorrectly labeled when compared to the field data. By reading down the columns, one can calculate the producer's error or the percent error of omission. This shows how many polygons for that type were left off the map. Numbers on the diagonal tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers off the diagonal yield important information about the deficiencies of the map including which types were either: (1) over-mapped—commission errors on the right—meaning more of this type was mapped than occurs at BIBE, or (2) under-mapped—omission errors on the bottom—meaning some of this type was mapped as other map units.



### ***Plant Associations and Fine Scale Mapping***

Based on the population accuracy analysis for BIBE the overall accuracy and Kappa values of the vegetation layer at the finest or association mapping level are as follows:

• TOTAL AA SITES (SAMPLES)	=	1,037
• TOTAL AA SITES CORRECT	=	821
• SAMPLE OVERALL ACCURACY	=	<b>79.2%</b>
• POPULATION OVERALL ACCURACY (P <sub>c</sub> )	=	<b>81.8%</b>
• LOWER LIMIT, 90% CONFIDENCE INTERVAL	=	78.8%
• UPPER LIMIT, 90% CONFIDENCE INTERVAL	=	84.8%
• KAPPA (K):	=	78.4%
• LOWER LIMIT, 90% CONFIDENCE INTERVAL, K	=	76.3%
• UPPER LIMIT, 90% CONFIDENCE INTERVAL, K	=	80.6%

Reviewing the AA data shows that over half of the association level map units had both high user's and producer's accuracy of at least 80%. The map units below 80% had either marginal accuracy of 60%–79% (Table 18) or low accuracy of < 60% (Table 19). One source of error for the rare and infrequent types at BIBE was the small number of AA points that fell below the NVIP standards (Lea and Curtis 2010). The low number of AA points for some of these types was likely due to the difficult logistics at BIBE and the financial constraints limiting the amount of time that the field crews could spend in the field, reducing the number of targets that they could visit. Noticeably the AA results for these map units with limited sample sizes (1–3) present either a highly inflated or a highly deflated value when compared to map units with more robust data. More sampling in the under-sampled types would better reflect the true individual map class accuracy and reduce the corresponding confidence intervals.

**Table 18.** Marginal Accuracy Level Map Classes and Sources of Error.

<b>Map Code</b>	<b>User's Population Accuracy</b>	<b>Producer's Population Accuracy</b>	<b>Results and Sources of Error</b>
H_BERM	100.0%	76.4%	Undermapped – Mapped as H_RIO (species overlap)
W_EOAK	100.0%	63.7%	Undermapped – Mapped as S_RJUN (species overlap)
S_ACAMEQ	96.7%	73.5%	Undermapped – Mapped as S_TMIX or S_WASH (similar topographic position)
W_HOAK	94.4%	74.1%	Undermapped – Mapped as W_ACYP or W_ROKBM (similar woodland types)
SP_MTAL	90.0%	62.3%	Undermapped – Mapped as S_MMIX (shrubs on talus)

**Table 18 (continued).** Marginal Accuracy Level Map Classes and Sources of Error.

Map Code	User's Population Accuracy	Producer's Population Accuracy	Results and Sources of Error
S_MMIX	88.9%	79.9%	Undermapped – Mapped as H_MUHL, S_GOAK, S_RJUN, W_APJ, or W_PJ (widespread type) Overmapped – Actually SP_MTAL or S_SOT (widespread type)
W_ROKEOK	83.3%	78.7%	Undermapped – Mapped as W_ROKBM or W_HOAK (similar woodland types) Overmapped – Actually W_ROKBM, W_MPJ, S_MMIX, or S_RJUN (species overlap)
W_APJ	81.5%	66.7%	Undermapped – Mapped as W_PJ or W_MPJ (species overlap) Overmapped – Actually W_PJ, W_MPJ, S_MMIX (similar types)
SP_BAD	78.9%	98.9%	Overmapped – Actually SP_LDES or S_CBO (similar sparse types)
H_RIO	78.6%	100.0%	Overmapped – Actually SP_WASH or H_BERM (species overlap and similar topographic position)
S_WASH	77.8%	100.0%	Overmapped – Actually S_ACAMEQ, S_TMIX, or S_CBO (species overlap and similar topographic position)
S_GOAK	77.8%	72.0%	Undermapped – Mapped as W_ROKEOK (similar species) Overmapped – Actually S_MMIX (similar species)
S_TAM	77.4%	76.1%	Undermapped – Mapped as S_RWIL, S_MRIP, S_CWIL, H_CANE, or H_GRS (bias to native species and species overlap) Overmapped – Actually H_CANE or S_MRIP (species overlap)
H_GRAM	74.3%	90.1%	Overmapped – Actually S_SOT, S_CBO, or S_CDS (species overlap)
S_CB	70.6%	83.9%	Overmapped – Actually S_CBO, S_MEQ, S_ACAMEQ, or H_GRS (species overlap)
W_FOR	66.7%	100.0%	Overmapped – Actually W_CWD (species overlap)
S_CLAY	60.0%	100.0%	Overmapped – Actually SP_LDES or S_CB (species overlap and similar topographic position)
W_CWD	60.0%	84.3%	Overmapped – Actually W_GWIL or S_TMIX (rare type)

**Table 19.** Low Accuracy Level Map Classes and Sources of Error.

Map Code	User's Population Accuracy	Producer's Population Accuracy	Results and Sources of Error
SP_LCAL	93.8%	53.6%	Undermapped – Mapped as S_YUC (similar sparse desert types – high species overlap)
S_CHAP	86.7%	49.4%	Undermapped – Mapped as S_CDS or SP_LDES (similar sparse desert types – high species overlap)
S_SOT	80.4%	51.7%	Undermapped – Mapped as H_GRAM (common types that intermix)
S_RJUN	78.9%	53.8%	Undermapped – Mapped as S_LMIX, W_PJ, or W_ROKEOK (high species overlap)
S_TMIX	71.9%	53.5%	Undermapped – Mapped as W_CWD, W_GWIL, S_ACAMEQ, S_CWIL, S_MEQ, or S_WASH (high species overlap)
H_TOB	57.1%	83.1%	Overmapped – Actually SP_LDES (common types that intermix and form ecotones)
H_MUHL	56.0%	100.0%	Overmapped – Actually S_LMIX or S_MMX (common understory grass in these shrublands – possible inclusions)
SP_CAL	50.0%	100.0%	Overmapped – Actually S_CDS (common limestone types that intermix)
H_GRS	48.4%	32.2%	Undermapped – Mapped as S_CB Overmapped – Actually H_TOB (common sparse desert types that intermix)
SP_TAL	42.9%	100.0%	Overmapped – Actually S_CBO or SP_LDES (common desert types that can grow on talus)
S_PERS	40.0%	31.4%	Undermapped – Mapped as S_FWASH Overmapped – Actually S_SOT (a rare type that intermixes with similar tall shrub types)
SP_IGN	37.5%	100.0%	Overmapped – Actually H_GRAM or SP_MTAL (species overlap and similar topographic positions)
W_GWIL	33.3%	47.6%	Undermapped – Mapped as W_CWD Overmapped – Actually S_TMIX or W_ROKEOK (a rare type that intermixes with species overlap)
S_RWIL	25.0%	9.1%	Undermapped – Mapped as S_MRIP or H_CANE Overmapped – Actually H_CANE or S_TAM (rare riparian type with high species overlap)
W_ROKBM	20.0%	69.3%	Undermapped – Mapped as W_ROKEOK Overmapped – Actually W_ROKEOK or W_HOAK (rare lower Chisos type with high species overlap)
S_CWIL	0.0%	0.0%	Overmapped – Actually S_TMIX or S_TAM (rare type with high species overlap – low sample size)
W_LOAK	0.0%	0.0%	Overmapped – Actually W_ROKEOK (rare type with high species overlap – low sample size)

Other general sources of error can likely be explained by the difficulty in resolving the differences in scale and perspective between viewing the vegetation on the imagery and assessing it on the ground. For example, sampling could have occurred in large inclusions of shrubs or herbaceous vegetation that were actually part of a larger sparse desert scrub type. In addition, the fine delineation of closely related mapping units likely led to confusion, especially when map units shared the same dominant species. More thoughts on the accuracy of the BIBE vegetation map and recommendations on how to improve it are included in the discussion section of this report.

### ***Plant Alliances and Coarse Scale Mapping***

By joining both the fine-scale association level vegetation map and the AA points to the rUSNVC hierarchy the coarse scale mapping for BIBE was assessed. The overall accuracy and Kappa values for the following rUSNVC mapping levels were calculated as follows:

<b>TOTAL AA SITES (all levels)</b>	<b>=</b>	<b>1,037</b>
● <b>ALLIANCE LEVEL</b>		
○ TOTAL AA SITES CORRECT	=	881
○ SAMPLE OVERALL ACCURACY	=	85.1%
○ KAPPA ( <b>K</b> ):	=	83.4%
○ LOWER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	81.3%
○ UPPER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	85.4%
● <b>GROUP LEVEL</b>		
○ TOTAL AA SITES CORRECT	=	889
○ SAMPLE OVERALL ACCURACY	=	85.7%
○ KAPPA ( <b>K</b> ):	=	83.7%
○ LOWER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	81.7%
○ UPPER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	85.8%
● <b>MACROGROUP LEVEL</b>		
○ TOTAL AA SITES CORRECT	=	896
○ SAMPLE OVERALL ACCURACY	=	86.4%
○ KAPPA ( <b>K</b> ):	=	83.9%
○ LOWER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	81.8%
○ UPPER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	86.0%
● <b>DIVISION, FORMATION, SUBCLASS, &amp; CLASS LEVELS</b>		
○ TOTAL AA SITES CORRECT	=	975
○ SAMPLE OVERALL ACCURACY	=	94.0%
○ KAPPA ( <b>K</b> ):	=	89.6%
○ LOWER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	87.5%
○ UPPER LIMIT, 90% CONFIDENCE INTERVAL, <b>K</b>	=	91.6%

By scaling up the map units in the rUSNVC hierarchy, the overall accuracy of the BIBE vegetation map improved by almost 15%. This is a direct result of similar map units being lumped together into broader categories. At the broadest or highest levels, the accuracy remained constant as the vegetation was sorted into herbaceous, shrub, and wooded physiognomic types.

## Discussion

The steep elevation gradient and rugged landscape at BIBE supports a wide variety of plant communities that are adapted to a variety of environments ranging from deep river canyons, to low desert basins, and high mountain woodlands. These harsh and remote habitats made for many unique challenges to the vegetation inventory project. Challenges included many logistical considerations due to travel distances, heat exposure, abbreviated growing seasons, working on steep slopes, negotiating routes through thick vegetation, and working on foot from limited roads, trails, and other access points. In addition to the difficulty of doing fieldwork at BIBE, the natural mixing of the vegetation and the overlap of similar dominant species made for both a challenging classification process and a complex mapping effort. The inventory and mapping processes described in this report although largely successful revealed opportunities for improvement and new approaches for future efforts that are discussed herein.

### Approaches that worked well

Having access to existing vegetation data at BIBE helped speed-up the classification process and allowed for targeted sampling in known types. Field data collection occurred over multiple years with continued review by knowledgeable BIBE staff. This approach allowed for gaps in the data collection to be quickly identified and for subsequent data collection efforts to be focused on the missing plant communities. AA field sampling was greatly aided by the use of BIBE-provided pack animals, canoes, and guides. BIBE staff also provided invaluable guidance on logistics and imparted local knowledge about possible unique stands of vegetation. Both spring and fall field efforts helped minimize the dangers from heat exposure while still allowing for accurate plant identification. Timely and high-resolution base imagery was essential to produce the detailed and accurate maps and the 2015 TOP imagery was of superior quality and resolution when compared to similar NAIP or other existing imagery sources. Further, having imagery with 4-bands and the ability to view the vegetation in color infrared format was essential to the detailed and accurate mapping of the vegetation at BIBE.

### Areas for Improvement

NPS vegetation inventory projects are by design lengthy projects that incorporate numerous cooperators and partners. Having more than one group working on the project can lead to a loss of intuitional knowledge and an overlap in responsibilities. Stream-lining the number of people working on the project, creating clear roles for each partner, mandating project reports, standardized interim products, and having designated project leads would help economize and make the project more efficient. Inherent to all vegetation mapping projects is also the need to produce both a complete and up-to-date vegetation classification and a rUSNVC-relatable set of map units. In the future, it may be possible to supplement the BIBE classification by collecting additional field data that may help remove the provisional or local status of the non-rUSNVC plant associations. Similarly, more fieldwork may also allow for more detailed ground-truthing and/or create new or refined map classes. More targeted sampling in unvisited areas may also help find potentially new types and/or complete the range of variation for existing types. Finally, new advances in aerial imagery acquisition (e.g.



drones, new sensors, higher resolutions, etc.) and other remotely sensed data (e.g. LIDAR, hyperspectral, etc.) may allow for more precise mapping of the vegetation.

### **Field Surveys**

At BIBE, the existing legacy data proved to be a valuable tool for starting the vegetation survey and classification efforts. The previous studies not only provided a framework for identifying plant associations in the field, but also provided a comprehensive list of known plant species occurring at BIBE. The Plumb data proved particularly helpful in providing both a list of vegetation cover types at BIBE (1992) and a digital map layer and supporting mapping documents (1991 and 1993). Combined these formed the basis for the gradsect layer (BPUs) that was used for fieldwork planning. The targeted plot data collection techniques at BIBE insured the efficient sampling of different habitats and minimized the time spent in large homogeneous areas. In addition, to improve further the sampling efficiency, the distribution of plots was reviewed after every round of sampling and any unique and/or large areas devoid of sampling was identified as a priority. These included the lower (east) Rio Grande River corridor and the Dead Horse Mountains. Both sites were eventually sampled during the AA stage thanks in large part to the commitment of the NVIP and the assistance provided by BIBE staff.

Overall, plot replication and representativeness was very robust, with the known exceptions of (1) riparian vegetation from the Rio Grande corridor and (2) higher elevations on limestone substrates (i.e., 3,500 to 6,000 feet). Future classification work would likely benefit from even more sampling in these remote and hard to access areas of the park. Other potential target areas would be the Rosillos Mountains and the southern portion of the Chisos Mountains and foothills north of the Rio Grande River. The Rio Grande River and its larger tributaries should also be monitored for any changes after flooding or when non-native species are removed.

During the course of the vegetation sampling, several interesting observations were made. The first was that the field crews identified the woody leguminous vine *Nissolia platycalyx* in one of the plots near the Window Trail in the Chisos Basin. This is believed to be the second record for the species in the United States, with the previous record a Barton Warnock collection from the 1950s near Lost Mine Peak. The second was that a large number (probably the majority) of large individual Arizona cypress trees had recently died within the large stand that was present just south of the upper Juniper Canyon Trail. It is likely that these trees succumbed to drought conditions beginning in 2010–2011. It is likely that these represent a large proportion of the full-sized trees that were extant in BIBE, which is the only site in Texas for Arizona cypress.

### **Vegetation Classification**

As the plot data was being collected the vegetation classification was also evolving. The preliminary plant associations were greatly refined, expanded, and modified to incorporate as much of the species variation as possible. While the associations were created primarily from the plot data, the subsequent AA and other observational data were also used to augment or otherwise improve the written descriptions. For example, most of the plot data were collected in 2011 during a severe drought and after freezing episodes. Both conditions influenced the vegetation by lowering the cover values for dead and dying cacti/succulents and for dormant or dead grasses. The cover values were

then adjusted in the final classification descriptions however by supplementing the 2011 data with the AA and other observation data that were collected under normal growing conditions.

The vegetation at BIBE was classified using the NVIP National Vegetation Standard, Version 2 (rUSNVC) (FGDC 2008). There exists some confusion over how physiognomy is used in classifying existing vegetation in the rUSNVC compared to how it was used in the previous version (FGDC 1997). To clarify, the physiognomy of a plant community (i.e. forest, woodland, shrubland, shrub steppe, herbaceous or sparse vegetation) does not trump floristic composition or ecology when classifying vegetation. Further, the strict and detailed physiognomic hierarchy of the USNVC version 1 is not maintained in the rUSNVC. Rather, very broad physiognomic criteria are applied at higher levels, with floristics playing an increasingly stronger role at the mid and lower levels. As a result, the association and alliance levels only have fine-scale physiognomic criteria when they are supported by floristics and ecology. Thus “forest to open woodland” is separated from “shrubland and grassland” at the highest levels, based on the 10% or more cover of trees and finer scale splits are only made at lower levels as needed.

The use of the new rUSNVC at BIBE likely helped reduce the number of potentially confusing plant associations resulting from mixed stands of vegetation. For example, shrub dominated vegetation with scattered trees (up to 9% cover of trees) is now classified as a shrubland and if there is 10% or more cover of trees, then the stand is classified as a woodland or forest. This discourages the classification of transitional vegetation (either spatial transitions such as in ecotones, or temporal transitions when trees colonize/invoke shrublands) to rUSNVC associations, reducing the proliferation of associations based solely on physiognomy and reducing the complexity of the classification in general. The 10% or more tree cover break for woodlands and forests is applied globally in the rUSNVC with few exceptions. One significant exception may occur in sparse woodlands (such as pinyon pine on rocky sites) where the total vegetation cover only equals 10–15% and the trees dominate with slightly less than 10% cover.

### **Digital Imagery and Mapping**

The vegetation map for BIBE was based primarily on the 2015 TOP orthoimagery. However, both the 2012 and 2016 NAIP products were used to help delineate confusing upland areas, areas with dark shadows, and rapidly changing areas along the Rio Grande River. In general, the BIBE vegetation map should be considered a snapshot in time directly relating to the 2015 TOP imagery. As the data are used, it should be remembered that fires, floods, and other changes to the landscape since 2015 are not included in this product. In the future, it might be beneficial to update the map with newer imagery and use GPS receivers to collect coordinates in the field after major events (e.g. wildfire perimeters, points for insect infestations, etc.).

It is also important to understand that the mapping portion of this project is primarily a remotely sensed exercise and the field work was conducted on site, therefore all resulting products are scale dependent. As a rule, the mapping portions should be considered as a broad overview and the field data as site-specific. An analyst can enlarge the imagery beyond the 1:12,000-scale using GIS software to see more detail. However, it should be remembered that the actual interpretation/mapping was conducted at 1:12,000-scale. As such, any work performed with this product at a finer scale

(enlarged image) could lead to some uncertainty. In contrast, the fieldwork was conducted at individual locations at one specific time and any extrapolation using these locations to represent outlying areas or using them to determine species presence at different times/seasons is less reliable. Database users should recognize scale limitations and balance research and modeling projects accordingly.

### **Accuracy Assessment**

A formal accuracy assessment is critical to determining the overall usefulness of the vegetation map and its ability to predict the size, shape, and location of individual map units on the landscape. As such, users of the vegetation mapping product should remember that the AA results were directly dependent on many key factors including:

- Field Surveys – thoroughness of the sampling to reach all areas of the park;
- Field Crews – level of expertise to consistently identify and record species and cover values;
- Classification – ability to describe ecotones and the full variation of each association;
- Field Key – its ability to reliably and consistently identify and separate unique associations;
- Date Entry – consistent maintenance of data with minimal errors;
- Orthoimagery – ability to provide consistent vegetation signatures that repeat across the landscape;
- Vegetation Stability – little if any changes occurred between the timing of the orthoimagery to when the AA fieldwork occurred.

Although the accuracy for BIBE was high, improvements can be made and users should fully explore and understand the sources of error in the contingency tables and the factors stated above. Specific areas at BIBE that could benefit from more investigation or future efforts to improve the accuracy include the following regions of the park:

1. **Chisos Mountains:** Mapping in this area was somewhat difficult due to the mixing of the various woodland and shrub types. An effort was made to separate the unique stands of Arizona pine (W\_APOAK) and Arizona cypress (W\_ACYP). Other conifer map units were created in slightly lower areas for the dry and mesic pinyon-juniper (W\_PJ and W\_MPJ), and alligator juniper (W\_APJ) types. Some confusion of these map units was encountered, especially in transition zones and when large inclusions were present. Oak and broad-leaf tree types were common in the Chisos and various map units were created to address the diversity. The W\_HOAK type was quite common around rock outcrops (SP\_IGN) and talus formations (SP\_MTAL). Difficulty emerged when trying to separate the other types based on understory species such as the two Grave's oak types (W\_ROKBM and W\_ROKEOK). The shrub component in the Chisos was represented by the widespread S\_MMIX and the rare S\_GOAK, S\_SOAK, and S\_CHAP types. Grasses were present in most of the woodland understories and the H\_MUHL and H\_FINE map units were used to delineate areas on bedrock that contained grasses. As requested during the mapping, woodland areas that had dead trees in the canopy were

noted in the GIS layer using the MORTALITY attribute. Some combining could be done for the two Grave's oak types and the grassland and bare rock types.

2. **Foothills:** Slightly lower in elevation were the foothill types that did integrate with both the high desert and the higher Chisos Mountain types, especially with the S\_SOT and W\_PJ map units. Common to this area were the S\_LMIX, S\_FWASH, S\_RJUN and W\_EOAK map units. The close proximity of these types and similar species diversity and structure created some map unit confusion. Based on the AA results it may make sense to combine some of the low elevation types into broader short woodland/tall shrub map units, such as the W\_EOAK and S\_RJUN types.
3. **High Desert:** The high desert regions of BIBE were dominated by sotol (S\_SOT) and chino grama grass (H\_GRAM) types. These two types had a lot of species overlap and were difficult to separate consistently. Other rare types occurred in this region including the W\_LOAK map unit that was mapped where it was known to occur. Sparse locations were designated with the SP\_NCAL and SP\_TAL labels depending if it was rock outcrops or talus. In the lower areas of this region, the S\_CBO and SP\_LDES types became intermixed. Some combining of these map units would result in higher accuracies but would remove a lot of map detail.
4. **Low Desert:** Mapping in the low desert regions of BIBE was largely based on the amount, diversity, and species associated with creosotebush and to a lesser degree with honey mesquite. To provide more detail, two main creosotebush map units were created, (1) one on slightly higher elevations that contains ocotillo and lechuguilla (S\_CBO) and (2) for lower elevations (S\_CB) that mainly lacks any other associated shrubs. The remaining areas were typically devoid of any one dominant species but contained low amounts of creosotebush, cacti, and other desert species (SP\_LDES). The SP\_LDES types were further separated into three variants to describe their unique substrates and locations. In addition, more detail was provided by separating sparse species compositions that occurred on clay fans and flats (S\_CLAY) and in badland formations (SP\_BAD). As requested during the mapping, low desert and high desert areas containing significant amounts of introduced grasses were noted by species in the GIS layer using the INTRO\_GRSS attribute. The SP\_LDES is widespread and could easily be fully merged and combined with the S\_CLAY, SP\_BAD, and S\_CB types. This would reduce the mapping detail, slightly increase the accuracy, and would combine different landforms that may or may not be significant to resource management.
5. **Limestone Mountains and Low Elevation:** During the classification stage, a large break in the plant associations occurred for those growing on limestone (calcareous) versus those on non-limestone geology. This was carried over into the mapping scheme by creating various calcareous map units such as S\_CDS, S\_CHAP, S\_YUC, and S\_YWASH. To capture the variation on the limestone formations, unique map units were also created, especially for those supporting sparse vegetation such as high rock outcrops (SP\_CAL) and lower scrub communities (SP\_LCAL). In addition, the S\_CTAL type was created for vegetation occurring on talus where more mesic conditions support higher vegetation concentrations. Similarly, the S\_YWASH map unit was used to label similar vegetation occurring in limestone washes. All of the

limestone/calcareous map units have similar species and can be easily combined into larger groupings if needed.

**Washes and Upland Riparian:** The importance of the hydrology at BIBE was discussed early in the planning stages. As a result, all of the drainages and washes in the project area, down to about 1–2 meters wide were mapped. The map attribution of the wash drainages proved challenging since similar species occurs in both the upland shrublands and in the washes. Some of the confusion was alleviated by creating an alternate or secondary map unit label. For example, a wide wash area would be a linear feature with the primary label of S\_WASH. Alternatively, large pockets within the drainage may support S\_CBO species. Thus, the secondary label would be S\_CBO. In addition, other map units were created specifically for sites containing high and tall mesquite and acacia shrubs (S\_ACAMEQ) and mixed tall shrubs (S\_TMX). Wide drainages devoid of vegetation were mapped as SP\_WASH. On limestone formations, the washes were given a park special designation of S\_YWASH to indicate the presence of yucca and other calcareous shrub species. In higher elevations, the shrub component of washes changed and these were mapped as S\_FWASH. Deciduous trees not in the Chisos were given a high priority in the mapping due to their rarity and proximity to springs, seeps, and perennial streams. Most of the trees were either cottonwood (W\_CWD) or a mix of Gooding willow (W\_GWIL) and shrubs (H\_SWIL). In addition, some of the trees in the campgrounds were found to be planted (W\_FOR). Various groupings of the wash and wetland types could be made such as combining the W\_CWD and W\_GWIL types

6. **Rosillos Mountains and Former Ranch Lands:** The northwest area of the park was difficult to map due to the disturbed nature of the vegetation. Efforts were made to pull out the non-native grasslands (H\_GRS and H\_TOB) from the disturbed mesquite and creosote bush types. In reality, large areas are probably more of a mosaic of vegetation consisting of low diversity shrublands with patches of grasses. Similarly, the vegetation in the Rosillos Mountains appeared greatly disturbed with low levels of grasses and cacti. Since no fieldwork was conducted in the mountains, the mapping focused on separating the high elevation grasslands from the shrublands. In all likelihood, these grasslands are probably not good representations of the chino grama type (H\_GRAM) but likely contain more disturbed or altered vegetation. To improve the accuracy, the H\_TOB and H\_GRS types could be combined. More knowledge of this area could also warrant the creation of a new map unit for the higher mountains that contain a non-native grass and cacti (prickly-pear cactus) component.
7. **Rio Grande River Corridor:** The river corridor was mapped twice during our efforts, once with the old boundary and once after receiving a new boundary from the NPS Lands Office. In both cases, the Mesquite bosque stands (S\_MRIP) were easily to distinguish except when they integrated with tamarisk (salt cedar). Some difficulties were encountered trying to map the native willow and reed types away from the giant cane (H\_CANE) and tamarisk (S\_TAM) types. Bermuda grass was also prevalent in some areas. The dynamic nature of the river also created some early successional herbaceous and bare alluvial bars that were labeled with the H\_RIO and SP\_RIO types.

## Future Recommendations

The vegetation inventory project for BIBE represents the best efforts put forth by many dedicated experts over a relatively short period of time. In order to create the best possible “long-term” product, this project should not be viewed as final, but rather as the starting point for an on-going effort. BIBE staff and researchers should continue to explore the recreation area and observe the vegetation. Improvements and up-dates to the products presented in this report should be made as needed and on a periodic basis. Present and future researchers should be encouraged to scrutinize the vegetation at BIBE, sample more of the rare and under-represented types, modify the classification and field key to better document the full range of variation, update and improve the GIS layers, and be ever vigilant to record any recent changes or new types that may have been overlooked.

In summary, the products produced as part of this project can assist and direct future vegetation and land-use monitoring and management, as follows:

1. The diversity of plant species and dynamic nature of BIBE with respect to the Rio Grande River, non-native species encroachment/eradication, native plant restorations, wildfires, water diversions, climate change, and other vegetation altering influences warrants periodic **field surveys** by experienced ecologists. Sampling more of the plant communities would also be beneficial allowing for the possibility of discovering new associations, updating the descriptions of the current plant associations, and devising better landscape management strategies. All new information could be used to update both the GIS map layer and the classification.
2. Remote sensing does not replace on-the-ground knowledge provided by GPS-linked plots, observations, site photographs, and verification/ground-truthing work. Time, difficult terrain, and funding limitations curtailed the amount of **ground-truthing** performed at BIBE. As research opportunities arise, maps should be examined in the field by experienced personnel. In addition, GPS receiver data and other GIS layers (such as soils and geology) should be used to improve and update the spatial data. Data could be collected on a standard field form, stored, and then used to update the GIS layer on an annual basis. The vegetation map layer should not be viewed as static but should be updated with more current and accurate information as it becomes available.
3. To understand better the limitations of the map layer, the **accuracy assessment** data as presented in the error matrices should be thoroughly reviewed by all users. Map classes with low accuracy should be examined to determine if they could be improved with future studies using ground-truthing or other remote-sensing formats (e.g. LIDAR, hyperspectral imagery, etc.). Landscape modeling may help to tease out the locations of rare types based on specific habitat information such as deep soil types, unique geologic formations, and distance from water sources. For some applications, it may make sense to combine map classes into higher units, such as rUSNVC Groups or biophysical types to improve accuracy and present a broader perspective.
4. For monitoring purposes, **change over time** could be addressed by similar remote sensing projects. New imagery as it becomes available could be analyzed to create up-to-date vegetation layers that could be overlain for comparison purposes. Also periodically, and immediately



following vegetation altering events, new data should be collected and any changes noted in a new vegetation layer. That way, new BIBE vegetation map layers can be prepared on a regular basis to prevent the vegetation map from becoming out-dated.

5. In the future, resource management personnel could link the habitat for **species of concern** to specific associations and map units. These map units could be used to help locate potential sites of rare, endangered, or threatened species or identify areas for non-native plant removal or treatment. Known populations of threatened, endangered, or non-native species could be overlain on the vegetation map using point or small polygon layers to extract helpful plant community indicator data such as soil type, slope, aspect, hydrology, etc.

### **Research Opportunities**

The wide array of final products produced for this project lends themselves for future research opportunities. On the inventory and classification side, research could include setting up a photo-monitoring project that periodically retakes plot photographs. This would help to document vegetation change over time. Another option would be mine the PLOTS database for locations of species of concern for both rare plants and problematic invasive species. For example, several plant species of conservation concern and that are endemic to Texas were documented in the plot data collection. These locations could be used as the basis for more rare plant surveys, the start of mapping their distributions, and/or analyzing their habitats for vulnerabilities (flooding, erosion, non-native species invasion, etc.).

On the mapping side, having an accurate and current vegetation map in a geodatabase presents many new and exciting opportunities including expanding or linking the GIS layer to derive other information such as fire models, wildlife habitat monitoring locations, habitat structural analyses, and inventorying areas that are likely vectors for invasive species. The map could also be enhanced by overlaying other existing GIS layers including geology, hydrology, elevation, and soils. In this manner complex interactions between these layers could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology. Through innovative analyses the vegetation layer could be used as a baseline for other ecological and climate-related studies including examining how the vegetation is impacted by global warming events and how it interacts with soil chemistry, pollution, paleontological/archeological sites, insect infestations, weather patterns, etc.

Having consistent ecological and digital map data for plant associations across a large geographical span (BIBE to RIGR to AMIS) could create some exciting prospects for ecoregion analysis and study. Investigations could include examining the distribution, health, and vigor of common species (such as creosotebush) overtime as it relates to drought, flooding, or human activities. The active control of non-native species upriver could also be examined in relation to the amount, or rate of recovery of these same types further down the Rio Grande River. These and many other opportunities could result from linking all of the regional vegetation data for the three neighboring NPS units into a seamless classification and related geo-database.

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# Appendix A: BIBE Field Data Forms

Examples of field data forms are presented in Figures A-1 through A-3.

CHIHUAHUA DESERT NETWORK - VEGETATION INVENTORY FORM				rev. 2011-06-17 by Chris Lea		P.1															
<b>GENERAL INFORMATION</b> PLOT: <u>BIBE</u> Project: <u>CHDN Vegetation classification and mapping</u> Date: _____ Surveyor names: _____  <i>(circle names of all staff making plant IDs)</i>  Plot dimensions: _____ by _____ m or, if irregular, check here and explain in diagram below _____  Plot area _____ sq. m  <b>Relative Stand Size (circle best one - or two, if borderline)</b> A - extensive (> 100x plot size) B - large (10-100x plot size) C - small (3-10x plot size) D - very small (1-3x plot size) U - Unknown				<b>PLOT LOCATION</b> Managed Area (Park): <u>Big Bend National Park (BIBE)</u> Survey Site: _____ County: <u>Brewster</u> State: <u>Texas</u>  Make & Model of GPS unit: _____ UTM zone: <u>13N</u> Datum: <u>NAD-83</u> or _____ est accuracy: _____ m/ft (circle one) Receiver status (circle one): <u>2D</u> / 3D / 3D WAAS  Field UTM X _____ E _____ Y _____ N If applicable, marked est. location on toposheet? _____ yes																	
<b>SITE CHARACTERISTICS</b> <b>Elevation</b> _____ m/ft (circle one) from (circle one) GPS topo map non-GPS altimeter																					
<b>Slope</b> clinometer reading (nearest 5° or 10°): _____ single measure (check) _____ or avg of _____ or circle category (if eyeballed) 0° (<2%) (flat) 1-5° (= 2-9%) (gentle) 6-14° (11-25%) (moderate) 15-25° (27-47%) (moderately steep) 26-45° (49-100%) (steep) 46-69° (104-261%) (very steep) 70-90° (275%-infinity) (extremely steep) > 90° (overhanging)		<b>Slope Shape (Vertically = parallel to greatest slope)</b> VERTICALLY      HORIZONTALLY C - concave      C - concave X - convex      X - convex S - straight      S - straight If applicable, circle and describe below H - hummock (____% of plot) and hollow (____%) microtopography I - irregular craggy/ bouldery microtopography		<b>Azimuth (0-359 degrees)</b> _____ single measure (check) _____ or avg of _____ circle one: magnetic or corrected check if slope is too gentle to discern azimuth: _____																	
<b>Topographic Position (circle one)</b> alluvial fan alluvial terrace badlands interfluvial/summit high slope high level mid slope low slope toe slope low level bottomland butte canyon		<b>Landform (circle all that apply)</b> channel      foothills      knoll      scree cliff      gorge      lakebed      seep collapse sinkhole      graben      ledge      slope gulch      mesa      stream terrace depression      hanging valley      mountain      saddle desert pavement      hill      oxbow      swale dike      hogback      plateau      talus dome      hoodoo      playa      valley floor draw      interdune      ravine dune      interfluvial      ridge earthflow      island      saddle floodplain      knob      scarp (bluff)																			
<b>List rock or other substrate types present (only if known)</b>		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Nonliving Surface Substrate</th> <th style="text-align: left; padding: 2px;">% Cover</th> </tr> </thead> <tbody> <tr><td style="padding: 2px;">bedrock</td><td style="padding: 2px;"></td></tr> <tr><td style="padding: 2px;">large rocks (boulders)*</td><td style="padding: 2px;"></td></tr> <tr><td style="padding: 2px;">small rocks (gravel &amp; cobbles)**</td><td style="padding: 2px;"></td></tr> <tr><td style="padding: 2px;">bare soil (including sand)***</td><td style="padding: 2px;"></td></tr> <tr><td style="padding: 2px;">litter/duff</td><td style="padding: 2px;"></td></tr> <tr><td style="padding: 2px;">wood****</td><td style="padding: 2px;"></td></tr> <tr> <td style="padding: 2px;"><b>TOTAL</b></td> <td style="padding: 2px;"><b>100%</b></td> </tr> </tbody> </table> * = >10 cm average diameter ** = 2mm to 10 cm average diameter *** = <2 mm average diameter **** = > 1 cm diameter				Nonliving Surface Substrate	% Cover	bedrock		large rocks (boulders)*		small rocks (gravel & cobbles)**		bare soil (including sand)***		litter/duff		wood****		<b>TOTAL</b>	<b>100%</b>
Nonliving Surface Substrate	% Cover																				
bedrock																					
large rocks (boulders)*																					
small rocks (gravel & cobbles)**																					
bare soil (including sand)***																					
litter/duff																					
wood****																					
<b>TOTAL</b>	<b>100%</b>																				

**Figure A-1a.** Example of CHDN plot form page one used to collect data on the following: plot name, dimensions, area, project name, date, surveyor names, and the relative stand size; plot location, GPS unit specifications, and GPS coordinates; site elevation, slope (to the nearest 5° using a clinometer or in category form from flat to overhanging), slope shape (both vertical and horizontal shape—concave, convex, straight, hummock, or irregular), and average or single measure azimuth (magnetic or corrected); topographic position (where on the slope), landform types (e.g., alluvial fan, basin, canyon, dune, floodplain, hill, plateau, seep, valley floor, etc.), and nonliving surface substrate with percent cover.

<b>Soil Drainage Class (circle one)</b> A - very poorly drained B - poorly drained C - somewhat poorly drained D - moderately well drained E - well drained F - rapidly drained	<b>Soil Texture (circle one)</b> A - clay B - loam (any) C - sand <b>Cowardin System (circle one)</b> A - Upland B - Lacustrine C - Riverine D - Palustrine	<b>Moisture or Flooding Regime (circle one)</b> A - Xeric B - Dry-mesic (intermediate) C - Mesic D - Intermittently flooded (e.g., playa) E - Temporarily flooded (e.g., wash) F - Seasonally flooded (e.g., tinaja) G - Semipermanently flooded H - Permanently flooded I - Saturated (e.g., ground water seep or spring)						
<b>Environmental Comments (optional):</b>								
<b>Landscape Comments (optional):</b>								
<b>Hydrology evidence (optional)</b>								
<b>Provisional vegetation type name:</b>								
<b>Sketch plot configuration</b> , indicate the plot shape, orientation (azimuth), sub-plots (if used), landscape position, and directions and distances to landmarks. Use the symbols in the key below to indicate positions of GPS points, photos, and permanent markers (if any), relative to the plot sides.								
		<table border="1" style="margin: auto;"> <tr> <td style="text-align: center;">⊗</td> <td>GPS position</td> </tr> <tr> <td style="text-align: center;">○ →</td> <td>Photo # and direction</td> </tr> <tr> <td style="text-align: center;">●</td> <td>Permanent Marker</td> </tr> </table>	⊗	GPS position	○ →	Photo # and direction	●	Permanent Marker
⊗	GPS position							
○ →	Photo # and direction							
●	Permanent Marker							
Driving and walking directions to plot:								

<b>II. VEGETATION STRUCTURE AND PHYSIOGNOMY</b>											PLOT <u>BIBE</u> , P. 2	
<b>Stratum</b>	T1	T2	T3	S1	S2	S3	H	NB	NL	NAC	T1 = Emergent trees	H = Herbaceous
% COVER*											T2 = Trees, > 10 meters	NB = Nonvascular, bryophytes
Max Height (meters)			10	5	2	0.5		N/A	N/A	N/A	T3 = Trees, 5-10 meters	NL = Nonvascular, lichens
* - if < 5%: estimate to nearest 1% (or as <1%) total vegetation cover of stand. if 5-15%, estimate to nearest 5% if different from plot (for sparse if > 15%, estimate to nearest 10% vegetation only)											S1 = Shrubs, 2-5 meters NAC = Nonvascular (algae, S2 = Shrubs, 0.5-2.0 meters and cyanobacteria) S3 = Shrubs, 0-0.5 m	
<b>PHYSIOGNOMIC CLASS</b>				<b>LEAF PHENOLOGY (dominant stratum)</b>				<b>LEAF TYPE (dominant stratum)</b>				
Forest (>60% Tree Cover)*				Deciduous (< 25% evergreen)				(may select more than one)				
Woodland (25-60% Tree Cover)*				Mixed deciduous (25-49% evergreen)				Broadleaf (including xeromorphic)				
Shrubland (> 25% Shrub Cover)**				Mixed evergreen (25-49% deciduous)				Needleleaf				
Shrubland with sparse (< 25%) tree layer				Evergreen (< 25% deciduous)				Mixed				
Herbaceous with sparse (< 25%) tree layer				Perennial graminoid*				Broadleaf Herbaceous				
Herbaceous with sparse (< 25%) shrub layer				Perennial forb*				Graminoid				
Herbaceous				Annual graminoid*				Pteridophyte				
Nonvascular Bryophyte				Annual herbaceous*				Bryophyte				
* - or, cover trees > cover shrubs & > cover herbs				Not applicable				Lichen				
** - or, cover shrubs > cover herbs				* = may select more than one, if mixed				Algae/Cyanobacteria				

**Figure A-1b.** Example of CHDN plot form page two used to collect data on the following: soil drainage class (from rapidly drained to very poorly drained), soil texture (clay, loam, or sand), Cowardin System (upland, lacustrine, riverine, or palustrine), and moisture or flooding moisture or flooding regime (from xeric to saturated); environmental comments, landscape comments, hydrology evidence, and provisional vegetation type; a sketch of the plot configuration including shape, orientation, sub-plots, landscape position, driving and walking directions to the plot, GPS position, photo number and direction, and permanent marker; percent cover and max height of trees, shrubs, herbaceous plants, and nonvascular plants; physiognomic class (forest, woodland, shrubland types, herbaceous types, and nonvascular brophyte); and leaf phenology (e.g., deciduous, evergreen perennial forb, etc.) and type (e.g., broadleaf, needleleaf, graminoid, etc.) of the dominant stratum.



NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM (1997)					
IDENTIFIERS/LOCATORS					
Plot Code _____		Polygon Code _____			
Provisional Community Name _____					
State _____		Park Name _____		Park Site Name _____	
Quad Name _____			Quad Code _____		
GPS file name _____		Field UTM X _____		m E Field UTM Y _____ m N	
please do not complete the following information when in the field					
Corrected UTM X _____		m E Corrected UTM Y _____		m N UTM Zone _____	
Survey Date _____ Surveyors _____					
ENVIRONMENTAL DESCRIPTION					
Elevation _____		Slope _____		Aspect _____	
Topographic Position _____					
Landform _____					
Cowardian System <input type="checkbox"/> Upland <input type="checkbox"/> Riverine <input type="checkbox"/> Palustrine <input type="checkbox"/> Lacustrine		Hydrologic Regime <input type="checkbox"/> Non-Tidal <input type="checkbox"/> Permanently Flooded <input type="checkbox"/> Semipermanently Flooded <input type="checkbox"/> Seasonally Flooded		Salinity Modifiers <input type="checkbox"/> Saltwater <input type="checkbox"/> Brackish <input type="checkbox"/> Freshwater	
Environmental Comments:		Unvegetated Surface: (please use the cover scale below) <input type="checkbox"/> Bedrock <input type="checkbox"/> Litter, duff <input type="checkbox"/> Wood (> 1 cm) <input type="checkbox"/> Large rocks (cobbles, boulders > 10 cm) <input type="checkbox"/> Small rocks (gravel, 0.2-10 cm) <input type="checkbox"/> Sand (0.1-2 mm) <input type="checkbox"/> Bare soil <input type="checkbox"/> Other: _____			
VEGETATION DESCRIPTION					
Leaf phenology (of dominant stratum)  <u>Trees and Shrubs</u> <input type="checkbox"/> Evergreen <input type="checkbox"/> Cold-deciduous <input type="checkbox"/> Drought-deciduous <input type="checkbox"/> Mixed evergreen - cold-deciduous <input type="checkbox"/> Mixed evergreen - drought-deciduous  <u>Herbs</u> <input type="checkbox"/> Annual <input type="checkbox"/> Perennial	Leaf Type (of dominant stratum)  <input type="checkbox"/> Broad-leaved <input type="checkbox"/> Needle-leaved <input type="checkbox"/> Mixed broad-leaved/Needle leaved <input type="checkbox"/> Microphyllous <input type="checkbox"/> Graminoid <input type="checkbox"/> Forb <input type="checkbox"/> Pteridophyte	Physiognomic class  <input type="checkbox"/> Forest <input type="checkbox"/> Woodland <input type="checkbox"/> Shrubland <input type="checkbox"/> Dwarf Shrubland <input type="checkbox"/> Herbaceous <input type="checkbox"/> Nonvascular <input type="checkbox"/> Sparsely Vegetated	Cover Scale for Strata & Unvegetated Surface  01      5% 02      10% 03      20% 04      30% 05      40% 06      50% 07      60% 08      70% 09      80% 10      90% 11      100%	Height Scale for Strata  01      <0.5 m 02      0.5-1m 03      1-2 m 04      2-5 m 05      5-10 m 06      10-15 m 07      15-20 m 08      20-35 m 09      35 - 50 m 10      >50 m	

**Figure A-2a.** Example of NPS observation point form page one used to collect data on the following: plot and polygon code, provisional community name, state, park name, park site name, quad name, and quad code; GPS file name and UTM coordinates, survey date, and surveyors; elevation, slope, aspect, topographic position, landform, Cowardian System (upland, riverine, palustrine, and lacustrine), hydrologic regime (permanently, semipermanently, seasonally, temporarily, or intermittently flooded, or saturated), salinity modifiers (saltwater, brackish, or freshwater), environmental comments, and unvegetated surface type (e.g., bedrock, sand, litter, etc.); leaf phenology (e.g., evergreen tree/shrub, drought-deciduous tree/shrub, annual herb, etc.) and type (broad-leaved, needle-leaved, herbaceous, etc.) of dominant stratum, physiognomic class (forest, woodland, shrubland, dwarf shrubland, herbaceous, nonvascular, or sparsely vegetated), cover scale for strata and unvegetated surface (5%, 10%, and increments of 10% through 100%), and height scale for strata (categories from <0.5 m to >50 m).



Strata	Height	Cover Class	Dominant species (mark any known diagnostic species with a * )	Cover Class
T1 Emergent	_____	_____	_____	
			_____	
			_____	
T2 Canopy	_____	_____	_____	
			_____	
			_____	
T3 Sub-canopy	_____	_____	_____	
			_____	
			_____	
S1 Tall shrub	_____	_____	_____	
			_____	
			_____	
S2 Short Shrub	_____	_____	_____	
			_____	
			_____	
S3 Dwarf-shrub			_____	
H Herbaceous	_____	_____	_____	
			_____	
			_____	
N Non-vascular	_____	_____	_____	
V Vine/liana	_____	_____	_____	
E Epiphyte	_____	_____	_____	
please see the table on the previous page for height and cover scales for strata				
Other Comments			Cover Scale for Species	
			01 <1%	
			02 1-5%	
			03 5-25%	
			04 25-50%	
			05 50-75%	
			06 75-100%	

**Figure A-2b.** Example of NPS observation point form page two used to collect data on the following: height, cover class, list of dominant species, and cover class (scale of 1–6 from <1% to 75–100%) by strata (emergent, canopy, sub-canopy, tall shrub, short shrub, dwarf-shrub, dwarf-shrub/herbaceous, non-vascular, vine/liana, and epiphyte).

**GEOGRAPHY/ENVIRONMENT FORM v 2**      **BIBE or RIGR\_AA** \_\_\_\_\_

**DATE:** \_\_\_\_\_ **ECOLOGIST:** \_\_\_\_\_ **ASSISTANT:** \_\_\_\_\_

**GPS MODEL:** Garmin Oregon 650t    **GPS ERROR (m):** \_\_\_\_\_ **GPS SATELLITES:** \_\_\_\_\_

**UTM EASTING:** \_\_\_\_\_ **UTM NORTHING:** \_\_\_\_\_

**PLOT SHAPE (CIRCLE ONE):**    **CIRCLE:**      30 m RADIUS      \_\_\_\_\_ m RADIUS|

**RECTANGLE:** 40m × □ 62m, 25m × □ 100m, 20m × □ 125m, 15m × □ 167m, 10m × □ 250m, 5m × □ 500m,  
\_\_\_\_\_ m × \_\_\_\_\_ m

**GROUND SUBSTRATE COVER (%):**

SOIL/SEDIMENT:      \_\_\_\_\_ %

TALUS/SCREE:      \_\_\_\_\_ %

BEDROCK      \_\_\_\_\_ %

OTHER:      \_\_\_\_\_ %    DESCRIBE: \_\_\_\_\_

**IF A WASH, CIRCLE PLOT LOCATION:** CHANNEL/BED      BANK/FLOODPLAIN/TERRACE

PHOTOS:		
FILE NUMBER	PHOTO DIRECTION	COMMENTS (if needed)

**PLOT SETUP AND SETTING COMMENTS (if needed):** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Figure A-3a.** Example of BIBE accuracy assessment form page one used to collect data on the following: BIBE or RIGR site, date, ecologist, assistant, GPS model, GPS error, GPS satellites, UTM coordinates, plot shape and size, ground substrate percent cover (soil/sediment, talus/scree, bedrock, or other), wash plot location if applicable (channel/bed or bank/floodplain/terrace), photo file number, photo direction, photo comments, and plot setup and setting comments.

<b>VEGETATION FORM ver 2</b>		<b>BIBE or RIGR_AA</b> _____	
<b>DATE:</b> _____		<b>ECOLOGIST:</b> _____	
<b>ASSISTANT:</b> _____			
<b>BEST ASSOCIATION CHOICE:</b> _____		<b>%</b> _____	
<b>2ND POSSIBILITY:</b> _____		<b>%</b> _____	
<b>3RD POSSIBILITY:</b> _____		<b>%</b> _____	
<b>PLOT COMMENTS (if needed):</b> _____			
<b>DOMINANT OR CHARACTERISTIC VEGETATION BY STRATUM:</b>			
<b>T1 (20-35m) T. STRATUM COVER:</b> _____		<b>%</b> _____	
<b>VINE</b>		<b>TOTAL STRATUM COVER:</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>1.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>T2 (10-20m)</b>		<b>TOTAL STRATUM COVER (ALL SPECIES):</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>3.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>2.</b> _____		<b>4.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>T3 (5-10m)</b>		<b>TOTAL STRATUM COVER (ALL SPECIES):</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>3.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>2.</b> _____		<b>4.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>S1 (2-5m)</b>		<b>TOTAL STRATUM COVER (ALL SPECIES):</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>3.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>2.</b> _____		<b>4.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>5.</b> _____		<b>6.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>S2 (0.5-2m)</b>		<b>TOTAL STRATUM COVER (ALL SPECIES):</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>3.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>2.</b> _____		<b>4.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>5.</b> _____		<b>6.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>S3 (&lt; 0.5m)</b>		<b>TOTAL STRATUM COVER (ALL SPECIES):</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>3.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>2.</b> _____		<b>4.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>5.</b> _____		<b>6.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>HERB (all non-vine herbaceous plants)</b>		<b>TOTAL STRATUM COVER (ALL SPECIES):</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>1.</b> _____		<b>3.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>2.</b> _____		<b>4.</b> _____	
<b>%</b> _____		<b>%</b> _____	
<b>5.</b> _____		<b>6.</b> _____	
<b>%</b> _____		<b>%</b> _____	

**Figure A-3b.** Example of BIBE accuracy assessment form page two used to collect data on the following: BIBE or RIGR site, date, ecologist, assistant, best association choice (type and percent), second and third possibility for association (type and percent), plot comments, list of dominant or characteristic vegetation (and percent cover for each) for each stratum (three tree classes, three shrub classes, herb, or vine).

## Appendix B: Plant Species Found During Field Sampling at Big Bend National Park

There were 659 unique plant species or taxa identified while sampling field plots and accuracy assessment sites at BIBE (Table B-1). This total includes taxa identified only to genus when no species within the genus were identified. Species and taxa are sorted alphabetically within families. The families are sorted alphabetically within the following order of Class/Division: Pteridophytes, Gymnosperms, Dicots, and Monocots. Scientific name nomenclature follows USDA PLANTS (2018), wherever possible. Common names follow USDA PLANTS, Powell (1994), or Powell and Worthington (2018). Family treatments follow Powell and Worthington (2018) for angiosperms and Turner et al. (2003) for pteridophytes and gymnosperms. See end of table for reference code legend.

**Table B-1.** Plant Species Sampled at Big Bend National Park.

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Aspleniaceae</b>	<i>Asplenium resiliens</i> Kunze	blackstem spleenwort	Tndd
<b>Dryopteridaceae</b>	<i>Woodsia</i> R. Br. sp.	cliff fern	PW
<b>Pteridaceae</b>	<i>Adiantum capillus-veneris</i> L.	common maidenhair	Tndd
	<i>Argyrochosma microphylla</i> (Mett. ex Kuhn) Windham	small-leaf false cloak fern	Tndd
	<i>Astrolepis cochisensis</i> (Goodding) Benham & Windham	Cochise scaly cloakfern	Tndd
	<i>Astrolepis integerrima</i> (Hook.) Benham & Windham	hybrid cloakfern	Tndd
	<i>Astrolepis sinuata</i> (Lag. ex Sw.) Benham & Windham	wavy scaly cloakfern	Tndd
	<i>Astrolepis windhamii</i> Benham	Windham's scaly cloakfern	Tndd
	<i>Bommeria hispida</i> (Mett. ex Kuhn) Underw.	copper fern	Tndd
	<i>Cheilanthes bonariensis</i> (Willd.) Proctor	golden lipfern	Tndd
	<i>Cheilanthes eatonii</i> Baker	Eaton's lipfern	Tndd
	<i>Cheilanthes lindheimeri</i> Hook.	fairyswords	Tndd
	<i>Cheilanthes tomentosa</i> Link	woolly lipfern	Tndd
	<i>Cheilanthes villosa</i> Davenport ex Maxon	villous lipfern	Tndd
	<i>Cheilanthes wrightii</i> Hook.	Wright's lipfern	Tndd
	<i>Notholaena nealleyi</i> Seaton ex J.M. Coult.	Nealley's cloak fern	Tndd
	<i>Pellaea atropurpurea</i> (L.) Link	purple cliffbrake	Tndd
	<i>Pellaea intermedia</i> Mett. ex Kuhn	intermediate cliffbrake	Tndd
	<i>Pellaea ternifolia</i> (Cav.) Link	Trans-Pecos cliffbrake	Tndd

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Pteridaceae</b> (continued)	<i>Pellaea wrightiana</i> Hook.	Wright's cliffbrake	Tndd
<b>Selaginellaceae</b>	<i>Selaginella arizonica</i> Maxon	Arizona spikemoss	Tndd
	<i>Selaginella lepidophylla</i> (Hook. & Grev.) Spring	resurrection plant	Tndd
	<i>Selaginella mutica</i> D.C. Eaton ex Underw.	bluntleaf spikemoss	Tndd
	<i>Selaginella peruviana</i> (Milde) Hieron.	Peruvian spikemoss	Tndd
	<i>Selaginella wrightii</i> Hieron.	Wright's spikemoss	Tndd
<b>Thelypteridaceae</b>	<i>Thelypteris ovata</i> R.P. St. John var. <i>lindheimeri</i> (C. Chr.) A.R. Sm.	Lindheimer's marsh fern	Sm
<b>Cupressaceae</b>	<i>Hesperocyparis arizonica</i> (Greene) Bartel	Arizona cypress	1
	<i>Juniperus coahuilensis</i> (Martinez) Gaussen ex R.P. Adams	redberry juniper	Tndd
	<i>Juniperus deppeana</i> Steud.	alligator juniper	Tndd
	<i>Juniperus flaccida</i> Schltld.	weeping (drooping) juniper	Tndd
	<i>Juniperus monosperma</i> (Engelm.) Sarg.	oneseed juniper	Tndd
	<i>Juniperus pinchotii</i> Sudw.	Pinchot's juniper	Tndd
	<i>Juniperus scopulorum</i> Sarg.	Rocky Mountain juniper	Tndd
<b>Ephedraceae</b>	<i>Ephedra antisyphilitica</i> Berl. ex C.A. Mey.	clapweed	PW
	<i>Ephedra aspera</i> Engelm. ex S. Watson	rough jointfir	Tndd
	<i>Ephedra trifurca</i> Torr. ex S. Watson	longleaf jointfir	Tndd
<b>Pinaceae</b>	<i>Pinus arizonica</i> Engelm. var. <i>stormiae</i> Martinez	Arizona pine	Po
	<i>Pinus cembroides</i> Zucc.	Mexican pinyon	Tndd
	<i>Pinus remota</i> (Little) D.K. Bailey & Hawksw.	papershell pinyon	Tndd
	<i>Pseudotsuga menziesii</i> (Mirb.) Franco	Douglas-fir	Tndd
<b>Acanthaceae</b>	<i>Anisacanthus linearis</i> (Hagen) Henrickson & Lott	narrowleaf desert honeysuckle	PW
	<i>Carlwrightia linearifolia</i> (Torr.) A. Gray	heath wrightwort	PW
	<i>Dyschoriste linearis</i> (Torr. & A. Gray) Kuntze	polkadots	PW
	<i>Justicia warnockii</i> B.L. Turner	Warnock's water-willow	Tndd
	<i>Ruellia drummondiana</i> (Nees) A. Gray	Drummond's wild petunia	Tndd
	<i>Ruellia parryi</i> A. Gray	Parry's wild petunia	PW
	<i>Stenandrium barbatum</i> Torr. & A. Gray	early shaggytuft	PW
<b>Aizoaceae</b>	<i>Sesuvium verrucosum</i> Raf.	verrucose seapurslane	PW
	<i>Trianthema portulacastrum</i> L.	desert horsepurslane	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Amaranthaceae</b>	<i>Amaranthus</i> L. sp.	pigweed	PW
	<i>Froelichia arizonica</i> Thornb. ex Standl.	Arizona snakecotton	PW
	<i>Froelichia gracilis</i> (Hook.) Moq.	slender snakecotton	PW
	<i>Iresine heterophylla</i> Standl.	Standley's bloodleaf	PW
	<i>Tidestromia carnosa</i> (Steyerm.) I.M. Johnst.	fleshy honeysweet	PW
	<i>Tidestromia lanuginosa</i> (Nutt.) Standl.	woolly tidestromia	PW
	<i>Tidestromia suffruticosa</i> (Torr.) Standl.	shrubby honeysweet	PW
<b>Anacardiaceae</b>	<i>Rhus microphylla</i> Engelm. ex A. Gray	littleleaf sumac	PW
	<i>Rhus trilobata</i> Nutt. var. <i>pilosissima</i> Engelm.	pubescent skunkbush sumac	A
	<i>Rhus virens</i> Lindh. ex A. Gray	evergreen sumac	PW
	<i>Toxicodendron radicans</i> (L.) Kuntze	eastern poison ivy	PW
<b>Apiaceae</b>	<i>Aletes acaulis</i> (Torr.) J.M. Coult. & Rose	stemless Indian parsley	AI
<b>Apocynaceae</b>	<i>Asclepias asperula</i> (Decne.) Woodson	spider milkweed	PW
	<i>Asclepias texana</i> A. Heller	Texas milkweed	PW
	<i>Cynanchum barbigerum</i> (Scheele) Shinnars	bearded swallow-wort	PW
	<i>Cynanchum pringlei</i> (A. Gray) Henrickson	Pringle's swallow-wort	PW
	<i>Cynanchum racemosum</i> (Jacq.) Jacq.	talayote	PW
	<i>Funastrum crispum</i> (Benth.) Schltr.	wavyleaf twinevine	PW
	<i>Funastrum cynanchoides</i> (Decne.) Schltr.	fringed twinevine	PW
	<i>Funastrum torreyi</i> (A. Gray) Schltr.	soft twinevine	PW
	<i>Mandevilla hypoleuca</i> (Benth.) Pichon	Davis Mountain rocktrumpet	PW
	<i>Mandevilla lanuginosa</i> (M. Martens & Galeotti) Pichon	plateau rocktrumpet	Tndd
	<i>Mandevilla macrosiphon</i> (Torr.) Pichon	plateau rocktrumpet	PW
	<i>Matelea parvifolia</i> (Torr.) Woodson	spearleaf	PW
	<i>Matelea reticulata</i> (Engelm. ex A. Gray) Woodson	netted milkvine	PW
<b>Aristolochiaceae</b>	<i>Aristolochia coryi</i> I.M. Johnst.	Cory's dutchman's pipe	PW
<b>Asteraceae</b>	<i>Acourtia nana</i> (A. Gray) Reveal & King	dwarf desertpeony	PW
	<i>Acourtia runcinata</i> (Lag. ex D. Don) B.L. Turner	featherleaf desertpeony	PW
	<i>Acourtia wrightii</i> (A. Gray) Reveal & King	brownfoot	PW



Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Asteraceae</b> <b>(continued)</b>	<i>Ageratina herbacea</i> (A. Gray) King & H. Rob.	fragrant snakeroot	PW
	<i>Ageratina rothrockii</i> (A. Gray) King & H. Rob.	Rothrock's snakeroot	PW
	<i>Ageratina wrightii</i> (A. Gray) King & H. Rob.	Wright's snakeroot	PW
	<i>Ambrosia psilostachya</i> DC.	Cuman ragweed	PW
	<i>Artemisia dracunculus</i> L.	tarragon	PW
	<i>Artemisia ludoviciana</i> Nutt.	Louisiana wormwood	PW
	<i>Baccharis havardii</i> A. Gray	Havard's false willow	PW
	<i>Baccharis neglecta</i> Britton	Rooseveltweed	PW
	<i>Baccharis salicifolia</i> (Ruiz & Pav.) Pers.	mule-fat	PW
	<i>Baccharis wrightii</i> A. Gray	Wright's baccharis	PW
	<i>Bahia absinthifolia</i> Benth.	hairyseed bahia	Tndd
	<i>Bahia pedata</i> A. Gray	bluntscale bahia	Tndd
	<i>Baileya multiradiata</i> Harv. & A. Gray ex A. Gray	desert marigold	PW
	<i>Bidens bigelovii</i> A. Gray	Bigelow's beggarticks	PW
	<i>Bidens leptcephala</i> Sherff	fewflower beggarticks	PW
	<i>Brickellia brachyphylla</i> (A. Gray) A. Gray	plumed brickellbush	PW
	<i>Brickellia coulteri</i> A. Gray	Coulter's brickellbush	PW
	<i>Brickellia laciniata</i> A. Gray	splitleaf brickellbush	PW
	<i>Brickellia lemmonii</i> A. Gray var. <i>lemmonii</i>	Lemmon's brickellbush	PW
	<i>Brickellia veronicifolia</i> (Kunth) A. Gray var. <i>petrophila</i> (B.L. Rob.) B.L. Rob.	veronicaleaf brickellbush	PW
	<i>Chloracantha spinosa</i> (Benth.) G.L. Nesom	devilweed	PW
	<i>Chromolaena bigelovii</i> (A. Gray) King & H. Rob.	Bigelow's thoroughwort	PW
	<i>Chrysactinia mexicana</i> A. Gray	damianita	PW
	<i>Chrysothamnus baileyi</i> Woot. & Standl.	Bailey's rabbitbrush	Tndd
	<i>Chrysothamnus spathulatus</i> L.C. Anderson	Guadalupe rabbitbrush	Tndd
	<i>Cirsium texanum</i> Buckley Asteraceae (cont.)	Texas thistle	PW
	<i>Conoclinium greggii</i> (A. Gray) Small	palmleaf thoroughwort	2
	<i>Conyza canadensis</i> (L.) Cronquist	Canadian horseweed	PW
	<i>Dyssodia</i> Cav. sp.	dyssodia	PW
	<i>Eclipta prostrata</i> (L.) L.	false daisy	PW
	<i>Erigeron flagellaris</i> A. Gray	trailing fleabane	PW
	<i>Erigeron modestus</i> A. Gray	plains fleabane	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Asteraceae</b> (continued)	<i>Eupatorium</i> L. sp.	thoroughwort	PW
	<i>Flourensia cernua</i> DC.	American tarwort	PW
	<i>Flyriella parryi</i> (A. Gray) King & H. Rob.	Chisos Mountain brickellbush	PW
	<i>Grindelia arizonica</i> A. Gray	Arizona gumweed	PW
	<i>Gutierrezia microcephala</i> (DC.) A. Gray	threadleaf snakeweed	PW
	<i>Gutierrezia sarothrae</i> (Pursh) Britton & Rusby	broom snakeweed	PW
	<i>Gymnosperma glutinosum</i> (Spreng.) Less.	gumhead	PW
	<i>Haploesthes greggii</i> A. Gray	false broomweed	PW
	<i>Helenium amarum</i> (Raf.) H. Rock	yellowdicks	PW
	<i>Helenium elegans</i> DC.	pretty sneezeweed	PW
	<i>Helenium microcephalum</i> DC. var. <i>microcephalum</i>	smallhead sneezeweed	PW
	<i>Helianthus</i> L.	sunflower	PW
	<i>Helianthus annuus</i> L.	common sunflower	PW
	<i>Helianthus ciliaris</i> DC.	Texas blueweed	PW
	<i>Helianthus petiolaris</i> Nutt.	prairie sunflower	PW
	<i>Heliomeris longifolia</i> (B.L. Rob. & Greenm.) Cockerell var. <i>longifolia</i>	longleaf false goldeneye	Sc
	<i>Heliopsis parvifolia</i> A. Gray	mountain oxeye	PW
	<i>Heterotheca fulcrata</i> (Greene) Shinnars	rockyscree false goldenaster	PW
	<i>Heterotheca subaxillaris</i> (Lam.) Britton & Rusby	camphorweed	PW
	<i>Hieracium schultzii</i> Fr.	roughstem hawkweed	PW
	<i>Hymenoclea monogyra</i> Torr. & A. Gray	singlewhorl burrobrush	Tndd
	<i>Isocoma pluriflora</i> (Torr. & A. Gray) Greene	southern goldenbush	PW
	<i>Jefea brevifolia</i> (A. Gray) Strother	shortleaf jefea	PW
	<i>Koanophyllon solidaginifolium</i> (A. Gray) King & H. Rob.	shrubby thoroughwort	PW
	<i>Laennecia coulteri</i> (A. Gray) G.L. Nesom	Coulter's horseweed	PW
	<i>Liatris punctata</i> Hook.	dotted blazing star	PW
	<i>Lygodesmia ramosissima</i> Greenm.	Pecos River skeletonplant	PW
	<i>Lygodesmia texana</i> (Torr. & A. Gray) Greene	Texas skeletonplant	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Asteraceae</b> (continued)	<i>Machaeranthera pinnatifida</i> (Hook.) Shinnars ssp. <i>pinnatifida</i> var. <i>chihuahuana</i> B.L. Turner & R.L. Hartm.	Chihuahua tansyaster	3
	<i>Machaeranthera tanacetifolia</i> (Kunth) Nees	tanseyleaf tansyaster	PW
	<i>Melampodium leucanthum</i> Torr. & A. Gray	plains blackfoot	PW
	<i>Packera millelobata</i> (Rydb.) W.A. Weber & A. Löve	Uinta ragwort	PW
	<i>Parthenium argentatum</i> A. Gray	guayule	PW
	<i>Parthenium confertum</i> A. Gray	Gray's feverfew	PW
	<i>Parthenium incanum</i> Kunth	mariola	PW
	<i>Pectis angustifolia</i> Torr.	lemonscent	PW
	<i>Pericome caudata</i> A. Gray	mountain tail-leaf	PW
	<i>Perityle vaseyi</i> J.M. Coult.	Vasey's rockdaisy	PW
	<i>Porophyllum scoparium</i> A. Gray	Trans-Pecos poreleaf	PW
	<i>Pseudognaphalium arizonicum</i> (A. Gray) Anderb.	Arizona cudweed	PW
	<i>Psilostrophe tagetina</i> (Nutt.) Greene	woolly paperflower	PW
	<i>Senecio flaccidus</i> Less.	threadleaf ragwort	PW
	<i>Sonchus asper</i> (L.) Hill	spiny sowthistle	PW
	<i>Sonchus oleraceus</i> L.	common sowthistle	PW
	<i>Stephanomeria pauciflora</i> (Torr.) A. Nelson	brownplume wirelettuce	PW
	<i>Stevia ovata</i> Willd. var. <i>texana</i> Grashoff	Texan candyleaf	PW
	<i>Stevia viscida</i> Kunth	viscid candyleaf	PW
	<i>Symphyotrichum expansum</i> (Poepp. ex Spreng.) G.L. Nesom	southwestern annual saltmarsh aster	PW
	<i>Tagetes micrantha</i> Cav.	licorice marigold	PW
	<i>Tetraneuris scaposa</i> (DC.) Greene	stemmy four-nerve daisy	PW
	<i>Thelesperma ambiguum</i> A. Gray	Colorado greenthread	St1
	<i>Thelesperma longipes</i> A. Gray	longstalk greenthread	PW
	<i>Thelesperma megapotamicum</i> (Spreng.) Kuntze	Hopi tea greenthread	St1
	<i>Thelesperma simplicifolium</i> A. Gray	slender greenthread	PW
	<i>Thymophylla acerosa</i> (DC.) Strother	pricklyleaf dogweed	PW
	<i>Thymophylla aurea</i> (A. Gray) Greene ex Britton var. <i>aurea</i>	manyawn pricklyleaf	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Asteraceae (continued)</b>	<i>Thymophylla pentachaeta</i> (DC.) Small var. <i>belenidium</i> (DC.) Strother	fiveneedle pricklyleaf	St2
	<i>Thymophylla pentachaeta</i> (DC.) Small var. <i>pentachaeta</i>	fiveneedle pricklyleaf	St2
	<i>Trixis californica</i> Kellogg	American threefold	PW
	<i>Verbesina encelioides</i> (Cav.) Benth. & Hook. f. ex A. Gray	golden crownbeard	PW
	<i>Verbesina oreophila</i> Woot. & Standl.	mountain crownbeard	Tndd
	<i>Viguiera dentata</i> (Cav.) Spreng.	toothleaf goldeneye	Tndd
	<i>Viguiera stenoloba</i> S.F. Blake	resinbush	Tndd
	<i>Xanthium strumarium</i> L.	rough cocklebur	PW
	<i>Xylorhiza wrightii</i> (A. Gray) Greene	Big Bend woodyaster	Tndd
	<i>Zinnia acerosa</i> (DC.) A. Gray	desert zinnia	Tndd
<b>Berberidaceae</b>	<i>Mahonia trifoliolata</i> (Moric.) Fedde	algerita	4
<b>Bignoniaceae</b>	<i>Chilopsis linearis</i> (Cav.) Sweet	desert willow	PW
	<i>Tecoma stans</i> (L.) Juss. ex Kunth	yellow trumpetbush	PW
<b>Boraginaceae</b>	<i>Heliotropium confertifolium</i> (Torr.) Torr. ex A. Gray	leafy heliotrope	Tndd
	<i>Heliotropium curassavicum</i> L. var. <i>curassavicum</i>	salt heliotrope	Tndd
	<i>Heliotropium molle</i> (Torr.) I.M. Johnst.	soft heliotrope	PW
	<i>Lithospermum incisum</i> Lehm.	narrowleaf stoneseed	PW
	<i>Lithospermum multiflorum</i> Torr. ex A. Gray	manyflowered stoneseed	PW
	<i>Nama havardii</i> A. Gray	Havard's fiddleleaf	PW
	<i>Nama hispidum</i> A. Gray	bristly nama	PW
	<i>Nama undulatum</i> Kunth	whitewhisker fiddleleaf	Tndd
	<i>Phacelia</i> Juss. sp.	phacelia	PW
	<i>Tiquilia canescens</i> (DC.) A.T. Richardson var. <i>canescens</i>	woody crinklemat	PW
	<i>Tiquilia gossypina</i> (Woot. & Standl.) A.T. Richardson	Texas crinklemat	PW
	<i>Tiquilia greggii</i> (Torr. & A. Gray) A.T. Richardson	plumed crinklemat	PW
	<i>Tiquilia hispidissima</i> (Torr. & A. Gray) A.T. Richardson	hairy crinklemat	PW
	<i>Tiquilia mexicana</i> (S. Watson) A.T. Richardson	Mexican crinklemat	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Brassicaceae</b>	<i>Cardamine macrocarpa</i> <i>Brandegee</i> var. <i>texana</i> Rollins	Texas bittercress	Tndd
	<i>Descurainia pinnata</i> (Walter) Britton	western tansymustard	PW
	<i>Lesquerella fendleri</i> (A. Gray) S. Watson	Fendler's bladderpod	Tndd
	<i>Lesquerella purpurea</i> (A. Gray) S. Watson	rose bladderpod	Tndd
	<i>Nerisyrenia camporum</i> (A. Gray) Greene	bicolor fanmustard	PW
	<i>Schoenocrambe linearifolia</i> (A. Gray) Rollins	slimleaf plainsmustard	Tndd
	<i>Sisymbrium auriculatum</i> A. Gray	eared hedgemustard	5
	<i>Sisymbrium irio</i> L.	London rocket	PW
<b>Cactaceae</b>	<i>Ariocarpus fissuratus</i> (Engelm.) K. Schum.	chautle livingrock	PW
	<i>Coryphantha echinus</i> (Engelm.) Britton & Rose	rhinoceros cactus	PW
	<i>Coryphantha macromeris</i> (Engelm.) Lem.	nipple beehive cactus	PW
	<i>Cylindropuntia davisii</i> (Engelm. & Bigelow) F.M. Knuth	thistle cholla	PW
	<i>Cylindropuntia imbricata</i> (Haw.) F.M. Knuth var. <i>argentea</i> (Anthony) Backeb.	tree cholla	PW
	<i>Cylindropuntia imbricata</i> (Haw.) F.M. Knuth var. <i>imbricata</i>	tree cholla	PW
	<i>Cylindropuntia leptocaulis</i> (DC.) F.M. Knuth	Christmas cactus	PW
	<i>Echinocactus horzonthalonius</i> Lem.	devilshead	PW
	<i>Echinocactus texensis</i> Hopffer	horse crippler	PW
	<i>Echinocereus coccineus</i> Engelm. var. <i>paucispinus</i> (Engelm.) D.J. Ferguson	scarlet hedgehog cactus	PW
	<i>Echinocereus dasyacanthus</i> Engelm.	Texas rainbow cactus	PW
	<i>Echinocereus enneacanthus</i> Engelm. var. <i>enneacanthus</i>	pitaya	PW
	<i>Echinocereus fendleri</i> (Engelm.) Sencke ex J.N. Haage	pinkflower hedgehog cactus	PW
	<i>Echinocereus russanthus</i> D. Weniger	browns spine hedgehog cactus	6
	<i>Echinocereus stramineus</i> (Engelm.) F. Seitz	strawberry hedgehog cactus	PW
	<i>Echinomastus warnockii</i> (L.D. Benson) Glass & R.A. Foster	Warnock's fishhook cactus	PW
	<i>Epithelantha bokei</i> L.D. Benson	pingpong-ball cactus	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Cactaceae</b> (continued)	<i>Epithelantha micromeris</i> (Engelm.) F.A.C. Weber ex Britton & Rose	pingpong-ball cactus	PW
	<i>Escobaria albicolumnaria</i> Hester	column foxtail cactus	7
	<i>Escobaria dasyacantha</i> var. <i>dasyacantha</i> (Engelm.) Britton & Rose	Big Bend foxtail cactus	8
	<i>Escobaria dasyacantha</i> (Engelm.) Britton & Rose var. <i>chaffeyi</i> (Britton & Rose) N.P. Taylor	Chaffey's foxtail cactus	9
	<i>Escobaria tuberculosa</i> (Engelm.) Britton & Rose var. <i>tuberculosa</i>	whitcolumn foxtail cactus	PW
	<i>Ferocactus hamatacanthus</i> (Muehlenpf.) Britton & Rose	turk's head	PW
	<i>Glandulicactus uncinatus</i> (Galeotti) Backeb. var. <i>wrightii</i> (Engelm.) Backeb.	Chihuahuan fishhook cactus	PW
	<i>Grusonia aggeria</i> (B.E. Ralston & Hilsenb.) E.F. Anderson	Big Bend dog cholla	Pi
	<i>Grusonia densispina</i> (Ralston & Hilsenbeck) Pinkava <sup>A</sup>	dense-spined dog cholla	Prb
	<i>Grusonia schottii</i> (Engelm.) H. Rob.	Schott's dog cholla	Pi
	<i>Mammillaria heyderi</i> Muehlenpf.	little nipple cactus	PW
	<i>Mammillaria lasiacantha</i> Engelm.	lacespine nipple cactus	PW
	<i>Mammillaria meiacantha</i> Engelm.	little nipple cactus	PW
	<i>Neolloydia conoidea</i> (DC.) Britton & Rose	Chihuahuan beehive	PW
	<i>Opuntia aureispina</i> (Brack & K.D. Heil) Pinkava & Parfitt	Rio Grande pricklypear	Tndd
	<i>Opuntia azurea</i> Rose var. <i>parva</i> A.M. Powell & Weedin <sup>C</sup>	Big Bend purplish pricklypear	PW
	<i>Opuntia camanchica</i> Engelm. & J.M. Bigelow	tulip pricklypear	PW
	<i>Opuntia chisosensis</i> (Anthony) D.J. Ferguson	Chisos Mountain pricklypear	PW
	<i>Opuntia dulcis</i> Engelm. <sup>D</sup>	sweet pricklypear	PW
	<i>Opuntia engelmannii</i> var. <i>engelmannii</i> Salm-Dyck ex Engelm. var. <i>engelmannii</i>	Engelmann's pricklypear	PW
	<i>Opuntia macrocentra</i> Engelm.	purple pricklypear	PW
	<i>Opuntia rufida</i> Engelm.	blind pricklypear	PW
	<i>Opuntia</i> × <i>spinosibacca</i> Anthony (pro sp.)	spiny-fruit pricklypear	PW
<b>Campanulaceae</b>	<i>Lobelia cardinalis</i> L.	cardinalflower	PW



Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Cannabaceae</b>	<i>Celtis ehrenbergiana</i> (Klotzsch) Liebm.	spiny hackberry	10
	<i>Celtis laevigata</i> Willd. var. <i>reticulata</i> (Torr.) L.D. Benson	netleaf hackberry	Po
<b>Caprifoliaceae</b>	<i>Lonicera albiflora</i> Torr. & A. Gray	western white honeysuckle	PW
	<i>Symphoricarpos palmeri</i> G.N. Jones	Palmer's snowberry	PW
<b>Caryophyllaceae</b>	<i>Paronychia jamesii</i> Torr. & A. Gray	James' nailwort	Tndd
<b>Celastraceae</b>	<i>Mortonia scabrella</i> A. Gray	Rio Grande saddlebush	PW
	<i>Schaefferia cuneifolia</i> A. Gray	desert yaupon	PW
<b>Chenopodiaceae</b>	<i>Atriplex acanthocarpa</i> (Torr.) S. Watson	tubercled saltbush	PW
	<i>Atriplex canescens</i> (Pursh) Nutt.	fourwing saltbush	PW
	<i>Atriplex obovata</i> Moq.	mound saltbush	PW
	<i>Chenopodium incanum</i> (S. Watson) A. Heller	mealy goosefoot	PW
	<i>Dysphania graveolens</i> (Willd.) Mosyakin & Clemants	fetid goosefoot	PW
	<i>Salsola tragus</i> L.	prickly Russian thistle	PW
	<i>Suaeda suffrutescens</i> S. Watson	desert seepweed	Tndd
<b>Cleomaceae</b>	<i>Cleomella longipes</i> Torr.	Chiricahua Mountain stinkweed	PW
<b>Convolvulaceae</b>	<i>Convolvulus equitans</i> Benth.	Texas bindweed	PW
	<i>Dichondra argentea</i> Humb. & Bonpl. ex Willd.	silver ponysfoot	PW
	<i>Dichondra brachypoda</i> Woot. & Standl.	New Mexico ponysfoot	PW
	<i>Evolvulus alsinoides</i> (L.) L.	slender dwarf morning-glory	PW
	<i>Ipomoea cardiophylla</i> A. Gray	heartleaf morning-glory	PW
	<i>Ipomoea costellata</i> Torr.	crestrub morning-glory	PW
	<i>Ipomoea cristulata</i> Hallier f.	Trans-Pecos morning-glory	PW
	<i>Ipomoea hederacea</i> Jacq.	ivy leaf morning-glory	PW
	<i>Ipomoea lindheimeri</i> A. Gray	Lindheimer's morning-glory	PW
	<i>Ipomoea tenuiloba</i> Torr.	spiderleaf	PW
<b>Crassulaceae</b>	<i>Echeveria strictiflora</i> A. Gray	desert savior	PW
	<i>Sedum havardii</i> Rose	Havard's stonecrop	PW
<b>Crossosomataceae</b>	<i>Glossopetalon spinescens</i> A. Gray	spiny greaseweed	PW

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<b>Cucurbitaceae</b>	<i>Ibervillea tenuisecta</i> (A. Gray) Small	slimlobe globeberry	PW
<b>Cuscutaceae</b>	<i>Cuscuta indecora</i> Choisy	bigseed alfalfa dodder	PW
<b>Ebenaceae</b>	<i>Diospyros texana</i> Scheele	Texas persimmon	PW
<b>Ericaceae</b>	<i>Arbutus xalapensis</i> Kunth	Texas madrone	PW
<b>Euphorbiaceae</b>	<i>Acalypha monostachya</i> Cav.	round copperleaf	PW
	<i>Acalypha phleoides</i> Cav.	shrubby copperleaf	PW
	<i>Argythamnia humilis</i> (Engelm. & A. Gray) Müll. Arg.	low silverbush	PW
	<i>Argythamnia humilis</i> (Engelm. & A. Gray) Müll. Arg. var. <i>humilis</i>	low silverbush	11
	<i>Argythamnia serrata</i> (Torr.) Müll. Arg.	Yuma silverbush	PW
	<i>Bernardia myricifolia</i> (Scheele) S. Watson	mouse's eye	PW
	<i>Bernardia obovata</i> I.M. Johnst.	desert myrtlecroton	PW
	<i>Chamaesyce albomarginata</i> (Torr. & A. Gray) Small	whitemargin sandmat	Tndd
	<i>Chamaesyce chaetocalyx</i> (Boiss.) Woot. & Standl. var. <i>chaetocalyx</i>	bristlecup sandmat	12
	<i>Chamaesyce cinerascens</i> (Engelm.) Small	ashy sandmat	Tndd
	<i>Chamaesyce fendleri</i> (Torr. & A. Gray) Small	Fendler's sandmat	Tndd
	<i>Chamaesyce prostrata</i> (Aiton) Small	prostrate sandmat	Tndd
	<i>Chamaesyce serpens</i> (Kunth) Small	matted sandmat	Tndd
	<i>Chamaesyce serpyllifolia</i> (Pers.) Small	thymeleaf sandmat	Tndd
	<i>Chamaesyce spurca</i> (M.C. Johnst.) B.L. Turner	low sandmat	Tndd
	<i>Chamaesyce villifera</i> (Scheele) Small	hairy sandmat	Tndd
	<i>Croton bigbendensis</i> B.L. Turner <sup>E</sup>	Big Bend croton	PW
	<i>Croton dioicus</i> Cav.	grassland croton	PW
	<i>Croton fruticosus</i> Engelm. ex Torr.	bush croton	PW
	<i>Croton incanus</i> Kunth	Torrey's croton	PW
	<i>Croton monanthogynus</i> Michx.	prairie tea	PW
	<i>Croton pottsii</i> (Klotzsch) Müll. Arg.	leatherweed	PW
	<i>Croton pottsii</i> (Klotzsch) Müll. Arg. var. <i>thermophilus</i> (M.C. Johnst.) M.C. Johnst.	leatherweed	vB
	<i>Croton sancti-lazari</i> Croizat	Trans-Pecos croton	PW
	<i>Croton texensis</i> (Klotzsch) Müll. Arg.	Texas croton	PW

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<b>Euphorbiaceae (continued)</b>	<i>Euphorbia antisiphilitica</i> Zucc.	candelilla	PW
	<i>Euphorbia dentata</i> Michx.	toothed spurge	PW
	<i>Euphorbia eriantha</i> Benth.	beetle spurge	PW
	<i>Euphorbia exstipulata</i> Engelm.	squareseed spurge	PW
	<i>Jatropha dioica</i> Cerv.	leatherstem	PW
	<i>Phyllanthus ericoides</i> Torr.	heather leaf-flower	PW
	<i>Phyllanthus polygonoides</i> Nutt. ex Spreng.	smartweed leaf-flower	PW
	<i>Tragia amblyodonta</i> (Müll. Arg.) Pax & K. Hoffm.	dogtooth noseburn	PW
	<i>Tragia ramosa</i> Torr.	branched noseburn	PW
<b>Fabaceae</b>	<i>Acaciella angustissima</i> (Mill.) Britton & Rose	prairie acacia	PW
	<i>Astragalus mollissimus</i> Torr.	woolly locoweed	PW
	<i>Calliandra eriophylla</i> Benth.	fairyduster	PW
	<i>Calliandra humilis</i> Benth.	dwarf stickpea	PW
	<i>Cercis canadensis</i> L. var. <i>mexicana</i> (Rose) M. Hopkins	Mexican redbud	PW
	<i>Cologania angustifolia</i> Kunth	longleaf cologania	PW
	<i>Dalea formosa</i> Torr.	featherplume	PW
	<i>Dalea frutescens</i> A. Gray	black prairie clover	PW
	<i>Dalea nana</i> Torr. ex A. Gray	dwarf prairie clover	PW
	<i>Dalea neomexicana</i> (A. Gray) Cory	downy prairie clover	PW
	<i>Dalea pogonathera</i> A. Gray	bearded prairie clover	PW
	<i>Desmanthus cooleyi</i> (Eaton) Trel.	Cooley's bundleflower	PW
	<i>Desmanthus glandulosus</i> (B.L. Turner) Luckow	glandular bundleflower	PW
	<i>Desmanthus velutinus</i> Scheele	velvet bundleflower	PW
	<i>Desmodium psilophyllum</i> Schltdl.	simpleleaf ticktrefoil	PW
	<i>Eysenhardtia texana</i> Scheele	Texas kidneywood	PW
	<i>Gleditsia triacanthos</i> L.	honeylocust	Tnnd
	<i>Leucaena retusa</i> Benth.	littleleaf leadtree	PW
	<i>Lupinus havardii</i> S. Watson	Big Bend bluebonnet	PW
	<i>Mimosa aculeaticarpa</i> Ortega var. <i>biuncifera</i> (Benth.) Barneby	catclaw mimosa	PW
	<i>Mimosa borealis</i> A. Gray	fragrant mimosa	PW
	<i>Mimosa emoryana</i> Benth.	Emory's mimosa	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Fabaceae</b> (continued)	<i>Mimosa texana</i> (A. Gray) Small	Texas mimosa	PW
	<i>Parkinsonia aculeata</i> L.	Jerusalem thorn	PW
	<i>Phaseolus angustissimus</i> A. Gray	slimleaf bean	PW
	<i>Phaseolus filiformis</i> Benth.	slimjim bean	PW
	<i>Phaseolus pedicellatus</i> Benth. var. <i>grayanus</i> (Woot. & Standl.) A. Delgado ex Isely	Gray's bean	AI
	<i>Pomaria melanosticta</i> S. Schauer	Parry's holdback	PW
	<i>Prosopis glandulosa</i> Torr. var. <i>torreyana</i> (L.D. Benson) M.C. Johnst.	western honey mesquite	PW
	<i>Prosopis pubescens</i> Benth.	screwbean mesquite	PW
	<i>Rhynchosia senna</i> Gillies ex Hook. var. <i>texana</i> (Torr. & A. Gray) M.C. Johnst.	Texas snoutbean	Is
	<i>Senna bauhinioides</i> (A. Gray) Irwin & Barneby	twinleaf senna	PW
	<i>Senegalia berlandieri</i> Britton & Rose	guajillo	PW
	<i>Senegalia greggii</i> (A. Gray) Britton & Rose	Gregg's catclaw	PW
	<i>Senegalia roemeriana</i> (Scheele) Britton & Rose	Roemer's acacia	PW
	<i>Senna bauhinioides</i> (A. Gray) Irwin & Barneby	twinleaf senna	PW
	<i>Senna durangensis</i> (Rose) Irwin & Barneby	Durango senna	PW
	<i>Senna lindheimeriana</i> (Scheele) Irwin & Barneby	velvet leaf senna	PW
	<i>Sophora secundiflora</i> (Ortega) Lag. ex DC.	mescal bean	Tndd
	<i>Vachellia constricta</i> (Benth.) Seigler & Ebinger	whitethorn acacia	PW
	<i>Vachellia farnesiana</i> (L.) Wight & Arn.	huisache	PW
	<i>Vachellia rigidula</i> (Benth.) Seigler & Ebinger	blackbrush acacia	PW
	<i>Vachellia vernicosa</i> (Britton & Rose) Seigler & Ebinger	viscid acacia	PW
	<i>Vicia ludoviciana</i> Nutt.	Louisiana vetch	PW
<b>Fagaceae</b>	<i>Quercus arizonica</i> Sarg.	Arizona white oak	PW
	<i>Quercus emoryi</i> Torr.	Emory oak	PW
	<i>Quercus graciliformis</i> C.H. Mull.	Chisos oak	PW
	<i>Quercus gravesii</i> Sudw.	Graves' oak	PW
	<i>Quercus grisea</i> Liebm.	gray oak	PW
	<i>Quercus intricata</i> Trel.	Coahuila scrub oak	PW
	<i>Quercus laceyi</i> Small	Lacey oak	PW
	<i>Quercus mohriana</i> Buckley ex Rydb.	Mohr's shin oak	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Fagaceae</b> (continued)	<i>Quercus muehlenbergii</i> Engelm.	chinkapin oak	PW
	<i>Quercus pungens</i> Liebm.	pungent oak	PW
	<i>Quercus robusta</i> C.H. Mull.	robust oak	PW
	<i>Quercus rugosa</i> Née	netleaf oak	PW
	<i>Quercus vaseyana</i> Buckley	sandpaper oak	PW
<b>Fouquieriaceae</b>	<i>Fouquieria splendens</i> Engelm.	ocotillo	PW
<b>Garryaceae</b>	<i>Garrya ovata</i> Benth. ssp. <i>goldmanii</i> (Woot. & Standl.) Dahling	Goldman's silktassel	Tndd
<b>Gentianaceae</b>	<i>Centaurium arizonicum</i> (A. Gray) A. Heller	Arizona centaury	Tndd
	<i>Centaurium calycosum</i> (Buckley) Fernald	Arizona centaury	Tndd
	<i>Eustoma exaltatum</i> (L.) Salisb. ex G. Don	catchfly prairie gentian	PW
<b>Hydrangeaceae</b>	<i>Fendlera rupicola</i> A. Gray	cliff fendlerbush	PW
<b>Juglandaceae</b>	<i>Carya illinoensis</i> (Wangenh.) K. Koch	pecan	PW
	<i>Juglans microcarpa</i> Berl.	little walnut	PW
<b>Koeberliniaceae</b>	<i>Koeberlinia spinosa</i> Zucc.	crown of thorns	PW
<b>Krameriaceae</b>	<i>Krameria erecta</i> Willd. ex Schult.	littleleaf ratany	PW
	<i>Krameria grayi</i> Rose & Painter	white ratany	Tndd
	<i>Krameria ramosissima</i> (A. Gray) S. Watson	manystem ratany	PW
<b>Lamiaceae</b>	<i>Hedeoma drummondii</i> Benth.	Drummond's false pennyroyal	PW
	<i>Hedeoma plicata</i> Torr.	veiny false pennyroyal	PW
	<i>Salazaria mexicana</i> Torr.	Mexican bladdersage	Tndd
	<i>Salvia arizonica</i> A. Gray	desert indigo sage	PW
	<i>Salvia greggii</i> A. Gray	autumn sage	PW
	<i>Salvia lycioides</i> A. Gray	canyon sage	PW
	<i>Salvia regla</i> Cav.	mountain sage	PW
	<i>Scutellaria potosina</i> Brandegee	Mexican skullcap	PW
	<i>Teucrium laciniatum</i> Torr.	lacy germander	PW
<b>Linaceae</b>	<i>Linum australe</i> A. Heller	southern flax	PW
	<i>Linum schiedeanum</i> Schltldl. & Cham.	Schied's flax	PW
<b>Loasaceae</b>	<i>Cevallia sinuata</i> Lag.	stinging serpent	PW
	<i>Mentzelia mexicana</i> H.J. Thomp. & Zavort.	Mexican blazingstar	PW
	<i>Mentzelia multiflora</i> (Nutt.) A. Gray	Adonis blazingstar	Tndd

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Loasaceae</b> (continued)	<i>Mentzelia oligosperma</i> Nutt. ex Sims	chickenthief	PW
<b>Lythraceae</b>	<i>Lythrum californicum</i> Torr. & A. Gray	California loosestrife	PW
<b>Malpighiaceae</b>	<i>Janusia gracilis</i> A. Gray	slender janusia	Tnnd
<b>Malvaceae</b>	<i>Abutilon fruticosum</i> Guill. & Perr.	Texas Indian mallow	PW
	<i>Abutilon malacum</i> S. Watson	yellow Indian mallow	PW
	<i>Abutilon wrightii</i> A. Gray	Wright's Indian mallow	PW
	<i>Hibiscus coulteri</i> Harv. ex A. Gray	desert rosemallow	PW
	<i>Hibiscus denudatus</i> Benth.	paleface	PW
	<i>Malvella leprosa</i> (Ortega) Krapov.	alkali mallow	PW
	<i>Sida abutifolia</i> Mill.	spreading fanpetals	Tnnd
	<i>Sida longipes</i> A. Gray	stockflower fanpetals	PW
	<i>Sphaeralcea angustifolia</i> (Cav.) G. Don	copper globemallow	PW
<b>Martyniaceae</b>	<i>Proboscidea louisianica</i> (Mill.) Thell.	ram's horn	PW
<b>Meliaceae</b>	<i>Melia azedarach</i> L.	Chinaberrytree	PW
<b>Montiaceae</b>	<i>Phemeranthus aurantiacus</i> (Engelm.) Kiger	orange fameflower	K
	<i>Phemeranthus longipes</i> (Woot. & Standl.) Kiger	pink fameflower	PW
<b>Moraceae</b>	<i>Morus microphylla</i> Buckley	Texas mulberry	PW
<b>Nyctaginaceae</b>	<i>Acleisanthes longiflora</i> A. Gray	angel's trumpets	PW
	<i>Allionia incarnata</i> L.	trailing windmills	PW
	<i>Anulocaulis eriosolenus</i> (A. Gray) Standl.	Big Bend ringstem	PW
	<i>Boerhavia anisophylla</i> Torr.	wineflower	Tnnd
	<i>Boerhavia coccinea</i> Mill.	scarlet spiderling	PW
	<i>Boerhavia diffusa</i> L.	red spiderling	Tnnd
	<i>Boerhavia intermedia</i> M.E. Jones	fivewing spiderling	Tnnd
	<i>Boerhavia scandens</i> L.	climbing wartclub	13
	<i>Cyphomeris gypsophiloides</i> (M. Martens & Galeotti) Standl.	red cyphomeris	PW
	<i>Mirabilis linearis</i> (Pursh) Heimerl	narrowleaf four o'clock	PW
	<i>Mirabilis longiflora</i> L.	sweet four o'clock	PW
	<i>Mirabilis oxybaphoides</i> (A. Gray) A. Gray	smooth spreading four o'clock	PW
	<i>Mirabilis texensis</i> (J.M. Coult.) B.L. Turner	Texas four o'clock	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Nyctaginaceae</b> (continued)	<i>Nyctaginia capitata</i> Choisy	devil's bouquet	PW
	<i>Selinocarpus angustifolius</i> Torr.	narrowleaf moonpod	Tndd
	<i>Selinocarpus parvifolius</i> (Torr.) Standl.	littleleaf moonpod	Tndd
<b>Oleaceae</b>	<i>Forestiera angustifolia</i> Torr.	Texas swampprivet	PW
	<i>Fraxinus cuspidata</i> Torr.	fragrant ash	PW
	<i>Fraxinus greggii</i> A. Gray	Gregg's ash	PW
	<i>Fraxinus velutina</i> Torr.	velvet ash	PW
	<i>Menodora longiflora</i> A. Gray	showy menodora	PW
	<i>Menodora scabra</i> A. Gray	rough menodora	PW
<b>Onagraceae</b>	<i>Ludwigia</i> L. sp.	primrose-willow	PW
	<i>Oenothera curtiflora</i> W.L. Wagner & Hoch	velvetweed	PW
	<i>Oenothera suffrutescens</i> (Ser.) W.L. Wagner & Hoch	scarlet beeblossom	PW
<b>Orobanchaceae</b>	<i>Castilleja lanata</i> A. Gray	Sierra woolly Indian paintbrush	PW
	<i>Castilleja rigida</i> Eastw.	rigid Indian paintbrush	PW
	<i>Conopholis alpina</i> Liebm.	alpine cancer-root	PW
	<i>Orobanche cooperi</i> (A. Gray) A. Heller	desert broomrape	PW
	<i>Orobanche ludoviciana</i> Nutt.	Louisiana broomrape	PW
	<i>Seymeria scabra</i> A. Gray	limpia blacksennea	PW
<b>Oxalidaceae</b>	<i>Oxalis drummondii</i> A. Gray	Drummond's woodsorrel	Tndd
<b>Papaveraceae</b>	<i>Argemone albiflora</i> Hornem. ssp. <i>texana</i> G.B. Ownbey	bluestem pricklypoppy	Tndd
	<i>Argemone chisosensis</i> G.B. Ownbey	Chisos Mountain pricklypoppy	PW
<b>Phytolaccaceae</b>	<i>Rivina humilis</i> L.	rougeplant	PW
<b>Plantaginaceae</b>	<i>Bacopa monnieri</i> (L.) Pennell	herb of grace	PW
	<i>Maurandella antirrhiniflora</i> (Humb. & Bonpl. ex Willd.) Rothm.	climbing snapdragon	PW
	<i>Penstemon barbatus</i> (Cav.) Roth	beardlip penstemon	PW
<b>Polemoniaceae</b>	<i>Gilia stewartii</i> I.M. Johnst.	Stewart's gilia	Tndd
	<i>Giliastrum acerosum</i> (A. Gray) Rydb.	bluebowls	Tndd
	<i>Giliastrum incisum</i> (Benth.) J.M. Porter	splitleaf gilia	Tndd
	<i>Ipomopsis havardii</i> (A. Gray) V.E. Grant	Havard's ipomopsis	Tndd



Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Polemoniaceae</b> (continued)	<i>Phlox nana</i> Nutt.	Santa Fe phlox	PW
<b>Polygalaceae</b>	<i>Polygala alba</i> Nutt.	white milkwort	PW
	<i>Polygala barbeyana</i> Chod.	blue milkwort	Tndd
	<i>Polygala lindheimeri</i> A. Gray var. <i>parvifolia</i> Wheelock	shrubby milkwort	Tndd
	<i>Polygala macradenia</i> A. Gray	glandleaf milkwort	PW
	<i>Polygala scoparioides</i> Chod.	broom milkwort	PW
<b>Polygonaceae</b>	<i>Eriogonum hemipterum</i> (Torr.) S. Stokes	Chisos Mountain buckwheat	PW
	<i>Eriogonum jamesii</i> Benth.	James' buckwheat	PW
	<i>Eriogonum tenellum</i> Torr.	tall buckwheat	PW
	<i>Eriogonum wrightii</i> Torr. ex Benth.	bastardsage	PW
	<i>Polygonum lapathifolium</i> L.	curlytop knotweed	Tndd
	<i>Polygonum persicaria</i> L.	spotted ladysthumb	Dlo
	<i>Rumex crispus</i> L.	curly dock	PW
	<i>Rumex maritimus</i> L.	golden dock	PW
<b>Portulacaceae</b>	<i>Portulaca pilosa</i> L.	kiss me quick	PW
<b>Ranunculaceae</b>	<i>Aquilegia longissima</i> A. Gray	longspur columbine	PW
	<i>Clematis drummondii</i> Torr. & A. Gray	Drummond's clematis	PW
	<i>Clematis pitcheri</i> Torr. & A. Gray	bluebill	PW
<b>Resedaceae</b>	<i>Oligomeris linifolia</i> (Vahl) J.F. Macbr.	lineleaf whitepuff	PW
<b>Rhamnaceae</b>	<i>Ceanothus fendleri</i> A. Gray	Fendler's ceanothus	PW
	<i>Ceanothus greggii</i> A. Gray	desert ceanothus	Tndd
	<i>Condalia correllii</i> M.C. Johnst.	Correll's snakewood	AI
	<i>Condalia ericoides</i> (A. Gray) M.C. Johnst.	javelina bush	PW
	<i>Condalia viridis</i> I.M. Johnst.	green snakewood	PW
	<i>Condalia warnockii</i> M.C. Johnst.	Warnock's snakewood	PW
	<i>Frangula betulifolia</i> (Greene) V. Grub.	beecheaf frangula	PW
	<i>Rhamnus serrata</i> Humb. & Bonpl. ex Schult.	sawleaf buckthorn	Tndd
	<i>Ziziphus obtusifolia</i> (Hook. ex Torr. & A. Gray) A. Gray var. <i>obtusifolia</i>	lotebush	PW
<b>Rosaceae</b>	<i>Cercocarpus montanus</i> Raf.	alderleaf mountain mahogany	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Rosaceae (continued)</b>	<i>Fallugia paradoxa</i> (D. Don) Endl. ex Torr.	Apache plume	PW
	<i>Holodiscus discolor</i> (Pursh) Maxim.	oceanspray	PW
	<i>Prunus havardii</i> (W. Wight) S.C. Mason	Havard's plum	PW
	<i>Prunus serotina</i> Ehrh.	black cherry	PW
	<i>Purshia ericifolia</i> (Torr. ex A. Gray) Henrickson	heath cliffrose	PW
	<i>Vauquelinia corymbosa</i> Humb. & Bonpl. ssp. <i>angustifolia</i> (Rydb.) Hess & Henrickson	slimleaf rosewood	PW
<b>Rubiaceae</b>	<i>Bouvardia ternifolia</i> (Cav.) Schtdl.	firecrackerbush	PW
	<i>Galium mexicanum</i> Kunth ssp. <i>flexicum</i> Dempster	Mexican bedstraw	PW
	<i>Galium microphyllum</i> A. Gray	bracted bedstraw	PW
	<i>Hedyotis intricata</i> Fosberg	tangled starviolet	Tndd
	<i>Houstonia acerosa</i> (A. Gray) A. Gray ex Benth. & Hook. f.	needleleaf bluet	PW
	<i>Stenaria nigricans</i> (Lam.) Terrell	diamond-flowers	PW
<b>Rutaceae</b>	<i>Ptelea trifoliata</i> L.	common hoptree	PW
	<i>Thamnosma texana</i> (A. Gray) Torr.	rue of the mountains	PW
<b>Salicaceae</b>	<i>Populus deltoides</i> Bartram ex Marsh.	eastern cottonwood	PW
	<i>Populus fremontii</i> S. Watson	Fremont cottonwood	PW
	<i>Populus fremontii</i> S. Watson ssp. <i>mesetae</i> Eckenwalder	Fremont cottonwood	E
	<i>Populus tremuloides</i> Michx.	quaking aspen	PW
	<i>Salix gooddingii</i> C.R. Ball	Goodding willow	PW
	<i>Salix thurberi</i> Rowlee <sup>G</sup>	Thurber's willow	PW
<b>Sapindaceae</b>	<i>Acer grandidentatum</i> Nutt.	bigtooth maple	PW
	<i>Sapindus saponaria</i> L. var. <i>drummondii</i> (Hook. & Arn.) L.D. Benson	western soapberry	Tndd
	<i>Ungnadia speciosa</i> Endl.	Mexican buckeye	PW
<b>Saxifragaceae</b>	<i>Heuchera rubescens</i> Torr.	pink alumroot	PW
<b>Scrophulariaceae</b>	<i>Buddleja marrubiifolia</i> Benth.	woolly butterflybush	PW
	<i>Leucophyllum candidum</i> I.M. Johnst.	Boquillas silverleaf	PW
	<i>Leucophyllum frutescens</i> (Berl.) I.M. Johnst.	cenizo	PW
	<i>Leucophyllum minus</i> A. Gray	Big Bend silverleaf	PW
<b>Simaroubaceae</b>	<i>Holacantha stewartii</i> C.H. Mull.	Stewart's crucifixionthorn	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Solanaceae</b>	<i>Datura wrightii</i> Regel	sacred thorn-apple	PW
	<i>Lycium berlandieri</i> Dunal	Berlandier's wolfberry	PW
	<i>Lycium puberulum</i> A. Gray var. <i>berberoides</i> (Correll) Chiang	downy desert-thorn	PW
	<i>Nicotiana glauca</i> Graham	tree tobacco	PW
	<i>Nicotiana obtusifolia</i> M. Martens & Galeotti	desert tobacco	14
	<i>Physalis hederifolia</i> A. Gray	ivy leaf groundcherry	PW
	<i>Quincula lobata</i> (Torr.) Raf.	Chinese lantern	PW
	<i>Solanum elaeagnifolium</i> Cav.	silverleaf nightshade	PW
	<i>Solanum ptycanthum</i> Dunal	West Indian nightshade	PW
<b>Sterculiaceae</b>	<i>Ayenia filiformis</i> S. Watson	Trans-Pecos ayenia	PW
	<i>Ayenia microphylla</i> A. Gray	dense ayenia	PW
<b>Tamaricaceae</b>	<i>Tamarix aphylla</i> (L.) Karst.	Athel tamarisk	PW
	<i>Tamarix ramosissima</i> Ledeb.	saltcedar	Tndd
<b>Theophrastaceae</b>	<i>Samolus ebracteatus</i> Kunth ssp. <i>cuneatus</i> (Small) R. Knuth	limewater brookweed	Dlo
<b>Urticaceae</b>	<i>Parietaria pensylvanica</i> Muhl. ex Willd.	Pennsylvania pellitory	PW
<b>Verbenaceae</b>	<i>Aloysia gratissima</i> (Gillies & Hook.) Troncoso	whitebrush	PW
	<i>Aloysia wrightii</i> (A. Gray) A. Heller	Wright's beebrush	PW
	<i>Bouchea spathulata</i> Torr.	spoonleaf	PW
	<i>Lantana achyranthifolia</i> Desf.	brushland shrubverbena	PW
	<i>Phyla nodiflora</i> (L.) Greene	turkey tangle fogfruit	PW
	<i>Tetradlea coulteri</i> A. Gray	Coulter's wrinklefruit	PW
	<i>Verbena neomexicana</i> (A. Gray) Small var. <i>hirtella</i> L.M. Perry	hillside vervain	15
<b>Viscaceae</b>	<i>Phoradendron coryae</i> Trel.	Cory's mistletoe	AI
	<i>Phoradendron hawksworthii</i> (Wiens) Wiens	Hawksworth's mistletoe	Tndd
	<i>Phoradendron juniperinum</i> Engelm. ex A. Gray	juniper mistletoe	PW
	<i>Phoradendron tomentosum</i> (DC.) Engelm. ex A. Gray	Christmas mistletoe	Tndd
<b>Vitaceae</b>	<i>Cissus trifoliata</i> (L.) L.	sorrelvine	PW
	<i>Vitis arizonica</i> Engelm.	canyon grape	Tndd
	<i>Vitis monticola</i> Buckley	sweet mountain grape	PW
<b>Zygophyllaceae</b>	<i>Guaiacum angustifolium</i> Engelm.	Texas lignum-vitae	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Zygophyllaceae</b> (continued)	<i>Kallstroemia grandiflora</i> Torr. ex A. Gray	Arizona poppy	PW
	<i>Kallstroemia parviflora</i> J.B.S. Norton	warty caltrop	PW
	<i>Larrea tridentata</i> (DC.) Coville	creosotebush	PW
<b>Alismataceae</b>	<i>Sagittaria</i> L. sp.	arrowhead	PW
<b>Amaryllidaceae</b>	<i>Allium kunthii</i> G. Don	Kunth's onion	PW
	<i>Zephyranthes longifolia</i> Hemsl.	copper zephyrlily	Tndd
<b>Asparagaceae</b>	<i>Agave glomeruliflora</i> (Engelm.) A. Berger	Chisos Mountain century plant	PW
	<i>Agave havardiana</i> Trel.	Havard's century plant	PW
	<i>Agave lechuguilla</i> Torr.	lechuguilla	PW
	<i>Dasyllirion leiophyllum</i> Engelm. ex Trel.	green sotol	PW
	<i>Nolina erumpens</i> (Torr.) S. Watson	foothill beargrass	PW
	<i>Yucca elata</i> (Engelm.) Engelm.	soaptree yucca	Tndd
	<i>Yucca faxoniana</i> (Trel.) Sarg.	giant dagger	Tndd
	<i>Yucca thompsoniana</i> Trel.	Thompson's yucca	PW
	<i>Yucca torreyi</i> Shafer	Torrey's yucca	PW
<b>Bromeliaceae</b>	<i>Hechtia texensis</i> S. Watson	Texas false agave	PW
	<i>Tillandsia recurvata</i> (L.) L.	small ballmoss	PW
<b>Commelinaceae</b>	<i>Commelina dianthifolia</i> Delile	birdbill dayflower	PW
	<i>Commelina erecta</i> L.	whitemouth dayflower	PW
	<i>Tradescantia brevifolia</i> (Torr.) Rose	Trans-Pecos spiderwort	PW
<b>Cyperaceae</b>	<i>Carex</i> L. sp.	sedge	PW
	<i>Cyperus laevigatus</i> L.	smooth flatsedge	PW
	<i>Cyperus odoratus</i> L.	fragrant flatsedge	PW
	<i>Cyperus seslerioides</i> Kunth	Texas flatsedge	PW
	<i>Cyperus sphaerolepis</i> Boeckeler	Rusby's flatsedge	PW
	<i>Eleocharis</i> R. Br. sp.	spikerush	PW
	<i>Fuirena simplex</i> Vahl	western umbrella-sedge	PW
	<i>Fuirena simplex</i> Vahl var. <i>simplex</i>	western umbrella-sedge	PW
	<i>Schoenoplectus californicus</i> (C.A. Mey.) Palla	California bulrush	PW
	<i>Schoenoplectus pungens</i> (Vahl) Palla var. <i>longispicatus</i> (Britton) S.G. Sm.	common threesquare	PW
<b>Juncaceae</b>	<i>Juncus torreyi</i> Coville	Torrey's rush	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Orchidaceae</b>	<i>Dichromanthus cinnabarinus</i> (Llave & Lex.) Garay	scarlet lady's tresses	PW
<b>Poaceae</b>	<i>Andropogon glomeratus</i> (Walter) Britton, Sterns & Poggenb.	bushy bluestem	PW
	<i>Aristida adscensionis</i> L.	sixweeks threeawn	PW
	<i>Aristida arizonica</i> Vasey	Arizona threeawn	PW
	<i>Aristida divaricata</i> Humb. & Bonpl. ex Willd.	poverty threeawn	PW
	<i>Aristida purpurea</i> Nutt. var. <i>nealleyi</i> (Vasey) Allred	blue threeawn	PW
	<i>Aristida purpurea</i> Nutt. var. <i>purpurea</i>	purple threeawn	PW
	<i>Aristida purpurea</i> Nutt. var. <i>wrightii</i> (Nash) Allred	Wright's threeawn	PW
	<i>Aristida schiedeana</i> Trin. & Rupr.	single threeawn	PW
	<i>Aristida ternipes</i> Cav. var. <i>gentilis</i> (Henr.) Allred	spidergrass	PW
	<i>Aristida ternipes</i> Cav. var. <i>ternipes</i>	spidergrass	PW
	<i>Arundo donax</i> L.	giant reed	PW
	<i>Blepharoneuron tricholepis</i> (Torr.) Nash	pine dropseed	Tndd
	<i>Bothriochloa barbinodis</i> (Lag.) Herter	cane bluestem	PW
	<i>Bothriochloa ischaemum</i> (L.) Keng	yellow bluestem	PW
	<i>Bothriochloa laguroides</i> (DC.) Herter	silver beardgrass	PW
	<i>Bothriochloa springfieldii</i> (Gould) Parodi	Springfield's beardgrass	PW
	<i>Bouteloua aristidoides</i> (Kunth) Griseb.	needle grama	PW
	<i>Bouteloua barbata</i> Lag.	sixweeks grama	PW
	<i>Bouteloua breviseta</i> Vasey	gypsum grama	PW
	<i>Bouteloua curtipendula</i> (Michx.) Torr.	sideoats grama	PW
	<i>Bouteloua eriopoda</i> (Torr.) Torr.	black grama	PW
	<i>Bouteloua gracilis</i> (Willd. ex Kunth) Lag. ex Griffiths	blue grama	PW
	<i>Bouteloua hirsuta</i> Lag.	hairy grama	PW
	<i>Bouteloua ramosa</i> Scribn. ex Vasey	Chino grama	PW
	<i>Bouteloua trifida</i> Thurb.	red grama	PW
	<i>Bromus anomalus</i> Rupr. ex Fourn.	nodding brome	PW
	<i>Cathastecum erectum</i> Vasey & Hack.	false grama	Tndd
	<i>Cenchrus spinifex</i> Cav.	coastal sandbur	PW
	<i>Chloris verticillata</i> Nutt.	tumble windmill grass	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Poaceae</b> <b>(continued)</b>	<i>Chloris virgata</i> Sw.	feather fingergrass	PW
	<i>Cynodon dactylon</i> (L.) Pers.	Bermudagrass	PW
	<i>Dasyochloa pulchella</i> (Kunth) Willd. ex Rydb.	fluffgrass or low woollygrass	PW
	<i>Dichanthelium acuminatum</i> (Sw.) Gould & C.A. Clark	tapered rosette grass	PW
	<i>Digitaria californica</i> (Benth.) Henr.	Arizona cottontop	PW
	<i>Digitaria cognata</i> (Schult.) Pilg.	fall witchgrass	Tnnd
	<i>Echinochloa crus-galli</i> (L.) P. Beauv.	barnyardgrass	PW
	<i>Elymus arizonicus</i> (Scribn. & J.G. Sm.) Gould	Arizona wheatgrass	PW
	<i>Enneapogon desvauxii</i> Desv. ex P. Beauv.	nineawn pappusgrass	PW
	<i>Eragrostis airoides</i> Nees	darnel lovegrass	Tnnd
	<i>Eragrostis cilianensis</i> (All.) Vign. ex Janchen	stinkgrass	PW
	<i>Eragrostis intermedia</i> Hitchc.	plains lovegrass	PW
	<i>Eragrostis lehmanniana</i> Nees	Lehmann lovegrass	PW
	<i>Erioneuron pilosum</i> (Buckley) Nash	hairy woollygrass	PW
	<i>Festuca ligulata</i> Swallen	Guadalupe fescue	PW
	<i>Heteropogon contortus</i> (L.) P. Beauv. ex Roem. & Schult.	tanglehead	PW
	<i>Hilaria</i> Kunth sp.	galleta grass	PW
	<i>Imperata brevifolia</i> Vasey	California satintail	PW
	<i>Koeleria macrantha</i> (Ledeb.) Schult.	prairie Junegrass	Tnnd
	<i>Leptochloa dubia</i> (Kunth) Nees	green sprangletop	Sn
	<i>Leptochloa fusca</i> (L.) Kunth ssp. <i>uninervia</i> (J. Presl) N. Snow	Mexican sprangletop	Sn
	<i>Leptochloa panicea</i> (Retz.) Ohwi ssp. <i>mucronata</i> (Michx.) Nowack	mucronate sprangletop	Sn
	<i>Lycurus phleoides</i> Kunth	common wolfstail	Tnnd
	<i>Lycurus setosus</i> (Nutt.) C.G. Reeder	bristly wolfstail	Tnnd
	<i>Muhlenbergia dubia</i> Fourn. ex Hemsl.	pine muhly	PW
	<i>Muhlenbergia emersleyi</i> Vasey	bullgrass	PW
	<i>Muhlenbergia glauca</i> (Nees) B.D. Jacks.	desert muhly	PW
	<i>Muhlenbergia porteri</i> Scribn. ex Beal	bush muhly	PW
	<i>Muhlenbergia rigens</i> (Benth.) Hitchc.	deergrass	PW

Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Poaceae</b> (continued)	<i>Muhlenbergia rigida</i> (Kunth) Trin.	purple muhly	PW
	<i>Muhlenbergia schreberi</i> J.F. Gmel.	nimblewill	PW
	<i>Muhlenbergia tenuifolia</i> (Kunth) Trin.	slender muhly	PW
	<i>Nassella tenuissima</i> (Trin.) Barkworth	finestem needlegrass	PW
	<i>Panicum bulbosum</i> Kunth	bulb panicgrass	Tndd
	<i>Panicum hallii</i> Vasey	Hall's panicgrass	PW
	<i>Panicum obtusum</i> Kunth	vine mesquite	Tndd
	<i>Panicum virgatum</i> L.	switchgrass	PW
	<i>Pappophorum bicolor</i> Fourn.	pink pappusgrass	Tndd
	<i>Pappophorum vaginatum</i> Buckley	whiplash pappusgrass	PW
	<i>Paspalum distichum</i> L.	knotgrass	PW
	<i>Pennisetum ciliare</i> (L.) Link	buffelgrass	PW
	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	common reed	PW
	<i>Piptochaetium fimbriatum</i> (Kunth) Hitchc.	pinyon ricegrass	PW
	<i>Pleuraphis mutica</i> Buckley	tobosagrass	PW
	<i>Poa strictiramea</i> Hitchc.	Big Bend bluegrass	PW
	<i>Polypogon monspeliensis</i> (L.) Desf.	annual rabbitsfoot grass	PW
	<i>Schizachyrium scoparium</i> (Michx.) Nash	little bluestem	PW
	<i>Setaria adhaerens</i> (Forssk.) Chiov.	bur bristlegrass	PW
	<i>Setaria grisebachii</i> Fourn.	Grisebach's bristlegrass	PW
	<i>Setaria leucopila</i> (Scribn. & Merr.) K. Schum.	streambed bristlegrass	PW
	<i>Setaria pumila</i> (Poir.) Roem. & Schult.	yellow foxtail	PW
	<i>Setaria scheelei</i> (Steud.) Hitchc.	southwestern bristlegrass	PW
	<i>Sorghum halepense</i> (L.) Pers.	Johnsongrass	PW
	<i>Sporobolus airoides</i> (Torr.) Torr.	alkali sacaton	PW
	<i>Sporobolus contractus</i> Hitchc.	spike dropseed	PW
	<i>Sporobolus cryptandrus</i> (Torr.) A. Gray	sand dropseed	PW
	<i>Sporobolus flexuosus</i> (Thurb. ex Vasey) Rydb.	mesa dropseed	PW
	<i>Sporobolus pyramidatus</i> (Lam.) Hitchc.	Madagascar dropseed	PW
	<i>Trichloris crinita</i> (Lag.) Parodi	false Rhodes grass	Tndd
	<i>Tridens albescens</i> (Vasey) Woot. & Standl.	white tridens	PW
	<i>Tridens muticus</i> (Torr.) Nash	slim tridens	PW



Family	Scientific (Latin) Name and Author	Common Name	Ref.
<b>Poaceae</b> (continued)	<i>Tripsacum dactyloides</i> (L.) L.	eastern gamagrass	PW
<b>Typhaceae</b>	<i>Typha domingensis</i> Pers.	southern cattail	PW
	<i>Typha latifolia</i> L.	broadleaf cattail	PW

### Nomenclature Footnotes:

In the “Ref.” (reference) column, the following codes denote literature sources are used as the stable source of the taxonomic concept that is associated with the Scientific (Latin) name that is used by USDA-NRCS (2018). While use of USDA-NRCS (2018) generally is required for many federal projects, the content lacks stability as a concept source, since the taxonomic concepts behind unique names are sometimes revised without notification to users.

- A = Ackerfield (2015).
- AI = Allred and Ivey (2012).
- Dlo = Diggs et al. (1999).
- E = Eckenwalder (2010).
- Is = Isely(1998).
- K = Kiger (2003).
- Pi = Pinkava (2003).
- Prb = Pinkava et al. (2001).
- Po = Powell (1998).
- PW = Powell and Worthington (2018).
- Sc = Schilling (2006).
- Sm = Smith (1993).
- Sn = Snow (2003).
- St1 = Strother (2006a).
- St2 = Strother (2006b).
- Tnnd = Turner et al. (2003).
- Veb = van Ee and Berry (2016).

In the “Ref.” column, the following numeric designation is used to denote a synonym or equivalent concept for USDA-NRCS (2018) Latin names that could not be located in a published source.

1. = *Cupressus arizonica* Greene of Powell (1998).
2. = *Conoclinium dissectum* A. Gray of Powell and Worthington (2018).
3. = *Xanthisma spinulosum* (Pursh) D.R. Morgan & R.L. Hartm. var. *chihuahuanum* (B.L. Turner & R.L. Hartm.) D.R. Morgan & R.L. Hartm. of Powell and Worthington (2018).
4. = *Berberis trifoliolata* Moric. of Powell and Worthington (2018).
5. = *Coelophragmus auriculatus* (A. Gray) O.E. Schulz of Turner et al. (2003).
6. = *Echinocereus viridiflorus* Engelm. var. *russanthus* (Weniger) A.D. Zimmerman of Powell and Worthington (2018).

7. = *Escobaria sneedii* Britton & Rose var. *albocolumnaria* (Hester) A.M. Powell of Powell and Worthington (2018).
8. = *Escobaria dasyacantha* Britton & Rose of Powell and Worthington (2018).
9. = *Escobaria chaffeyi* Britton & Rose of Powell and Worthington (2018).
10. = *Celtis pallida* Torr. of Powell and Worthington (2018).
11. = *Ditaxis humilis* (Engelm. & A. Gray) Pax var. *humilis* of Diggs et al. (1999).
12. = *Chamaesyce chaetocalyx* (Boiss.) Wooton & Standl. of Turner et al. (2003).
13. = *Commicarpus scandens* (L.) Standl. of Powell and Worthington (2018).
14. = *Nicotiana obtusifolia* M. Martens & Galeotti of Powell and Worthington (2018).
15. = *Verbena hirtella* (L.M. Perry) G.L. Nesom of Powell and Worthington (2018).

In the “Scientific (Latin) Name and Author” column, the following alphabetic designations are used to denote USDA-NRCS (2018) names that include or probably include a named taxonomic concept on this list that is not recognized by USDA-NRCS (2018). These are often recently described taxa not yet recognized by USDA-NRCS (2018).

- A. *Grusonia densispina* (Ralston & Hilsenbeck) Pinkava (of this report) is part of *Grusonia schottii* (Engelm.) H. Rob. (of USDA-NRCS 2018).
- B. *Opuntia azurea* Rose var. *parva* A.M. Powell & Weedon (of this report) is part of *Opuntia macrocentra* Engelm. (of USDA-NRCS 2018).
- C. *Opuntia dulcis* Engelm. of this report) is part of *Opuntia phaeacantha* Engelm. (of USDA-NRCS 2018).
- D. *Croton bigbendensis* B.L. Turner (of this report) is part of *Croton dioicus* Cav. (of USDA-NRCS 2018).
- E. *Salix thurberi* Rowlee (of this report) is part of *Salix exigua* Nutt. (of USDA-NRCS 2018).

# Appendix C: Field Key to the Vegetation of Big Bend National Park, Texas

## Instructions for Use of Key to Vegetation Associations of Big Bend National Park

The purpose of this key is to allow an observer to identify a vegetation association (i.e. plant community) at Big Bend National Park (BIBE) both accurately and efficiently and to set relatively firm (if sometimes arbitrary) boundaries on the conceptual limits of the classified associations. As a companion to this key, all associations are also fully described in the individual association descriptions (**Appendix D**) as they occur in both their most common forms and across possible variations.

### Requirements:

The user of this key should have a familiarity with most common vascular plant species at BIBE, including those that can dominate plant communities, and any potential “look-alikes”. Minimally, the user should be familiar with the indicator species in **Lists A, B, C1, and C2**. The user should also know how to measure canopy cover for trees, shrubs, grasses, and forbs by ocular estimation with the following precision: (1) 10% error for cover levels above 20% cover, (2) 5% error for 10% to 20% cover, and (3) 1% error for up to 10% cover. Finally, the user should be able to estimate the height of vegetation with the following precision: (1) 5 meters of error for heights above 10 meters, (2) within 1 meter of error from 1 to 10 meters of height, and (3) within 0.1 meter for less than 1 meter in height.

### List A – Montane Indicator Taxa

- *Acer grandidentatum* (bigtooth maple)
- *Agave havardiana* (Havard’s century plant)
- *Arbutus xalapensis* (Texas madrone)
- *Artemisia dracuncululus* (wild tarragon)
- *Artemisia ludoviciana* (Louisiana wormwood)
- *Blepharoneuron tricholepis* (pine dropseed)
- *Bouteloua gracilis* (blue grama)
- *Bouvardia ternifolia* (firecrackerbush)
- *Ceanothus fendleri* (Fendler’s ceanothus)
- *Ceanothus greggii* (desert ceanothus)
- *Cercocarpus montanus* (alderleaf mountain mahogany)
- *Cheilanthes bonariensis* (golden lip fern)
- *Cheilanthes eatonii* (Eaton’s lip fern)
- *Elymus arizonicus* (Arizona wheatgrass)
- *Eragrostis intermedia* (plains lovegrass)
- *Garrya ovata* ssp. *goldmanii* (Goldman’s silktassel)
- *Hesperocyparis arizonica* (Arizona cypress)
- *Juniperus coahuilensis* (redberry juniper)
- *Juniperus coahuilensis* × *J. pinchotii* (hybrid juniper)
- *Juniperus deppeana* (alligator juniper)

- *Juniperus flaccida* (weeping juniper)
- *Juniperus pinchotii* (Pinchot juniper)
- *Leptochloa dubia* (sprangletop)
- *Lycurus phleoides* (common wolfstail)
- *Lycurus setosus* (bristly wolfstail)
- *Muhlenbergia dubia* (pine muhly)
- *Muhlenbergia emersleyi* (bull muhly)
- *Muhlenbergia glauca* (desert muhly)
- *Muhlenbergia rigida* (purple muhly)
- *Nassella tenuissima* (finestem needlegrass)
- *Nolina erumpens* (foothill beargrass)
- *Opuntia chisosensis* (Chisos Mountain pricklypear)
- *Pinus arizonica* var. *stormiae* (Arizona pine)
- *Pinus cembroides* (Mexican pinyon)
- *Piptochaetium fimbriatum* (pinyon ricegrass)
- *Prunus serotina* var. *virens* (Texas black cherry)
- *Quercus arizonica* (Arizona oak)
- *Quercus emoryi* (Emory oak)
- *Quercus graciliformis* (Chisos oak)
- *Quercus gravesii* (Graves' oak)
- *Quercus grisea* (gray oak)
- *Quercus intricate* (Coahuila scrub oak)
- *Quercus pungens* (sandpaper oak)
- *Quercus robusta* (robust oak)\*
- *Quercus rugosa* (Arizona white oak)
- *Quercus* × *tharpii* (Tharp's oak)
- *Rhus virens* (evergreen sumac)
- *Rhus trilobata* var. *pilosissima* (skunkbush sumac)
- *Salvia regla* (mountain sage)
- *Schizachyrium scoparium* (little bluestem)
- *Viguiera dentata* (toothleaf goldeneye)

\* = *Quercus emoryi* × *Quercus gravesii*

#### **List B – Riparian Indicator Taxa**

- *Arundo donax* (giant cane)
- *Baccharis salicifolia* (seepwillow)
- *Bacopa monnieri* (water hyssop)
- *Bothriochloa ischaemum* (yellow bluestem)
- *Carya illinoensis* (pecan)
- *Cephalanthus occidentalis* (common buttonbush)
- *Chilopsis linearis* (desertwillow)
- *Cynodon dactylon* (Bermuda grass)

- *Heliotropium curassavicum* (salt heliotrope)
- *Hymenoclea monogyra* (singlewhorl burrobrush)
- *Juglans microcarpa* (littleleaf walnut)
- *Nicotiana glauca* (tree-tobacco)
- *Phragmites australis* (common reed)
- *Phyla nodiflora* (turkey tangle fogfruit)
- *Polygonum* spp. (smartweeds)\*
- *Polypogon monspeliensis* (annual rabbitsfoot grass)
- *Populus fremontii* ssp. *mesetae* (Arizona cottonwood)
- *Porophyllum scoparium* (shrubby poreleaf)
- *Prosopis pubescens* (screwbean mesquite)
- *Salix* spp.\* (willows)
- *Schoenoplectus* spp. (bulrushes)\*
- *Sorghum halepense* (Johnson grass)
- *Sporobolus airoides* (alkali sacaton)
- *Sporobolus wrightii* (big sacaton)
- *Tamarix aphylla* (athel tamarisk)
- *Tamarix ramosissima* (tamarisk)
- *Toxicodendron radicans* (eastern poison-ivy)
- *Typha* spp. (cattails)\*
- *Vachellia farnesiana* (huisache)
- *Verbesina encelioides* (alkali sacaton)

\* Treat these genera as single taxa (equivalent to a single species)

#### **List C1 – Foothills Indicator Taxa**

- *Agave havardiana* (Havard's century plant)
- *Bommeria hispida* (copper fern)
- *Bouvardia ternifolia* (firecrackerbush)
- *Cercocarpus montanus* (alderleaf mountain mahogany)
- *Cheilanthes* spp.\* (lip ferns)
- *Juniperus coahuilensis* (redberry juniper)
- *Juniperus coahuilensis* × *J. pinchotii* (hybrid juniper)
- *Juniperus pinchotii* (Pinchot juniper)
- *Mimosa* spp.\* (mimosas)
- *Nolina erumpens* (foothill beargrass)
- *Notholaena* spp.\* (cloak ferns)
- *Opuntia chisosensis* (Chisos Mountain pricklypear)
- *Prunus havardii* (Havard's plum)
- *Rhus trilobata* var. *pilosissima* (skunkbush sumac)
- *Rhus virens* (evergreen sumac)
- *Ungnadia speciosa* (Mexican buckeye)

\* Treat these genera as single taxa (equivalent to a single species)

### **List C2 – (Desert Lowlands Indicator Taxa)**

- *Andropogon glomeratus* (bushy bluestem)
- *Bouteloua ramosa* (chino grama)
- *Bouteloua trifida* (red grama)
- *Cathastecum erectum* (false grama)
- *Chilopsis linearis* (desertwillow)
- *Dasyochloa pulchella* (fluffgrass)
- *Euphorbia antisyphilitica* (candelilla)
- *Hymenoclea monogyra* (singlewhorl burrobrush)
- *Jatropha dioica* (leatherstem)
- *Larrea tridentata* (creosotebush)
- *Leucophyllum candidum* (Boquillas silverleaf)
- *Leucophyllum frutescens* (cenizo)
- *Leucophyllum minus* (Big Bend silverleaf)
- *Lippia graveolens* (Mexican oregano)
- *Opuntia rufida* (blind pricklypear)
- *Parthenium incanum* (mariola)
- *Pennisetum ciliare* (buffelgrass)
- *Porophyllum scoparium* (shrubby poreleaf)
- *Prosopis glandulosa* (honey mesquite)
- *Vachellia rigidula* (blackbrush)
- *Vachellia vernicosa* (viscid acacia)

### **How to Use the Key:**

The key starts with all possible associations identified at BIBE during this project and then walks the user through a progressive series of couplets. Each couplet (designated by a number) consists of two mutually exclusive (contrasting) and mutually comprehensive statements (designated by the letters A and B) about selected vegetation conditions. The user then selects the statement that better satisfies the condition of the vegetation and follows the directions at the end of the statement. These directions will direct the user to a new couplet or (eventually) to the name of the association that best describes all the conditions encountered. Because the vegetation of BIBE is diverse, it is convenient to divide the entire key into five subkeys of ecologically and floristically related vegetation associations. The five ecological subkeys and their subject vegetation are listed on the following page.

#### **1. Montane Forests and Woodlands**

Tree-dominated vegetation of uplands (non-riparian areas) from the highest elevations of BIBE, down to about 5,000 feet elevation and occasionally as low as about 4,200 feet. Tree stratum cover usually is at least 15%, but occasionally may be lower.

#### **2. Montane Open Woodlands, Shrublands, Grasslands, and Sparse Vegetation**

Vegetation dominated by shrubs, herbaceous plants, and/or non-vascular taxa of uplands (non-riparian areas) from the highest elevations of BIBE, down to about 5,000 feet elevation and occasionally as low as about 4,200 feet. Tree stratum cover usually is less than 15%.

### 3. Riparian Vegetation

Vegetation (of any physiognomy) in primarily riparian settings, including the alluvial features (floodplains, banks, bars) of the Rio Grande River, the channels and immediate banks of dry or intermittently wet washes, and areas influenced by springs and shallow groundwater, generally below 5,000 feet elevation.

### 4. Foothills Vegetation

Upland vegetation mostly dominated by shrubs, herbaceous plants, and/or non-vascular taxa (rarely trees), mostly from about 2,500 feet to 5,600 feet (but occasionally to the highest elevations). (Note: some vegetation within this elevation range is reached only through the Desert Lowlands Vegetation subkey).

### 5. Desert Lowlands Vegetation

Vegetation mostly dominated by shrubs, herbaceous plants, and/or non-vascular taxa (rarely trees), mostly from the lowest elevations of BIBE up to about 4,800 feet (but occasionally to about 5,600 feet).

The user starts by reading through a short series of couplets in the **Master Key** that directs them to one of the five **Subkeys** that evaluates the presence and/or abundance of a pool of possibly present indicator plant taxa. The indicator taxa are enumerated on **Lists A, B, C1, and C2** and follow the couplets of the master key. While the user may start with a subkey, it is recommended to use the master key first. This process better defines and delimits the vegetation associations using specific criteria and will better guide users to the proper subkey more consistently. Please note that because of the diversity of vegetation at BIBE, the list of indicator taxa can be somewhat lengthy and contain a wide range of indicator species that might or might not be present.

**User Recommendations and Suggestions:** After working through the master key a few times, the user should be able to identify the most common indicator species and where they normally occur in BIBE. Familiarity of common species and their locations will allow a user to determine quickly which subkey to use.

**Example 1:** An observation site contains high cover of *Arundo donax* (giant cane/arundo), *Tamarix ramosissima* (tamarisk/saltcedar, or *Salix* spp. (willows) the experienced user will quickly turn to the Riparian Vegetation Subkey since all three taxa only occur in riparian settings at BIBE.

**Example 2:** An observation site contains high cover of *Prosopis glandulosa* (honey mesquite). More careful examination of the site would be required since honey mesquite can occur as the dominant species in both riparian and upland settings. If the honey mesquite is at low elevation



and along a major drainage then the Riparian Vegetation Subkey should be used. If it occurs in desert lowlands away from large drainages and floodplains then the user should look in the Desert Lowlands Vegetation Subkey.

Example 3: Depending on the scope of the intended observations, the full range of subkeys seldom would apply to a local area. In some cases, the user can narrow down the choice of subkeys or choose a single subkey based on location. These situations are:

Chisos Mountains above 5,300 feet = Keys 1 and 2

Dead Horse Mountains and Limestone Formations (including foothills) = Key 5

2,400 feet and 4,200 feet in Elevation = Keys 3, 4, and 5

Below 2,400 feet in Elevation = Keys 3 and 5

When the user has arrived at a final answer (i.e. the name of an association), it is always advisable to read the description and synthesis (floristic composition) tables for that association (Appendix D). If the description and synthesis of that association do not match reasonably well with the vegetation being evaluated, it is possible that a keying error has occurred. Either the user may have made a mistake or there is an error in the key's logic that has been uncovered. In these cases, it is advisable to key the vegetation again, paying close attention to steps in the key where the vegetation is close to a stated threshold condition between the couplet statements. For individual couplets where these thresholds are approached, the user may wish to check both paths through the key from that point and select the best answer from these two (or more) choices.

**Example 4:** Couplet 5 of the Montane Forests and Woodlands Key:

5A. The cover of *Pinus cembroides* (Mexican pinyon) is > 10%.....go to 6

5B. The cover of *Pinus cembroides* (Mexican pinyon) is < 10%.....go to 7

The user estimates the cover of *Pinus cembroides* to be 8%, the more likely path would be through statement 5B. However, the observed value (8%) is so close to the threshold for this couplet (10%) that error cannot be ruled out. In this case, it may be advisable to follow the results of both statements (5A and 5B) and choose the result whose description and synthesis table better fits the observed stand.

Users of the key should also remember that the vegetation at BIBE is transitional and can change along ecotones and contain inclusions of other associations. The BIBE classification descriptions try to address some of this variation, whereas the key only describes the best or most common representation of the type. It is therefore likely that multiple associations may occur in close proximity and more than one answer may be applicable. Some areas may be best keyed-out to a primary type (user's best estimate) and a secondary or tertiary plant association(s) representing inclusions or a gradation of types. Reading the descriptions of these types after keying them out may help refine the initial determination.

With practice, the user will observe that some associations can be reached from multiple paths or from both couplets in the key. This was intended to account for associations occurring in multiple locations (e.g. types that occur in both montane and foothill settings) and cases that are best reached using the explanations of both couplets instead of either/or paths (i.e. both A and B = C vs. A and not B = C). These associations may span the threshold condition stated by the couplet and can only be addressed through both pathways in the key.

Finally, it is possible that the classification or the key does not address the vegetation association under consideration. In such a case, it is possible that no path through the key is likely to produce a reasonable answer. In these cases it is important to remember that the classified and described associations are intended to be broad and flexible. A vegetation type that deviates from a described association by just a single or very few factors does not necessarily mean it is a new or undocumented type. Careful examination of the associated species and cover value cut-offs may help identify it as a variant of a common type. New associations would most likely be either of small and limited extent and/or in remote or otherwise seldom-visited areas of BIBE.

## Master Key to Vegetation Associations of Big Bend National Park

**1A.** The individual vascular plant taxon with the highest cover is a montane indicator (**List A**). If two or three vascular plant taxa have equal or near equal cover, then at least two of those taxa with the highest cover are montane indicators. (Generally, upland vegetation of elevations above 4,200 feet).....go to **2**

**2A.** The combined individual cover amount for *Acer grandidentatum* (bigtooth maple), *Arbutus xalapensis* (Texas madrone), *Hesperocyparis arizonica* (Arizona cypress), *Juniperus deppeana* (alligator juniper), *Juniperus flaccida* (weeping juniper), *Pinus cembroides* (Mexican pinyon), *Quercus emoryi* (Emory oak), *Quercus gravesii* (Graves' oak), *Quercus grisea* (gray oak), *Quercus robusta* (robust oak), and/or *Quercus graciliformis* (Chisos oak) is  $\geq 15\%$ .....  
.....use **Montane Forests and Woodlands Key**

**2B.** The combined individual cover amount for *Acer grandidentatum* (bigtooth maple), *Arbutus xalapensis* (Texas madrone), *Hesperocyparis arizonica* (Arizona cypress), *Juniperus deppeana* (alligator juniper), *Juniperus flaccida* (weeping juniper), *Pinus cembroides* (Mexican pinyon), *Quercus emoryi* (Emory oak), *Quercus gravesii* (Graves' oak), *Quercus grisea* (gray oak), *Quercus robusta* (robust oak), and/or *Quercus graciliformis* (Chisos oak) is  $< 15\%$ .....  
.....use **Montane Open Woodlands, Shrublands, Grasslands, and Sparse Vegetation Key**

**1B.** The individual vascular plant taxon with the highest cover is not a montane indicator (**not in List A**), or, no vascular plants are evident. If two or three vascular plant taxa have equal or near equal cover, then no more than one of those taxa that have the highest cover is a montane indicator (included in **List A**) (Generally, vegetation of elevations below 5,600 feet).....go to **3**

**3A.** Discounting the cover of *Pennisetum ciliare* (buffelgrass) and/or *Eragrostis lehmanniana* (Lehmann lovegrass) (if present), the individual vascular plant taxon with the highest cover is one of the riparian indicators (**List B**). If two or more vascular plant taxa have equal or near equal cover, then at least two of those taxa with the highest cover are a riparian indicators (Generally, vegetation along the Rio Grande River, desert washes, or associated with springs).....use **Riparian Vegetation Key**

**3B.** Discounting the cover of *Pennisetum ciliare* (buffelgrass) and/or *Eragrostis lehmanniana* (Lehmann lovegrass) (if present), the individual vascular plant taxon with the highest cover is a taxon OTHER THAN one of the riparian indicators (**List B**), or no vascular plants are evident. If two or more vascular plant taxa have equal or near equal cover, then no more than one of those taxa that have the highest cover is a riparian indicator (Generally, vegetation of uplands or desert washes below 5,600 feet).....go to **4**

**4A.** The combined individual cover amount for all plant taxa from foothills indicators (**List C1**) (is  $>$  the combined individual cover amount for all plant taxa from desert lowlands indicators (**List C2**)).....use **Foothills Vegetation Key**

**4B.** The combined individual cover amount for all plant taxa from desert lowlands indicators (**List C1**) is  $\leq$  the combined individual cover amount for all plant taxa from desert lowlands indicators (**List C2**) .....use **Desert Lowlands Vegetation Key1**

**Montane Forests and Woodlands Subkey**

**1A.** The cover of *Hesperocyparis arizonica* (Arizona cypress) is  $\geq 10\%$ .....  
.....**Arizona Cypress – Graves’ Oak – Pinyon Pine**

**Forest**

**1B.** The cover of *Hesperocyparis arizonica* (Arizona cypress) is  $< 10\%$ .....go to **2**

**2A.** Either *Quercus emoryi* (Emory oak), *Quercus gravesii* (Graves’ oak), *Quercus graciliformis* (Chisos oak), *Quercus robusta* (robust oak) (= *Quercus gravesii*  $\times$  *emoryi*), *Quercus*  $\times$  *tharpii* (Tharp’s oak), *Arbutus xalapensis* (Texas madrone), *Acer grandidentatum* (bigtooth maple), *Garrya ovata* ssp. *goldmanii* (Goldman’s silktassel) or *Pinus arizonica* var. *stormiae* (Arizona pine) is the most abundant woody species (or tied with another species as the most abundant).....go to **3**

**3A.** Either *Quercus emoryi* (Emory oak) or *Quercus robusta* (robust oak) is the most abundant woody species (or is tied with another woody species as most abundant).....go to **4**

**4A.** At least two of the following three conditions are true: (1) The combined individual covers of *Arbutus xalapensis* (Texas madrone), *Garrya ovata* ssp. *goldmanii* (Goldman’s silktassel), *Juniperus flaccida* (weeping juniper), and/or *Quercus gravesii* (Graves’ oak) is  $\geq 3\%$ ; (2) the combined individual covers of all grass (*Poaceae*) species is  $< 5\%$ ; (3) *Schizachyrium scoparium* (little bluestem) is absent.....**Graves’ Oak – Emory Oak Canyon Forest**

**4B.** At least two of the following three conditions are true: (1) The combined individual covers of *Arbutus xalapensis* (Texas madrone), *Garrya ovata* ssp. *goldmanii* (Goldman’s silktassel), *Juniperus flaccida* (weeping juniper), and/or *Quercus gravesii* (Graves’ oak) is  $< 5\%$ ; (2) the combined individual covers of all grass (*Poaceae*) species is  $\geq 3\%$ ; (3) *Schizachyrium scoparium* (little bluestem) is present.....**Emory Oak Woodland**

**3B.** A species other than *Quercus emoryi* (Emory oak) is the most abundant woody species (usually, *Quercus gravesii* (Graves’ oak), *Arbutus xalapensis* (Texas madrone), *Acer grandidentatum* (bigtooth maple), *Garrya ovata* ssp. *goldmanii* (Goldman’s silktassel), or *Pinus arizonica* var. *stormiae* (Arizona pine)).....go to **5**

**5A.** The cover of *Pinus cembroides* (Mexican pinyon) is  $> 10\%$ .....go to **6**

**6A.** The combined individual cover amount for *Quercus gravesii* (Graves’ oak), *Arbutus xalapensis* (Texas madrone), and/or *Garrya ovata* ssp. *goldmanii* (Goldman’s silktassel) is  $\geq$  the combined individual covers of *Pinus cembroides* (Mexican pinyon), *Quercus grisea* (gray oak), and/or *Juniperus flaccida* (weeping juniper).....**High Chisos Oak – Pine Forest**

**6B.** The combined individual cover amount for *Quercus gravesii* (Grave's oak), *Arbutus xalapensis* (Texas madrone), and/or *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel) is < the combined individual covers of *Pinus cembroides* (Mexican pinyon), *Quercus grisea* (gray oak), and/or *Juniperus flaccida* (weeping juniper).....**Dry-Mesic Pinyon Pine – Oak – Juniper Forest**

**5B.** The cover of *Pinus cembroides* (Mexican pinyon) is  $\leq 10\%$ .....go to **7**

**7A.** The tree stratum cover (i.e., the cover of all woody plants that are  $\geq 5$  meters maximum height) is  $\geq 25\%$  (i.e., primarily woodlands or forests).....go to **8**

**8A.** The cover of *Acer grandidentatum* (bigtooth maple) is  $\geq 15\%$ .....  
.....**Graves' Oak – Bigtooth Maple Forest**

**8B.** The cover of *Acer grandidentatum* (bigtooth maple) is < 15%.....go to **9**

**9A.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper), *Hesperocyparis arizonica* (Arizona cypress), *Pseudotsuga menziesii* (Douglas-fir), and/or *Salvia regla* (mountain sage) is  $\geq$  the combined individual cover amount for *Quercus emoryi* (Emory oak), *Quercus robusta* (robust oak), *Prunus serotina* var. *virens* (Texas black cherry), *Rhus virens* (evergreen sumac), and/or *Fraxinus greggii* (littleleaf ash).....**High Chisos Oak – Pine Forest**

**9B.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper), *Hesperocyparis arizonica* (Arizona cypress), *Pseudotsuga menziesii* (Douglas-fir), and/or *Salvia regla* (mountain sage) is < the combined individual cover amount for *Quercus emoryi* (Emory oak), *Quercus robusta* (robust oak), *Prunus serotina* var. *virens* (Texas black cherry), *Rhus virens* (evergreen sumac), and/or *Fraxinus greggii* (littleleaf ash).....**Graves' Oak – Emory Oak Canyon Forest**

**7B.** The tree stratum cover (i.e., the cover of all woody plants that are  $\geq 5$  meters maximum height) is < 25% (i.e., primarily shrublands or open woodland).....go to **10**

**10A.** The combined individual cover amount for *Arbutus xalapensis* (Texas madrone), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and/or *Juniperus flaccida* (weeping juniper) is  $\geq$  the combined individual cover amount for *Quercus grisea* (gray oak) and/or *Rhus virens* (evergreen sumac).....go back to **9**

**10B.** The combined individual cover amount for *Arbutus xalapensis* (Texas madrone), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and/or *Juniperus flaccida* (weeping juniper) is < the combined individual cover amount for *Quercus grisea* (gray oak) and/or *Rhus virens* (evergreen sumac).....**Montane Mixed Chaparral**

**2B.** A woody species other than *Quercus emoryi* (Emory oak), *Quercus gravesii* (Graves' oak), *Quercus graciliformis* (Chisos oak), *Quercus robusta* (robust oak) (= *Quercus gravesii* × *emoryi*), *Quercus* × *tharp* (Tharp's oak), *Arbutus xalapensis* (Texas madrone), *Acer grandidentatum* (bigtooth maple), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel) or *Pinus arizonica* var. *stormiae* (Arizona pine) is more abundant than any of those species (if so, usually, *Pinus cembroides* (Mexican pinyon), *Quercus grisea* (gray oak), *Juniperus deppeana* (alligator juniper), *Juniperus flaccida* (weeping juniper), or *Hesperocyparis arizonica* (Arizona cypress) is the most abundant).....go to **11**

**11A.** The tree stratum cover (i.e., the cover of all woody plants that are ≥ 5 meters maximum height) is ≥ 20% (i.e., primarily woodlands or forests).....go to **12**

**12A.** The combined individual cover amount for *Quercus gravesii* (Graves' oak), *Arbutus xalapensis* (Texas madrone), and/or *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel) is ≥ the combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Quercus grisea* (gray oak), and/or *Juniperus flaccida* (weeping juniper).....**High Chisos Oak – Pine Forest**

**12B.** The combined individual cover amount for *Quercus gravesii* (Graves' oak), *Arbutus xalapensis* (Texas madrone), and/or *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel) is < the combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Quercus grisea* (gray oak), and/or *Juniperus flaccida* (weeping juniper).....go to **13**

**13A.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon) and/or *Juniperus flaccida* (weeping juniper) is > 10%.....go to **14**

**14A.** The cover of *Muhlenbergia emersleyi* (bull muhly) is ≥ 10%.....**Dry Pinyon Pine Woodland**

**14B.** The cover of *Muhlenbergia emersleyi* (bull muhly) is < 10%.....go to **15**

**15A.** The combined individual cover amount for *Quercus gravesii* (Graves' oak), *Quercus emoryi* (Emory oak) and/or *Quercus robusta* (robust oak) is > the cover of *Pinus cembroides* (Mexican pinyon).....go back to **9**

**15B.** The combined individual cover amount for *Quercus gravesii* (Graves' oak), *Quercus emoryi* (Emory oak) and/or *Quercus robusta* (robust oak) is  $\leq$  the cover of *Pinus cembroides* (Mexican pinyon).....  
.....**Dry-Mesic Pinyon Pine – Oak – Juniper Forest**

**13B.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon) and/or *Juniperus flaccida* (weeping juniper) is  $\leq 10\%$ .....  
.....**Alligator Juniper – Pinyon Pine – Gray Oak Woodland**

**11B.** The tree stratum cover (i.e., the cover of all woody plants that are  $\geq 5$  meters maximum height) is  $< 20\%$  (i.e., primarily open woodlands, savannas, or tall shrublands).....go to **16**

**16A.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper), and/or *Juniperus flaccida* (weeping juniper) is  $\geq 8\%$ .....go to **17**

**17A.** The cover of *Pinus cembroides* (Mexican pinyon) is  $\geq$  the combined individual cover amount for *Juniperus deppeana* (alligator juniper) and *Quercus grisea* (gray oak).....**Dry Pinyon Pine Woodland**

**17B.** The cover of *Pinus cembroides* (Mexican pinyon) is  $<$  the combined individual cover amount for *Juniperus deppeana* (alligator juniper) and *Quercus grisea* (gray oak).....go to **18**

**18A.** The combined individual cover amount for *Piptochaetium fimbriatum* (pinyon ricegrass), *Salvia regla* (mountain sage), and/or *Bouvardia ternifolia* (firecrackerbush) is  $\geq$  the combined individual cover amount for *Bouteloua curtipendula* (sideoats grama), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Dasyllirion leiophyllum* (green sotol), and/or *Quercus emoryi* (Emory oak).....**Dry Pinyon Pine Woodland**

**18B.** The combined individual cover amount for *Piptochaetium fimbriatum* (pinyon ricegrass), *Salvia regla* (mountain sage), and/or *Bouvardia ternifolia* (scarlet bouvardia) is  $<$  the combined individual cover amount for *Bouteloua curtipendula* (sideoats grama), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Dasyllirion leiophyllum* (green sotol), and/or *Quercus emoryi* (Emory oak).....**Alligator Juniper – Pinyon Pine – Gray Oak Woodland**

**16B.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper), and/or *Juniperus flaccida* (weeping juniper) is  $< 8\%$ .....go to **19**



19A. The combined individual cover amount for *Quercus grisea* (gray oak) and/or *Cercocarpus montanus* (alderleaf mountain mahogany) is  $\geq 50\%$ .....  
.....**High Chisos Gray Oak – Mountain Mahogany**

**Chaparral**

19B. The combined individual cover amount for *Quercus grisea* (gray oak) and/or *Cercocarpus montanus* (alderleaf mountain mahogany) is  $< 50\%$ .....  
.....**Montane Mixed Chaparral**

**Montane Open Woodlands, Shrublands, Grasslands, and Sparse Vegetation Subkey**

1A. The cover of *Quercus intricata* (Coahuila scrub oak) is  $\geq 5\%$ .....  
.....**Coahuila Scrub Oak Chaparral**

1B. The cover of *Quercus intricata* (Coahuila scrub oak) is  $< 5\%$ .....go to 2

2A. The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper), and/or *Juniperus flaccida* (weeping juniper) is  $\geq 8\%$ .....go to 3

3A. The cover of *Pinus cembroides* (Mexican pinyon) is  $\geq$  the combined individual cover amount for *Juniperus deppeana* (alligator juniper) and *Quercus grisea* (gray oak).....  
.....**Dry Pinyon Pine Woodland**

3B. The cover of *Pinus cembroides* (Mexican pinyon) is  $<$  the combined individual cover amount for *Juniperus deppeana* (alligator juniper) and *Quercus grisea* (gray oak).....go to 4

4A. The combined individual cover amount for *Piptochaetium fimbriatum* (pinyon ricegrass), *Salvia reglia* (mountain sage), and/or *Bouvardia ternifolia* (firecrackerbush) is  $\geq$  the combined individual cover amount for *Bouteloua curtipendula* (sideoats grama), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Dasyllirion leiophyllum* (green sotol), and/or *Quercus emoryi* (Emory oak).....**Dry Pinyon Pine Woodland**

4B. The combined individual cover amount for *Piptochaetium fimbriatum* (pinyon ricegrass), *Salvia reglia* (mountain sage), and/or *Bouvardia ternifolia* (firecrackerbush) is  $<$  the combined individual cover amount for *Bouteloua curtipendula* (sideoats grama), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Dasyllirion leiophyllum* (green sotol), and/or *Quercus emoryi* (Emory oak).....  
.....**Alligator Juniper – Pinyon Pine – Gray Oak**  
**Woodland**

2B. The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper) and/or *Juniperus flaccida* (weeping juniper) is  $< 8\%$ .....go to 5

**5A.** BOTH (1) The cover of *Nassella tenuissima* (finestem needlegrass) is  $\geq 10\%$  AND (2) *Nassella tenuissima* is the most abundant herbaceous species (or tied with another species as most abundant).....**Finestem Needlegrass Montane Grassland**

**5B.** EITHER (1) The cover of *Nassella tenuissima* (finestem needlegrass) is  $< 10\%$  OR (2) at least one other herbaceous species is more abundant than *Nassella tenuissima*, or both (1) and (2) are true.....go to **6**

**6A.** The cover of *Muhlenbergia emersleyi* (bull muhly) is  $\geq 10\%$ .....**Bull Muhly Montane Grassland**

**6B.** The cover of *Muhlenbergia emersleyi* (bull muhly) is  $< 10\%$ .....go to **7**

**7A.** The cover of *Selaginella* spp. (spikemosses) is  $\geq 5\%$ .....**Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation**

**7B.** The cover of *Selaginella* spp. (spikemosses) is  $< 5\%$ .....go to **8**

**8A.** The combined individual cover amount for *Leucophyllum minus* (Big Bend silverleaf), *Hechtia texensis* (Texas false agave), *Quercus mohriana* (Mohr's shin oak), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Yucca faxoniana* (giant dagger), and/or *Yucca thompsoniana* (Thompson's yucca) is  $\geq 2\%$ .....**Calcareous Chaparral**

**8B.** The combined individual cover amount for *Leucophyllum minus* (Big Bend silverleaf), *Hechtia texensis* (Texas false agave), *Quercus mohriana* (Mohr's shin oak), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Yucca faxoniana* (giant dagger), and/or *Yucca thompsoniana* (Thompson's yucca) is  $< 2\%$ .....go to **9**

**9A.** Total vascular plant cover is  $\geq 5\%$ .....go to **10**

**9B.** Total vascular plant cover is  $< 5\%$ .....go to **16**

**10A.** BOTH (1) the combined individual cover amount for *Dasyllirion leiophyllum* (green sotol), *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), *J. coahuilensis*  $\times$  *J. pinchotii* (hybrid juniper), and/or *Selaginella peruviana* (Peruvian spikemoss) is  $\geq 5\%$ , AND (2) at least two of those taxa are present (for purposes of this couplet, treat the complex of *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), and *J. coahuilensis*  $\times$  *J. pinchotii* (hybrid juniper) as a single taxon).....**Redberry Juniper – Sotol Shrubland**

**10B.** EITHER (1) the combined individual cover amount for *Dasyllirion leiophyllum* (green sotol), *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), *J. coahuilensis* × *J. pinchotii* (hybrid juniper), and/or *Selaginella peruviana* (Peruvian spikemoss) is < 5%, OR (2) no more than one of those taxa are present (for purposes of this couplet, treat the complex of *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), and *J. coahuilensis* × *J. pinchotii* (hybrid juniper) as a single taxon), or both (1) and (2) are true.....go to **11**

**11A.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Prunus havardii* (Havard's plum), *Viguiera stenoloba* (skeletonleaf goldeneye), *Fraxinus greggii* (littleleaf ash), *Cercocarpus montanus* (alderleaf mountain mahogany), and/or *Quercus* spp. (oaks) is > 15%.....go to **12**

**12A.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and/or *Quercus* spp. (oaks) is ≥ 2%.....**Montane Mixed Chaparral**

**12B.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and/or *Quercus* spp. (oaks) is < 2%.....**Montane Talus and Cliff Rocky Sparse Shrubland**

**11B.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Prunus havardii* (Havard's plum), *Viguiera stenoloba* (skeletonleaf goldeneye), *Fraxinus greggii* (littleleaf ash), *Cercocarpus montanus* (alderleaf mountain mahogany), and/or *Quercus* spp. (oaks) is ≤ 15%.....go to **13**

**13A.** At least three of the following taxa are present (treat all individual species of each genus as a single taxon): *Chrysactinia mexicana* (damianita), *Fouquieria splendens* (ocotillo), *Echinocereus* spp. (hedgehog cactuses), *Mammillaria* spp. (globe cactuses), *Selaginella* spp. (spikemosses), and/or *Eriogonum* spp. (buckwheats).....go to **14**

**14A.** The combined individual cover amount for *Muhlenbergia emersleyi* (bull muhly), *Selaginella* spp. (spikemosses), and/or *Quercus* spp. (oaks) is ≥ 5%.....**Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation**

**14B.** The combined individual cover amount for *Muhlenbergia emersleyi* (bull muhly), *Selaginella* spp. (spikemosses), and/or *Quercus* spp. (oaks) is < 5%.....**Montane Talus and Cliff Rocky Sparse Shrubland**

- 13B.** No more than two of the following taxa are present (treat all individual species of each genus as a single taxon): *Chrysactinia mexicana* (damianita), *Fouquieria splendens* (ocotillo), *Echinocereus* spp. (hedgehog cactuses), *Mammillaria* spp. (globe cactuses), *Selaginella* spp. (spikemosses), and/or *Eriogonum* spp. (buckwheats).....go to **15**
- 15A.** The combined individual cover amount for *Aloysia gratissima* (whitebrush), *Prunus havardii* (Havard's plum), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Nolina erumpens* (foothill beargrass), and/or *Juniperus* spp. (juniper) is  $\geq 2\%$ .....  
.....**Redberry Juniper – Sotol Shrubland**
- 15B.** The combined individual cover amount for *Aloysia gratissima* (whitebrush), *Prunus havardii* (Havard's plum), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Nolina erumpens* (foothill beargrass), and/or *Juniperus* spp. (juniper) is  $< 2\%$ .....  
.....**Montane Talus and Cliff Rocky Sparse Shrubland**
- 16A.** *Selaginella* spp. (spikemosses) comprise  $\geq 30\%$  of the relative vascular plant cover (from all strata).....**Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation**
- 16B.** *Selaginella* spp. (spikemosses) comprise  $< 30\%$  of the relative vascular plant cover (from all strata).....go to **17**
- 17A.** Vegetation of cliffs or other bedrock outcrops, with vascular vegetation largely restricted to crevices or ledges.....go to **18**
- 18B.** The cover of *Fouquieria splendens* (ocotillo) is  $\geq 1\%$ .....  
.....**Montane Talus and Cliff Rocky Sparse Shrubland**
- 18B.** The cover of *Fouquieria splendens* (ocotillo) is  $< 1\%$ .....  
.....**Montane Igneous Outcrop Lichen Vegetation**
- 17B.** Vegetation not on cliffs or other bedrock outcrops, and vascular vegetation is not largely restricted to crevices or ledges.....**Montane Talus and Cliff Rocky Sparse Shrubland**

## RIPARIAN VEGETATION KEY

**1A.** The combined individual cover amount for *Populus fremontii* ssp. *mesetae* (Arizona cottonwood), *Salix* spp. (willows), *Prosopis pubescens* (screwbean mesquite), *Juglans microcarpa* (littleleaf walnut), *Rhus virens* (evergreen sumac), *Fraxinus velutina* (velvet ash) and/or *Carya illinoensis* (pecan) is  $\geq 15\%$ .....go to **2**

**2A.** The combined individual cover of *Populus fremontii* ssp. *mesetae* (Arizona cottonwood) and/or *Fraxinus velutina* (velvet ash) in the tree stratum is  $\geq 2\%$ .....go to **3**

**3A.** The combined individual cover amount for *Salix* spp. (willows), *Prosopis pubescens* (screwbean mesquite), *Tamarix ramosissima* (tamarisk) and/or *Baccharis salicifolia* (seepwillow) is  $\geq 10\%$ ; naturally occurring woodlands, with unmanaged understories.....**Cottonwood – Goodding Willow Spring Woodland**

**3B.** The combined individual cover amount for *Salix* spp. (willows), *Prosopis pubescens* (screwbean mesquite), *Tamarix ramosissima* (tamarisk) and/or *Baccharis salicifolia* (seepwillow) is  $< 10\%$ ; woodlands with managed (usually mowed) understories.....**Cottonwood – Ash – Huisache Planted Woodland**

**2B.** The combined individual cover of *Populus fremontii* ssp. *mesetae* (Arizona cottonwood) and/or *Fraxinus velutina* (velvet ash) in the tree stratum is  $< 2\%$ .....go to **4**

**4A.** Either *Prosopis pubescens* (screwbean mesquite) or *Carya illinoensis* (pecan) has the highest (or equal to highest) cover of any woody species.....**Cottonwood – Goodding Willow Spring**

### Woodland

**4B.** A species other than *Prosopis pubescens* (screwbean mesquite) or *Carya illinoensis* (pecan) has the highest cover of any woody s.....go to **5**

**5A.** The combined individual cover amount for *Juglans microcarpa* (littleleaf walnut) and/or *Rhus virens* (evergreen sumac), is  $\geq 5\%$ .....**Cottonwood – Goodding Willow Spring Woodland**

**5B.** The combined individual cover amount for *Juglans microcarpa* (littleleaf walnut) and/or *Rhus virens* (evergreen sumac), is  $< 5\%$ .....go to **6**

**6A.** The combined individual cover amount for all *Tamarix* spp. (tamarisk) is  $>$  the combined individual cover amount for all *Salix* spp. (willows).....**Tamarisk – (Tree Tobacco) Riparian Shrubland**

**6B.** The combined individual cover amount for all *Tamarix* spp. (tamarisk) is  $\leq$  the combined individual cover amount for all *Salix* spp. (willows).....go to **8**

7A. The combined individual cover amount for *Arundo donax* (giant cane), *Phragmites australis* (common reed), *Nicotiana glauca* (tree-tobacco), and/or *Vachellia farnesiana* (huisache) is  $\geq 1\%$ .....  
.....**Rio Grande Willow Riparian Bosque**

7B. The combined individual cover amount for *Arundo donax* (giant cane), *Phragmites australis* (common reed), *Nicotiana glauca* (tree-tobacco), and/or *Vachellia farnesiana* (huisache) is  $< 1\%$ .....go to 8

8A. Either *Salix thurberi* (Thurber's willow) or *Salix exigua* (coyote willow) has the highest cover of any woody species.....  
.....**Coyote Willow Spring Shrubland**

8B. At least one other species has cover higher than or equal to the cover of *Salix thurberi* (Thurber's willow) or *Salix exigua* (coyote willow).....  
.....**Cottonwood – Goodding Willow Spring Woodland**

1B. The combined individual cover amount for *Populus fremontii* ssp. *mesetae* (Arizona cottonwood), *Salix* spp. (willows), *Prosopis pubescens* (screwbean mesquite), *Juglans microcarpa* (littleleaf walnut), *Rhus virens* (evergreen sumac), *Fraxinus velutina* (velvet ash) and/or *Carya illinoensis* (pecan) is  $< 15\%$ .....go to 9

9A. The combined individual cover amount for *Andropogon glomeratus* (bushy bluestem), *Adiantum capillus-veneris* (common maidenhair fern), and/or *Lobelia cardinalis* (cardinal flower) is  $\geq 5\%$ .....**Seepwillow – Bushy Bluestem Spring Vegetation**

9B. The combined individual cover amount for *Andropogon glomeratus* (bushy bluestem), *Adiantum capillus-veneris* (common maidenhair fern), and/or *Lobelia cardinalis* (cardinal flower) is  $< 5\%$ .....go to 10

10A. BOTH (1) The total woody stratum cover (all species and strata pooled) is  $> 15\%$  AND (2) the combined individual cover amount for *Prosopis glandulosa* (honey mesquite) and/or *Vachellia farnesiana* (huisache) is  $\geq 25\%$  of the relative cover of the total woody strata cover.....go to 11

11A. The cover of *Prosopis glandulosa* (honey mesquite) is  $\geq$  one third of the combined individual cover of cover of *Sorghum halepense* (Johnson grass) and/or *Salsola tragus* (Russian thistle).....**Rio Grande Mesquite Riparian Bosque**

11B. The cover of *Prosopis glandulosa* (honey mesquite) is  $<$  one third of the combined individual cover of cover of *Sorghum halepense* (Johnson grass) and/or *Salsola tragus* (Russian thistle).....**Johnson Grass – Russian Thistle Desert Grassland**

**10B.** EITHER (1) The total woody stratum cover (all species and strata pooled) is  $\leq 15\%$  OR (2) the combined individual cover amount for *Prosopis glandulosa* (honey mesquite) and/or *Vachellia farnesiana* (huisache) is  $< 25\%$  of the relative cover of the total woody strata cover, or both (1) and (2) are true.....go to **12**

**12A.** The woody cover (shrubs and trees combined) is  $\geq 15\%$ .....go to **13**

**13A.** The combined individual cover amount for all *Tamarix* spp. (tamarisk) and/or *Nicotiana glauca* (tree-tobacco) is  $\geq 15\%$ .....

.....**Tamarisk – (Tree Tobacco) Riparian Shrubland**

**13B.** The combined individual cover amount for all *Tamarix* spp. (tamarisk) and/or *Nicotiana glauca* (tree-tobacco) is  $< 15\%$ .....go to **14**

**14A.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), and/or *Brickellia laciniata* (splitleaf brickellia) is  $\geq 3\%$ .....go to **15**

**15A.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $>$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass).....**Big Bend Lowland Wash Channel Shrubland**

**15B.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $\leq$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass).....**Foothills Wash Channel Shrubland**

**14B.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), and/or *Brickellia laciniata* (splitleaf brickellia) is  $< 3\%$ .....**Rio Grande Seepwillow Riparian Shrubland**



**12B.** The woody cover (shrubs and trees combined) is < 15%.....go to **16**

**16A.** The combined individual cover amount for *Sporobolus airoides* (alkali sacaton), *Sporobolus wrightii* (big sacaton), *Phragmites australis* (common reed), *Arundo donax* (giant cane), *Sorghum halepense* (Johnson grass), *Cynodon dactylon* (Bermuda grass), and/or *Salsola tragus* (Russian thistle) is  $\geq 25\%$ .....go to **17**

**17A.** Either *Sporobolus airoides* (alkali sacaton) or *Sporobolus wrightii* (big sacaton) is the most abundant herbaceous species (or is tied in cover as the most abundant species).....**Alkali Sacaton Riparian Grassland**

**17B.** At least one other herbaceous species has higher cover than *Sporobolus airoides* (alkali sacaton) and *Sporobolus wrightii* (big sacaton).....go to **18**

**18A.** *Cynodon dactylon* (Bermuda grass) is the most abundant herbaceous species (or no other herbaceous species is more abundant than *Cynodon dactylon*).....go to **19**

**19A.** The combined individual cover amount for of *Phragmites australis* (common reed) and/or *Arundo donax* (giant cane) is < 25%.....  
.....**Bermuda Grass Herbaceous Vegetation**

**19B.** The combined individual cover amount for *Phragmites australis* (common reed) and/or *Arundo donax* (giant cane) is  $\geq 25\%$ .....go to **20**

**20A.** The cover of *Phragmites australis* (common reed) is  $\geq$  the cover of *Arundo donax* (giant cane).....  
.....**Common Reed Riparian Herbaceous Vegetation**

**20B.** The cover of *Phragmites australis* (common reed) is < the cover of *Arundo donax* (giant cane).....  
.....**Giant Cane Riparian Herbaceous Vegetation**

**18B.** At least one other herbaceous species has higher cover than *Cynodon dactylon* (Bermuda grass).....go to **21**

**21A.** *Phragmites australis* (common reed) is the most abundant herbaceous species (or no other herbaceous species is more abundant than *Phragmites australis*).....  
.....**Common Reed Riparian Herbaceous Vegetation**

**21B.** At least one other herbaceous species has higher cover than *Phragmites australis* (common reed).....go to **22**

**22A.** *Arundo donax* (giant cane) is the most abundant herbaceous species (or no other herbaceous species is more abundant than *Arundo donax*).....

.....**Giant Cane Riparian Herbaceous Vegetation**

**22B.** At least one other herbaceous species has higher cover than *Arundo donax* (giant cane).....go to **23**

**23A.** Either *Sorghum halepense* (Johnson grass) or *Salsola tragus* (Russian thistle) is the most abundant herbaceous species (or no other herbaceous species is more abundant than *Sorghum halepense* or *Salsola tragus*).....

.....**Johnson Grass – Russian Thistle Desert Grassland**

**23B.** At least one other herbaceous species has higher cover than *Sorghum halepense* (Johnson grass) and *Salsola tragus* (Russian thistle).....go to **24**

**24A.** *Cynodon dactylon* (Bermuda grass) is the most abundant herbaceous species (or no other herbaceous species is more abundant than *Cynodon dactylon*).....

.....**Bermuda Grass Herbaceous Vegetation**

**24B.** At least one other herbaceous species has higher cover than *Cynodon dactylon* (Bermuda grass).....go to **25**

**25A.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush) and/or *Porophyllum scoparium* (shrubby poreleaf) is  $\geq 3\%$ .....

.....**Big Bend Lowland Wash Channel Shrubland**

**25B.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush) and/or *Porophyllum scoparium* (shrubby poreleaf) is  $< 3\%$ .....

.....**Rio Grande Alluvial Herbaceous Vegetation**

**16B.** The combined individual cover amount for *Sporobolus airoides* (alkali sacaton), *Sporobolus wrightii* (big sacaton), *Phragmites australis* (common reed), *Arundo donax* (giant cane), *Sorghum halepense* (Johnson grass), *Cynodon dactylon* (Bermuda grass) and/or *Salsola tragus* (Russian thistle) is  $< 25\%$ .....go to **26**

**26A.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Diospyros texana* (Texas persimmon), *Rhus microphylla* (littleleaf sumac), *Porophyllum scoparium* (shrubby poreleaf), *Senegalia* spp. (catclaw acacias), *Vachellia constricta* (whitethorn acacia), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Brickellia laciniata* (splitleaf brickellia), and/or *Fallugia paradoxa* (Apache plume) is  $\geq 3\%$ .....go to **27**

**27A.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), and/or *Fallugia paradoxa* (Apache plume) is  $\geq 15\%$  of the **relative** shrub stratum cover.....go to **28**

**28A.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $>$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass).....**Big Bend Lowland Wash Channel Shrubland**

**28B.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $\leq$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass).....**Foothills Wash Channel Shrubland**

**27B.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), and/or *Fallugia paradoxa* (Apache plume) is  $< 15\%$  of the **relative** shrub stratum cover.....**Mixed Tall Shrubs Wash Shrubland**

**26B.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Diospyros texana* (Texas persimmon), *Rhus microphylla* (littleleaf sumac), *Porophyllum scoparium* (shrubby poreleaf), *Senegalia* spp. (catclaw acacias), *Vachellia constricta* (whitethorn acacia), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Brickellia laciniata* (splitleaf brickellia), and/or *Fallugia paradoxa* (Apache plume) is < 3%.....go to **29**

**29A.** *Cynodon dactylon* (Bermuda grass) is the most abundant herbaceous species (or no other herbaceous species is more abundant than *Cynodon dactylon*).....**Bermuda Grass Herbaceous Vegetation**

**29B.** At least one other herbaceous species has higher cover than *Cynodon dactylon* (Bermuda grass).....go to **30**

**30A.** The combined individual cover amount for all *Schoenoplectus* spp. (bulrushes), *Polygonum* spp. (smartweeds), *Typha* spp. (cattails), *Bacopa monnieri* (water hyssop), *Polypogon monspeliensis* (annual rabbitsfoot grass), *Heliotropium curassavicum* (salt heliotrope), and/or *Phyla nodiflora* (turkey tangle fogfruit) is  $\geq 10\%$ .....go to **31**

**31A.** *Schoenoplectus californicus* (California bulrush) is the most abundant herbaceous species.....  
.....**California Bulrush Herbaceous Vegetation**

**31B.** A species other than *Schoenoplectus californicus* (California bulrush) is the most abundant herbaceous species.....  
.....**Wet Riverbank Herbaceous Vegetation**

**30B.** The combined individual cover amount for all *Schoenoplectus* spp. (bulrushes), *Polygonum* spp. (smartweeds), *Typha* spp. (cattails), *Bacopa monnieri* (water hyssop), *Polypogon monspeliensis* (annual rabbitsfoot grass), *Heliotropium curassavicum* (salt heliotrope), and/or *Phyla nodiflora* (turkey tangle fogfruit) is < 10%.....go to **32**

**32A.** Vegetation of active channels of tributary washes.....go to **33**

**33A.** Elevation is at or below 3,000 feet.....  
.....**Big Bend Lowland Wash Channel Shrubland**

**33B.** Elevation is above 3,000 feet.....  
.....**Foothills Wash Channel Shrubland**

**32B.** Vegetation of floodplains, banks, or alluvial bars of the Rio Grande.....**Rio Grande Alluvial Herbaceous Vegetation**

## **Foothills Vegetation Key**

**1A.** *Quercus laceyi* (Lacey's oak) cover is  $\geq 15\%$ .....**Lacey's Oak Woodland**

**1B.** *Quercus laceyi* (Lacey's oak) cover is  $< 5\%$ .....go to **2**

**2A.** The combined individual cover amount for *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Diospyros texana* (Texas persimmon), *Eysenhardtia texana* (Texas kidneywood), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Janusia gracilis*, (propeller bush), *Sophora secundiflora* (mescal bean), and/or *Ziziphus obtusifolia* (lotebush) is  $\geq 5\%$ .....go to **3**

**3A.** The combined individual cover amount of *Fraxinus greggii* (littleleaf ash) *Sophora secundiflora* (mescal bean), *Gutierrezia* spp. (snakeweeds), and/or *Juniperus flaccida* (weeping juniper) is  $\geq$  the combined individual cover amount for *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Forestiera angustifolia* (desert olive), *Prosopis glandulosa* (honey mesquite), and/or *Rhus microphylla* (littleleaf sumac).....**Persimmon – Littleleaf Ash Foothills Shrubland**

**3B.** The combined individual cover amount of *Fraxinus greggii* (littleleaf ash) *Sophora secundiflora* (mescal bean), *Gutierrezia* spp. (snakeweeds), and/or *Juniperus flaccida* (weeping juniper) is  $<$  the combined individual cover amount for *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Forestiera angustifolia* (desert olive), *Prosopis glandulosa* (honey mesquite), and/or *Rhus microphylla* (littleleaf sumac).....**Mixed Tall Shrubs Wash Shrubland**

**2B.** The combined individual cover amount for *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Diospyros texana* (Texas persimmon), *Eysenhardtia texana* (Texas kidneywood), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Janusia gracilis*, (propeller bush), *Sophora secundiflora* (mescal bean), and/or *Ziziphus obtusifolia* (lotebush) is  $< 5\%$ .....go to **4**

**4A.** The combined individual cover amount for *Larrea tridentata*, (creosotebush), *Leucophyllum frutescens* (cenizo), *Vachellia constricta* (whitethorn acacia), *Fouquieria splendens* (ocotillo), *Forestiera angustifolia* (desert olive), *Cylindropuntia imbricata* (tree cholla), *Tecoma stans* (yellow trumpetbush), *Bouteloua eriopoda* (black grama), *Bouteloua ramosa* (chino grama), *Cathestecum erectum* (false grama), *Heteropogon contortus* (tanglehead), *Pleuraphis mutica* (tobosa grass), and/or *Tiquilia* spp. (crinklemats) is  $\geq$  the combined individual covers *Juniperus* spp. (junipers), *Nolina erumpens* (foothill beargrass), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Garrya ovata* ssp. *goldmanii*, (Goldman's silktassel), *Prunus havardii* (Havard's plum), *Yucca faxoniana* (giant dagger), *Quercus* spp. (oaks), *Rhus virens* (evergreen sumac), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Agave havardiana* (Havard's century plant), *Ungnadia speciosa* (Mexican buckeye), *Muhlenbergia emersleyi* (bull muhly), *Notholaena standleyi* (star cloakfern), and/or *Astrolepis* spp. (cloak ferns).....  
.....**Sotol – Lechuguilla Foothills Shrub Grassland**

**4B.** The combined individual cover amount for *Larrea tridentata*, (creosotebush), *Leucophyllum frutescens* (cenizo), *Vachellia constricta* (whitethorn acacia), *Fouquieria splendens* (ocotillo), *Forestiera angustifolia* (desert olive), *Cylindropuntia imbricata* (tree cholla), *Tecoma stans* (yellow trumpetbush), *Bouteloua eriopoda* (black grama), *Bouteloua ramosa* (chino grama), *Cathestecum erectum* (false grama), *Heteropogon contortus* (tanglehead), *Pleuraphis mutica* (tobosa grass), and/or *Tiquilia* spp. (crinklemats) is  $<$  the combined individual covers *Juniperus* spp. (junipers), *Nolina erumpens* (foothill beargrass), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Garrya ovata* ssp. *goldmanii*, (Goldman's silktassel), *Prunus havardii* (Havard's plum), *Yucca faxoniana* (giant dagger), *Quercus* spp. (oaks), *Rhus virens* (evergreen sumac), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Agave havardiana* (Havard's century plant), *Ungnadia speciosa* (Mexican buckeye), *Muhlenbergia emersleyi* (bull muhly), *Notholaena standleyi* (star cloakfern), and/or *Astrolepis* spp. (cloak ferns).....go to **5**

**5A.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper) and/or *Juniperus flaccida* (weeping juniper) is  $\geq$  8%.....**Alligator Juniper – Pinyon Pine – Gray Oak Woodland**

**5B.** The combined individual cover amount for *Pinus cembroides* (Mexican pinyon), *Juniperus deppeana* (alligator juniper) and/or *Juniperus flaccida* (weeping juniper) is  $<$  8%.....go to **6**

**6A.** The combined individual cover amount for *Leucophyllum minus* (Big Bend silverleaf), *Hechtia texensis* (Texas false agave), *Quercus mohriana* (Mohr's shin oak), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Yucca faxoniana* (giant dagger), and/or *Yucca thompsoniana* (Thompson's yucca) is  $\geq$  2%.....go to **7**

**7A.** The combined individual cover amount for *Quercus* spp. (oaks), *Fraxinus greggii* (littleleaf ash), *Prunus havardii* (Havard's plum), *Juniperus* spp. (junipers), *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), and/or *Chrysactinia mexicana* (damianita) is  $\geq 15\%$ .....**Calcareous Chaparral**

**7B.** The combined individual cover amount for *Quercus* spp. (oaks), *Fraxinus greggii* (littleleaf ash), *Prunus havardii* (Havard's plum), *Juniperus* spp. (junipers), *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), and/or *Chrysactinia mexicana* (damianita) is  $< 15\%$ .....

.....**Yucca – Sotol Calcareous Shrub**

**Grassland**

**6B.** The combined individual cover amount for *Leucophyllum minus* (Big Bend silverleaf), *Hechtia texensis* (Texas false agave), *Quercus mohriana* (Mohr's shin oak), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Yucca faxoniana* (giant dagger), and/or *Yucca thompsoniana* (Thompson's yucca) is  $< 2\%$ .....go to **8**

**8A.** Total vascular plant cover is  $\geq 5\%$ .....go to **9**

**8B.** Total vascular plant cover is  $< 5\%$ .....go to **15**

**9A.** BOTH (1) the combined individual cover amount for *Dasyllirion leiophyllum* (green sotol), *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), *J. coahuilensis*  $\times$  *J. pinchotii* (hybrid juniper), and/or *Selaginella peruviana* (Peruvian spikemoss) is  $\geq 5\%$ , AND (2) at least two of those taxa are present (for purposes of this couplet, treat the complex of *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), and *J. coahuilensis*  $\times$  *J. pinchotii* (hybrid juniper) as a single taxon).....**Redberry Juniper – Sotol Shrubland**

**9B.** EITHER (1) the combined individual cover amount for *Dasyllirion leiophyllum* (green sotol), *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), *J. coahuilensis*  $\times$  *J. pinchotii* (hybrid juniper), and/or *Selaginella peruviana* (Peruvian spikemoss) is  $< 5\%$ , OR (2) no more than one of those taxa are present (for purposes of this couplet, treat the complex of *Juniperus coahuilensis* (redberry juniper), *J. pinchotii* (Pinchot juniper), and *J. coahuilensis*  $\times$  *J. pinchotii* (hybrid juniper) as a single taxon), or both (1) and (2) are true.....go to **10**

**10A.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Prunus havardii* (Havard's plum), *Viguiera stenoloba* (skeletonleaf goldeneye), *Fraxinus greggii* (littleleaf ash), *Cercocarpus montanus* (alderleaf mountain mahogany), and/or *Quercus* spp. (oaks) is  $> 15\%$ .....go to **11**

**11A.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and/or *Quercus* spp. (oaks) is  $\geq 2\%$ .....**Montane Mixed Chaparral**

**11B.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and/or *Quercus* spp. (oaks) is < 2%.....

.....**Montane Talus and Cliff Rocky Sparse Shrubland**

**10B.** The combined individual cover amount for *Rhus virens* (evergreen sumac), *Prunus havardii* (Havard's plum), *Viguiera stenoloba* (skeletonleaf goldeneye), *Fraxinus greggii* (littleleaf ash), *Cercocarpus montanus* (alderleaf mountain mahogany), and/or *Quercus* spp. (oaks) is ≤ 15%.....go to **12**

**12A.** At least three of the following taxa are present (treat all individual species of each genus as a single taxon): *Chrysactinia mexicana* (damianita), *Fouquieria splendens* (ocotillo), *Echinocereus* spp. (hedgehog cactuses), *Mammillaria* spp. (globe cactuses), *Selaginella* spp. (spikemosses), and/or *Eriogonum* spp. (buckwheats).....go to **13**

**13A.** The combined individual cover amount for *Muhlenbergia emersleyi* (bull muhly), *Selaginella* spp. (spikemosses), and/or *Quercus* spp. (oaks) is ≥ 5%.....  
.....**Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation**

**13B.** The combined individual cover amount for *Muhlenbergia emersleyi* (bull muhly), *Selaginella* spp. (spikemosses), and/or *Quercus* spp. (oaks) is < 5%.....  
.....**Montane Talus and Cliff Rocky Sparse Shrubland**

**12B.** No more than two of the following taxa are present (treat all individual species of each genus as a single taxon): *Chrysactinia mexicana* (damianita), *Fouquieria splendens* (ocotillo), *Echinocereus* spp. (hedgehog cactuses), *Mammillaria* spp. (globe cactuses), *Selaginella* spp. (spikemosses), and/or *Eriogonum* spp. (buckwheats).....go to **14**

**14A.** The combined individual cover amount for *Aloysia gratissima* (whitebrush), *Prunus havardii* (Havard's plum), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Nolina erumpens* (foothill beargrass), and/or *Juniperus* spp. (juniper) is ≥ 2%.....**Redberry Juniper – Sotol Shrubland**

**14B.** The combined individual cover amount for *Aloysia gratissima* (whitebrush), *Prunus havardii* (Havard's plum), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Nolina erumpens* (foothill beargrass), and/or *Juniperus* spp. (juniper) is < 2%.....**Montane Talus and Cliff Rocky Sparse Shrubland**

**15A.** *Selaginella* spp. (spikemosses) comprise ≥ 30% of the relative vascular plant cover (from all strata).....  
.....**Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation**

**15B.** *Selaginella* spp. (spikemosses) comprise < 30% of the relative vascular plant cover (from all strata).....go to **16**



**16A.** Vegetation of cliffs or other bedrock outcrops, with vascular vegetation largely restricted to crevices or ledges.....go to **17**

**17B.** The cover of *Fouquieria splendens* (ocotillo) is  $\geq 1\%$ .....  
.....**Montane Talus and Cliff Rocky Sparse Shrubland**

**17B.** The cover of *Fouquieria splendens* (ocotillo) is  $< 1\%$ .....  
.....**Montane Igneous Outcrop Lichen Vegetation**

**16B.** Vegetation not on cliffs or other bedrock outcrops, and vascular vegetation is not largely restricted to crevices or ledges.....  
.....**Montane Talus and Cliff Rocky Sparse Shrubland**

### **Desert Lowlands Vegetation Key**

**1A.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), and/or *Fallugia paradoxa* (Apache plume) is  $\geq 15\%$  of the **relative** shrub stratum cover.....go to **2**

**2A.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $>$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass) .....**Big Bend Lowland Wash Channel Shrubland**

**2B.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $\leq$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass).....**Foothills Wash Channel Shrubland**

**1B.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), and/or *Fallugia paradoxa* (Apache plume) is  $< 15\%$  of the **relative** shrub stratum cover.....go to **3**

**3A.** The cover of *Andropogon glomeratus* (bushy bluestem) is  $\geq 5\%$ .....  
.....**Seepwillow – Bushy Bluestem Spring Vegetation**

**3B.** The cover of *Andropogon glomeratus* (bushy bluestem) is  $< 5\%$ .....go to **4**

- 4A.** The combined individual cover amount for *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Diospyros texana* (Texas persimmon), *Forestiera angustifolia* (desert olive), and/or *Rhus microphylla* (littleleaf sumac), is  $> 5\%$ .....go to **5**
- 5A.** The relative cover of *Prosopis glandulosa* (honey mesquite) across all woody strata is  $\geq 50\%$ .....**Rio Grande Mesquite Riparian Bosque**
- 5B.** The relative cover of *Prosopis glandulosa* (honey mesquite) across all woody strata is  $< 50\%$ .....**Mixed Tall Shrubs Wash Shrubland**
- 4B.** The combined individual cover amount for *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Diospyros texana* (Texas persimmon), *Forestiera angustifolia* (desert olive), and/or *Rhus microphylla* (littleleaf sumac), is  $\leq 5\%$ .....go to **6**
- 6A.** Total vascular plant cover is  $\geq 5\%$ .....go to **7**
- 6B.** Total vascular plant cover is  $< 5\%$ .....go to **29**
- 7A.** At least two of the following species (calcareous indicators) are present: *Euphorbia antisyphilitica* (candelilla), *Hechtia texensis* (Texas false agave), *Leucophyllum minus* (Big Bend silverleaf), *Leucophyllum candidum* (Boquillas silverleaf), *Yucca faxoniana* (giant dagger), *Yucca thompsoniana*, (Thompson's yucca), *Tiquilia gossypina* (Texas crinklemat), *Tiquilia hispidissima* (hairy crinklemat), *Tiquilia mexicana* (Mexican crinklemat), *Escobaria tuberculosa* (cob cactus), *Ariocarpus fissuratus* (living rock cactus), and/or *Opuntia ×spinosibacca* (spiny-fruited pricklypear).....go to **8**
- 8A.** The cover amount for *Leucophyllum frutescens* (cenizo) is  $\geq$  the combined individual cover amount for *Hechtia texensis* (Texas false agave), *Leucophyllum minus* (Big Bend silverleaf), *Yucca faxoniana* (giant dagger), *Yucca thompsoniana*, (Thompson's yucca), *Tiquilia gossypina* (Texas crinklemat), *Tiquilia hispidissima* (hairy crinklemat), *Tiquilia mexicana* (Mexican crinklemat), *Escobaria tuberculosa* (cob cactus), *Ariocarpus fissuratus* (living rock cactus), and/or *Opuntia ×spinosibacca* (spiny-fruited pricklypear).....**Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub**
- 8B.** The cover amount for *Leucophyllum frutescens* (cenizo) is  $<$  the combined individual cover amount for *Hechtia texensis* (Texas false agave), *Leucophyllum minus* (Big Bend silverleaf), *Yucca faxoniana* (giant dagger), *Yucca thompsoniana*, (Thompson's yucca), *Tiquilia gossypina* (Texas crinklemat), *Tiquilia hispidissima* (hairy crinklemat), *Tiquilia mexicana* (Mexican crinklemat), *Escobaria tuberculosa* (cob cactus), *Ariocarpus fissuratus* (living rock cactus), and/or *Opuntia ×spinosibacca* (spiny-fruited pricklypear).....go to **9**
- 9A.** The total cover of the herbaceous stratum is  $> 10\%$ .....go to **10**

**10A.** The combined individual cover amount for *Dasyilirion leiophyllum* (green sotol), *Leucophyllum minus* (Big Bend silverleaf), *Fraxinus greggii* (littleleaf ash), *Nolina erumpens* (foothill beargrass), *Rhus virens* (evergreen sumac), *Quercus pungens* (sandpaper oak), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Viguiera stenoloba* (skeletonleaf goldeneye), *Bouteloua hirsuta* (hairy grama), and/or *Bouteloua curtipendula* (sideoats grama) is  $\geq$  combined individual cover amount for *Larrea tridentata* (creosotebush), *Opuntia rufida* (blind pricklypear), *Jatropha dioica* (leatherstem), *Tiquilia greggii* (Gregg's crinklemat), *Yucca torreyi* (Torrey's yucca), *Thymophylla acerosa* (pricklyleaf dogweed), *Leucophyllum candidum* (Boquillas silverleaf), *Echinocactus horizonthalonius* (eagle-claw cactus), *Escobaria tuberculosa* (cob cactus), and/or *Bouteloua ramosa* (chino grama); generally above 4800 feet in the Chisos and Dead Horse Mountains .....go to **11**

**11A.** The combined individual cover amount for *Quercus* spp. (oaks), *Fraxinus greggii* (littleleaf ash), *Prunus havardii* (Havard's plum), *Juniperus* spp. (junipers), *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), and/or *Chrysactinia mexicana* (damianita) is  $\geq 15\%$ .....**Calcareous Chaparral**

**11B.** The combined individual cover amount for *Quercus* spp. (oaks), *Fraxinus greggii* (littleleaf ash), *Prunus havardii* (Havard's plum), *Juniperus* spp. (junipers), *Rhus virens* (evergreen sumac), *Nolina erumpens* (foothill beargrass), and/or *Chrysactinia mexicana* (damianita) is  $< 15\%$ .....**Yucca – Sotol Calcareous Shrub Grassland**

**10B.** The combined individual cover amount for *Dasyilirion leiophyllum* (green sotol), *Leucophyllum minus* (Big Bend silverleaf), *Fraxinus greggii* (littleleaf ash), *Nolina erumpens* (foothill beargrass), *Rhus virens* (evergreen sumac), *Quercus pungens* (sandpaper oak), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Viguiera stenoloba* (skeletonleaf goldeneye), *Bouteloua hirsuta* (hairy grama), and/or *Bouteloua curtipendula* (sideoats grama) is  $<$  the combined individual cover amount for *Larrea tridentata* (creosotebush), *Opuntia rufida* (blind pricklypear), *Jatropha dioica* (leatherstem), *Tiquilia greggii* (Gregg's crinklemat), *Yucca torreyi* (Torrey's yucca), *Thymophylla acerosa* (pricklyleaf dogweed), *Leucophyllum candidum* (Boquillas silverleaf), *Echinocactus horizonthalonius* (eagle-claw cactus), *Escobaria tuberculosa* (cob cactus), and/or *Bouteloua ramosa* (chino grama); generally below 4800 feet.....**Calcareous Mixed Desert Scrub**

**9B.** The total cover of the herbaceous stratum is  $\leq 10\%$ .....go to **12**

**12A.** The number of species present from among: *Euphorbia antisyphilitica* (candelilla), *Dasyilirion leiophyllum* (green sotol), *Senegalia greggii* (Gregg's catclaw), *Dalea formosa* (featherplume), *Thymophylla acerosa* (pricklyleaf dogweed), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Opuntia camanchica* (Comanche pricklypear), *Opuntia rufida* (blind pricklypear), and/or *Tiquilia greggii* (Gregg's crinklemat) is  $\geq$  the number of species present from among: *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Tiquilia canescens* (woody crinklemat), *Ariocarpus fissuratus* (living rock cactus), *Echinocactus horizonthalonius* (eagle-claw cactus), *Opuntia*  $\times$  *spinosibacca* (spiny-fruited pricklypear), *Escobaria tuberculosa* (cob cactus), *Cathastecum erectum* (false grama), *Hibiscus denudatus* (paleface rosemallow), *Senna durangensis* (Durango senna), and/or *Bahia absinthifolia* (hairyseed bahia).....  
.....**Calcareous Mixed Desert Scrub**

**12B.** The number of species present from among: *Euphorbia antisyphilitica* (candelilla), *Dasyilirion leiophyllum* (green sotol), *Senegalia greggii* (Gregg's catclaw), *Dalea formosa* (featherplume), *Thymophylla acerosa* (pricklyleaf dogweed), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Opuntia camanchica* (Comanche pricklypear), *Opuntia rufida* (blind pricklypear), and/or *Tiquilia greggii* (Gregg's crinklemat) is  $<$  the number of species present from among: *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Tiquilia canescens* (woody crinklemat), *Ariocarpus fissuratus* (living rock cactus), *Echinocactus horizonthalonius* (eagle-claw cactus), *Opuntia*  $\times$  *spinosibacca* (spiny-fruited pricklypear), *Escobaria tuberculosa* (cob cactus), *Cathastecum erectum* (false grama), *Hibiscus denudatus* (paleface rosemallow), *Senna durangensis* (Durango senna), and/or *Bahia absinthifolia* (hairyseed bahia) .....  
.....**Boquillas Basin Calcareous Creosotebush Desert Scrub**

**7B.** No more than one of the following species (calcareous indicators) are present: *Euphorbia antisyphilitica* (candelilla), *Hechtia texensis* (Texas false agave), *Leucophyllum minus* (Big Bend silverleaf), *Leucophyllum candidum* (Boquillas silverleaf), *Yucca faxoniana* (giant dagger), *Yucca thompsoniana*, (Thompson's yucca), *Tiquilia gossypina* (Texas crinklemat), *Tiquilia hispidissima* (hairy crinklemat), *Tiquilia mexicana* (Mexican crinklemat), *Escobaria tuberculosa* (cob cactus), *Ariocarpus fissuratus* (living rock cactus), and/or *Opuntia*  $\times$  *spinosibacca* (spiny-fruited pricklypear).....go to **13**

**13A.** BOTH (1) *Pleuraphis mutica* (tobosa grass) comprises  $\geq 50\%$  of the relative cover in the herbaceous stratum AND (2) total herbaceous cover is  $\geq 15\%$ .....  
.....**Tobosa Grass Desert Grassland**

**13B.** EITHER (1) *Pleuraphis mutica* (tobosa grass) comprises  $< 50\%$  of the relative cover in the herbaceous stratum OR (2) total herbaceous cover is  $< 15\%$ , or both (1) and (2) are true.....go to **14**

**14A.** (1) BOTH (1) the combined relative cover of *Prosopis glandulosa* (honey mesquite) and/or *Flourensia cernua* (American tarbush) is  $\geq 20\%$  AND (2) the total shrub and tree strata cover combined is  $> 15\%$ .....go to **15**

**15A.** The combined individual cover amount for *Flourensia cernua* (American tarbush), *Viguiera stenoloba* (skeletonleaf goldeneye), *Parthenium incanum* (mariola), *Aloysia* spp. (beebrushes), *Vachellia constricta* (whitethorn acacia), *Vachellia vernicosa* (viscid acacia), *Senegalia* spp. (catclaw acacias), *Yucca* spp. (yuccas), and/or *Bouteloua* spp. (grama grasses) is  $\geq$  the combined individual cover amounts of *Baccharis salicifolia* (seepwillow), *Vachellia farnesiana* (huisache), *Tamarix ramosissima* (tamarisk), *Celtis ehrenbergiana* (spiny hackberry), *Arundo donax* (giant cane)and/or *Cynodon dactylon* (Bermuda grass).....go to **16**

**16A.** At least some *Prosopis glandulosa* (honey mesquite) are taller than 10 meters.....**Rio Grande Mesquite Riparian Bosque**

**16B.** No *Prosopis glandulosa* (honey mesquite) (if present) are taller than 10 meters.....go to **17**

**17A.** The combined individual cover amount for *Prosopis glandulosa* (honey mesquite) *Larrea tridentata* (creosotebush), and/or *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear) is  $\geq$  the combined individual cover amounts of *Aloysia* spp. (beebrushes), *Vachellia* spp. (acacias), *Senegalia* spp. (catclaw acacias), *Yucca elata* (soaptree yucca), and/or *Salazaria mexicana* (bladdersage).....**Mesquite – Creosotebush Desert Scrub**

**17B.** The combined individual cover amount for *Prosopis glandulosa* (honey mesquite) *Larrea tridentata* (creosotebush), and/or *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear) is  $<$  the combined individual cover amounts of *Aloysia* spp. (beebrushes), *Vachellia* spp. (acacias), *Senegalia* spp. (catclaw acacias), *Yucca elata* (soaptree yucca), and/or *Salazaria mexicana* (bladdersage).....**Acacia – Mesquite Wash Shrubland**

**15B.** The combined individual cover amount for *Flourensia cernua* (American tarbush), *Viguiera stenoloba* (skeletonleaf goldeneye), *Parthenium incanum* (mariola), *Aloysia* spp. (beebrushes), *Vachellia constricta* (whitethorn acacia), *Vachellia vernicosa* (viscid acacia), *Senegalia* spp. (catclaw acacias), *Yucca* spp. (yuccas), and/or *Bouteloua* spp. (grama grasses) is  $<$  the combined individual cover amounts of *Baccharis salicifolia* (seepwillow), *Vachellia farnesiana* (huisache), *Tamarix ramosissima* (tamarisk), *Celtis ehrenbergiana* (spiny hackberry), *Arundo donax* (giant cane)and/or *Cynodon dactylon* (Bermuda grass).....**Rio Grande Mesquite Riparian Bosque**

**14B.** EITHER (1) the combined relative cover of *Prosopis glandulosa* (honey mesquite) and/or *Flourensia cernua* (American tarbush) is < 20% OR (2) the total shrub and tree strata cover combined is  $\leq$  15%, or both (1) and (2) are true.....go to **18**

**18A.** Herbaceous vegetation of areas that have been significantly disturbed in the recent past by human activity (construction, etc.) and/or that are maintained by ongoing maintenance (e.g., regular mowing). Dominated by ruderal native or non-native species, including, but not limited to, *Heteropogon contortus* (tanglehead), *Eragrostis lehmanniana* (Lehmann lovegrass), *Pennisetum ciliare* (buffelgrass), *Conyza canadensis* (Canadian horseweed), *Salsola tragus* (Russian thistle).....  
.....**Upland Ruderal Herbaceous Vegetation**

**18B.** Vegetation not as above (maintained by mostly natural processes) and of varied physiognomy. Includes natural vegetation that has been invaded by ruderal species, including riparian vegetation that has dominated by non-native grasses such as *Eragrostis lehmanniana* (Lehmann lovegrass) or *Pennisetum ciliare* (buffelgrass)) or regularly flooded riparian bars that have native and non-native ruderal species prominent.....go to **19**

**19A.** The combined individual cover amount for *Dasyilirion leiophyllum* (green sotol), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Cylindropuntia imbricata* (tree cholla), *Bouteloua curtipendula* (sideoats grama), *Bouteloua hirsuta* (hairy grama), *Bouteloua eriopoda* (black grama), and/or *Heteropogon contortus* (tanglehead) is  $\geq$  5%.....go to **20**

**20A.** The combined individual cover amount for *Hechtia texensis* (Texas false agave), *Yucca faxoniana* (giant dagger), *Yucca thompsoniana* (Thompson's yucca), and/or *Leucophyllum minus* (Big Bend silverleaf) is  $\geq$  2%; associations of the high Dead Horse Mountains, generally above 4,800 feet.....**Yucca – Sotol Calcareous Shrubland**

**20B.** The combined individual cover amount for *Hechtia texensis* (Texas false agave), *Yucca faxoniana* (giant dagger), *Yucca thompsoniana* (Thompson's yucca), and/or *Leucophyllum minus* (Big Bend silverleaf) is < 2%; associations of the foothills and lower elevations of other ranges (Chisos, Rosillos, and Santiago Mountains and Sierra Quemada).....go to **21**

**21A.** The cover of *Bouteloua ramosa* (chino grama) is > the cover of *Parthenium incanum* (mariola).....go to **22**

**22A.** BOTH (1) The cover of *Bouteloua ramosa* (chino grama) is  $\geq$  10% AND (2) the cover of *Bouteloua ramosa*  $\geq$  the cover of all other individual grass species.....**Chino Grama Shrub Grassland**

**22B.** EITHER (1) the cover of *Bouteloua ramosa* (chino grama) is < 10% OR (2) the cover of *Bouteloua ramosa* < the cover of at least one other individual grass species, or both (1 and 2) are true.....

.....**Sotol – Lechuguilla Foothills Shrub**

**Grassland**

**21B.** The cover of *Bouteloua ramosa* (chino grama) is ≤ the cover of *Parthenium incanum* (mariola).....

.....**Sotol – Lechuguilla Foothills Shrub**

**Grassland**

**19B.** The combined individual cover amount for *Dasyllirion leiophyllum* (green sotol), *Opuntia engelmannii* var. *engelmannii* (Engelmann’s pricklypear), *Cylindropuntia imbricata* (tree cholla), *Bouteloua curtipendula* (sideoats grama), *Bouteloua hirsuta* (hairy grama), *Bouteloua eriopoda* (black grama), and/or *Heteropogon contortus* (tanglehead) is < 5%.....go to **23**

**23A.** The combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Dasyllirion leiophyllum* (green sotol), *Opuntia engelmannii* var. *engelmannii* (Engelmann’s pricklypear), *Bouteloua ramosa* (chino grama), *Leucophyllum frutescens* (cenizo), *Heteropogon contortus* (tanglehead), and/or *Gutierrezia* spp. (snakeweeds) is ≥ 2%.....go to **24**

**24A.** The combined individual cover amount for *Fouquieria splendens* (ocotillo), *Dasyllirion leiophyllum* (green sotol), *Viguiera stenoloba* (skeletonleaf goldeneye), *Euphorbia antispyphilica* (candelilla), *Parthenium incanum* (mariola), *Opuntia rufida* (blind pricklypear), *Tiquilia greggii* (Gregg’s crinklemat), *Tiquilia canescens* (woody crinklemat), *Guaiacum angustifolium* (guayacan), *Leucophyllum* spp. (barometerbushes), and/or *Gutierrezia* spp. (snakeweeds) is ≥ 1%.....go to **25**

**25A.** The cover of *Bouteloua ramosa* (chino grama) is ≥ 15%.....  
.....**Chino Grama Shrub Grassland**

**25B.** The cover of *Bouteloua ramosa* (chino grama) is < 15%.....  
.....**Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub**

**24B.** The combined individual cover amount for *Fouquieria splendens* (ocotillo), *Dasyllirion leiophyllum* (green sotol), *Viguiera stenoloba* (skeletonleaf goldeneye), *Euphorbia antispyphilica* (candelilla), *Parthenium incanum* (mariola), *Opuntia rufida* (blind pricklypear), *Tiquilia greggii* (Gregg’s crinklemat), *Tiquilia canescens* (woody crinklemat), *Guaiacum angustifolium* (guayacan), *Leucophyllum* spp. (barometerbushes), and/or *Gutierrezia* spp. (snakeweeds) is < 1%.....**Badlands Sparse Vegetation**

**23B.** The combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Dasyilirion leiophyllum* (green sotol), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Bouteloua ramosa* (chino grama), *Leucophyllum frutescens* (cenizo), *Heteropogon contortus* (tanglehead), and/or *Gutierrezia* spp. (snakeweeds) is < 2%.....go to **26**

**26A.** EITHER (1) *Suaeda suffrutescens* (desert seepweed) has the highest cover of any species present (or is tied with another species with the highest cover) OR (2) at least two of the following species (gypseous indicators) are present: *Suaeda suffrutescens* (desert seepweed) *Sporobolus pyramidatus* (whorled dropseed), and/or *Echinochloa crus-galli* (barnyardgrass).....**Alkaline Clay Flat Shrubland**

**26B.** BOTH (1) A species other than *Suaeda suffrutescens* (desert seepweed) has the highest cover of any species present AND no more than one of the following species (gypseous indicators) are present: *Suaeda suffrutescens* (desert seepweed) *Sporobolus pyramidatus* (whorled dropseed), and/or *Echinochloa crus-galli* (barnyardgrass).....go to **27**

**27A.** The combined individual cover amount for *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Vachellia* spp. (acacias), *Senegalia* spp. (catclaw acacias), *Jatropha dioica* (leatherstem), *Yucca torreyi* (Torrey's yucca), *Dasyochloa pulchella* (fluffgrass), and/or *Senna durangensis* (Durango senna) is > the combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Prosopis glandulosa* (honey mesquite), *Cylindropuntia leptocaulis* (Christmas cactus), *Atriplex* spp.(saltbushes), *Sporobolus* spp. (dropseeds), and/or *Bouteloua ramosa* (chino grama).....go to **28**

**28A.** The combined individual cover amount for *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Jatropha dioica* (leatherstem) *Krameria* spp. (ratany), *Dasyochloa pulchella* (fluffgrass), and/or *Senna durangensis* (Durango senna) is  $\geq$  the combined individual covers of *Vachellia* spp. (acacias), *Senegalia* spp. (catclaw acacias), *Prosopis glandulosa* (honey mesquite), *Aloysia* spp. (beebrushes), *Salazaria mexicana* (bladdersage), and/or *Yucca elata* (soaptree yucca).....**Big Bend Lowlands Creosotebush Desert Scrub**

**28B.** The combined individual cover amount for *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Jatropha dioica* (leatherstem) *Krameria* spp. (ratany), *Dasyochloa pulchella* (fluffgrass), and/or *Senna durangensis* (Durango senna) is < the combined individual covers of *Vachellia* spp. (straight-thorned acacias), *Senegalia* spp. (catclaw acacias), *Prosopis glandulosa* (honey mesquite), *Aloysia* spp. (beebrushes), *Salazaria mexicana* (bladdersage), and/or *Yucca elata* (soaptree yucca).....**Acacia – Mesquite Wash Shrubland**



**27B.** The combined individual cover amount for *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Vachellia* spp. (straight-thorned acacias), *Senegalia* spp. (catclaw acacias), *Jatropha dioica* (leatherstem), *Yucca torreyi* (Torrey's yucca), *Dasyochloa pulchella* (fluffgrass), and/or *Senna durangensis* (Durango senna) is  $\leq$  the combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Prosopis glandulosa* (honey mesquite), *Cylindropuntia leptocaulis* (Christmas cholla), *Atriplex* spp. (saltbushes), *Sporobolus* spp. (dropseeds), and/or *Bouteloua ramosa* (chino grama).....**Badlands Sparse Vegetation**

**29A.** Sparse vegetation or apparently unvegetated surfaces of either banks or alluvial bars of the Rio Grande or in channels of tributary washes.....go to **30**

**30A.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singelwhorl burrobrush), *Diospyros texana* (Texas persimmon), *Rhus microphylla* (littleleaf sumac), *Porophyllum scoparium* (shrubby poreleaf), *Senegalia* spp. (catclaw acacias), *Vachellia* spp. (acacias), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Brickellia laciniata* (splitleaf brickellia), and/or *Fallugia paradoxa* (Apache plume) is  $\geq 2\%$ .....go to **31**

**31A.** The combined individual cover amount for *Hymenoclea monogyra* (singlewhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $>$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass)  
.....**Big Bend Lowland Wash Channel Shrubland**

**31B.** The combined individual cover amount for *Hymenoclea monogyra* (singelwhorl burrobrush), *Prosopis glandulosa* (honey mesquite), *Vachellia* spp. (acacias), *Sorghum halepense* (Johnson grass), and/or *Bouteloua barbata* (sixweeks grama) is  $\leq$  the combined individual cover amount for *Fallugia paradoxa* (Apache plume), *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), *Viguiera stenoloba* (skeletonleaf goldeneye), *Brickellia laciniata* (splitleaf brickellia), *Yucca torreyi* (Torrey's yucca), and/or *Eragrostis lehmanniana* (Lehmann lovegrass).....**Foothills Wash Channel Shrubland**

**30B.** The combined individual cover amount for *Chilopsis linearis* (desertwillow), *Hymenoclea monogyra* (singlewhorl burrobrush), *Diospyros texana* (Texas persimmon), *Rhus microphylla* (littleleaf sumac), *Porophyllum scoparium* (shrubby poreleaf), *Senegalia* spp. (catclaw acacias), *Vachellia* spp. (acacias), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Brickellia laciniata* (splitleaf brickellia), and/or *Fallugia paradoxa* (Apache plume) is  $< 2\%$ .....go to **32**

- 32A.** Either *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), or both are present.....  
.....**Big Bend Lowland Wash Channel Shrubland**
- 32B.** Neither *Hymenoclea monogyra* (singlewhorl burrobrush) nor *Porophyllum scoparium* (shrubby poreleaf), is present.....go to **33**
- 33A.** Vegetation (or apparently unvegetated surfaces) of active channels of tributary washes.....go to **34**
- 34A.** Elevation is at or below 3,000 feet.....  
.....**Big Bend Lowland Wash Channel Shrubland**
- 34B.** Elevation is above 3,000 feet.....**Foothills Wash Channel Shrubland**
- 33B.** Vegetation (or apparently unvegetated surfaces) of floodplains, banks or alluvial bars of the Rio Grande.....**Rio Grande Alluvial Herbaceous Vegetation**
- 29B.** Sparse vegetation or apparently unvegetated surfaces of various settings, not on banks or alluvial bars of the Rio Grande nor in channels of tributary washes.....go to **35**
- 35A.** At least two of the following taxa are present: *Senegalia greggii* (Gregg's catclaw), *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Diospyros texana*, *Eysenhardtia texana* (Texas kidneywood), *Forestiera angustifolia* (desert olive), , and/or *Fallugia paradoxa* (Apache plume), *Rhus microphylla* (littleleaf sumac), *Sophora secundiflora* (mescal bean), and/or *Ziziphus obtusifolia* (lotebush)  
.....**Mixed Tall Shrubs Wash Shrubland**
- 35B.** No more than one of the following taxa are present: *Senegalia greggii* (Gregg's catclaw), *Senegalia roemeriana* (Roemer's catclaw), *Celtis ehrenbergiana* (spiny hackberry), *Diospyros texana*, *Eysenhardtia texana* (Texas kidneywood), *Forestiera angustifolia* (desert olive), , and/or *Fallugia paradoxa* (Apache plume), *Rhus microphylla* (littleleaf sumac), *Sophora secundiflora* (mescal bean), and/or *Ziziphus obtusifolia* (lotebush).....go to **36**
- 36A.** At least one of the following species (calcareous indicators) are present: *Euphorbia antisiphilitica* (candelilla), *Hechtia texensis* (Texas false agave), *Leucophyllum candidum* (Boquillas silverleaf), *Tiquilia gossypina* (Texas crinklemat), *Tiquilia hispidissima* (hairy crinklemat), *Tiquilia mexicana* (Mexican crinklemat), *Escobaria tuberculosa* (cob cactus), *Ariocarpus fissuratus* (living rock cactus), and/or *Opuntia ×spinosibacca* (spiny-fruited pricklypear).....**Boquillas Basin Calcareous Creosotebush Desert Scrub**

**36B.** None of the following species (calcareous indicators) are present: *Euphorbia antisyphilitica* (candelilla), *Hechtia texensis* (Texas false agave), *Leucophyllum candidum* (Boquillas silverleaf), *Tiquilia gossypina* (Texas crinklemat), *Tiquilia hispidissima* (hairy crinklemat), *Tiquilia mexicana* (Mexican crinklemat), *Escobaria tuberculosa* (cob cactus), *Ariocarpus fissuratus* (living rock cactus), and/or *Opuntia ×spinosibacca* (spiny-fruited pricklypear).....go to **37**

**37A.** The combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Bouteloua ramosa* (chino grama), *Leucophyllum frutescens* (cenizo), *Heteropogon contortus* (tanglehead), *Ziziphus obtusifolia* (lotebush) and/or *Gutierrezia* spp. (snakeweeds) is  $\geq 0.5\%$ .....go to **38**

**38A.** The combined individual cover amount for *Fouquieria splendens* (ocotillo), *Dasyllirion leiophyllum* (green sotol), *Viguiera stenoloba* (skeletonleaf goldeneye), *Euphorbia antisyphilitica* (candelilla), *Parthenium incanum* (mariola), *Opuntia rufida* (blind pricklypear), *Tiquilia greggii* (plumed crinklemat), *Tiquilia canescens*, (woody crinklemat), *Guaiaacum angustifolium* (guayacan), *Leucophyllum* spp. (barometerbushes), and/or *Gutierrezia* spp. (snakeweeds), is  $\geq 1\%$ .....go to **39**

**39A.** Vegetation of talus, scree, or sand dunes.....

.....**Low Elevation Talus and Dune Sparse Vegetation**

**39B.** Vegetation not on talus, scree, or sand dunes.....

.....**Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub**

**38B.** The combined individual cover amount for *Fouquieria splendens* (ocotillo), *Dasyllirion leiophyllum* (green sotol), *Viguiera stenoloba* (skeletonleaf goldeneye), *Euphorbia antisyphilitica* (candelilla), *Parthenium incanum* (mariola), *Opuntia rufida* (blind pricklypear), *Tiquilia greggii* (plumed crinklemat), *Tiquilia canescens*, (woody crinklemat), *Guaiaacum angustifolium* (guayacan), *Leucophyllum* spp. (barometerbushes), and/or *Gutierrezia* spp. (snakeweeds), is  $< 1\%$ .....**Badlands Sparse Vegetation**

**37B.** The combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Bouteloua ramosa* (chino grama), *Leucophyllum frutescens* (cenizo), *Heteropogon contortus* (tanglehead), *Ziziphus obtusifolia* (lotebush) and/or *Gutierrezia* spp. (snakeweeds) is  $< 0.5\%$ .....go to **40**

**40A.** Vegetation of cliffs or other bedrock outcrops, with vascular vegetation absent or restricted to crevices or ledges.....go to **41**

- 41A.** Lichen and/or sparse vascular vegetation of calcareous substrates (limestone, *etc.*).....**Calcareous Outcrop Lichen Vegetation**
- 41B.** Lichen and/or sparse vascular vegetation of non-calcareous substrates (igneous, sandstone, *etc.*).....go to **42**
- 42A.** Lichen and/or sparse vascular vegetation at or above 4,500 feet in elevation.....**Montane Igneous Outcrop Lichen Vegetation**
- 42B.** Lichen and/or sparse vascular vegetation below 4,500 feet in elevation.....  
     .....**Low Elevation Non-calcareous Outcrop Lichen Vegetation**
- 40B.** Sparse vascular vegetation not of cliffs or of other bedrock outcrops, and not restricted to crevices or ledges.....go to **43**
- 43A.** EITHER (1) *Suaeda suffrutescens* (desert seepweed) has at least 20% of the **relative** cover OR (2) at least two of the following species (gypseous indicators) are present: *Suaeda suffrutescens* (desert seepweed) *Sporobolus pyramidatus* (whorled dropseed), and/or *Echinochloa crus-galli* (barnyardgrass).....**Alkaline Clay Flat Shrubland**
- 43B.** BOTH (1) *Suaeda suffrutescens* (desert seepweed) has less than 20% of the **relative** cover AND (2) no more than one of the following species (gypseous indicators) are present: *Suaeda suffrutescens* (desert seepweed) *Sporobolus pyramidatus* (whorled dropseed), and/or *Echinochloa crus-galli* (barnyardgrass).....go to **44**
- 44A.** The combined individual cover amount for *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Vachellia* spp. (acacias), *Senegalia* spp. (catclaw acacias), *Jatropha dioica* (leatherstem), *Yucca torreyi* (Torrey's yucca), *Dasyochloa pulchella* (fluffgrass), and/or *Senna durangensis* (Durango senna) is > the combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Prosopis glandulosa* (honey mesquite), *Cylindropuntia leptocaulis* (Christmas cactus), *Atriplex* spp.(saltbushes), *Sporobolus* spp. (dropseeds), and/or *Bouteloua ramosa* (chino grama).....**Big Bend Lowlands Creosotebush Desert Scrub**

**44B.** The combined individual cover amount for *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), *Vachellia* spp. (acacias), *Senegalia* spp. (catclaw acacias), *Jatropha dioica* (leatherstem), *Yucca torreyi* (Torrey's yucca), *Dasyochloa pulchella* (fluffgrass), and/or *Senna durangensis* (Durango senna) is  $\leq$  the combined individual cover amount for *Agave lechuguilla* (lechuguilla), *Prosopis glandulosa* (honey mesquite), *Cylindropuntia leptocaulis* (Christmas cactus), *Atriplex* spp. (saltbushes), *Sporobolus* spp. (dropseeds), and/or *Bouteloua ramosa* (chino grama).....**Badlands Sparse Vegetation**

# Appendix D: Plant Association Descriptions for Big Bend National Park, Texas

## List of Big Bend National Park Plant Associations Within the USNVC Hierarchy

Vegetation associations are indicated by either (1) a global identification code assigned by USNVC (2017) and beginning with the letters “CEGL”, if the local association matches an association currently recognized by the USNVC or (2) a NPS identification code assigned by this project and beginning with the letters “NPS” (Lea 2011). Associations are grouped within their currently recognized (<http://usnvc.org>) or projected USNVC hierarchy assignments. At this time, all alliances that have been recognized by the USNVC to date are under review and revision and descriptions are not available from or through usnvc.org.

Plant species scientific names in text, tables, and locally recognized (NPS) vegetation types follow the treatment listed by USDA PLANTS as of January 31, 2019. Some plant species scientific names in vegetation types that are recognized by the USNVC follow Kartesz (1999) and may vary from the USDA PLANTS treatment.

## USNVC Class: Forest & Woodland Class (1)

### USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

#### USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

*USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)*

#### USNVC Macrogroup: Madrean Lowland Evergreen Woodland Macrogroup (M010)

#### **USNVC Group: Madrean Pinyon – Juniper Woodland Group (G200)**

USNVC Alliance: *Pinus cembroides* – *Pinus discolor* – *Pinus edulis* / Shrub Understory Woodland Alliance (A3131)

USNVC Association: *Pinus cembroides* – *Quercus grisea* – *Quercus emoryi* – *Juniperus flaccida* / *Salvia regla* / *Bouteloua curtipendula* Woodland Association (CEGL004597) (BIG BEND NATIONAL PARK NAME: Alligator Juniper – Pinyon Pine – Gray Oak Woodland)

USNVC Association: *Pinus cembroides* – *Quercus grisea* – *Juniperus flaccida* / *Salvia regla* / *Muhlenbergia emersleyi* Woodland Association (CEGL004596) (BIG BEND NATIONAL PARK NAME: Dry Pinyon Pine Woodland)

USNVC Association: *Pinus cembroides* – *Quercus gravesii* – *Juniperus flaccida* / *Salvia regla* / *Piptochaetium fimbriatum* Woodland Association (CEGL004600) (BIG BEND NATIONAL PARK NAME: Dry-Mesic Pinyon Pine – Oak – Juniper Forest)

#### **USNVC Group: Madrean Encinal Group (G201)**

USNVC Alliance: *Quercus arizonica* – *Quercus emoryi* – *Quercus grisea* Scrub Woodland Alliance (A3101)

NPS Association: *Quercus laceyi* Madrean Woodland Association (NPSBIBE012) (BIG BEND NATIONAL PARK NAME: Lacey's Oak Woodland)

USNVC Association: *Quercus emoryi* / *Muhlenbergia emersleyi* Scrub Woodland Association (CEGL000685) (BIG BEND NATIONAL PARK NAME: Emory Oak Woodland)

USNVC Macrogroup: Madrean Montane Forest & Woodland Macrogroup (M011)

**USNVC Group: Madrean Lower Montane Pine – Oak Forest & Woodland Group (G203)**

USNVC Alliance: *Arbutus xalapensis* – *Acer grandidentatum* – *Quercus* spp. Forest & Woodland Alliance (A0368)

USNVC Association: *Acer grandidentatum* – *Quercus gravesii* Forest Association (CEGL004548) (BIG BEND NATIONAL PARK NAME: Graves' Oak – Bigtooth Maple Forest)

NPS Association: *Quercus gravesii* – *Quercus emoryi* / *Arbutus xalapensis* / *Garrya ovata* ssp. *goldmanii* Forest Association (NPSBIBE007) (BIG BEND NATIONAL PARK NAME: Graves' Oak – Emory Oak Canyon Forest)

NPS Association: *Quercus gravesii* – *Pinus (cembroides, arizonica)* / *Quercus grisea* Forest Association (NPSBIBE004) (BIG BEND NATIONAL PARK NAME: High Chisos Oak – Pine Forest)

USNVC Alliance: *Cupressus arizonica* Forest & Woodland Alliance (A0163)

NPS Association: *Hesperocyparis arizonica* / *Quercus gravesii* – *Pinus cembroides* / *Piptochaetium fimbriatum* Forest Association (NPSBIBE002) (BIG BEND NATIONAL PARK NAME: Arizona Cypress – Graves' Oak – Pinyon Pine Forest)

USNVC Formation: Temperate Flooded & Swamp Forest Formation (1.B.3)

*USNVC Division: Western North American Interior Flooded Forest Division (D013)*

USNVC Macrogroup: Interior Warm & Cool Desert Riparian Forest Macrogroup (M036)

**USNVC Group: Western Interior Riparian Forest & Woodland Group (G797)**

USNVC Alliance: *Populus fremontii* – *Fraxinus velutina* – *Salix gooddingii* Flooded Forest & Woodland Alliance (A3803)

USNVC Association: *Populus fremontii* – *Salix gooddingii* Woodland Association (CEGL000944) (BIG BEND NATIONAL PARK NAME: Cottonwood – Goodding Willow Spring Woodland)

NPS Association: *Salix (gooddingii, thurberi)* Rio Grande Woodland Association (NPSBIBE019) (BIG BEND NATIONAL PARK NAME: Rio Grande Willow Riparian Bosque)

USNVC Macrogroup: Interior West Ruderal Flooded & Swamp Forest Macrogroup (M298)

**USNVC Group: Interior West Ruderal Riparian Forest & Scrub Group (G510)**

USNVC Alliance: *Tamarix* spp. Ruderal Riparian Scrub Alliance (A0842)

USNVC Association: *Tamarix* spp. Temporarily Flooded Semi-natural Shrubland Association (CEGL003114) (BIG BEND NATIONAL PARK NAME: Tamarisk – (Tree Tobacco) Riparian Shrubland)

**USNVC Class: Shrub & Herb Vegetation Class (2)**

**USNVC Subclass: Temperate and Boreal Grassland & Shrubland Subclass (2.B)**

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

*USNVC Division: Western North American Interior Chaparral Division (D061)*

USNVC Macrogroup: Warm Interior Chaparral Macrogroup (M091)

**USNVC Group: Eastern Madrean Chaparral Group (G280)**

USNVC Alliance: *Quercus pungens* – *Quercus intricata* – *Quercus vaseyana* Chaparral Alliance (A3971)

USNVC Association: *Quercus intricata* – *Dasyllirion leiophyllum* Shrubland Association (CEGL004530) (BIG BEND NATIONAL PARK NAME: Coahuila Scrub Oak Chaparral)

NPS Association: *Quercus grisea* – *Cercocarpus montanus* Shrubland Association (NPSBIBE022) (BIG BEND NATIONAL PARK NAME: High Chisos Gray Oak – Mountain Mahogany Chaparral)

NPS Association: *Quercus (pungens, mohriana)* – *Fraxinus greggii* – *Rhus virens* – (*Yucca faxoniana*) Shrubland Association (NPSBIBE009) (BIG BEND NATIONAL PARK NAME: Calcareous Chaparral)

USNVC Alliance: *Sophora secundiflora* – *Vachellia roemeriana* – *Cercocarpus montanus* Chaparral Alliance (A3972)

NPS Association: *Rhus virens* – *Quercus* spp. / *Viguiera stenoloba* – *Nolina erumpens* Shrubland Association (NPSBIBE005) (BIG BEND NATIONAL PARK NAME: Montane Mixed Chaparral)

USNVC Alliance: *Juniperus pinchotii* Chaparral Alliance (A0505)

NPS Association: *Juniperus (coahuilensis, pinchotii)* / *Dasyllirion leiophyllum* – *Nolina erumpens* – *Bouteloua curtipendula* Shrubland Association (NPSBIBE021) (BIG BEND NATIONAL PARK NAME: Redberry Juniper – Sotol Shrubland)

### ***USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)***

#### **USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation (2.C.4)**

*USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)*

#### **USNVC Macrogroup: Western North American Ruderal Marsh, Wet Meadow & Shrubland Macrogroup (M301)**

#### ***USNVC Group: Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524)***

USNVC Alliance: *Phragmites australis* – *Arundo donax* – *Alopecurus pratensis* Ruderal Marsh Alliance (A3847)

USNVC Association: *Arundo donax* Riverbank Herbaceous Vegetation association (CEGL004101) (BIG BEND NATIONAL PARK NAME: Giant Cane Riparian Herbaceous Vegetation)

NPS Association: *Phragmites australis* Chihuahuan Desert Riparian Herbaceous Vegetation Association (NPSBIBE023) (BIG BEND NATIONAL PARK NAME: Common Reed Riparian Herbaceous Vegetation)

NPS Association: *Cynodon dactylon* Arid Southwest Herbaceous Vegetation Association (NPSBIBE017) (BIG BEND NATIONAL PARK NAME: Bermuda Grass Herbaceous Vegetation)

#### **USNVC Macrogroup: Arid West Interior Freshwater Marsh Macrogroup (M888)**

#### ***USNVC Group: Arid West Interior Freshwater Marsh Group (G531)***

USNVC Alliance: *Schoenoplectus americanus* – *Schoenoplectus acutus* – *Schoenoplectus californicus* Marsh Alliance (A3895)

USNVC Association: *Schoenoplectus pungens* Herbaceous Vegetation Association (CEGL001587) (BIG BEND NATIONAL PARK NAME: Wet Riverbank Herbaceous Vegetation)



NPS Association: *Schoenoplectus californicus* Chihuahuan-Tamaulipan Riparian Herbaceous Vegetation Association (NPSBIBE050) (BIG BEND NATIONAL PARK NAME: California Bulrush Herbaceous Vegetation)

NPS Association: Arid West Alluvial Shrub Herbaceous Vegetation Association (NPSBIBE024)  
BIG BEND NATIONAL PARK NAME: Rio Grande Alluvial Herbaceous Vegetation

USNVC Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland Macrogroup (M076)

**USNVC Group: North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)**

USNVC Alliance: *Salix exigua* – *Forestiera pubescens* Warm Desert Wet Shrubland Alliance (A0947)

USNVC Association: *Salix thurberi* – *Baccharis salicifolia* Shrubland Association (CEGL005980)  
(BIG BEND NATIONAL PARK NAME: Thurber's Willow Spring Shrubland)

USNVC Alliance: *Baccharis salicifolia* Wet Shrubland Alliance (A0933)

NPS Association: *Baccharis salicifolia* / *Andropogon glomeratus* Shrub Herbaceous Vegetation Association (NPSBIBE016) (BIG BEND NATIONAL PARK NAME: Seepwillow – Bushy Bluestem Spring Vegetation)

NPS Association: *Baccharis salicifolia* / (*Phragmites australis*) Chihuahuan Riparian Shrubland Association (NPSBIBE047) (BIG BEND NATIONAL PARK NAME: Rio Grande Seepwillow Riparian Shrubland)

USNVC Alliance: *Prosopis glandulosa* – *Prosopis velutina* – *Prosopis pubescens* Wet Scrub Alliance (A3877)

USNVC Association: *Prosopis glandulosa* Wet Scrub Association (CEGL004934) (BIG BEND NATIONAL PARK NAME: Rio Grande Mesquite Riparian Bosque)

**USNVC Class: Desert & Semi-Desert Class (3)**

**USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)**

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

**USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)**

USNVC Alliance: *Muhlenbergia emersleyi* – *Muhlenbergia setifolia* – *Hesperostipa neomexicana* Madrean Lower Montane Grassland Alliance (A3206)

NPS Association: *Muhlenbergia emersleyi* – *Bommeria hispida* – *Cheilanthes bonariensis* Herbaceous Vegetation Association (NPSBIBE008) (BIG BEND NATIONAL PARK NAME: Bull Muhly Montane Grassland)

NPS Association: *Nassella tenuissima* Herbaceous Vegetation Association (NPSBIBE003) (BIG BEND NATIONAL PARK NAME: Finestem Needlegrass Montane Grassland)

USNVC Alliance: *Dasyilirion* spp. – *Bouteloua curtipendula* – *Muhlenbergia setifolia* Foothill Desert Grassland Alliance (A3205)

NPS Association: *Agave lechuguilla* – *Viguiera stenoloba* / *Selaginella peruviana* – *Bommeria hispida* – *Muhlenbergia emersleyi* Shrub Herbaceous Vegetation Association (NPSBIBE006)

(BIG BEND NATIONAL PARK NAME: Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation)

NPS Association: *Fouquieria splendens* – *Dasyllirion leiophyllum* / *Bouteloua curtipendula* – *Notholaena standleyi* Rocky Sparse Shrubland Association (NPSBIBE020) (BIG BEND NATIONAL PARK NAME: Montane Talus and Cliff Rocky Sparse Shrubland)

NPS Association: *Yucca faxoniana* – *Yucca thompsoniana* / *Dasyllirion leiophyllum* – *Nolina erumpens* – *Bouteloua curtipendula* Shrub Grassland Association (NPSBIBE040) (BIG BEND NATIONAL PARK NAME: Yucca – Sotol Calcareous Shrub Grassland)]

NPS Association: *Dasyllirion leiophyllum* – *Agave lechuguilla* / *Bouteloua curtipendula* – *Heteropogon contortus* Shrub Grassland Association (NPSBIBE030) (BIG BEND NATIONAL PARK NAME: Sotol – Lechuguilla Foothills Shrub Grassland)

USNVC Association: *Dasyllirion leiophyllum* – *Viguiera stenoloba* – *Agave lechuguilla* / *Bouteloua ramosa* Shrubland Association (CEGL004604) (BIG BEND NATIONAL PARK NAME: Chino Grama Shrub Grassland)

**USNVC Group: Chihuahuan Semi-Desert Lowland Grassland Group (G489)**

USNVC Alliance: *Pleuraphis mutica* Lowland Grassland Alliance (A3185)

USNVC Association: *Pleuraphis mutica* Monotype Herbaceous Vegetation Association (CEGL001637) (BIG BEND NATIONAL PARK NAME: Tobosa Grass Desert Grassland)

**USNVC Group: Chihuahuan Gypsophilous Grassland Group (G492)**

USNVC Alliance: *Tiquilia hispidissima* / *Sporobolus nealleyi* – *Tidestromia carnosae* Gypsum Outcrop & Alluvial Flat Desert Scrub Alliance (A3243)

USNVC Association: *Atriplex obovata* / *Tidestromia carnosae* Dwarf-shrubland (CEGL004575) (BIG BEND NATIONAL PARK NAME: Badlands Sparse Vegetation)

NPS Association: *Suaeda suffrutescens* / *Sporobolus pyramidatus* Shrubland Association (NPSBIBE027) (BIG BEND NATIONAL PARK NAME: Alkaline Clay Flat Shrubland)

**USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)**

**USNVC Group: Chihuahuan Creosotebush – Mixed Desert Scrub Group (G288)**

USNVC Alliance: *Larrea tridentata* Chihuahuan Desert Scrub Alliance (A3164)

NPS Association: *Larrea tridentata* – *Fouquieria splendens* – *Agave lechuguilla* – *Leucophyllum frutescens* Shrubland Association (NPSBIBE044) (BIG BEND NATIONAL PARK NAME: Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub)

NPS Association: *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathastecum erectum* Shrubland Association (NPSBIBE031) (BIG BEND NATIONAL PARK NAME: Big Bend Lowlands Creosotebush Desert Scrub)

NPS Association: *Prosopis glandulosa* – *Larrea tridentata* – (*Flourensia cernua*, *Parthenium incanum*) Shrubland Association (NPSBIBE025) (BIG BEND NATIONAL PARK NAME: Mesquite – Creosotebush Desert Scrub)

NPS Association: *Larrea tridentata* – *Agave lechuguilla* – *Hechtia texensis* – *Echinocactus horizonthalonius* Shrubland Association (NPSBIBE011) (BIG BEND NATIONAL PARK NAME: Boquillas Basin Calcareous Cresotebush Desert Scrub)

**USNVC Group: Chihuahuan Desert Succulent Scrub Group (G286)**

USNVC Alliance: *Agave lechuguilla* – *Euphorbia antisiphilitica* Chihuahuan Desert Succulent Scrub Alliance (A3157)

NPS Association: *Agave lechuguilla* – *Euphorbia antisyphilitica* – *Ephedra aspera* / *Bouteloua ramosa* Shrubland Association (NPSBIBE010) (BIG BEND NATIONAL PARK NAME: Calcareous Mixed Desert Scrub)

**USNVC Group: Chihuahuan Lowland Basin Semi-Desert Scrub Group (G299)**

USNVC Alliance: *Atriplex canescens* Lowland Basin Desert Scrub Alliance (A3151)

NPS Association: *Atriplex canescens* – *Suaeda suffrutescens* / *Sporobolus airoides* Shrub Herbaceous Vegetation Association (NPSBIBE026) (BIG BEND NATIONAL PARK NAME: Alkali Sacaton Riparian Grassland)

**USNVC Macrogroup: North American Warm-Desert Xero-Riparian Scrub Macrogroup (M092)**

**USNVC Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541)**

USNVC Alliance: *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan-Sonoran Desert Wash Alliance (A3262)

NPS Association: *Hymenoclea monogyra* – *Chilopsis linearis* – *Porophyllum scoparium* Shrubland Association (NPSBIBE014) (BIG BEND NATIONAL PARK NAME: Big Bend Lowland Wash Channel Shrubland)

NPS Association: *Chilopsis linearis* – *Yucca torreyi* – (*Brickellia laciniata*) Shrubland Association (NPSBIBE042) (BIG BEND NATIONAL PARK NAME: Foothills Wash Channel Shrubland)

NPS Association: *Diospyros texana* – *Forestiera angustifolia* – *Prosopis glandulosa* – (*Rhus microphylla*) Shrubland Association (NPSBIBE029) (Mixed Tall Shrubs Wash Shrubland)

NPS Association: *Fraxinus greggii* – *Diospyros texana* – *Rhus virens* – *Senegalia* spp. Shrubland Association (NPSBIBE013) (BIG BEND NATIONAL PARK NAME: Persimmon – Littleleaf Ash Foothills Shrubland)

NPS Association: *Vachellia* spp. – *Senegalia greggii* – *Prosopis glandulosa* – *Yucca elata* Shrubland Association (NPSBIBE043) (Acacia – Mesquite Wash Shrubland)

**USNVC Macrogroup: North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Macrogroup (M117)**

**USNVC Group: North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation Group (G569)**

USNVC Alliance: Sparsely Vegetated Clay Flats, Hills & Badlands Alliance (A4023)

NPS Association: *Jatropha dioica* – *Opuntia rufida* Sparse Vegetation Association (NPSBIBE036) (BIG BEND NATIONAL PARK NAME: Low Elevation Talus and Dune Sparse Vegetation)

**USNVC Macrogroup: North American Warm Desert Ruderal Scrub & Grassland Macrogroup (M512)**

**USNVC Group: North American Warm Desert Ruderal Grassland Group (G677)**

USNVC Alliance: *Eragrostis lehmanniana* – *Eragrostis curvula* Ruderal Desert Grassland Alliance (A2687)

NPS Association: *Sorghum halepense* Chihuahuan Desert Herbaceous Vegetation Association (NPSBIBE018) (BIG BEND NATIONAL PARK NAME: Johnson Grass – Russian Thistle Desert Grassland)

NPS Association: (*Heteropogon contortus*, *Pennisetum ciliare*, *Eragrostis lehmanniana*) – Mixed Forbs) Chihuahuan Ruderal Herbaceous Vegetation Association (NPSBIBE046) (BIG BEND NATIONAL PARK NAME: Upland Ruderal Herbaceous Vegetation)

## **USNVC Class: Open Rock Vegetation Class (6)**

### ***USNVC Subclass: Temperate & Boreal Open Rock Vegetation Subclass (6.B)***

#### **USNVC Formation: Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation (6.B.1)**

*USNVC Division: Western North American Temperate & Boreal Cliff, Scree & Rock Vegetation (D052)*

#### **USNVC Macrogroup: Western North American Cliff, Scree & Rock Vegetation Macrogroup (M887)**

#### ***USNVC Group: Western North American Cliff, Scree & Rock Vegetation Group (G565)***

USNVC Alliance: Undefined

NPS Association: Madrean Igneous Outcrop Lichen Vegetation Association (NPSBIBE037) (BIG BEND NATIONAL PARK NAME: Montane Igneous Outcrop Lichen Vegetation)

NPS Association: Chihuahuan Desert Non-calcareous Outcrop Lichen Vegetation Association (NPSBIBE038) (BIG BEND NATIONAL PARK NAME: Low Elevation Non-calcareous Outcrop Lichen Vegetation)

NPS Association: Chihuahuan Desert Calcareous Outcrop Lichen Vegetation Association (NPSBIBE039) (BIG BEND NATIONAL PARK NAME: Calcareous Outcrop Lichen Vegetation)

## **USNVC Class: Agricultural & Developed Vegetation Class (7)**

### ***USNVC Subclass: Developed Vegetation Subclass (7.C)***

#### **USNVC Formation: Other Developed Vegetation Formation (7.C.2)**

*USNVC Division: Other Developed Vegetation Division (7.C.1.2)*

#### **USNVC Macrogroup: Tree Developed Vegetation Macrogroup (CGR040)**

#### ***USNVC Group: Temperate Tree Developed Vegetation Group (CSG045)***

USNVC Subformation: Other Developed Vegetation Subformation (7.C.2.1)

USNVC Cultural Group: Tree Developed Vegetation Cultural Group (CGR040)

#### ***USNVC Cultural Subgroup: Temperate Tree Developed Vegetation Cultural Subgroup (CSG047)***

NPS Cultural Type: *Populus* spp. – *Fraxinus* spp. Planted Woodland Cultural Type (NPSBIBE045) (BIG BEND NATIONAL PARK NAME: Mixed Ornamental and Planted Woodland)

## Big Bend National Park Plant Association Descriptions

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## **Alligator Juniper – Pinyon Pine – Gray Oak Woodland**

### Local Type Concept:

Open woodlands or tall shrublands of middle elevations in the Chisos Mountains, dominated in the tree or tall shrub strata by *Juniperus deppeana* (alligator juniper), *Pinus cembroides* (Mexican pinyon), and/or *Quercus grisea* (gray oak). Of the three pinyon pine dominated woodland or forest types of the Chisos Mountains, this association is most typical of lower elevations.

### Vegetation:

The relatively open uppermost stratum (trees and short trees) is dominated by *Juniperus deppeana* (alligator juniper), *Pinus cembroides* (Mexican pinyon), and/or *Quercus grisea* (gray oak), with all three species usually present. *Juniperus flaccida* (weeping juniper) is a constant low cover tree species and somewhat replaces *J. deppeana* in Pine Canyon, where the latter species appears to be inexplicably absent. Lower cover tall shrubs or short trees include (in decreasing order of constancy) *Quercus gravesii* (Graves' oak), *Cercocarpus montanus* (alderleaf mountain mahogany), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Rhus virens* (evergreen sumac), and *Quercus emoryi* (Emory oak). Among shorter shrubs, *Agave havardiana* (Havard's century plant), *Opuntia chisosensis* (Chisos Mountain pricklypear), and *Nolina erumpens* (foothill beargrass) are constant. *Viguiera stenoloba* (skeletonleaf goldeneye), *Chrysactinia mexicana* (damianita), *Vachellia constricta* (whitethorn acacia), *Mimosa aculeaticarpa* var. *biuncifera* (catclaw mimosa), *Gymnosperma glutinosum* (gumhead), *Dasyllirion leiophyllum* (green sotol), *Agave lechuguilla* (lechuguilla), and *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear) are less so. Small cacti may be represented by *Echinocereus coccineus* var. *paucispinus* (Texas claret-cup cactus), *Echinocereus russanthus* (rusty hedgehog cactus), and/or *Mammillaria meiacantha* (little nipple cactus). The grass-dominated herbaceous stratum is moderately dense to dense; *Bouteloua curtipendula* (sideoats grama) and *Muhlenbergia emersleyi* (bull muhly) are the most frequent and abundant species. Less constant and, usually, low cover grass species include *Piptochaetium fimbriatum* (pinyon ricegrass), *Schizachyrium scoparium* (little bluestem), *Bothriochloa barbinodis* (cane bluestem), and *Muhlenbergia rigida* (purple muhly), and *Blepharoneuron tricholepis* (pine dropseed). *Cheilanthes eatonii* (Eaton's lipfern) is a constant fern occurring at low cover. Other herbaceous species include the forbs *Dyschoriste linearis* (polkadots), *Artemisia ludoviciana* (Louisiana wormwood), and *Cologania angustifolia* (longleaf cologania) and the ferns *Bommeria hispida* (copper fern) and *Pellaea intermedia* (intermediate cliffbrake). Stratum and substrate cover for Alligator Juniper – Pinyon Pine – Gray Oak Woodland are shown in Table D-1.



**Table D-1.** Stratum and substrate cover recorded for in Alligator Juniper – Pinyon Pine – Gray Oak Woodland at Big Bend National Park (# plots=7).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	8	0–20
	Tall Shrub	26	15–30
	Short Shrub	17	5–35
	Herb	16	3–50
Substrate	Bedrock	0	0–0
	Large/Small Rocks	45	11–70
	Litter/Duff	41	15–79

Environment:

This association usually occurs on middle to upper slopes at elevations ranging from 5,150 to 6,100 feet in the Chisos Mountains, and is the most abundant pinyon – juniper type within that elevation range. Sites are most often north facing, since slopes with more exposed slopes at these elevations generally appear to be too warm to support extensive stands of pinyon – juniper woodland. The association is common in the Chisos Basin and occurs in Pine and Juniper Canyons and probably elsewhere in the Chisos Mountains.

USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Lowland Evergreen Woodland Macrogroup (M010)

USNVC Group: Madrean Pinyon – Juniper Woodland Group (G200)

USNVC Alliance: *Pinus cembroides* – *Pinus discolor* – *Pinus edulis* / Shrub Understory Woodland Alliance (A3131)

USNVC Association: *Pinus cembroides* – *Quercus grisea* – *Quercus emoryi* – *Juniperus flaccida* / *Salvia regla* / *Bouteloua curtipendula* Woodland Association (CEGL004597)

Comments:

The plots associated with this local type appear to match the USNVC (2017) recognized CEGL004597 *Pinus cembroides* – *Quercus grisea* – *Quercus emoryi* – *Juniperus flaccida* / *Salvia regla* / *Bouteloua curtipendula* Woodland Association (said to be limited to the Chisos Mountains within the United States). The revised name of *Juniperus deppeana* – *Pinus cembroides* – *Quercus grisea* / *Opuntia chisosensis* / *Bouteloua curtipendula* Woodland Association is suggested as a better name for CEGL004597, since, within the context of all Chios Mountains woodlands and forests, *Juniperus deppeana* is more characteristic than are *Quercus emoryi* or *Juniperus flaccida* and *Opuntia chisosensis* is more characteristic than is *Salvia regla* (which usually is absent from the BIBE plots assigned to this association).

As defined here and by the USNVC (2017), this association probably is endemic to the Chisos Mountains within the United States, partly because of the complete or partial restriction of many of the characteristic species to the Chisos Mountains within the United States. The same or similar types may occur in the Sierra del Carmen (Wood et al. 1999) and other ranges in Mexico.

BIBE Classification Plots Included in Concept:

BIBE0027, BIBE0074, BIBE0217, BIBE0246, BIBE0326, BIBE0329, BIBE0330.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0156, BIBEAA0159, BIBEAA0160, BIBEAA0161, BIBEAA0162, BIBEAA0164, BIBEAA0166, BIBEAA0167, BIBEAA0169, BIBEAA0249, BIBEAA0273, BIBEAA0692, BIBEAA1263, BIBEAA1264, BIBEAA1265, BIBEAA1266, BIBEAA1268, BIBEAA1269.

Most frequent plant taxa recorded in Alligator Juniper – Pinyon Pine – Gray Oak Woodland are shown in Table D-2.

**Table D-2.** Synthesis table for the most frequent plant taxa recorded in Alligator Juniper – Pinyon Pine – Gray Oak Woodland at Big Bend National Park (# plots=7).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Juniperus deppeana</i>	Tree / Shrub	100.0%	11.3	2–36
<i>Pinus cembroides</i>	Tree / Shrub	100.0%	6.4	2–15
<i>Quercus grisea</i>	Tree / Shrub	85.7%	8.9	0–27
<i>Juniperus flaccida</i>	Tree / Shrub	71.4%	1.0	0–5
<i>Quercus emoryi</i>	Tree / Shrub	28.6%	1.2	0–7
<i>Agave havardiana</i>	Shrub	100.0%	2.4	0–10
<i>Opuntia chisosensis</i>	Shrub	100.0%	1.2	0–5
<i>Nolina erumpens</i>	Shrub	85.7%	2.3	0–10
<i>Quercus gravesii</i>	Shrub	71.4%	3.4	0–10
<i>Cercocarpus montanus</i>	Shrub	71.4%	1.7	0–10
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	71.4%	0.8	0–5
<i>Dasyllirion leiophyllum</i>	Shrub	57.1%	0.9	0–5
<i>Chrysactinia mexicana</i>	Shrub	57.1%	0.9	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	57.1%	0.6	0–2
<i>Rhus virens</i>	Shrub	42.9%	1.1	0–6
<i>Vachellia constricta</i>	Shrub	42.9%	0.4	0–2
<i>Viguiera stenoloba</i>	Shrub	42.9%	0.2	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	42.9%	0.2	0–1
<i>Echinocereus rusanthus</i>	Shrub	42.9%	0.1	0–1
<i>Agave lechuguilla</i>	Shrub	28.6%	1.3	0–10
<i>Mimosa aculeaticarpa</i>	Shrub	28.6%	1.1	0–10

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Arbutus xalapensis</i>	Shrub	28.6%	0.2	0–2
<i>Mammillaria meiacantha</i>	Shrub	28.6%	0.1	0–1
<i>Juniperus</i> sp.	Shrub	14.3%	1.1	0–11
<i>Gymnosperma glutinosum</i>	Shrub	14.3%	0.5	0–5
<i>Koeberlinia spinosa</i>	Shrub	14.3%	0.2	0–2
<i>Bouteloua curtipendula</i>	Herb	85.7%	2.7	0–10
<i>Cheilanthes eatonii</i>	Herb	85.7%	0.4	0–1
<i>Muhlenbergia emersleyi</i>	Herb	57.1%	1.4	0–10
<i>Dyschoriste linearis</i>	Herb	57.1%	0.4	0–2
<i>Blepharoneuron tricholepis</i>	Herb	42.9%	0.8	0–5
<i>Piptochaetium fimbriatum</i>	Herb	42.9%	0.6	0–5
<i>Artemisia ludoviciana</i>	Herb	42.9%	0.2	0–1
<i>Bommeria hispida</i>	Herb	42.9%	0.2	0–1
<i>Cologania angustifolia</i>	Herb	28.6%	0.1	0–1
<i>Pellaea intermedia</i>	Herb	28.6%	0.1	0–1
<i>Aristida</i> sp.	Herb	28.6%	0.1	0–1
<i>Schizachyrium scoparium</i>	Herb	28.6%	0.1	0–1
<i>Muhlenbergia rigida</i>	Herb	14.3%	2.5	0–25
<i>Bouteloua hirsuta</i>	Herb	14.3%	0.5	0–5
<i>Astrolepis sinuata</i>	Herb	14.3%	0.2	0–2
<i>Conoclinium greggii</i>	Herb	14.3%	0.2	0–2
<i>Bothriochloa</i> sp.	Herb	14.3%	0.2	0–2





Photo 1. Alligator Juniper – Pinyon Pine – Gray Oak Woodland, along Basin Loop Trail, Chisos Basin (BIBE0027). Photo by Christian Skorik.



Photo 2. Alligator Juniper – Pinyon Pine – Gray Oak Woodland, along Lost Mine Trail, Chisos Basin (BIBE0074). Photo by Wendy Redding/Lars Pomara.

## **Dry Pinyon Pine Woodland**

### Local Type Concept:

Relatively open woodlands of middle to high elevations in the Chisos Mountains, strongly dominated in the tree stratum by *Pinus cembroides* (Mexican pinyon) and with *Muhlenbergia emersleyi* (bull muhly) dominant or co-dominant in the herbaceous stratum. Of the three pinyon pine dominated woodland or forest types of the Chisos Mountains, this association is most typical of drier sites of the higher elevations.

### Vegetation:

*Pinus cembroides* (Mexican pinyon) is constant and is the leading or only dominant in the uppermost stratum, which is a short tree (sometimes “dwarf” tree, with trees less than 5 meters tall) stratum. *Quercus grisea* (gray oak) is constant as a tall shrub or as a small tree, and is overall the second most abundant woody species, sometimes attaining high cover than *P. cembroides*. *Juniperus deppeana* (alligator juniper) is a relatively constant associate at lower cover in the tree or tall shrub stratum. *Juniperus flaccida* (weeping juniper) often occurs as a short tree or tall shrub, usually at low cover. Several species are constant at low cover in a short shrub stratum; these are *Opuntia chisosensis* (Chisos Mountain pricklypear), *Agave havardiana* (Havard’s century plant), and *Nolina erumpens* (foothill beargrass). Less constant short shrubs are *Opuntia engelmannii* var. *engelmannii* (Engelmann’s pricklypear), *Echinocereus coccineus* var. *paucispinus* (Texas claret-cup cactus), *Cercocarpus montanus* (alderleaf mountain mahogany), *Salvia regla* (mountain sage), *Viguiera stenoloba* (skeletonleaf goldeneye), and/or *Bouvardia ternifolia* (firecrackerbush). The grassy herbaceous stratum is moderately dense to dense, with *Muhlenbergia emersleyi* (bull muhly) dominant or co-dominant. It generally has at least 5% cover and its cover is often much higher (up to 80%). *Piptochaetium fimbriatum* (pinyon ricegrass), *Blepharoneuron tricholepis* (pine dropseed), *Muhlenbergia glauca* (desert muhly), *Muhlenbergia rigida* (purple muhly), *Nassella tenuissima* (finestem needlegrass), *Bouteloua curtipendula* (sideoats grama), and *Schizachyrium scoparium* (little bluestem). The last two species occur more often in the lower elevation range of this association), where they are moderately constant and occasionally co-dominant with *M. emersleyi*. A number of low cover forbs and ferns may be present; among the more frequently observed are *Commelina dianthifolia* (birdbill dayflower), *Oxalis* sp. (wood sorrel), *Bommeria hispida* (copper fern), *Cheilanthes* spp. (lip ferns), *Artemisia ludoviciana* (Louisiana wormwood), *Hieracium schultzii* (roughstem hawkweed), and *Tradescantia brevifolia* (Trans-Pecos spiderwort). Stratum and substrate cover for Dry Pinyon Pine Woodland are shown in Table D-3.

**Table D-3.** Stratum and substrate cover recorded for Dry Pinyon Pine Woodland at Big Bend National Park (# plots=40).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	20	0–40
	Tall Shrub	22	1–50
	Short Shrub	13	4–43
	Herb	21	3–70
Substrate	Bedrock	6	0–70
	Large/Small Rocks	26	3–79
	Litter/Duff	53	5–92

Environment:

This association is the most abundant woodland or forest association of the Chisos Mountains and often is the vegetation matrix across large areas. Stands occupy a wide variety of topographic positions and aspects in the higher parts of the Chisos Mountains, but trend more toward drier exposures. Elevations of sampled sites range from 5,300 to 7,500 feet. Below 6,000 feet, the similar Alligator Juniper – Pinyon Pine – Gray Oak Woodland occupies many of the analogous landforms, and where the Dry Pinyon Pine Woodland is present within this lower elevation range, it usually is on the more mesic sites, such as lower canyon slopes.

USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Lowland Evergreen Woodland Macrogroup (M010)

USNVC Group: Madrean Pinyon – Juniper Woodland Group (G200)

USNVC Alliance: *Pinus cembroides* – *Pinus discolor* – *Pinus edulis* / Shrub Understory Woodland Alliance (A3131)

USNVC Association: *Pinus cembroides* – *Quercus grisea* – *Juniperus flaccida* / *Salvia regla* / *Muhlenbergia emersleyi* Woodland Association (CEGL004596)

Comments:

This type appears to match closely the USNVC association represented by CEGL004596 (USNVC 2017), which was described from the Chisos Mountains.

As defined here and by the USNVC (2017), this association probably is endemic to the Chisos Mountains within the United States, partly because of the complete or partial restriction of many of the characteristic species to the Chisos Mountains within the United States. The same or similar types may occur in the Sierra del Carmen (Wood et al. 1999) and other ranges in Mexico.

During the map accuracy assessment in 2017, much recent mortality of mature *Pinus cembroides* trees was seen in and around these woodlands, evidently following the severe drought of 2010–2011. In some cases, grasslands, primarily the Bull Muhly Montane Grassland, appeared to be expanding somewhat at the expense of this woodland association. It would be expected that such a pattern of fluctuation between montane woodlands and grasslands in the drier exposures of the Chisos Mountains would follow wetter and drier climate cycles in the long run and acute drought events or fire in the short run.

BIBE Classification Plots Included in Concept:

BIBE0002, BIBE0040, BIBE0185, BIBE0186, BIBE0228, BIBE0249, BIBE0250, BIBE0251, BIBE0252, BIBE0253, BIBE0255, BIBE0256, BIBE0257, BIBE0258, BIBE0259, BIBE0264, BIBE0266, BIBE0267, BIBE0268, BIBE0271, BIBE0274, BIBE0279, BIBE0280, BIBE0282, BIBE0283, BIBE0286, BIBE0287, BIBE0288, BIBE0290, BIBE0299, BIBE0301, BIBE0304, BIBE0305, BIBE0306, BIBE0308, BIBE0310, BIBE0311, BIBE0374, BIBE0377, BIBE0378.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0154, BIBEAA0158, BIBEAA0170, BIBEAA0201, BIBEAA0218, BIBEAA0236, BIBEAA0238, BIBEAA0251, BIBEAA0252, BIBEAA0253, BIBEAA0254, BIBEAA0256, BIBEAA0257, BIBEAA0258, BIBEAA0259, BIBEAA0261, BIBEAA0267, BIBEAA0268, BIBEAA0269, BIBEAA0270, BIBEAA0272, BIBEAA0276, BIBEAA0277, BIBEAA0278, BIBEAA0279, BIBEAA0280, BIBEAA0281, BIBEAA0282, BIBEAA0283, BIBEAA0284, BIBEAA0285, BIBEAA0286, BIBEAA0287, BIBEAA0288, BIBEAA0289, BIBEAA0290, BIBEAA0292, BIBEAA0296, BIBEAA0299, BIBEAA0300, BIBEAA0301, BIBEAA0306, BIBEAA0689, BIBEAA0693.

Most frequent plant taxa recorded in Dry Pinyon Pine Woodland are shown in Table D-4.

**Table D-4.** Synthesis table for the most frequent plant taxa recorded in Dry Pinyon Pine Woodland at Big Bend National Park (# plots=40).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pinus cembroides</i>	Tree / Shrub	100.0%	26.9	2–100
<i>Juniperus deppeana</i>	Tree / Shrub	83.3%	4.4	0–25
<i>Juniperus flaccida</i>	Tree / Shrub	50.0%	1.3	0–15
<i>Opuntia chisosensis</i>	Shrub	95.2%	1.3	trace–6
<i>Nolina erumpens</i>	Shrub	90.5%	2.1	0–11
<i>Quercus grisea</i>	Shrub/Tree	88.1%	10.6	0–52
<i>Agave havardiana</i>	Shrub	88.1%	1.2	0–7
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	54.8%	0.3	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	50.0%	0.4	0–3
<i>Cercocarpus montanus</i>	Shrub	45.2%	1.3	0–26
<i>Salvia regla</i>	Shrub	38.1%	0.4	0–3



SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Bouvardia ternifolia</i>	Shrub	38.1%	0.2	0–2
<i>Viguiera stenoloba</i>	Shrub	31.0%	0.2	0–3
<i>Gutierrezia</i> sp.	Shrub	26.2%	0.2	0–2
<i>Agave lechuguilla</i>	Shrub	19.0%	0.3	0–5
<i>Mammillaria meiacantha</i>	Shrub	19.0%	0.1	0–1
<i>Quercus gravesii</i>	Shrub/Tree	16.7%	0.7	0–20
<i>Chrysactinia mexicana</i>	Shrub	14.3%	0.1	0–2
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	14.3%	0.1	0–2
<i>Quercus emoryi</i>	Shrub	11.9%	0.4	0–10
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	11.9%	0.1	0–2
<i>Gutierrezia microcephala</i>	Shrub	11.9%	0.1	0–2
<i>Muhlenbergia emersleyi</i>	Herb	100.0%	13.5	few–75
<i>Piptochaetium fimbriatum</i>	Herb	69.0%	6.0	0–50
<i>Blepharoneuron tricholepis</i>	Herb	40.5%	0.9	0–25
<i>Muhlenbergia glauca</i>	Herb	35.7%	0.3	0–2
<i>Commelina dianthifolia</i>	Herb	35.7%	0.2	0–1
<i>Schizachyrium scoparium</i>	Herb	26.2%	0.7	0–25
<i>Bouteloua hirsuta</i>	Herb	26.2%	0.3	0–2
<i>Oxalis drummondii</i>	Herb	26.2%	0.1	0–1
<i>Aristida</i> sp.	Herb	23.8%	0.2	0–2
<i>Bommeria hispida</i>	Herb	23.8%	0.1	0–1
<i>Nassella tenuissima</i>	Herb	21.4%	2.1	0–50
<i>Aristida arizonica</i>	Herb	19.0%	0.1	0–2
<i>Artemisia ludoviciana</i>	Herb	19.0%	0.1	0–5
<i>Cheilanthes bonariensis</i>	Herb	19.0%	0.1	0–1
<i>Hieracium schultzii</i>	Herb	19.0%	0.1	0–1
<i>Panicum hallii</i>	Herb	19.0%	0.1	0–1
<i>Tradescantia brevifolia</i>	Herb	19.0%	0.1	0–1
<i>Bouteloua curtipendula</i>	Herb	16.7%	0.3	0–10
<i>Selaginella peruviana</i>	Herb	16.7%	0.2	0–5
<i>Cheilanthes tomentosa</i>	Herb	16.7%	0.1	0–1
<i>Ageratina herbacea</i>	Herb	14.3%	0.1	0–1
<i>Cheilanthes eatonii</i>	Herb	14.3%	0.1	0–1
<i>Elymus arizonica</i>	Herb	14.3%	0.1	0–1
<i>Tagetes micrantha</i>	Herb	14.3%	0.1	0–1
<i>Cheilanthes villosa</i>	Herb	11.9%	0.1	0–1





Photo 3. Dry Pinyon Pine Woodland, above Lost Mine Trail, Chisos Basin (BIBEAA169). Photo by Jeff Renfrow.



Photo 4. Dry Pinyon Pine Woodland, along Laguna Meadows Trail, west of Emory Peak (BIBEAA259). Dominant grass is *Muhlenbergia emersleyi*. Photo by Kelon Crawford.

## **Dry-Mesic Pinyon Pine – Oak – Juniper Forest**

### Local Type Concept:

Forests or somewhat closed canopy woodlands of middle to high elevations in the Chisos Mountains, dominated in the tree and tall shrub strata by *Pinus cembroides* (Mexican pinyon) and co-dominated by or with a significant component of *Quercus* spp. (oaks) and/or *Juniperus* spp. (junipers), and with a herbaceous stratum that is either densely dominated by *Piptochaetium fimbriatum* (pinyon ricegrass) or is sparse. Of the three pinyon pine dominated woodland or forest types of the Chisos Mountains, this association is most typical of mesic sites and has the most closed (highest cover) tree stratum.

### Vegetation:

*Pinus cembroides* (Mexican pinyon) is constant and usually is the leading dominant in the tree and tall shrub strata. It usually shares dominance with a combination of *Quercus grisea* (gray oak), *Quercus gravesii* (Graves' oak), *Juniperus deppeana* (alligator juniper), and/or *Juniperus flaccida* (weeping juniper). The combined cover of oaks and junipers in these strata typically approaches, equals, or exceeds that of *P. cembroides*, as opposed to the situation for the Dry Pinyon Pine Forest, in which *P. cembroides* often is a strongly dominant tree. Several species are constant at low cover in a short shrub stratum; these are *Opuntia chisosensis* (Chisos Mountain pricklypear), *Nolina erumpens* (foothill beargrass), *Agave havardiana* (Havard's century plant), and *Salvia regla* (mountain sage). Less constant short shrubs are *Echinocereus coccineus* var. *paucispinus* (Texas claret-cup cactus) and *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear). The herbaceous stratum averages 15% total cover and either may have high cover of *Piptochaetium fimbriatum* (pinyon ricegrass), a shade tolerant grass, or may be relatively sparse. In either case, *P. fimbriatum* is the most constant, and usually most abundant, herbaceous species. *Muhlenbergia emersleyi* (bull muhly) often is present, but, in contrast to its usual abundance in the Dry Pinyon Pine Woodland, it comprises usually less than 10% cover. Low cover herbs may include *Packera millelobata* (Uinta ragwort), *Ageratina herbacea* (fragrant snakeroot), *Salvia arizonica* (desert indigo sage), *Artemisia ludoviciana* (Louisiana wormwood), *Verbesina oreophila* (mountain crownbeard), and *Eriogonum jamesii* (James' buckwheat). Stratum and substrate cover for Dry-Mesic Pinyon Pine – Oak – Juniper Forest are shown in Table D-5.

**Table D-5.** Stratum and substrate cover recorded for in Dry-Mesic Pinyon Pine – Oak – Juniper Forest at Big Bend National Park (# plots=15).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	57	30–95
	Tall Shrub	14	1–40
	Short Shrub	9	1–50
	Herb	13	1–90
Substrate	Bedrock	3	0–30
	Large/Small Rocks	23	1–40
	Litter/Duff	51	30–92

### Environment:

Site for the Dry-Mesic Pinyon Pine – Oak – Juniper Forest are generally above 5,900 feet in elevation in the Chisos Mountains (occasionally as low as 5,700 feet). While widespread within the higher Chisos, it appears to cover much less area than does the Dry Pinyon Pine Woodland and is more confined to mesic settings, such as north-facing slopes and ravine bottoms. While the environmental differences between these pinyon-juniper types are not fully clear, the preferred topographic settings of the Dry-Mesic Pinyon Pine – Oak – Juniper Forest suggest that the fire return interval may be longer.

### USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Lowland Evergreen Woodland Macrogroup (M010)

USNVC Group: Madrean Pinyon – Juniper Woodland Group (G200)

USNVC Alliance: *Pinus cembroides* – *Pinus discolor* – *Pinus edulis* / Shrub Understory Woodland Alliance (A3131)

USNVC Association: *Pinus cembroides* – *Quercus gravesii* – *Juniperus flaccida* / *Salvia regla* / *Piptochaetium fimbriatum* Woodland Association (CEGL004600)

### Comments:

The three most abundant tree-dominated associations of the High Chisos Mountains, in order of preference from xeric to mesic sites, are the Dry Pinyon Pine Woodland, the Dry-Mesic Pinyon Pine – Oak – Juniper Forest, and the High Chisos Oak-Pine Forest. The Dry-Mesic Pinyon Pine – Oak – Juniper Forest can be regarded as somewhat transitional between open pinyon pine woodlands of more exposed settings (Dry Pinyon Pine Woodland) and *Quercus gravesii* (Graves' oak) dominated forests (High Chisos Oak-Pine Forest) of the most protected settings. The three associations share an overlapping flora, but there are several key differences between the types.

The Dry Pinyon Pine Woodland has the most open tree and tall tree stratum and can be characterized as a woodland or open woodland. The Dry-Mesic Pinyon Pine – Oak – Juniper Forest has a relatively closed tree stratum and can be characterized as relatively closed canopy woodland or a forest. A value of 30% tree stratum cover (as adjusted for substrata overlap) is a reliable differential criterion between these two associations. While *Quercus gravesii* has about 50% constancy in the Dry-Mesic Pinyon Pine – Oak – Juniper Forest, its occurrence in abundance (when present) is a good indicator of this type in differentiating the two. A yet higher degree of dominance of *Q. gravesii* (e.g., more than *Pinus cembroides*), is more indicative of the High Chisos Oak-Pine Forest.

The Dry Pinyon Pine Woodland has a higher cover (average 30%) herbaceous stratum, as would be expected for woodlands that are more open. The abundance of *Muhlenbergia emersleyi* (bull muhly) (which is greater in the Dry Pinyon Pine Woodland) seems well correlated (negatively) with tree stratum closure across the gradient of both types, and *M. emersleyi* abundance (with a threshold value of about 10%) is probably the best single-species differential between the two types. Moreover, the



average total cover of the herbaceous stratum of the Dry-Mesic Pinyon Pine – Oak – Juniper Forest is about 15% (range: 1–20%, but occasionally higher, where *Piptochaetium fimbriatum* is abundant). A total herbaceous stratum threshold of 15–20% cover or dominance by *P. fimbriatum*, when herbaceous cover is higher, is an additional useful differential condition.

The Dry-Mesic Pinyon Pine – Oak – Juniper Forest differs from the more mesic High Chisos Oak-Pine Forest mostly in a greater and more even relative dominance of tree species (*P. cembroides*, *Juniperus deppeana*, *Juniperus flaccida*, *Quercus grisea*), other than the more moisture demanding *Quercus gravesii*. In the High Chisos Oak-Pine Forest, the abundance of *Q. gravesii* usually equals or exceeds that of the other four species.

As defined here and by the USNVC (2017), the Dry-Mesic Pinyon Pine – Oak – Juniper Forest probably is endemic to the Chisos Mountains within the United States, partly because of the complete or partial restriction of many of the characteristic species to the Chisos Mountains within the United States. The same or similar types may occur in the Sierra del Carmen (Wood et al. 1999) and other ranges in Mexico.

BIBE Classification Plots Included in Concept:

BIBE0051, BIBE0260, BIBE0269, BIBE0270, BIBE0272, BIBE0276, BIBE0284, BIBE0285, BIBE0294, BIBE0295, BIBE0297, BIBE0298, BIBE0379, BIBE0382, BIBE0384.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0146, BIBEAA0152, BIBEAA0219, BIBEAA0232, BIBEAA0234, BIBEAA0248, BIBEAA0250, BIBEAA0255, BIBEAA0260, BIBEAA0262, BIBEAA0263, BIBEAA0264, BIBEAA0265, BIBEAA0266, BIBEAA0271, BIBEAA0297, BIBEAA0332.

Most frequent plant taxa recorded in Dry-Mesic Pinyon Pine – Oak – Juniper Forest are shown in Table D-6.

**Table D-6.** Synthesis table for the most frequent plant taxa recorded in Dry-Mesic Pinyon Pine – Oak – Juniper Forest at Big Bend National Park (# plots=15).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pinus cembroides</i>	Tree / Shrub	100.0%	38.2	6–94
<i>Juniperus deppeana</i>	Tree / Shrub	93.3%	10.4	0–36
<i>Quercus grisea</i>	Tree / Shrub	86.7%	10.6	0–35
<i>Juniperus flaccida</i>	Tree / Shrub	66.7%	10.4	0–60
<i>Quercus gravesii</i>	Tree / Shrub	53.3%	9.2	0–50
<i>Hesperocyparis arizonica</i>	Tree / Shrub	6.7%	1.7	0–37
<i>Juniperus coahuilensis</i> / <i>J. coahuilensis</i> × <i>pinchotii</i>	Tree / Shrub	6.7%	0.5	0–11
<i>Quercus emoryi</i>	Tree / Shrub	6.7%	0.5	0–10
<i>Opuntia chisosensis</i>	Shrub	93.3%	0.8	0–3

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Nolina erumpens</i>	Shrub	86.7%	2.4	0–25
<i>Agave havardiana</i>	Shrub	86.7%	0.8	0–6
<i>Salvia regla</i>	Shrub	66.7%	1.0	0–6
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	40.0%	0.2	0–1
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	33.3%	0.4	0–5
<i>Cercocarpus montanus</i>	Shrub	20.0%	0.6	0–5
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	20.0%	0.2	0–3
<i>Arbutus xalapensis</i>	Shrub	13.3%	0.2	0–5
<i>Gutierrezia</i> sp.	Shrub	13.3%	0.2	0–1
<i>Bouvardia ternifolia</i>	Shrub	13.3%	0.1	0–2
<i>Ptelea trifoliata</i>	Shrub	6.7%	0.1	0–3
<i>Piptochaetium fimbriatum</i>	Herb	80.0%	9.1	0–75
<i>Muhlenbergia emersleyi</i>	Herb	60.0%	0.9	0–5
<i>Nassella tenuissima</i>	Herb	46.7%	4.6	0–75
<i>Blepharoneuron tricholepis</i>	Herb	46.7%	0.3	0–2
<i>Oxalis drummondii</i>	Herb	46.7%	0.2	0–1
<i>Cheilanthes eatonii</i>	Herb	40.0%	0.2	0–1
<i>Muhlenbergia glauca</i>	Herb	26.7%	0.2	0–2
<i>Ageratina herbacea</i>	Herb	26.7%	0.1	0–1
<i>Cheilanthes bonariensis</i>	Herb	26.7%	0.1	0–1
<i>Cheilanthes villosa</i>	Herb	26.7%	0.1	0–1
<i>Hieracium schultzei</i>	Herb	20.0%	0.1	0–1
<i>Packera millelobata</i>	Herb	20.0%	0.1	0–1
<i>Aristida</i> sp.	Herb	13.3%	0.1	0–2
<i>Bouteloua curtipendula</i>	Herb	13.3%	0.1	0–1
<i>Cologania angustifolia</i>	Herb	13.3%	0.1	0–1
<i>Eriogonum</i> sp.	Herb	13.3%	0.1	0–1
<i>Phaseolus angustissimus</i>	Herb	13.3%	0.1	0–1
<i>Salvia lycioides</i>	Herb	13.3%	0.1	0–1
<i>Tridens</i> sp.	Herb	13.3%	0.1	0–1
<i>Verbesina oreophila</i>	Herb	13.3%	0.1	0–1
<i>Tagetes micrantha</i>	Herb	13.3%	<0.1	0–trace
<i>Stevia ovata</i> var. <i>texana</i>	Herb	6.7%	2.50	0–50
<i>Bouteloua gracilis</i>	Herb	6.7%	0.1	0–2
<i>Phoradendron juniperinum</i>	Epiphyte	20.0%	0.1	0–2
<i>Phoradendron tomentosum</i>	Epiphyte	13.3%	0.1	0–3





Photo 5. Dry – Mesic Pinyon Pine – Oak – Juniper Forest, along Colima Trail, south of Emory Peak (BIBEAA0234). Photo by Photo by Rebecca Evans.



Photo 6. Dry – Mesic Pinyon Pine – Oak – Juniper Forest, east of Juniper Flat, Chisos Basin (BIBEAA0332). Dominant grass is *Piptochaetium fimbriatum*. Photo by Rebecca Evans.

## ***Lacey's Oak Woodland***

### Local Type Concept:

Woodlands or forests dominated (probably strongly so) by *Quercus laceyi* (Lacey's oak).

### Vegetation:

As the single plot indicates, strong (monotypic) dominance in the tree stratum by *Quercus laceyi* (Lacey's oak) is characteristic. *Diospyros texana* (Texas persimmon), *Rhus virens* (evergreen sumac), *Ungnadia speciosa* (Mexican buckeye), *Celtis laevigata* var. *reticulata* (netleaf hackberry), *Senegalia roemeriana* (Roemer's catclaw) were recorded as the most abundant shrub species. The herbaceous stratum was sparse. Despite the relatively low elevation of the site, a number of species that are more characteristic of higher elevation (more montane), including *R. virens*, *Bouvardia ternifolia* (firecrackerbush), *Agave havardiana* (Havard's century plant), *Galium microphyllum* (bracted bedstraw), and *Cheilanthes eatonii* (Eaton's lipfern), associate with typically desert species. Stratum and substrate cover for Lacey's Oak Woodland are shown in Table D-7.

**Table D-7.** Stratum and substrate cover recorded for Lacey's Oak Woodland at Big Bend National Park (# plots=1).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	70	70–70
	Tall Shrub	2	10–13
	Short Shrub	8	5–8
	Herb	0	0–2
Substrate	Bedrock	10	10–10
	Large/Small Rocks	89	89–89
	Litter/Duff	5	5–5

### Environment:

The plot is in a canyon bottom in an upper tributary of Hannold Draw at 4120 feet, just south (upstream from) of Panther Junction, in the Chisos Mountain foothills. The surficial geology is mapped as alluvium. *Quercus laceyi* usually occurs on limestone substrates in Texas (Powell 1998), and it is possible that a small inclusion of unmapped limestone is present.

### USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Lowland Evergreen Woodland Macrogroup (M010)

USNVC Group: Madrean Encinal Group (G201)



USNVC Alliance: *Quercus arizonica* – *Quercus emoryi* – *Quercus grisea* Scrub Woodland Alliance (A3101)

NPS Association: *Quercus laceyi* Madrean Woodland Association (NPSBIBE012)

Comments:

This type is represented by a single plot that is an outlier in analysis, partly because of the abundance of the unusual *Q. laceyi* and partly because of the mix of montane and desert species. This uniqueness suggests at least interim taxonomic recognition.

While other stands may occur along the north side of the lower Chisos Mountains, this vegetation clearly is rare and limited in extent at BIBE. *Quercus laceyi* is infrequent in the Madrean floristic region within Texas and is more characteristic of the Balconian (e.g., Edwards Plateau) region (Powell and Worthington 2018).

Recognized USNVC associations with *Quercus laceyi* as a nominal species are in Macrogroup M015 of the Edwards Plateau. Were a second nominal species to be applied to the BIBE entity, it should be a species whose distribution is Chihuahuan or Madrean and that is not characteristic of the Balconian region (e.g., *Bouvardia ternifolia*, *Agave havardiana*). Because the type is known from a single stand and the most characteristic species over a potentially wider distribution have not been determined, a more generic term (*Quercus laceyi* Madrean Woodland) is used as a placeholder in order to clarify the phytogeographic concept.

BIBE Classification Plots Included in Concept:

BIBE0041.

Most frequent plant taxa recorded in Lacey's Oak Woodland are shown in Table D-8.

**Table D-8.** Synthesis table for all plant taxa recorded in Lacey's Oak Woodland at Big Bend National Park (# plots=1).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus laceyi</i>	Tree	100.0%	62.5	50–75
<i>Diospyros texana</i>	Shrub	100.0%	3.5	2–5
<i>Rhus virens</i>	Shrub	100.0%	3.5	2–5
<i>Ungradia speciosa</i>	Shrub	100.0%	3.5	2–5
<i>Celtis laevigata</i> var. <i>reticulata</i>	Shrub	100.0%	1.5	1–2
<i>Senegalia roemeriana</i>	Shrub	100.0%	0.5	few–1
<i>Agave havardiana</i>	Shrub	100.0%	0.5	few–1
<i>Bouvardia ternifolia</i>	Shrub	100.0%	0.5	few–1
<i>Croton fruticosus</i>	Shrub	100.0%	0.5	few–1
<i>Echeveria strictiflora</i>	Shrub	100.0%	0.5	few–1
<i>Echinocereus enneacanthus</i>	Shrub	100.0%	0.5	few–1
<i>Eysenhardtia texana</i>	Shrub	100.0%	0.5	few–1



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Herb	100.0%	0.5	few–1
<i>Mahonia trifoliolata</i>	Shrub	100.0%	0.5	few–1
<i>Opuntia</i> sp.	Shrub	100.0%	0.5	few–1
<i>Porophyllum scoparium</i>	Shrub	100.0%	0.5	few–1
<i>Clematis pitcheri</i>	Vine	100.0%	1.5	1–2
<i>Cheilanthes eatonii</i>	Herb	100.0%	0.5	few–1
<i>Galium microphyllum</i>	Herb	100.0%	0.5	few–1
<i>Muhlenbergia tenuifolia</i>	Herb	100.0%	0.5	few–1
<i>Phyllanthus ericoides</i>	Herb	100.0%	0.5	few–1
<i>Stenaria nigricans</i>	Herb	100.0%	0.5	few–1



Photo 7. Lacey's Oak Woodland, Hannold Draw above Panther Junction (BIBE0041). Photo by Christian Skorik.



Photo 8. Lacey's Oak Woodland, Hannold Draw above Panther Junction (BIBE0041). Photo by Christian Skorik.

## Emory Oak Woodland

### Local Type Concept:

Open to somewhat closed woodlands in lower montane settings with *Quercus emoryi* (Emory oak) or, less frequently, *Quercus robusta* (robust oak) the dominant tree or tall shrub stratum.

### Vegetation:

*Quercus emoryi* (Emory oak) is the leading dominant (usually strongly dominant) in a rather open (5–30% cover) short tree or tall shrub stratum. Occasionally, *Quercus robusta* (robust oak), which is sometimes regarded as a hybrid between *Q. emoryi* and *Q. gravesii*, serves this role. Various other short trees, including *Quercus grisea* (gray oak), *Pinus cembroides* (Mexican pinyon) and or *Juniperus* spp. (junipers) often are present at lower cover or may co-dominate. Constant or relatively constant shorter shrubs include *Agave havardiana* (Havard's century plant), *Nolina erumpens* (foothill beargrass), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Dasyllirion leiophyllum* (green sotol), *Mimosa aculeaticarpa* var. *biuncifera* (catclaw mimosa), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Fraxinus greggii* (littleleaf ash), *Rhus virens* (evergreen sumac), *Senegalia roemeriana* (Roemer's catclaw), *Chrysactinia mexicana* (damianita), *Acaciella angustissima* (prairie acacia), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Agave lechuguilla* (lechuguilla), and *Echinocereus russanthus* (rusty hedgehog cactus). The herbaceous stratum usually is well-developed and grassy, but may be somewhat sparse in stands with more closed canopies. Dominant, or otherwise frequent, species include *Schizachyrium scoparium* (little bluestem), *Muhlenbergia emersleyi* (bull muhly), *Bouteloua curtipendula* (sideoats grama), and *Nassella tenuissima* (finestem needlegrass). *Cheilanthes* spp. (lip ferns) usually are present at low cover. Stratum and substrate cover for Emory Oak Woodland are shown in Table D-9.

**Table D-9.** Stratum and substrate cover recorded for Emory Oak Woodland at Big Bend National Park (# plots=5).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	19	0–70
	Tall Shrub	9	0–30
	Short Shrub	31	7–62
	Herb	32	5–50
Substrate	Bedrock	0	0–0
	Large/Small Rocks	36	4–70
	Litter/Duff	51	15–89

### Environment:

This association is known from 4,700 to 5,700 feet on relatively gentle lower slopes and, occasionally, in ravines in the Chisos Mountains. It tends to occur in small patches and is relatively rare within BIBE. Most known stands and all stands sampled during the classification phase are in

Green Gulch. During the mapping accuracy assessment, stands were found in Blue Creek Canyon, Pine Canyon, and Oak Canyon.

USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Lowland Evergreen Woodland Macrogroup (M010)

USNVC Group: Madrean Encinal Group (G201)

USNVC Alliance: *Quercus arizonica* – *Quercus emoryi* – *Quercus grisea* Scrub Woodland Alliance (A3101)

USNVC Association: *Quercus emoryi* / *Muhlenbergia emersleyi* Scrub Woodland Association (CEGL000685)

Comments:

Within the current concept of this type, there is some heterogeneity between more closed canopy stands and open stands. With further examination, a treatment of *Quercus emoryi* dominated stands at BIBE as alternative dominant patterns within either the Graves' Oak – Emory Oak Canyon Forest (for more closed canopy stands) or the Redberry Juniper – Sotol Shrubland (more open stands), rather than as a distinct association, may be more appropriate.

Although *Schizachyrium scoparium* (little bluestem) was the dominant grass species as found in the classification plots (possibly an artifact of the plots all in an area of relatively limited extent) *Muhlenbergia emersleyi* (bull muhly) was most constant and abundant at sites observed during the map accuracy assessment.

BIBE Classification Plots Included in Concept:

BIBE0054, BIBE0156, BIBE0177, BIBE0183, BIBE0184.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0203, BIBEAA0209 , BIBEAA0210, BIBEAA0227, BIBEAA0314, BIBEAA0320, BIBEAA0893.

Most frequent plant taxa recorded in Emory Oak Woodland are shown in Table D-10.



**Table D-10.** Synthesis table for the most frequent plant taxa recorded in Emory Oak Woodland at Big Bend National Park (# plots=5).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus emoryi</i>	Tree / Shrub	100.0%	45.8	10–100
<i>Pinus cembroides</i>	Tree / Shrub	80.0%	1.3	0–6
<i>Agave havardiana</i>	Shrub	100.0%	0.5	few–1
<i>Dasyllirion leiophyllum</i>	Shrub	80.0%	1.2	0–6
<i>Nolina erumpens</i>	Shrub	80.0%	1.1	0–3
<i>Opuntia chisosensis</i>	Shrub	80.0%	0.6	0–2
<i>Echinocereus rusanthus</i>	Shrub	80.0%	0.2	0–1
<i>Senegalia roemeriana</i>	Shrub	60.0%	0.3	0–1
<i>Juniperus coahuilensis</i> / <i>J. coahuilensis</i> × <i>pinchotii</i>	Shrub	40.0%	1.6	0–10
<i>Agave lechuguilla</i>	Shrub	40.0%	0.8	0–5
<i>Rhus virens</i>	Shrub	40.0%	0.8	0–5
<i>Juniperus deppeana</i>	Shrub	40.0%	0.7	0–5
<i>Quercus grisea</i>	Shrub	40.0%	0.4	0–2
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	40.0%	0.2	0–1
<i>Juniperus monosperma</i>	Shrub	40.0%	0.1	0–1
<i>Arbutus xalapensis</i>	Shrub	20.0%	0.3	0–2
<i>Quercus arizonica</i>	Shrub	20.0%	0.3	0–2
<i>Mimosa aculeaticarpa</i> var. <i>biuncifera</i>	Shrub	20.0%	0.3	0–2
<i>Juniperus flaccida</i>	Shrub	20.0%	0.2	0–2
<i>Chrysactinia mexicana</i>	Shrub	20.0%	0.1	0–1
<i>Fraxinus greggii</i>	Shrub	20.0%	0.1	0–1
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	20.0%	0.1	0–1
<i>Rhus microphylla</i>	Shrub	20.0%	0.1	0–1
<i>Viguiera stenoloba</i>	Shrub	20.0%	0.1	0–1
<i>Echinocereus rusanthus</i>	Shrub	20.0%	0.1	0–1
<i>Mammillaria meiacantha</i>	Shrub	20.0%	0.1	0–1
<i>Bouvardia ternifolia</i>	Shrub	20.0%	0.1	0–trace
<i>Schizachyrium scoparium</i>	Herb	100.0%	18.1	few–50
<i>Muhlenbergia emersleyi</i>	Herb	80.0%	4.0	0–25
<i>Bouteloua curtipendula</i>	Herb	80.0%	0.8	0–2
<i>Cheilanthes</i> sp.	Herb	80.0%	0.4	0–1
<i>Sporobolus</i> sp.	Herb	40.0%	4.0	0–10
<i>Bouteloua hirsuta</i>	Herb	40.0%	2.2	0–10
<i>Panicum hallii</i>	Herb	40.0%	1.0	0–5
<i>Astrolepis cochisensis</i>	Herb	40.0%	0.1	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Muhlenbergia rigida</i>	Herb	20.0%	3.5	0–25
<i>Artemisia ludoviciana</i>	Herb	20.0%	0.1	0–1
<i>Aristida schiedeana</i>	Herb	20.0%	0.1	0–1
<i>Astrolepis integerrima</i>	Herb	20.0%	0.1	0–1
<i>Bouteloua ramosa</i>	Herb	20.0%	0.1	0–1
<i>Dyschoriste linearis</i>	Herb	20.0%	0.1	0–1
<i>Heteropogon contortus</i>	Herb	20.0%	0.1	0–1
<i>Linum australe</i>	Herb	20.0%	0.1	0–1
<i>Lycurus setosus</i>	Herb	20.0%	0.1	0–1
<i>Polygala alba</i>	Herb	20.0%	0.1	0–1
<i>Tragia amblyodonta</i>	Herb	20.0%	0.1	0–trace



Photo 9. Emory Oak – Little Bluestem Woodland, Green Gulch (BIBE0054). Photo by Christian Skorik.



Photo 10. Emory Oak – Little Bluestem Woodland, Green Gulch (BIBEAA0209). Photo by Kelon Crawford.

## **Graves' Oak – Bigtooth Maple Forest**

### Local Type Concept:

Mesic forests in canyon bottoms dominated by *Quercus gravesii* (Graves' oak) and *Acer grandidentatum* (bigtooth maple) in the tree and tall shrub strata.

### Vegetation:

*Quercus gravesii* (Graves' oak) is dominant in the tree stratum. *Acer grandidentatum* (bigtooth maple) is either co-dominant with *Q. gravesii* or is important as an understory tree or tall shrub. *Quercus grisea* (gray oak) and *Arbutus xalapensis* (Texas madrone) may occur as understory trees or tall shrubs. Shorter shrubs include *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), *Ungnadia speciosa* (Mexican buckeye), and *Nolina erumpens* (foothill beargrass). *Prunus serotina* var. *virens* (black cherry) and *Vitis arizonica* (canyon grape) are present in both stands that were sampled by classification plots, show a greater frequency in this than in related types, and may prove to be somewhat characteristic. Overall, this association is floristically similar to the Graves' Oak – Emory Oak Canyon Forest and somewhat similar to the High Chisos Oak – Pine Forest, differing in the abundance of *A. grandidentatum* and in the occurrence of other (mostly low cover) moisture-demanding species. Stratum and substrate cover for Graves' Oak – Bigtooth Maple Forest are shown in Table D-11.

**Table D-11.** Stratum and substrate cover recorded for Graves' Oak – Bigtooth Maple Forest at Big Bend National Park (# plots=3).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	55	30–65
	Tall Shrub	27	20–30
	Short Shrub	15	20–40
	Herb	7	0–20
Substrate	Bedrock	5	0–15
	Large/Small Rocks	30	4–55
	Litter/Duff	45	30–55

### Environment:

This association is closely restricted to mesic canyon bottoms in the Chisos Mountains, usually where the water table is near the ground surface. Known stands are from about 5,150 feet to 6,800 feet in elevation. Two classification plots are in Pine Canyon and are undoubtedly from a single stand. The other classification plot is from a tributary canyon to Boot Canyon. A third stand was found during the map accuracy assessment in Juniper Canyon near Upper Juniper Spring. The type also may be present in Maple Canyon. This association spans the elevation ranges of the similar Graves' Oak – Emory Oak Canyon Forest and the High Chisos Oak – Pine Forest, and occupies the most mesic settings that are otherwise available to those more abundant types. The Graves' Oak –



Bigtooth Maple Forest appears to be fairly rare and restricted to mesic canyon bottoms in the higher elevations of the Chisos.

USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Montane Forest & Woodland Macrogroup (M011)

USNVC Group: Madrean Lower Montane Pine – Oak Forest & Woodland Group (G203)

USNVC Alliance: *Arbutus xalapensis* – *Acer grandidentatum* – *Quercus* spp. Forest & Woodland Alliance (A0368)

USNVC Association: *Acer grandidentatum* – *Quercus gravesii* Forest Association (CEGL004548)

Comments:

As represented in plots from BIBE, the Graves' Oak – Bigtooth Maple Forest is floristically similar to Graves' Oak – Emory Oak Canyon Forest and to the High Chisos Oak – Pine Forest and it might be considered to be a more mesic variant of those types. Since it is established as a USNVC association, and the few BIBE plots are more similar to one another than to plots assigned to the most similar types, it is recognized as a distinct association in the BIBE classification.

The USNVC association description (CEGL004548) (USNVC 2017) is based on stands observed in the Chisos Mountains, and the USNVC concept is limited to this area within the United States. BIBE plot data suggest that *Quercus gravesii* (Graves' oak) is more abundant than *A. grandidentatum* in these stands. That finding and the close similarity of stands to other BIBE associations that have *Q. gravesii* abundant (the Graves' Oak – Emory Oak Canyon Forest and the High Chisos Oak – Pine Forest) suggest that *Q. gravesii* might be a better first nominal species.

The USNVC concepts of CEGL004548 (*Acer grandidentatum* – *Quercus gravesii* Forest Association) and CEGL004553 (*Arbutus xalapensis* – *Quercus grisea* – *Juniperus flaccida* – *Acer grandidentatum* – *Quercus gravesii* Forest Association) are both from the Chisos Mountains. Given the very limited extent of *Acer grandidentatum* within the Chisos, these two associations seem to have much redundancy, are assigned, rather arbitrarily, into different USNVC Groups, and probably should be consolidated. The global rarity ranking of G2 that is attributed to both of these USNVC concepts (or perhaps a G1 ranking) seems appropriate for this very limited Chisos Mountain entity, regardless of its national level treatment. Depending on its ultimate circumscription, it may also occur in the Sierra del Carmen or elsewhere in Mexico (Wood et al. 1999).

BIBE Classification Plots Included in Concept:

BIBE0031, BIBE0174, BIBE0381.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0307.

Most frequent plant taxa recorded in Graves' Oak – Bigtooth Maple Forest are shown in Table D-12.

**Table D-12.** Synthesis table for all plant taxa recorded in Graves' Oak – Bigtooth Maple Forest at Big Bend National Park (# plots=3).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus gravesii</i>	Tree / Shrub	100.0%	41.5	20–100
<i>Acer grandidentatum</i>	Tree / Shrub	100.0%	32.5	17–50
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	100.0%	7.7	few–15
<i>Salvia regla</i>	Shrub	100.0%	2.0	few–6
<i>Rhus virens</i>	Shrub	100.0%	1.6	trace–6
<i>Ungradia speciosa</i>	Shrub	66.7%	6.0	0–25
<i>Prunus serotina</i> var. <i>virens</i>	Shrub	66.7%	1.5	0–7
<i>Quercus grisea</i>	Shrub	66.7%	0.5	0–2
<i>Nolina erumpens</i>	Shrub	66.7%	0.2	0–1
<i>Senegalia roemeriana</i>	Shrub	33.3%	0.5	0–2
<i>Pinus cembroides</i>	Shrub	33.3%	0.3	0–2
<i>Koanophyllon solidaginifolium</i>	Shrub	33.3%	0.2	0–1
<i>Vitis arizonica</i>	Vine	100.0%	3.7	1–10
<i>Clematis pitcheri</i>	Vine	66.7%	1.3	0–5
<i>Matelea reticulata</i>	Vine	33.3%	0.2	0–1
<i>Phoradendron</i> sp.	Epiphyte	33.3%	0.2	0–1
<i>Cheilanthes eatonii</i>	Herb	66.7%	0.2	0–1
<i>Rivina humilis</i>	Herb	33.3%	2.5	0–10
<i>Flyriella parryi</i>	Herb	33.3%	1.2	0–5
<i>Ageratina herbacea</i>	Herb	33.3%	0.2	0–1
<i>Aletes acaulis</i>	Herb	33.3%	0.2	0–1
<i>Aquilegia longissima</i>	Herb	33.3%	0.2	0–1
<i>Argemone chisosensis</i>	Herb	33.3%	0.2	0–1
<i>Asplenium resiliens</i>	Herb	33.3%	0.2	0–1
<i>Cheilanthes bonariensis</i>	Herb	33.3%	0.2	0–1
<i>Cheilanthes</i> sp.	Herb	33.3%	0.2	0–1
<i>Cologania angustifolia</i>	Herb	33.3%	0.2	0–1
<i>Cyphomeris gypsophiloides</i>	Herb	33.3%	0.2	0–1
<i>Desmodium psilophyllum</i>	Herb	33.3%	0.2	0–1
<i>Iresine heterophylla</i>	Herb	33.3%	0.2	0–1
<i>Nassella tenuissima</i>	Herb	33.3%	0.2	0–1
<i>Oxalis drummondii</i>	Herb	33.3%	0.2	0–1
<i>Pellaea atropurpurea</i>	Herb	33.3%	0.2	0–1
<i>Physalis</i> sp.	Herb	33.3%	0.2	0–1
<i>Piptochaetium fimbriatum</i>	Herb	33.3%	0.2	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Salvia arizonica</i>	Herb	33.3%	0.2	0–1
<i>Salvia lycioides</i>	Herb	33.3%	0.2	0–1
<i>Setaria grisebachii</i>	Herb	33.3%	0.2	0–1
<i>Tradescantia brevifolia</i>	Herb	33.3%	0.2	0–1
<i>Verbesina oreophila</i>	Herb	33.3%	0.2	0–1



Photo 11. Graves' Oak – Bigtooth Maple Forest, Pine Canyon (BIBE0031). Photo by Christian Skorik.



Photo 12. Graves' Oak – Bigtooth Maple Forest, Pine Canyon (BIBE0174). Photo by Neal Schmidt/Sarah King/Jenny Goucher.



## **Graves' Oak – Emory Oak Canyon Forest**

### Local Type Concept:

Mesic forests, woodlands or tall shrublands in middle elevation montane settings (typically canyon bottoms) that are dominated in the tree stratum by *Quercus gravesii* (Graves' oak), with *Quercus emoryi* (Emory oak) usually co-dominant or constant.

### Vegetation:

*Quercus gravesii* (Graves' oak) usually is the leading dominant in the uppermost (usually, tree) stratum. *Quercus emoryi* (Emory oak) and/or the purported hybrid between *Q. gravesii* and *Q. emoryi*, *Quercus robusta* (= *Quercus ×robusta*, robust oak) is constant in the tree and shrub strata and occasionally co-dominant in the tree stratum. Some variation of dominance may occur: one observed stand lacks *Q. gravesii*, and *Q. emoryi* is the leading tree dominant; another has *Quercus grisea* (gray oak) dominant. In stands in Blue Creek Canyon, the Chisos endemic *Quercus graciliformis* (Chisos oak) or *Quercus ×tharpai* (Tharp's oak, a purported hybrid between *Q. graciliformis* and *Q. gravesii*) may dominate. These dominance variants are floristically consistent with the primary association concept. *Arbutus xalapensis* (Texas madrone) (as a tall shrub or understory tree) is a good character species for the type, as is the less constant *Prunus serotina* var. *virens* (Texas black cherry). The ubiquitous Chisos Mountain trees *Pinus cembroides* (Mexican pinyon), *Juniperus flaccida* (weeping juniper), and *Quercus grisea* (gray oak) often are present, but usually are at low cover. *Nolina erumpens* (foothills beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and *Rhus virens* (evergreen sumac) are the most constant shrub species, while *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Agave havardiana* (Havard's century plant), *Dasyllirion leiophyllum* (green sotol), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Echinocereus coccineus* var. *paucispinus* (Texas claret-cup cactus), *Salvia regla* (mountain sage), *Bouvardia ternifolia*, (firecrackerbush), and/or *Ungnadia speciosa* (Mexican buckeye) also may occur. The woody vines *Lonicera albiflora* (western white honeysuckle) and *Vitis arizonica* (canyon grape) may be present. The herbaceous stratum cover usually is low, with relatively few constant species and almost all of them at low cover. *Cheilanthes* spp. (lip ferns), *Bouteloua curtipendula* (sideoats grama), *Muhlenbergia emersleyi* (bull muhly), *Piptochaetium fimbriatum* (pinyon ricegrass), and *Tradescantia brevifolia* (Trans-Pecos spiderwort) were among the most frequently observed.

Although the uppermost stratum typically is comprised of trees that are at least 10 meters tall, this association may occur with a short tree to tall shrub physiognomy, often 3–10 meters in height when it occurs on stable talus slopes. Stratum and substrate cover for Graves' Oak – Emory Oak Canyon Forest are shown in Table D-13.

**Table D-13.** Stratum and substrate cover recorded for Graves' Oak – Emory Oak Canyon Forest at Big Bend National Park (# plots=12).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	68	30–100
	Tall Shrub	12	2–30
	Short Shrub	5	0–12
	Herb	8	0–40
Substrate	Bedrock	0	0–0
	Large/Small Rocks	37	2–77
	Litter/Duff	53	10–88

Environment:

This association was found consistently from 4600 to 5900 feet in elevation throughout the Chisos Mountains, with an anomalously low stand at about 4,200 feet. The setting is in the most mesic settings within its elevation range: either the bottoms or lower slopes of ravines or canyons, where it occurs in linear strips, or on steep north-facing slopes, often with talus substrate. Above about 5,900 feet, it is replaced by the High Chisos Oak – Pine Forest in similar settings. It can be found in most major drainages of the Chisos at the appropriate elevations, including Blue Creek, Juniper Canyon, Pine Canyons, upper Oak Creek, and in many north facing ravines along the north side of the range.

USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Montane Forest & Woodland Macrogroup (M011)

USNVC Group: Madrean Lower Montane Pine – Oak Forest & Woodland Group (G203)

USNVC Alliance: *Arbutus xalapensis* – *Acer grandidentatum* – *Quercus spp.* Forest & Woodland Alliance (A0368)

NPS Association: *Quercus gravesii* – *Quercus emoryi* / *Arbutus xalapensis* / *Garrya ovata* ssp. *goldmanii* Woodland Association (NPSBIBE007)

Comments:

This association is a lower elevation analog to the High Chisos Oak – Pine Forest, which also has *Quercus gravesii* (Graves' oak) dominance. There is little to no elevation overlap between the two types. Floristically, the Graves' Oak – Emory Oak Canyon Forest is characterized by the presence of *Quercus emoryi* (Emory oak) or *Quercus robusta* (robust oak) in abundance and sometime co-dominant with *Q. gravesii* (Graves' oak); *Q. emoryi* is infrequent and never abundant in High Chisos Oak – Pine Forest and seems to be somewhat limited in frequency and abundance in the highest elevations of the Chisos in general. *Pinus cembroides* (Mexican pinyon) and *Quercus grisea* (gray

oak) are more important components of the High Chisos Oak – Pine Forest, suggesting a somewhat drier moisture regime.

The USNVC association *Arbutus xalapensis* – *Quercus grisea* – *Juniperus flaccida* – *Acer grandidentatum* – *Quercus gravesii* Forest Association (CEGL004553) (USNVC 2017) is the closest fit within recognized USNVC associations. However, it is overly generalized (some of the listed characteristic almost never co-occur), in view of the findings of the BIBE classification. Since it is described only from the Chisos Mountains and, it might be reworked to fit this vegetation. CEGL004553 also is separated into a different USNVC Group from that to which closely related associations that fit Chisos vegetation are assigned (e.g., CEGL004548 *Acer grandidentatum* – *Quercus gravesii* Forest Association).

As defined here, this association probably is endemic to the Chisos Mountains within the United States, partly because of the complete or partial restriction of many of the characteristic species to the Chisos Mountains within the United States. The same or similar types may occur in the Sierra del Carmen (Wood et al. 1999) and other ranges in Mexico.

BIBE Classification Plots Included in Concept:

BIBE0062, BIBE0158, BIBE0169, BIBE0171, BIBE0172, BIBE0173, BIBE0180, BIBE0181, BIBE0182, BIBE0209, BIBE0218, BIBE0371.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0212, BIBEAA0246, BIBEAA0309, BIBEAA0310, BIBEAA0312, BIBEAA0315, BIBEAA0316, BIBEAA0317, BIBEAA0318, BIBEAA0319, BIBEAA0321, BIBEAA0322, BIBEAA0324, BIBEAA0326, BIBEAA0327, BIBEAA0328, BIBEAA0329, BIBEAA0330, BIBEAA0333, BIBEAA0334, BIBEAA0336.

Most frequent plant taxa recorded in Graves' Oak – Emory Oak Canyon Forest are shown in Table D-14.

**Table D-14.** Synthesis table for most frequent plant taxa recorded in Graves' Oak – Emory Oak Canyon Forest at Big Bend National Park (# plots=12).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus gravesii</i>	Tree / Shrub	91.7%	30.3	0–81
<i>Quercus emoryi</i>	Tree / Shrub	91.7%	14.2	0–62
<i>Arbutus xalapensis</i>	Tree / Shrub	91.7%	9.7	0–75
<i>Juniperus flaccida</i>	Tree / Shrub	58.3%	3.1	0–31
<i>Prunus serotina</i> var. <i>virens</i>	Tree / Shrub	25.0%	1.8	0–25
<i>Quercus grisea</i>	Tree	16.7%	3.3	0–50
<i>Nolina erumpens</i>	Shrub	100.0%	0.7	trace–2
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	91.7%	3.5	0–25
<i>Rhus virens</i>	Shrub	75.0%	1.4	0–8



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	66.7%	0.7	0–3
<i>Agave havardiana</i>	Shrub	66.7%	0.8	0–5
<i>Dasyllirion leiophyllum</i>	Shrub	50.0%	0.3	0–2
<i>Opuntia chisosensis</i>	Shrub	50.0%	0.3	0–2
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	45.5%	0.2	0–1
<i>Salvia regla</i>	Shrub	41.7%	0.5	0–5
<i>Pinus cembroides</i>	Shrub	41.7%	0.4	0–2
<i>Bouvardia ternifolia</i>	Shrub	41.7%	0.2	0–1
<i>Ungradia speciosa</i>	Shrub	33.3%	0.3	0–2
<i>Opuntia</i> sp.	Shrub	33.3%	0.1	0–1
<i>Fraxinus greggii</i>	Shrub	25.0%	1.0	0–10
<i>Diospyros texana</i>	Shrub	25.0%	0.7	0–8
<i>Cercocarpus montanus</i>	Shrub	25.0%	0.4	0–7
<i>Quercus arizonica</i>	Shrub	25.0%	0.3	0–5
<i>Acer grandidentatum</i>	Shrub	16.7%	0.7	0–11
<i>Morus microphylla</i>	Shrub	16.7%	0.2	0–2
<i>Cercis canadensis</i> var. <i>mexicana</i>	Shrub	16.7%	0.1	0–1
<i>Yucca torreyi</i>	Shrub	16.7%	0.1	0–1
<i>Chrysactinia mexicana</i>	Shrub	16.7%	0.1	0–1
<i>Celtis laevigata</i> var. <i>reticulata</i>	Shrub	16.7%	0.1	0–1
<i>Viguiera stenoloba</i>	Shrub	16.7%	0.1	0–1
<i>Lonicera albiflora</i>	Vine	41.7%	0.3	0–3
<i>Vitis arizonica</i>	Vine	33.3%	0.3	0–2
<i>Clematis pitcheri</i>	Vine	16.7%	0.1	0–1
<i>Cheilanthes</i> sp.	Herb	58.3%	0.3	0–1
<i>Brickellia</i> sp.	Herb	33.3%	1.0	0–10
<i>Tradescantia brevifolia</i>	Herb	33.3%	0.3	0–2
<i>Bouteloua curtipendula</i>	Herb	33.3%	0.2	0–2
<i>Eriogonum</i> sp.	Herb	33.3%	0.2	0–1
<i>Artemisia ludoviciana</i>	Herb	25.0%	0.1	0–1
<i>Oxalis drummondii</i>	Herb	16.7%	0.2	0–2
<i>Astrolepis sinuata</i>	Herb	16.7%	0.1	0–1
<i>Cheilanthes villosa</i>	Herb	16.7%	0.1	0–1
<i>Cologania angustifolia</i>	Herb	16.7%	0.1	0–1
<i>Tragia amblyodonta</i>	Herb	16.7%	0.1	0–1
<i>Pellaea</i> sp.	Herb	16.7%	0.1	0–1
<i>Physalis</i> sp.	Herb	16.7%	0.1	0–1



Photo 13. Graves' Oak – Emory Oak Canyon Forest, Blue Creek Canyon (BIBEAA0317). Photo by Jeff Renfrow.



Photo 14. Graves' Oak – Emory Oak Canyon Forest, Juniper Canyon (BIBEAA0333). Photo by Jeff Renfrow.

## High Chisos Oak – Pine Forest

### Local Type Concept:

Mesic forests in montane canyons dominated in the tree stratum by *Quercus gravesii* (Graves' oak). *Quercus grisea* (gray oak) and *Pinus cembroides* (Mexican pinyon) are usually present and may be co-dominant. In a small number of stands, *Pinus arizonica* var. *stormiae* (Arizona pine) co-dominates, often as a tall tree substratum above that dominated by *Q. gravesii*.

### Vegetation:

*Quercus gravesii* (Graves' oak) is constant and dominant or co-dominant in the tree stratum. *Quercus grisea* (gray oak) and *Pinus cembroides* (Mexican pinyon) are relatively constant trees or tall shrubs; occasionally, they may co-dominate. In several stands in Pine Canyon (Crown Mountain), *Pinus arizonica* var. *stormiae* (Arizona pine) is a co-dominant with *Q. gravesii* in the tree stratum, often as an emergent taller tree. Relatively constant shrubs include *Opuntia chisosensis* (Chisos Mountain pricklypear), *Salvia regla* (mountain sage), *Agave havardiana* (Havard's century plant), *Echinocereus coccineus* var. *paucispinus* (Texas claret-cup cactus), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silk tassel), and *Arbutus xalapensis* (Texas madrone), with the latter two species achieving locally high cover in some stands. *Juniperus flaccida* (weeping juniper) and *Juniperus deppeana* (alligator juniper) are occasional, low cover tall shrubs or small trees. The woody vines *Lonicera albiflora* (western white honeysuckle) and/or *Vitis arizonica* (canyon grape) occasionally occur. The herbaceous stratum seldom achieves high cover, and its composition is somewhat variable, with *Piptochaetium fimbriatum* (pinyon ricegrass), *Packera millelobata* (Uinta ragwort), *Tradescantia brevifolia* (Trans-Pecos spiderwort), *Conopholis alpina* var. *mexicana* (Mexican cancer-root), *Ageratina herbacea* (fragrant snakeroot), *Commelina dianthifolia* (birdbill dayflower), *Muhlenbergia emersleyi* (bull muhly), *Hedeoma plicata* (veiny false pennyroyal), and *Verbesina oreophila* (mountain crownbeard) among the most constant species.

Although the uppermost stratum typically is comprised of trees that are at least 10 meters tall, this association may occur with a short tree to tall shrub physiognomy, often 3–10 meters in height when it occurs on stable talus slopes. Stratum and substrate cover for High Chisos Oak – Pine Forest are shown in Table D-15.

**Table D-15.** Stratum and substrate cover recorded for High Chisos Oak – Pine Forest at Big Bend National Park (# plots=8).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	55	30–65
	Tall Shrub	27	20–30
	Short Shrub	15	20–40
	Herb	7	0–20
Substrate	Bedrock	3	0–10
	Large/Small Rocks	31	1–50
	Litter/Duff	49	35–84



### Environment:

This association was found consistently from 5,900 to 7,300 feet in elevation in the Chisos Mountains. As with the Graves' Oak – Emory Oak Canyon Forest of lower elevations, its setting is in the more mesic settings within its elevation range: either the bottoms or lower slopes of ravines or canyons, where it occurs in linear strips, or on steep north-facing slopes, often with talus substrate that is relatively stable. Compared to the Graves' Oak – Emory Oak Canyon Forest, it is more likely to occur in the latter settings. It can be reliably be found on many of the steep, north-facing slopes of the Chisos, including those below the summits of Lost Mine Peak, Mount Huffman, Casa Grande, Toll Mountain, Crown Mountain, Emory Peak, and the Northeast Rim; it also occurs along the bottoms of drainages of Boot Canyon.

### USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Montane Forest & Woodland Macrogroup (M011)

USNVC Group: Madrean Lower Montane Pine – Oak Forest & Woodland Group (G203)

USNVC Alliance: *Arbutus xalapensis* – *Acer grandidentatum* – *Quercus spp.* Forest & Woodland Alliance (A0368)

NPS Association: *Quercus gravesii* – *Pinus (cembroides, arizonica)* / *Quercus grisea* Forest Association (NPSBIBE004)

This association is similar to and is a higher elevation analog to the Graves' Oak – Emory Oak Canyon Forest, which also has *Quercus gravesii* (Graves' oak) dominance. There is little to no elevation overlap between the associations. Floristically, Graves' Oak – Emory Oak Canyon Forest is characterized by the presence of *Quercus emoryi* (Emory oak) in abundance and sometime co-dominant with *Q. gravesii*; *Q. emoryi* is infrequent and not abundant in the High Chisos Oak – Pine Forest and seems to be somewhat limited in frequency and abundance in the highest elevations of the Chisos in general. *Pinus cembroides* (Mexican pinyon) and *Quercus grisea* (gray oak) are more important species in the High Chisos Oak – Pine Forest, suggesting a drier moisture regime.

Stands in Pine Canyon (along the north side of Crown Mountain) that have *Pinus arizonica* var. *stormiae* (Arizona pine) prominent in the tree stratum with *Quercus gravesii* or exceeding the oaks in height seem floristically consistent with the composition of those stands without *P. arizonica* var. *stormiae*.

The USNVC (2017) association *Arbutus xalapensis* – *Quercus grisea* – *Juniperus flaccida* – *Acer grandidentatum* – *Quercus gravesii* Forest Association (CEGL004553) is the closest fit within recognized USNVC associations. However, it is overly generalized (some of the listed characteristic almost never co-occur), in view of the findings of the BIBE classification. Since it is described only from the Chisos Mountains and, it might be reworked to fit this vegetation. CEGL004553 also is separated into a different USNVC Group from that to which closely related associations that fit

Chisos vegetation are assigned (e.g., CEG004548 *Acer grandidentatum* – *Quercus gravesii* Forest Association).

As defined here, this association probably is endemic to the Chisos Mountains within the United States, partly because of the complete or partial restriction of many of the characteristic species to the Chisos Mountains within the United States. The same or similar types may occur in the Sierra del Carmen (Wood et al. 1999) and other ranges in Mexico.

In BIBE, the rare grass *Festuca ligulata* (Guadalupe fescue), listed by the federal government as an endangered species, occurs in this vegetation.

BIBE Classification Plots Included in Concept:

BIBE0032, BIBE0044, BIBE0254, BIBE0278, BIBE0281, BIBE0319, BIBE0320, BIBE0383.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0145, BIBEAA0220, BIBEAA0221, BIBEAA0222, BIBEAA0223, BIBEAA0224, BIBEAA0225, BIBEAA0226, BIBEAA0228, BIBEAA0229, BIBEAA0230, BIBEAA0231, BIBEAA0235, BIBEAA0237, BIBEAA0239, BIBEAA0240, BIBEAA0241, BIBEAA0242, BIBEAA0243, BIBEAA0244, BIBEAA0245, BIBEAA0308, BIBEAA0323, BIBEAA0325.

Most frequent plant taxa recorded in High Chisos Oak – Pine Forest are shown in Table D-16.

**Table D-16.** Synthesis table for the most frequent plant taxa recorded in High Chisos Oak – Pine Forest at Big Bend National Park (# plots=8).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus gravesii</i>	Tree / Shrub	100.0%	50.2	10–80
<i>Quercus grisea</i>	Tree / Shrub	87.5%	14.3	0–76
<i>Pinus cembroides</i>	Tree / Shrub	75.0%	7.9	0–27
<i>Pinus arizonica</i> var. <i>stormiae</i>	Tree / Shrub	37.5%	9.7	0–55
<i>Quercus emoryi</i>	Tree	12.5%	0.4	0–5
<i>Opuntia chisosensis</i>	Shrub	100.0%	0.4	trace–1
<i>Salvia regla</i>	Shrub	87.5%	3.4	0–26
<i>Agave havardiana</i>	Shrub	87.5%	0.3	0–1
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	75.0%	8.8	0–77
<i>Arbutus xalapensis</i>	Shrub / Tree	75.0%	6.6	0–25
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	75.0%	0.2	0–1
<i>Juniperus flaccida</i>	Shrub / Tree	62.5%	1.8	0–12
<i>Nolina erumpens</i>	Shrub	62.5%	1.1	0–6
<i>Juniperus deppeana</i>	Shrub / Tree	50.0%	2.7	0–23
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	25.0%	0.6	0–5
<i>Prunus serotina</i> var. <i>virens</i>	Shrub	25.0%	0.5	0–5

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Acer grandidentatum</i>	Shrub	12.5%	1.1	0–12
<i>Symphoricarpos palmeri</i>	Shrub	12.5%	0.4	0–5
<i>Lonicera albiflora</i>	Vine	50.0%	0.3	0–2
<i>Vitis arizonica</i>	Vine	12.5%	0.2	0–3
<i>Clematis pitcheri</i>	Vine	12.5%	0.1	0–1
<i>Piptochaetium fimbriatum</i>	Herb	62.5%	1.2	0–10
<i>Packera millelobata</i>	Herb	62.5%	0.4	0–2
<i>Tradescantia brevifolia</i>	Herb	50.0%	0.3	0–1
<i>Conopholis alpina</i> var. <i>mexicana</i>	Herb	37.5%	0.2	0–1
<i>Ageratina herbacea</i>	Herb	25.0%	0.1	0–1
<i>Commelina dianthifolia</i>	Herb	25.0%	0.1	0–1
<i>Hedeoma plicata</i>	Herb	25.0%	0.1	0–1
<i>Muhlenbergia emersleyi</i>	Herb	25.0%	0.1	0–1
<i>Muhlenbergia glauca</i>	Herb	25.0%	0.1	0–1
<i>Salvia lycioides</i>	Herb	25.0%	0.1	0–1
<i>Verbesina oreophila</i>	Herb	25.0%	0.1	0–1
<i>Brickellia brachyphylla</i>	Herb	12.5%	0.4	0–5
<i>Ageratina rothrockii</i>	Herb	12.5%	0.2	0–2
<i>Festuca ligulata</i>	Herb	12.5%	0.2	0–2
<i>Phoradendron tomentosum</i>	Epiphyte	37.5%	0.5	0–5
<i>Phoradendron juniperinum</i>	Epiphyte	12.5%	0.4	0–5





Photo 15. High Chisos Oak – Pine Forest, northwest side of Emory Peak (BIBEAA0221). Photo by Jeff Renfrow.



Photo 16. High Chisos Oak – Pine Forest, along Colima Trail (BIBEAA0235). Photo by Rebecca Evans.



### **Arizona Cypress – Graves' Oak – Pinyon Pine Forest**

#### Local Type Concept:

Mesic forests in montane canyons dominated in an upper tree stratum by *Hesperocyparis arizonica* (= *Cupressus arizonica*) (Arizona cypress) and in a lower tree stratum by Graves' oak (*Quercus gravesii*).

#### Vegetation:

The species composition is fairly similar to that of the High Chisos Oak – Pine Forest. The only apparent difference between the two associations is the presence and abundance of *Hesperocyparis arizonica* (Arizona cypress) in the tree stratum, often as a higher substratum above most of the other tree species. *Quercus gravesii* (Graves' oak) and *Pinus cembroides* (Mexican pinyon) are also highly constant, one or both usually co-dominate with *H. arizonica*. Understory, usually lower cover, tree species or tall shrub include *Quercus grisea* (gray oak), *Arbutus xalapensis* (Texas madrone), *Juniperus flaccida* (weeping juniper), and/or *Juniperus deppeana* (alligator juniper). Relatively constant shorter shrubs include *Salvia regla* (mountain sage), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and *Salvia lycioides* (canyon sage). As with the High Chisos Oak – Pine Forest, the herbaceous stratum seldom achieves high cover, except in stands in which *H. arizonica* mortality has decreased shade. *Piptochaetium fimbriatum* (pinyon ricegrass) is the most constant species and the only one that achieves relatively high cover. Other herbaceous stratum species of moderately high constancy include *Packera millelobata* (Uinta ragwort), *Cheilanthes eatonii* (Eaton's lipfern), *Muhlenbergia glauca* (desert muhly), *Asplenium resiliens* (blackstem spleenwort), *Ageratina herbacea* (fragrant snakeroot), and *Galium mexicanum* ssp. *flexicum* (Mexican bedstraw).

In what was perhaps the largest stand of this association at BIBE, in upper Juniper Canyon, many large *Hesperocyparis arizonica* (Arizona cypress) trees died between 2011 and 2017 (when the map accuracy assessment was conducted), evidently because of the severe drought of 2010–2011. Throughout much of this stand, *H. arizonica* persists mostly as understory trees and saplings and might be expected to dominate stands eventually. Therefore, the concept of this association was modified to allow as little as 15% total cover by *H. arizonica*, regardless of height, to define this type. Mesic forest stands that have less *H. arizonica* present at lower cover within the elevation range of *H. arizonica* in the Chisos Mountains should be considered to be either the High Chisos Oak – Pine Forest, the Dry-Mesic Pinyon Pine – Oak – Juniper Forest, or the Graves' Oak – Bigtooth Maple Forest. Stratum and substrate cover for Arizona Cypress – Graves' Oak – Pinyon Pine Forest are shown in Table D-17.

**Table D-17.** Stratum and substrate cover recorded for Arizona Cypress – Graves' Oak – Pinyon Pine Forest at Big Bend National Park (# plots=11).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	68	30–100
	Tall Shrub	12	2–30
	Short Shrub	5	0–12
	Herb	8	0–40
Substrate	Bedrock	4	0–20
	Large/Small Rocks	33	6–65
	Litter/Duff	43	13–67

Environment:

The Arizona Cypress – Graves' Oak – Pinyon Pine Forest apparently is restricted to Boot Canyon and near the head of Juniper Canyon in the Chisos Mountains from 6,600 feet to 7,400 feet. It occurs usually on canyon bottoms or on steep, north to east facing slopes.

USNVC Translation:

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Warm Temperate Forest & Woodland Formation (1.B.1)

USNVC Division: Madrean – Balconian Forest & Woodland Division (D060)

USNVC Macrogroup: Madrean Montane Forest & Woodland Macrogroup (M011)

USNVC Group: Madrean Lower Montane Pine – Oak Forest & Woodland Group (G203)

USNVC Alliance: *Cupressus arizonica* Forest & Woodland Alliance (A0163)

USNVC Association: *Hesperocyparis arizonica* / *Quercus gravesii* – *Pinus cembroides* / *Piptochaetium fimbriatum* Forest Association (NPSBIBE002)

Comments:

This association is marginally different from the other mesic forest types of the High Chisos Mountains: the High Chisos Oak – Pine Forest, the Dry-Mesic Pinyon Pine – Oak – Juniper Forest, and the Graves' Oak – Bigtooth Maple Forest. Interest in *Hesperocyparis arizonica* aside, it might be considered a variant of one of those types with abundant *H. arizonica*.

Within Texas, *Hesperocyparis arizonica* is restricted to the high Chisos Mountains (Powell 1998). As defined here, this association is almost certainly limited to the Chisos Mountains within the United States, but may occur in Mexico.

BIBE Classification Plots Included in Concept:

BIBE0039, BIBE0262, BIBE0273, BIBE0275, BIBE0291, BIBE0292, BIBE0293, BIBE0313, BIBE0375, BIBE0376, BIBE0380.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0143, BIBEAA0144, BIBEAA0147, BIBEAA0148, BIBEAA0149, BIBEAA0150, BIBEAA0151.

Most frequent plant taxa recorded in Arizona Cypress – Graves’ Oak – Pinyon Pine Forest are shown in Table D-18.

**Table D-18.** Synthesis table for all plant taxa recorded in Arizona Cypress – Graves’ Oak – Pinyon Pine Forest at Big Bend National Park (# plots=11).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Hesperocyparis arizonica</i>	Tree / Shrub	100.0%	46.9	25–85
<i>Quercus gravesii</i>	Tree / Shrub	81.8%	25.8	0–100
<i>Pinus cembroides</i>	Tree / Shrub	81.8%	8.9	0–32
<i>Juniperus flaccida</i>	Tree / Shrub	72.7%	3.3	0–25
<i>Acer grandidentatum</i>	Tree	9.1%	0.7	0–10
<i>Quercus robusta</i>	Tree	9.1%	0.5	0–7
<i>Salvia regla</i>	Shrub	90.9%	1.2	0–5
<i>Quercus grisea</i>	Shrub / Tree	81.8%	7.4	0–26
<i>Nolina erumpens</i>	Shrub	81.8%	0.3	0–2
<i>Juniperus deppeana</i>	Shrub / Tree	63.6%	2.4	0–11
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	63.6%	0.5	0–3
<i>Arbutus xalapensis</i>	Shrub / Tree	54.5%	2.4	0–32
<i>Salvia lycioides</i>	Shrub	45.5%	0.2	0–1
<i>Agave havardiana</i>	Shrub	36.4%	0.2	0–1
<i>Opuntia chisosensis</i>	Shrub	36.4%	0.2	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	36.4%	0.1	0–1
<i>Cercocarpus montanus</i>	Shrub	36.4%	0.1	0–2
<i>Pseudotsuga menziesii</i>	Shrub	18.2%	0.1	0–2
<i>Bouvardia ternifolia</i>	Shrub	18.2%	0.1	0–1
<i>Fendlera rupicola</i>	Shrub	18.2%	0.1	0–1
<i>Forestiera pubescens</i>	Shrub	9.1%	0.3	0–4
<i>Lonicera albiflora</i>	Vine	9.1%	0.1	0–1
<i>Phoradendron juniperinum</i>	Epiphyte	9.1%	0.1	0–1
<i>Piptochaetium fimbriatum</i>	Herb	90.9%	11.2	0–75
<i>Cheilanthes eatonii</i>	Herb	72.7%	0.4	0–1
<i>Muhlenbergia glauca</i>	Herb	54.5%	0.5	0–2
<i>Asplenium resiliens</i>	Herb	45.5%	0.2	0–1
<i>Muhlenbergia emersleyi</i>	Herb	36.4%	0.4	0–5
<i>Oxalis drummondii</i>	Herb	36.4%	0.2	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Pellaea atropurpurea</i>	Herb	36.4%	0.2	0–1
<i>Verbesina oreophila</i>	Herb	36.4%	0.2	0–1
<i>Pellaea</i> sp.	Herb	36.4%	0.1	0–1
<i>Cheilanthes villosa</i>	Herb	27.3%	0.1	0–1
<i>Packera millelobata</i>	Herb	18.2%	0.2	0–2
<i>Acourtia wrightii</i>	Herb	18.2%	0.1	0–1
<i>Artemisia ludoviciana</i>	Herb	18.2%	0.1	0–1
<i>Phaseolus angustissimus</i>	Herb	18.2%	0.1	0–1
<i>Selaginella peruviana</i>	Herb	18.2%	0.1	0–1
<i>Ageratina rothrockii</i>	Herb	9.1%	0.3	0–5
<i>Panicum bulbosum</i>	Herb	9.1%	0.3	0–5
<i>Poa strictiramea</i>	Herb	9.1%	0.3	0–5
<i>Ageratina herbacea</i>	Herb	9.1%	0.1	0–2
<i>Linum schiedeanum</i>	Herb	9.1%	0.1	0–2
<i>Muhlenbergia rigida</i>	Herb	9.1%	0.1	0–2
<i>Salvia arizonica</i>	Herb	9.1%	0.1	0–2



Photo 17. Arizona Cypress – Graves' Oak – Pinyon Pine Forest, Juniper Canyon below Townsend Point, showing some cypress mortality (BIBEAA0144). Photo by Rebecca Evans.





Photo 18. Arizona Cypress – Graves' Oak – Pinyon Pine Forest, Juniper Canyon below Townsend Point (BIBEAA0150). Photo by Rebecca Evans.

## Coahuila Scrub Oak Chaparral

### Local Type Concept:

Shrublands with *Quercus intricata* (Coahuila scrub oak) constant and dominant.

### Vegetation:

*Quercus intricata* (Coahuila scrub oak) is consistently dominant in a very dense to somewhat open shrub stratum. It forms a highly distinctive assemblage along with *Ceanothus greggii* (desert ceanothus), *Cercocarpus montanus* (alderleaf mountain mahogany), *Agave havardiana* (Havard's century plant), *Dasyllirion leiophyllum* (green sotol), *Chrysactinia mexicana* (damianita), *Nolina erumpens* (foothill beargrass), *Rhus trilobata* var. *pilosissima* (skunkbush), and *Rhus virens* (evergreen sumac), each of which is highly to moderately constant and may provide substantial cover. In this vegetation, *D. leiophyllum* is anomalously frequent for this relatively high elevation setting. *Juniperus deppeana* (alligator juniper), *Pinus cembroides* (Mexican pinyon), and/or *Juniperus flaccida* (weeping juniper) may occur as lower cover short trees or tall shrubs often emergent from the oak canopy.

A grassy herb stratum occurs, and its cover varies inversely with the closure of the shrub canopy. The most numerous species include *Bouteloua curtipendula* (sideoats grama), *Muhlenbergia emersleyi* (bull muhly), *Schizachyrium scoparium* (little bluestem), and/or *Bouteloua gracilis* (blue grama). *Eriogonum hemipterum* (Chisos Mountain buckwheat), known only from the Chisos Mountains within Texas and the United States (Powell and Worthington 2018), appears to be a somewhat characteristic low cover forb. Stratum and substrate cover for Coahuila Scrub Oak Chaparral are shown in Table D-19.

**Table D-19.** Stratum and substrate cover recorded for Coahuila Scrub Oak Chaparral at Big Bend National Park (# plots=5).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	5	0–15
	Short Shrub	55	30–85
	Herb	15	5–30
Substrate	Bedrock	4	0–15
	Large/Small Rocks	29	6–50
	Litter/Duff	50	30–74

### Environment:

Four stands sampled are in a fairly limited area in the high Chisos Mountains in the Laguna Meadows area and in the headwaters of Cattail Canyon. They range from about 6500 to 6800 feet in elevation and are generally associated with areas mapped as the Boquillas Formation (limestone), which are limited in extent in the high Chisos.

USNVC Translation:

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland Subclass (2.B)

USNVC Formation: Temperate Grassland & Shrubland Formation (2.B.2)

USNVC Division: Western North American Interior Chaparral Division (D061)

USNVC Macrogroup: Warm Interior Chaparral Macrogroup (M091)

USNVC Group: Eastern Madrean Chaparral Group (G280)

USNVC Alliance: *Quercus pungens* – *Quercus intricata* – *Quercus vaseyana* Chaparral Alliance (A3971)

USNVC Association: *Quercus intricata* – *Dasyllirion leiophyllum* Shrubland Association (CEGL004530)

Comments:

The USNVC (2017) *Quercus intricata* / *Dasyllirion leiophyllum* Shrubland, recognized from limestone in the Chisos Mountains, apparently was described from this vegetation. Although of very limited distribution within the United States, *Quercus intricata* (Coahuila scrub oak) is apparently a common chaparral dominant in Coahuila in Mexico (Powell 1998).

BIBE Classification Plots Included in Concept:

BIBE0049, BIBE0312, BIBE0314, BIBE0316, BIBE0317

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0908, BIBEAA0909, BIBEAA0910, BIBEAA0911, BIBEAA0912, BIBEAA0913, BIBEAA0914, BIBEAA0915, BIBEAA0916, BIBEAA0917

Most frequent plant taxa recorded in Coahuila Scrub Oak Chaparral are shown in Table D-20.

**Table D-20.** Synthesis table for all plant taxa recorded in Coahuila Scrub Oak Chaparral at Big Bend National Park (# plots=5).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus intricata</i>	Shrub	100.0%	28.8	6–85
<i>Juniperus deppeana</i>	Shrub / Tree	100.0%	2.4	trace to 11
<i>Nolina erumpens</i>	Shrub	100.0%	2.3	1–5
<i>Agave havardiana</i>	Shrub	100.0%	1.0	few–3
<i>Ceanothus greggii</i>	Shrub	80.0%	13.5	0–53
<i>Dasyllirion leiophyllum</i>	Shrub	80.0%	2.3	0–6
<i>Chrysactinia mexicana</i>	Shrub	60.0%	2.9	0–10
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	60.0%	1.1	0–5
<i>Cercocarpus montanus</i>	Shrub	60.0%	0.7	0–2
<i>Opuntia chisosensis</i>	Shrub	60.0%	0.6	0–2
<i>Rhus virens</i>	Shrub	60.0%	0.2	0–1



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	60.0%	0.2	0–1
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	40.0%	1.0	0–7
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	40.0%	0.1	0–1
<i>Schizachyrium scoparium</i>	Herb	60.0%	3.7	0–25
<i>Muhlenbergia emersleyi</i>	Herb	60.0%	0.9	0–5
<i>Bouteloua curtipendula</i>	Herb	60.0%	0.5	0–2
<i>Bouteloua gracilis</i>	Herb	40.0%	0.8	0–5
<i>Piptochaetium fimbriatum</i>	Herb	40.0%	0.8	0–5
<i>Muhlenbergia glauca</i>	Herb	40.0%	0.4	0–2
<i>Helianthus ciliaris</i>	Herb	40.0%	0.2	0–1



Photo 19. Coahuila Shrub Oak Chaparral, Laguna Meadows (BIBEAA0908). Photo by Rebecca Evans.



Photo 20. Coahuila Shrub Oak Chaparral (foreground), Laguna Meadows (BIBEAA0912). Dry Pinyon Pine Woodland is in background. Photo by Rebecca Evans.

## **High Chisos Gray Oak – Mountain Mahogany Chaparral**

### Local Type Concept:

Tall shrublands at higher elevations of the Chisos Mountains, with *Quercus grisea* (gray oak) and, often, *Cercocarpus montanus* (alderleaf mountain mahogany) dominant.

### Vegetation:

*Quercus grisea* (gray oak) and/or *Cercocarpus montanus* (alderleaf mountain mahogany) are strongly dominant in a tall, fairly dense shrub (occasionally short tree) stratum. Relatively constant low cover shrubs include *Nolina erumpens* (foothill beargrass), *Opuntia chisosensis* (Chisos Mountain prickly pear), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), *Gymnosperma glutinosum* (gumhead), and *Rhus trilobata* var. *pilosissima* (skunkbush sumac). The herbaceous stratum is somewhat sparse, due to shading by tall shrubs to locally dense in canopy gaps. It is comprised of species both of open grasslands and of more closed canopy forests. *Muhlenbergia emersleyi* (bull muhly), *Bouteloua curtipendula* (sideoats grama), *Piptochaetium fimbriatum* (pinyon ricegrass), and *Cheilanthes bonariensis* (golden lip fern) are the most abundant species. Stratum and substrate cover for High Chisos Gray Oak – Mountain Mahogany Chaparral are shown in Table D-21.

**Table D-21.** Stratum and substrate cover recorded for in High Chisos Gray Oak – Mountain Mahogany Chaparral at Big Bend National Park (# plots=2).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	10	0–20
	Tall Shrub	35	30–40
	Short Shrub	19	10–20
	Herb	25	20–30
Substrate	Bedrock	0	0–0
	Large/Small Rocks	63	60–65
	Litter/Duff	17	13–20

### Environment:

This association appears sporadically and somewhat unpredictably in relatively small patches in the Chisos Mountains, mostly above 6,600 feet in elevation. One stand was encountered in Green Gulch at about 5,200 feet. Compared to the Montane Mixed Chaparral, it appears to occupy somewhat higher and/or more mesic settings and is much more limited in extent.

### USNVC Translation:

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland Subclass (2.B)

USNVC Formation: Temperate Grassland & Shrubland Formation (2.B.2)

USNVC Division: Western North American Interior Chaparral Division (D061)



USNVC Macrogroup: Warm Interior Chaparral Macrogroup (M091)

USNVC Group: Eastern Madrean Chaparral Group (G280)

USNVC Alliance: *Quercus pungens* – *Quercus intricata* – *Quercus vaseyana* Chaparral Alliance (A3971)

NPS Association: *Quercus grisea* – *Cercocarpus montanus* Shrubland Association (NPSBIBE022)

Comments:

This association was recognized tentatively during the classification phase and was based on only two plots, one of which appeared to be somewhat intergrading with the Dry Pinyon Pine Woodland, and it was speculated that the type might be a variant of that woodland with unusually high *Quercus grisea* cover. Subsequently, it was found in several locations during the map accuracy assessment, and these new locations had vegetation that seems reasonably distinct. Typical stands have high cover of *Cercocarpus montanus*, along with shrubby *Quercus grisea*, few true trees, and a fairly continuous and dense shrub cover. They have a distinctly chaparral, rather than woodland, character. The environmental differences between the Gray Oak – Mountain Mahogany Chaparral and the much more widespread Montane Mixed Chaparral, which is shorter-statured and has more mixed species dominance, are unclear, but the latter may tend to occur at higher elevations, in more mesic settings, or have other substrate factors.

The USNVC associations *Quercus grisea* / *Cercocarpus montanus* Woodland Association (CEGL00690) and the *Quercus grisea* / *Rhus trilobata* var. *pilosissima* Woodland Association (CEGL00691) both have nominal species present in plots at BIBE, but there is no described information for these on in USNVC (2017). Based on the woodland physiognomy and their placement in Group 201 (Madrean Encinal), these USNVC associations would seem to be a poor ecological fit for the BIBE settings.

BIBE Classification Plots Included in Concept:

BIBE0315, BIBE0372.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0337, BIBEAA0824, BIBEAA0825.

Most frequent plant taxa recorded in High Chisos Gray Oak – Mountain Mahogany Chaparral are shown in Table D-22.

**Table D-22.** Synthesis table for all plant taxa recorded in High Chisos Gray Oak – Mountain Mahogany Chaparral at Big Bend National Park (# plots=2).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Quercus grisea</i>	Shrub	100.0%	38.3	25–53
<i>Juniperus flaccida</i>	Shrub / Tree	100.0%	9.6	few–28
<i>Pinus cembroides</i>	Shrub	100.0%	5.2	1–12
<i>Nolina erumpens</i>	Shrub	100.0%	2.5	1–5
<i>Chrysactinia mexicana</i>	Shrub	100.0%	1.8	trace–5
<i>Cercocarpus montanus</i>	Shrub	100.0%	1.2	few–2
<i>Gutierrezia</i> sp.	Shrub	100.0%	0.5	few–1
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	100.0%	0.3	trace–1
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	100.0%	0.3	trace–1
<i>Quercus gravesii</i>	Shrub	50.0%	10.3	0–30
<i>Juniperus deppeana</i>	Shrub / Tree	50.0%	2.0	0–6
<i>Salvia regla</i>	Shrub	50.0%	1.0	0–3
<i>Mimosa emoryana</i>	Shrub	50.0%	0.8	0–2
<i>Bouvardia ternifolia</i>	Shrub	50.0%	0.5	0–3
<i>Forestiera pubescens</i>	Shrub	50.0%	0.5	0–2
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	50.0%	0.3	0–1
<i>Agave havardiana</i>	Shrub	50.0%	0.3	0–1
<i>Dasyllirion leiophyllum</i>	Shrub	50.0%	0.3	0–1
<i>Opuntia chisosensis</i>	Shrub	50.0%	0.3	0–1
<i>Viguiera stenoloba</i>	Shrub	50.0%	0.3	0–1
<i>Brickellia laciniata</i>	Shrub	50.0%	0.3	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	50.0%	0.1	0–trace
<i>Prunus serotina</i> var. <i>virens</i>	Shrub	50.0%	0.1	0–trace
<i>Muhlenbergia emersleyi</i>	Herb	100.0%	10.5	2–25
<i>Piptochaetium fimbriatum</i>	Herb	100.0%	4.5	1–10
<i>Cheilanthes bonariensis</i>	Herb	100.0%	0.5	few–1
<i>Blepharoneuron tricholepis</i>	Herb	50.0%	1.8	0–5
<i>Bouteloua curtipendula</i>	Herb	50.0%	1.8	0–5
<i>Ageratina herbacea</i>	Herb	50.0%	0.3	0–1
<i>Artemisia ludoviciana</i>	Herb	50.0%	0.5	0–1
<i>Cheilanthes eatonii</i>	Herb	50.0%	0.3	0–1
<i>Cheilanthes villosa</i>	Herb	50.0%	0.5	0–1
<i>Muhlenbergia glauca</i>	Herb	50.0%	0.3	0–1
<i>Nassella tenuissima</i>	Herb	50.0%	0.3	0–1
<i>Packera millelobata</i>	Herb	50.0%	0.3	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Salvia lycioides</i>	Herb	50.0%	0.3	0–1
<i>Tragia amblyodonta</i>	Herb	50.0%	0.3	0–1
<i>Phoradendron juniperinum</i>	Epiphyte	50.0%	0.3	0–1



Photo 21. High Chisos Gray Oak – Mountain Mahogany Chaparral, Green Gulch, north side of Lost Mine Peak (BIBEAA0337). Photo by Kelsey Wogan.



Photo 22. High Chisos Gray Oak – Mountain Mahogany Chaparral, upper Blue Creek drainage below Southwest Rim (BIBEAA0825). Photo by Rebecca Evans.



## **Calcareous Chaparral**

### Local Type Concept:

Somewhat dense, mostly sclerophyllous shrublands on calcareous substrates, primarily from 4,800 to 5,900 feet in elevation. It is the calcareous substrates analog to the Montane Mixed Chaparral of igneous substrates.

### Vegetation:

Calcareous Chaparral consists of moderately open to fairly dense stands of shrubs, usually from 1.5 to 3 meters tall. *Quercus pungens* (sandpaper oak), *Fraxinus greggii* (littleleaf ash), and *Rhus virens* (evergreen sumac) usually comprise much to most of the shrub stratum cover. *Quercus mohriana* (Mohr's shin oak) often is present, sometimes along with apparent hybrids with *Quercus grisea* (grey oak). While *Q. pungens* and *F. greggii* also occur in the analogous non-calcareous Montane Mixed Chaparral of igneous substrates, their relative abundance in the Calcareous Chaparral is diagnostic, as is the presence of *Q. mohriana*. In the Dead Horse stands, tall (up to 4 meters), scattered individuals of *Yucca faxoniana* (giant dagger) and, less frequently, *Yucca thompsoniana* (Thompson's yucca), often emergent from the main shrub stratum, are characteristic. Other frequent, but low cover, shrub species include *Dasyllirion leiophyllum* (green sotol), *Nolina erumpens* (foothill beargrass), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), and *Gymnosperma glutinosum* (gumhead). Less constant shrub species include *Ceanothus greggii* (desert ceanothus), *Viguiera stenoloba* (skeletonleaf goldeneye), *Cercocarpus montanus* (alderleaf mountain mahogany), *Juniperus pinchotii* (Pinchot juniper), *Dalea formosa* (featherplume), *Agave lechuguilla* (lechuguilla), *Ephedra aspera* (rough jointfir), *Argythamnia serrata* (Yuma silverbush), *Opuntia camanchica* (Comanche pricklypear), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Malacomeles denticulata* (toothed serviceberry), *Lonicera albiflora* (western white honeysuckle), and *Prunus havardii* (Havard's plum). Fenstermacher (2007) also reported *Juniperus coahuilensis* (redberry juniper), *Fendlera rupicola* var. *falcata* (cliff fendlerbush), *Mahonia trifoliolata* (agarita), and *Ptelea trifoliata* (hoptree) from this vegetation in the Dead Horse Mountains.

The herbaceous stratum is moderate (more the case for Chisos Basin stands) too sparse (as is often the case in the Dead Horse Mountains). *Tridens muticus* (slim tridens), *Bouteloua curtipendula* (sideoats grama), and *Cheilanthes* spp. (lip ferns) are the most constant species; Fenstermacher (2007) reported *Muhlenbergia parviglumis* (longawn muhly) from Dead Horse Mountain stands. In the Chisos Basin stands, *Argyrochosma microphylla* (small-leaf false cloak fern) is a characteristic low cover species. *Nissolia platycalyx* (broadsepal yellowhood), known from the United States only in the area of the Chisos Basin area, was seen in this vegetation during the map accuracy assessment (Michael Eason, pers. comm.). Stratum and substrate cover for Calcareous Chaparral are shown in Table D-23.

During the classification sampling, stands of this vegetation in the Chisos Basin were recorded by a single plot, and the Dead Horse stands were not visited, due to access challenges. The description is augmented by six Chisos Basin and eight Dead Horse Mountains (Sue Peaks) observations during the mapping accuracy assessment and by Fenstermacher's (2007) generally concurring account of her Chaparral vegetation type in the Dead Horse Mountains.

**Table D-23.** Stratum and substrate cover recorded for in High Chisos Gray Oak – Mountain Mahogany Chaparral at Big Bend National Park (# plots=1).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	20	20–20
	Short Shrub	43	43–43
	Herb	30	30–30
Substrate	Bedrock	20	20–20
	Large/Small Rocks	72	72–72
	Litter/Duff	5	5–5

Environment:

At Big Bend National Park, this vegetation occurs at higher elevations in the Dead Horse Mountains and locally in the Chisos Mountains on small areas of limestone outcrops in the Chisos Basin.

In the Dead Horse Mountains, stands were observed from about 4,800 to 5,900 feet on areas mapped as Santa Elena Limestone. In the Dead Horse Mountains, the association is restricted to the most mesic sites of the higher elevations, where it is sympatric with the Yucca – Sotol Calcareous Shrub Grassland. An exceptionally extensive stand occurs on the very steep (60–100%) northeastern slope of the Sue Peaks, and much smaller linear stands along drainage bottoms within a matrix of the Yucca – Sotol Calcareous Shrub Grassland in other settings of the higher Dead Horse Mountains.

In the Chisos Basin, stands were found from 4,900 feet to 5,700 feet on sites mapped as or observed to consist of Boquillas Formation (limestone). In the Basin, this association intergrades with the much more abundant Montane Mixed Chaparral, which is characteristic of the igneous (volcanic) matrix around the isolated limestone outcrops.

USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland Subclass (2.B)

USNVC Formation: Temperate Grassland & Shrubland Formation (2.B.2)

USNVC Division: Western North American Interior Chaparral Division (D061)

USNVC Macrogroup: Warm Interior Chaparral Macrogroup (M091)

USNVC Group: Eastern Madrean Chaparral Group (G280)

USNVC Alliance: *Quercus pungens* – *Quercus intricata* – *Quercus vaseyana* Chaparral Alliance (A3971)

NPS Association: *Quercus* (*pungens*, *mohriana*) – *Fraxinus greggii* – *Rhus virens* – (*Yucca faxoniana*) Shrubland Association (NPSBIBE009)

Comments:

The Chisos Basin and Dead Horse Mountains (Sue Peaks) stands differ from each other, with the Chisos Basin stands compositionally and geographically intergrading more with the Montane Mixed

Chaparral and the Dead Horse Mountains somewhat similar to the Yucca – Sotol Calcareous Shrub Grassland. More classification plot data, with more detailed accounting of minor species, from both the Chisos Basin and Dead Horse Mountains would help to elucidate whether more than one association is involved, but stands from the two disparate locations seem grossly similar enough to consider a single association at present.

BIBE Classification Plots Included in Concept:  
BIBE0026.

BIBE Accuracy Assessment Sites Included in Concept:  
BIBEAA0606, BIBEAA0607, BIBEAA0608, BIBEAA0609, BIBEAA0610, BIBEAA0612, BIBEAA0613, BIBEAA0614, BIBEAA0615, BIBEAA0617, BIBEAA0622, BIBEAA0624, BIBEAA0634, BIBEAA0840.

Most frequent plant taxa recorded in Calcareous Chaparral are shown in Table D-24.

**Table D-24.** Synthesis table for the most frequent plant taxa recorded in Calcareous Chaparral at Big Bend National Park (# plots=1).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Agave lechuguilla</i>	Shrub	100.0%	17.5	10–25
<i>Fraxinus greggii</i>	Shrub	100.0%	17.5	10–25
<i>Glossopetalon spinescens</i>	Shrub	100.0%	7.5	5–10
<i>Chrysactinia mexicana</i>	Shrub	100.0%	7.5	5–10
<i>Dasyliroium leiophyllum</i>	Shrub	100.0%	7.5	5–10
<i>Dalea formosa</i>	Shrub	100.0%	1.5	1–2
<i>Ephedra aspera</i>	Shrub	100.0%	1.5	1–2
<i>Forestiera angustifolia</i>	Shrub	100.0%	1.5	1–2
<i>Leucophyllum minus</i>	Shrub	100.0%	1.5	1–2
<i>Senegalia roemeriana</i>	Shrub	100.0%	0.5	few–1
<i>Koeberlinia spinosa</i>	Shrub	100.0%	0.5	few–1
<i>Krameria erecta</i>	Shrub	100.0%	0.5	few–1
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	100.0%	0.5	few–1
<i>Bernardia obovata</i>	Shrub	100.0%	0.5	few–1
<i>Echinocactus horizonthalonius</i>	Shrub	100.0%	0.5	few–1
<i>Echinocereus stramineus</i>	Shrub	100.0%	0.5	few–1
<i>Epithelantha micromeris</i>	Shrub	100.0%	0.5	few–1
<i>Hedyotis intricata</i>	Shrub	100.0%	0.5	few–1
<i>Jefea brevifolia</i>	Shrub	100.0%	0.5	few–1
<i>Ruellia parryi</i>	Shrub	100.0%	0.5	few–1
<i>Cynanchum barbigerum</i>	Vine	100.0%	1.5	1–2

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Cuscuta indecora</i>	Vine	100.0%	0.5	few–1
<i>Aristida purpurea</i>	Herb	100.0%	7.5	5–10
<i>Bouteloua ramosa</i>	Herb	100.0%	7.5	5–10
<i>Mandevilla macrosiphon</i>	Herb	100.0%	3.5	2–5
<i>Menodora scabra</i>	Herb	100.0%	1.5	1–2
<i>Polygala macradenia</i>	Herb	100.0%	1.5	1–2
<i>Astrolepis cochisensis</i>	Herb	100.0%	0.5	few–1
<i>Bouteloua curtipendula</i>	Herb	100.0%	0.5	few–1
<i>Chamaesyce cinerascens</i>	Herb	100.0%	0.5	few–1
<i>Houstonia acerosa</i>	Herb	100.0%	0.5	few–1
<i>Linum australe</i>	Herb	100.0%	0.5	few–1
<i>Tetraneuris scaposa</i>	Herb	100.0%	0.5	few–1



Photo 23. Calcareous Chaparral, Chisos Basin (Boquillas Formation) variant, Chisos Basin (BIBEAA0608). Photo by Kelon Crawford.





Photo 24. Calcareous Chaparral, Dead Horse (Santa Elena Formation) variant, northeast side of Sue Peaks, Dead Horse Mountains (BIIBEAA0617). Photo by Kelsey Wogan.

## ***Montane Mixed Chaparral***

### Local Type Concept:

Relatively open to dense shrublands (chaparral), generally with a significant tall shrub stratum, occurring at middle elevations of the Chisos Mountains. *Rhus virens* (evergreen sumac) is the most abundant and perhaps the most characteristic shrub species.

### Vegetation:

The shrub composition is variable and fairly diverse. *Rhus virens* (evergreen sumac) is perhaps the most characteristic species, contributing the highest cover across all plots and being among the most constant species. Other species, in somewhat decreasing order of constancy are: *Viguiera stenoloba* (skeletonleaf goldeneye), *Nolina erumpens* (foothill beargrass), *Quercus grisea* (gray oak), *Fraxinus greggii* (littleleaf ash), *Cercocarpus montanus* (alderleaf mountain mahogany), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Agave lechuguilla* (lechuguilla), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Gymnosperma glutinosum* (gumhead), *Agave havardiana* (Havard's century plant), *Prunus havardii* (Havard's plum), *Dasyllirion leiophyllum* (green sotol), *Mimosa aculeaticarpa* var. *biuncifera* (catclaw mimosa), and *Bouvardia ternifolia* (firecrackerbush). Several species of oaks in shrub form (*Quercus gravesii*, *Quercus emoryi*, and/or *Quercus pungens*) are less constant, but may contribute locally high (patchy) cover. The herbaceous stratum has low to moderate cover and is dominated by grasses, such as *Muhlenbergia emersleyi* (bull muhly), *Bouteloua curtipendula* (sideoats grama), *Leptochloa dubia* (sprangletop), *Bothriochloa barbinodis* (cane bluestem), and others. Ferns (e.g., *Cheilanthes* spp. (lip ferns), *Astrolepis* spp. (cloak ferns), *Notholaena standleyi* (star cloak fern), and *Bommeria hispida* (copper fern)) are frequent. Stratum and substrate cover for Montane Mixed Chaparral are shown in Table D-25.

**Table D-25.** Stratum and substrate cover recorded for Montane Mixed Chaparral at Big Bend National Park (# plots=9).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	4	0–30
	Tall Shrub	13	0–40
	Short Shrub	45	30–90
	Herb	12	3–35
Substrate	Bedrock	4	0–30
	Large/Small Rocks	47	1–100
	Litter/Duff	30	0–82

### Environment:

Sites are almost invariably on slopes, usually moderately steep to steep, throughout the Chisos Mountains, where this vegetation is common. Solar exposure of sites is probably greater than that incurred by woodlands. Specific locations are along the lower slopes of Lost Mine Peak, Mount

Huffman, and Casa Grande Peak. Elevations range from 4,600 to 6,800 feet, with one anomalously low stand at 4,200 feet.

USNVC Translation:

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland Subclass (2.B)

USNVC Formation: Temperate Grassland & Shrubland Formation (2.B.2)

USNVC Division: Western North American Interior Chaparral Division (D061)

USNVC Macrogroup: Warm Interior Chaparral Macrogroup (M091)

USNVC Group: Eastern Madrean Chaparral Group (G280)

USNVC Alliance: *Sophora secundiflora* – *Vachellia roemeriana* – *Cercocarpus montanus* Chaparral Alliance (A3972)

NPS Association: *Rhus virens* – *Quercus* spp. / *Viguiera stenoloba* – *Nolina erumpens* Shrubland Association (NPSBIBE005)

Comments:

Foothill and montane (*i.e.*, those occurring usually above 4,600 feet in elevation) shrublands in the Chisos Mountains appear to best assigned within the USNVC to the Madrean Oriental Chaparral Group (of the Western North American Interior Sclerophyllous Chaparral Shrubland Division). These shrublands are often more open than some definitions of chaparral (*e.g.*, those depicting closed canopy shrublands); this may be because of relatively shallow, rocky soils. They may differ from closed canopy chaparral in having a fairly prominent component of semi-desert scrub elements, including light-demanding, often succulent, short shrubs or subshrubs (*e.g.*, *Agave* (century plants), *Dasyllirion* (sotols), *Nolina* (beargrass), *Opuntia* (pricklypears), and *Echinocereus* (hedgehog cactuses)).

BIBE Classification Plots Included in Concept:

BIBE0001, BIBE0151, BIBE0164, BIBE0167, BIBE0219, BIBE0225, BIBE0234, BIBE0235, BIBE0247.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0157, BIBEAA0168, BIBEAA0171, BIBEAA0173, BIBEAA0175, BIBEAA0176, BIBEAA0177, BIBEAA0178, BIBEAA0179, BIBEAA0180, BIBEAA0181, BIBEAA0182, BIBEAA0275, BIBEAA0291, BIBEAA0303, BIBEAA0305, BIBEAA0331, BIBEAA0335, BIBEAA0338, BIBEAA0339, BIBEAA0341, BIBEAA0447, BIBEAA0452, BIBEAA0453, BIBEAA0454, BIBEAA0455, BIBEAA0456, BIBEAA0457, BIBEAA0458, BIBEAA0459, BIBEAA0460, BIBEAA0468, BIBEAA0473, BIBEAA0476, BIBEAA0494, BIBEAA0684, BIBEAA0685, BIBEAA0686, BIBEAA0687, BIBEAA0688, BIBEAA0690, BIBEAA0691, BIBEAA0697, BIBEAA0713, BIBEAA0818, BIBEAA0819, BIBEAA0821, BIBEAA0822, BIBEAA0823, BIBEAA0826, BIBEAA0829, BIBEAA0830, BIBEAA0831, BIBEAA0832, BIBEAA0833, BIBEAA0834, BIBEAA0835, BIBEAA0836, BIBEAA0837, BIBEAA0838, BIBEAA0839, BIBEAA0841, BIBEAA0842, BIBEAA0843, BIBEAA0873, BIBEAA1262.

Most frequent plant taxa recorded in Montane Mixed Chaparral are shown in Table D-26.



**Table D-26.** Synthesis table for the most frequent plant taxa recorded in Montane Mixed Chaparral at Big Bend National Park (# plots=9).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Viguiera stenoloba</i>	Shrub	90.9%	4.5	0–10
<i>Rhus virens</i>	Shrub	81.8%	13.6	0–7
<i>Nolina erumpens</i>	Shrub	81.8%	2.0	0–5
<i>Quercus grisea</i>	Shrub	72.7%	5.3	0–1
<i>Opuntia chisosensis</i>	Shrub	72.7%	0.9	0–1
<i>Agave lechuguilla</i>	Shrub	72.7%	0.7	0–1
<i>Garrya ovata</i> ssp. <i>goldmanii</i>	Shrub	63.6%	3.1	0–1
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	63.6%	0.9	0–1
<i>Agave havardiana</i>	Shrub	63.6%	0.4	0–1
<i>Prunus havardii</i>	Shrub	54.5%	1.1	0–1
<i>Bouvardia ternifolia</i>	Shrub	54.5%	0.3	0–1
<i>Quercus emoryi</i>	Shrub	45.5%	2.8	0–1
<i>Dasyllirion leiophyllum</i>	Shrub	45.5%	0.2	0–1
<i>Ungradiopsis speciosa</i>	Shrub	36.4%	0.8	0–1
<i>Pinus cembroides</i>	Tree / Shrub	36.4%	0.5	0–1
<i>Quercus gravesii</i>	Tree / Shrub	27.3%	4.7	0–1
<i>Quercus pungens</i>	Shrub	27.3%	2.7	0–1
<i>Viguiera dentata</i>	Shrub	27.3%	0.4	0–1
<i>Fraxinus greggii</i>	Shrub	18.2%	3.7	0–1
<i>Cercocarpus montanus</i>	Shrub	18.2%	1.7	0–1
<i>Aloysia wrightii</i>	Shrub	18.2%	0.7	0–1
<i>Eysenhardtia texana</i>	Shrub	18.2%	0.4	0–1
<i>Mimosa</i> sp.	Shrub	18.2%	0.4	0–1
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	18.2%	0.3	0–1
<i>Dalea formosa</i>	Shrub	18.2%	0.2	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	18.2%	0.0	0–5
<i>Escobaria dasyacantha</i>	Shrub	18.2%	0.0	0–2
<i>Matelea reticulata</i>	Vine / Herb	27.3%	0.1	0–1
<i>Funastrum cynanchoides</i>	Vine / Herb	18.2%	0.1	0–1
<i>Funastrum torreyi</i>	Vine / Herb	18.2%	0.1	0–1
<i>Muhlenbergia emersleyi</i>	Herb	72.7%	4.3	0–25
<i>Bouteloua curtipendula</i>	Herb	63.6%	1.4	0–10
<i>Astrolepis sinuata</i>	Herb	63.6%	0.3	0–1
<i>Cheilanthes</i> sp.	Herb	63.6%	0.2	0–1
<i>Notholaena standleyi</i>	Herb	45.5%	0.2	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Croton</i> sp.	Herb	36.4%	0.1	0–1
<i>Astrolepis integerrima</i>	Herb	27.3%	0.1	0–1
<i>Bommeria hispida</i>	Herb	27.3%	0.1	0–1
<i>Tradescantia brevifolia</i>	Herb	27.3%	0.1	0–1
<i>Aristida</i> sp.	Herb	27.3%	0.1	0–1
<i>Eriogonum</i> sp.	Herb	27.3%	0.1	0–1
<i>Bouteloua hirsuta</i>	Herb	18.2%	0.4	0–5
<i>Desmanthus glandulosus</i>	Herb	18.2%	0.1	0–1
<i>Heteropogon contortus</i>	Herb	18.2%	0.1	0–1
<i>Ipomoea</i> sp.	Herb	18.2%	0.1	0–1
<i>Astrolepis</i> sp.	Herb	18.2%	0.1	0–1



Photo 25. Montane Mixed Chaparral, along Lost Mine Trail, upper Juniper Canyon (BIBEA0454). Photo by Jeff Renfrow.



Photo 26. Montane Mixed Chaparral, along Blue Creek Trail, upper Blue Creek drainage below Southwest Rim (BIBEAA0685). Photo by Rebecca Evans.

## Redberry Juniper – Sotol Shrubland

### Local Type Concept:

Fairly open short-statured shrublands to grasslands with a sparse shrub stratum with a diverse shrub species composition, often with *Juniperus coahuilensis* × *pinchotii* (redberry juniper) and *Bouteloua curtipendula* (sideoats grama) dominant or co-dominant in the herbaceous stratum. Occurs usually in valley bottoms with gentle slopes in low montane settings of the Chisos Mountains.

### Vegetation:

The shrub stratum is somewhat variable and fairly diverse (species-rich and species-even) *Juniperus coahuilensis* (including *J. coahuilensis* × *pinchotii*) (redberry juniper) is a fairly constant tall shrub in this stratum, usually at low (< 5%) cover. *Nolina erumpens* (foothill beargrass) and *Dasyllirion leiophyllum* (green sotol) are constant shorter shrubs, and the latter species may occur at fairly high (up to 25%) cover locally. Other frequent taller shrubs are *Rhus virens* (evergreen sumac), *Rhus trilobata* var. *pilosissima* (skunkbush sumac), *Aloysia gratissima* (whitebrush), *Quercus grisea* (gray oak), *Mahonia trifoliolata* (agarita), *Prunus havardii* (Havard's plum), *Cylindropuntia imbricata* (tree cholla), *Cercocarpus montanus* (alderleaf mountain mahogany), *Vachellia constricta* (whitethorn acacia), and *Fouquieria splendens* (ocotillo). *Pinus cembroides* (Mexican pinyon) occasionally is present as a tall shrub or as scattered trees. Shorter shrubs are *Agave havardiana* (Havard's century plant), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Viguiera stenoloba* (skeletonleaf goldeneye), *Parthenium incanum* (mariola), *Echinocereus rusanthus* (rusty hedgehog cactus), *Chrysactinia mexicana* (damianita), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Mammillaria lasiacantha* (lacespine nipple cactus), and *Dalea formosa* (featherplume). Stratum and substrate cover for Redberry Juniper – Sotol Shrubland are shown in Table D-27.

**Table D-27.** Stratum cover recorded for Redberry Juniper – Sotol Shrubland at Big Bend National Park (# plots=13).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	4	0–30
	Tall Shrub	4	0–20
	Short Shrub	27	10–50
	Herb	28	4–80
Substrate	Bedrock	5	0–34
	Large/Small Rocks	45	1–94
	Litter/Duff	45	2–99

*Bouteloua curtipendula* (sideoats grama) is the most constant herbaceous species and is often dominant or co-dominant. Other grass species include *Muhlenbergia emersleyi* (bull muhly), *Bouteloua hirsuta* (hairy grama), *Heteropogon contortus* (tanglehead), *Bothriochloa laguroides* (silver beardgrass), *Aristida arizonica* (Arizona threeawn), and *Bothriochloa springfieldii*



(Springfield's beardgrass). Pteridophytes are frequent and include *Astrolepis sinuata* (wavy scaly cloak fern), *Astrolepis cochisensis* (Cochise scaly cloak fern), *Notholaena standleyi* (star cloak fern), *Bommeria hispida* (copper fern), and *Selaginella peruviana* (Peruvian spikemoss).

Environment:

Most stands are in the Green Gulch and Pine Canyon areas of the northern side of the Chisos Mountains, where the type is locally common on broad valley floors, with several stands in the Chisos Basin and one stand in Juniper Canyon. Elevations range from 4,600 to 5,600 feet in elevation. They occupy mostly gentle to moderate slopes. Relative to the Emory Oak – Little Bluestem Woodland, this type occurs in lower, gentler slopes.

USNVC Translation:

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland Subclass (2.B)

USNVC Formation: Temperate Grassland & Shrubland Formation (2.B.2)

USNVC Division: Western North American Interior Chaparral Division (D061)

USNVC Macrogroup: Warm Interior Chaparral Macrogroup (M091)

USNVC Group: Eastern Madrean Chaparral Group (G280)

USNVC Alliance: *Juniperus pinchotii* Chaparral Alliance (A0505)

NPS Association: *Juniperus (coahuilensis, pinchotii)* / *Dasyllirion leiophyllum* – *Nolina erumpens* – *Bouteloua curtipendula* Shrubland Association (NPSBIBE021)

Comments:

Placement of this vegetation within the USNVC is difficult because of its transitional nature between foothills grasslands and montane chaparral. It is intermediate between two locally defined associations that are happen to fall into different widely separated major units in the USNVC hierarchy: the (BIBE) Sotol – Lechuguilla Foothills Shrub Grassland (association) of the USNVC Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490), within USNVC Class 3 and the (BIBE) Montane Mixed Chaparral Association of the USNVC Eastern Madrean Chaparral Group (G280) in USNVC Class 2. Because of the frequent presence of junipers of the *J. coahuilensis* / *J. pinchotii* complex, an additional case could be made for placement in the Madrean Lowland Evergreen Woodland Macrogroup (M010) of USNVC Class 1. However, the junipers are relatively short, low cover, and inconstant, and the association has a typically open chaparral to shrub grassland, rather than woodland, character. The *Juniperus pinchotii* Chaparral Alliance (A0505) of G280 seems the best placement, although the *Dasyllirion* spp. – *Bouteloua curtipendula* – *Muhlenbergia setifolia* Foothill Desert Grassland Alliance (A3205) of G490 seems almost as applicable.

This association has much species overlap with the Montane Mixed Chaparral, but is lacking some of the higher elevation species (e.g., *Garrya ovata* ssp. *goldmanii*, *Fraxinus greggii*) and has higher constancy and abundance for lower elevation (foothills) shrub grassland species, particularly *Dasyllirion leiophyllum* and *Juniperus coahuilensis* × *pinchotii*.

BIBE Classification Plots Included in Concept:

BIBE0155, BIBE0157, BIBE0159, BIBE0163, BIBE0165, BIBE0168, BIBE0175, BIBE0178, BIBE0199, BIBE0200, BIBE0201, BIBE0203, BIBE0206.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0155, BIBEAA0163, BIBEAA0198, BIBEAA0199, BIBEAA0200, BIBEAA0202, BIBEAA0204, BIBEAA0205, BIBEAA0206, BIBEAA0207, BIBEAA0208, BIBEAA0211, BIBEAA0274, BIBEAA0461, BIBEAA0462, BIBEAA0463, BIBEAA0464, BIBEAA0474, BIBEAA0475, BIBEAA0469, BIBEAA0696, BIBEAA0698, BIBEAA0699, BIBEAA0700, BIBEAA0701, BIBEAA0703, BIBEAA0705, BIBEAA0706, BIBEAA0707, BIBEAA0708, BIBEAA0709, BIBEAA0711, BIBEAA0712, BIBEAA0721, BIBEAA0722, BIBEAA0723, BIBEAA0889, BIBEAA0890, BIBEAA0892, BIBEAA0894, BIBEAA0895, BIBEAA0896, BIBEAA0897, BIBEAA0898, BIBEAA1261.

Most frequent plant taxa recorded in Redberry Juniper – Sotol Shrubland are shown in Table D-28.

**Table D-28.** Synthesis table for the most frequent plant taxa recorded in Redberry Juniper – Sotol Shrubland at Big Bend National Park (# plots=8).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Pinus cembroides</i>	Tree /Shrub	53.8%	3.8	0–53
<i>Juniperus coahuilensis</i> / <i>J. coahuilensis</i> × <i>pinchotii</i>	Shrub	76.9%	4.9	0–26
<i>Dasyllirion leiophyllum</i>	Shrub	76.9%	3.0	0–26
<i>Nolina erumpens</i>	Shrub	76.9%	1.1	0–5
<i>Rhus virens</i>	Shrub	61.5%	1.4	0–5
<i>Agave havardiana</i>	Shrub	61.5%	0.3	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	53.8%	1.8	0–12
<i>Viguiera stenoloba</i>	Shrub	53.8%	0.7	0–6
<i>Aloysia gratissima</i>	Shrub	46.2%	2.3	0–35
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	46.2%	0.9	0–7
<i>Prunus havardii</i>	Shrub	46.2%	0.9	0–11
<i>Echinocereus russanthus</i>	Shrub	46.2%	0.2	0–1
<i>Quercus grisea</i>	Shrub	38.5%	2.6	0–30
<i>Chrysactinia mexicana</i>	Shrub	38.5%	1.2	0–10
<i>Parthenium incanum</i>	Shrub	38.5%	0.6	0–6
<i>Mahonia trifoliolata</i>	Shrub	38.5%	0.5	0–5
<i>Cylindropuntia imbricata</i>	Shrub	38.5%	0.1	0–1
<i>Opuntia chisosensis</i>	Shrub	30.8%	1.1	0–12
<i>Cercocarpus montanus</i>	Shrub	30.8%	0.6	0–4
<i>Vachellia constricta</i>	Shrub	30.8%	0.5	0–3

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Fouquieria splendens</i>	Shrub	30.8%	0.1	0–2
<i>Fallugia paradoxa</i>	Shrub	23.1%	0.3	0–4
<i>Dalea formosa</i>	Shrub	23.1%	0.2	0–2
<i>Mammillaria lasiacantha</i>	Shrub	23.1%	0.1	0–1
<i>Agave lechuguilla</i>	Shrub	15.4%	0.2	0–2
<i>Yucca torreyi</i>	Shrub	15.4%	0.1	0–2
<i>Bouvardia ternifolia</i>	Shrub	15.4%	0.1	0–1
<i>Krameria erecta</i>	Shrub	15.4%	0.1	0–1
<i>Forestiera angustifolia</i>	Shrub	15.4%	0.1	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	15.4%	0.0	0–1
<i>Aloysia wrightii</i>	Shrub	15.4%	0.0	0–1
<i>Phoradendron hawksworthii</i>	Epiphyte	23.1%	0.1	0–1
<i>Bouteloua curtipendula</i>	Herb	92.3%	3.8	0–25
<i>Astrolepis sinuata</i>	Herb	76.9%	0.4	0–2
<i>Muhlenbergia emersleyi</i>	Herb	53.8%	1.3	0–10
<i>Bouteloua hirsuta</i>	Herb	38.5%	0.2	0–3
<i>Heteropogon contortus</i>	Herb	30.8%	5.5	0–75
<i>Bothriochloa laguroides</i>	Herb	30.8%	0.4	0–7
<i>Aristida arizonica</i>	Herb	23.1%	1.3	0–10
<i>Selaginella peruviana</i>	Herb	23.1%	1.3	0–10
<i>Bothriochloa springfieldii</i>	Herb	23.1%	0.2	0–2
<i>Astrolepis cochisensis</i>	Herb	23.1%	0.1	0–1
<i>Bommeria hispida</i>	Herb	23.1%	0.1	0–1
<i>Notholaena standleyi</i>	Herb	23.1%	0.1	0–1
<i>Schizachyrium scoparium</i>	Herb	15.4%	0.2	0–2
<i>Panicum hallii</i>	Herb	15.4%	0.1	0–1





Photo 27. Redberry Juniper – Sotol Shrubland, Green Gulch (BIBEAA0208). Photo by Bobski Gray.



Photo 28. Low Montane Sideoats Grama Shrub Grassland, in Green Gulch (BIBEAA0708). Photo by Bobski Gray.

## ***Bull Muhly Montane Grassland***

### Local Type Concept:

Grasslands in mostly high montane settings in the Chisos Mountains, with low shrub cover in some stands. *Muhlenbergia emersleyi* (bull muhly) usually is strongly dominant and is the most abundant and characteristic herb.

### Vegetation:

*Muhlenbergia emersleyi* (bull muhly) is strongly dominant or co-dominant in a dense grass-dominated herbaceous stratum and usually exceeds 10% cover. There are no consistently co-dominant species; *Muhlenbergia rigida* (purple muhly), *Schizachyrium scoparium* (little bluestem), *Bouteloua curtipendula* (sideoats grama), *Lycurus phleoides* (common wolfstail), *Nassella tenuissima* (finestem needlegrass), and/or *Bouteloua gracilis* (blue grama) are often present and may co-dominate stands. *Blepharoneuron tricholepis* (pine dropseed), *Selaginella peruviana* (Peruvian spikemoss), *Bommeria hispida* (copper fern), *Cheilanthes* spp. (lip ferns), and *Astrolepis* (cloak ferns) often occur at low cover. *Allium kunthii* (Kunth's onion), *Aristida divaricata* (poverty threeawn), *Elymus arizonicus* (Arizona wheatgrass), and *Ipomoea costellata* (crestrub morning-glory) have strong to moderate constancy maxima in this vegetation and may be useful character species. Scattered shrubs, including *Opuntia chisosensis* (Chisos Mountain pricklypear), *Nolina erumpens* (foothill beargrass), *Agave havardiana* (Havard's century plant), *Bouvardia ternifolia* (firecrackerbush), *Echinocereus coccineus* var. *paucispinus* (Texas claret-up cactus), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Agave lechuguilla* (lechuguilla), and others and occasional trees such as *Pinus cembroides* (Mexican pinyon), *Juniperus* spp. (junipers), and/or *Quercus grisea* (gray oak) contribute small amounts of woody cover. Stratum and substrate cover for Bull Muhly Montane Grassland are shown in Table D-29.

**Table D-29.** Stratum and substrate cover recorded for Bull Muhly Montane Grassland at Big Bend National Park (# plots=15).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	2	0–10
	Tall Shrub	6	0–20
	Short Shrub	12	2–30
	Herb	54	20–80
Substrate	Bedrock	31	0–75
	Large/Small Rocks	34	5–84
	Litter/Duff	26	1–74

### Environment:

Stands are scattered at from higher elevations in the Chisos Mountains (mostly from 6,500 to 7,600 feet), with occasional stands as low as 5,600 feet. They usually occur as openings of small to moderately large size (up to several hectares) within a matrix of the Dry Pinyon Pine Woodland or other vegetation with dry exposure.

During the map accuracy assessment in 2017, much recent mortality of mature *Pinus cembroides* trees, evidently following the severe drought of 2010–2011, was seen in pinyon woodlands; this phenomenon seemed to promote the expansion of these grasslands. It would be expected that such a pattern of fluctuation between montane woodlands and grasslands in the drier exposures of the Chisos Mountains would follow wetter and drier climate cycles in the long run and acute drought events or fire in the short run.

### USNVC Translation:

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)

USNVC Alliance: *Muhlenbergia emersleyi* – *Muhlenbergia setifolia* – *Hesperostipa neomexicana*  
Madrean Lower Montane Grassland Alliance (A3206)

NPS Association: *Muhlenbergia emersleyi* – *Bommeria hispida* – *Cheilanthes bonariensis*  
Herbaceous Vegetation Association (NPSBIBE008)

### Comments:

The *Muhlenbergia emersleyi* – *Bouteloua curtipendula* Herbaceous Vegetation Association (CEGL001644), said to occur in Trans-Pecos ranges, is the closest recognized USNVC (2017) association match to this BIBE vegetation. There are some conceptual problems in applying that concept to BIBE. For the BIBE classification plot data, *Bouteloua curtipendula* (sideoats grama) is important in only the anomalously lower elevation plot, and it occurs in only two of the other 13 plots. Some of the other species listed for are absent from this vegetation in the Chisos, and the association may better describe vegetation from other ranges. Given that high mountains in the Trans-Pecos are somewhat isolated “sky islands”, each range may well harbor different assemblages, and, with the supporting data from this project, it seems best to offer a Chisos-specific concept.

The ecological differences between this type and the sympatric Finestem Needlegrass Montane Grassland, with strong dominance by *Nassella tenuissima* (finestem needlegrass), are unknown, except that the latter seems to be absent from the highest elevations of the Chisos Mountains.

### BIBE Classification Plots Included in Concept:

BIBE0045, BIBE0052, BIBE0223, BIBE0248, BIBE0277, BIBE0289, BIBE0296, BIBE0300, BIBE0302, BIBE0303, BIBE0307, BIBE0309, BIBE0321, BIBE0370, BIBE0373.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0293, BIBEAA0294, BIBEAA0298, BIBEAA0304, BIBEAA0450, BIBEAA0451, BIBEAA0466, BIBEAA0472, BIBEAA0496. BIBEAA1257.

Most frequent plant taxa recorded in Bull Muhly Montane Grassland are shown in Table D-30.

**Table D-30.** Synthesis table for the most frequent plant taxa recorded in Bull Muhly Montane Grassland at Big Bend National Park (# plots=15).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Opuntia chisosensis</i>	Shrub	100.0%	1.1	0–2
<i>Nolina erumpens</i>	Shrub	78.6%	1.8	0–3
<i>Agave havardiana</i>	Shrub	78.6%	0.8	few–1
<i>Bouvardia ternifolia</i>	Shrub	78.6%	0.6	0–trace
<i>Pinus cembroides</i>	Shrub / Tree	71.4%	3.2	0–6
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	64.3%	0.2	0–1
<i>Viguiera stenoloba</i>	Shrub	57.1%	0.5	0–1
<i>Quercus grisea</i>	Shrub / Tree	50.0%	3.1	0–15
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	42.9%	0.5	0–1
<i>Agave lechuguilla</i>	Shrub	35.7%	2.8	0–5
<i>Gutierrezia</i> sp.	Shrub	35.7%	0.3	0–1
<i>Gutierrezia microcephala</i>	Shrub	28.6%	0.3	0–1
<i>Cercocarpus montanus</i>	Shrub	28.6%	0.3	0–1
<i>Escobaria tuberculosa</i>	Shrub	28.6%	0.1	0–2
<i>Juniperus flaccida</i>	Shrub / Tree	28.6%	0.1	0–2
<i>Juniperus deppeana</i>	Shrub	21.4%	0.1	0–5
<i>Rhus virens</i>	Shrub	21.4%	0.1	0–5
<i>Escobaria dasyacantha</i>	Shrub	21.4%	0.1	0–1
<i>Mammillaria meiacantha</i>	Shrub	21.4%	0.1	0–1
<i>Muhlenbergia emersleyi</i>	Herb	100.0%	28.6	2–75
<i>Bommeria hispida</i>	Herb	78.6%	0.4	0–1
<i>Cheilanthes bonariensis</i>	Herb	71.4%	1.3	0–10
<i>Allium kunthii</i>	Herb	64.3%	0.3	0–1
<i>Blepharoneuron tricholepis</i>	Herb	57.1%	2.2	0–10
<i>Selaginella peruviana</i>	Herb	57.1%	1.8	0–25
<i>Aristida divaricata</i>	Herb	57.1%	0.4	0–2
<i>Commelina dianthifolia</i>	Herb	57.1%	0.3	0–1
<i>Elymus arizonicus</i>	Herb	50.0%	0.3	0–2
<i>Ipomoea costellata</i>	Herb	50.0%	0.3	0–2
<i>Bouteloua gracilis</i>	Herb	42.9%	2.7	0–25

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Piptochaetium fimbriatum</i>	Herb	35.7%	0.3	0–2
<i>Astrolepis cochisensis</i>	Herb	35.7%	0.2	0–1
<i>Oxalis drummondii</i>	Herb	35.7%	0.2	0–1
<i>Phemeranthus longipes</i>	Herb	35.7%	0.2	0–1
<i>Tagetes micrantha</i>	Herb	35.7%	0.2	0–1
<i>Schizachyrium scoparium</i>	Herb	28.6%	2.9	0–50
<i>Eragrostis intermedia</i>	Herb	28.6%	0.2	0–2
<i>Artemisia ludoviciana</i>	Herb	28.6%	0.1	0–1
<i>Astrolepis sinuata</i>	Herb	28.6%	0.1	0–1
<i>Cheilanthes eatonii</i>	Herb	28.6%	0.1	0–1
<i>Tradescantia brevifolia</i>	Herb	28.6%	0.1	0–1
<i>Bouteloua curtipendula</i>	Herb	21.4%	1.5	0–25
<i>Calliandra humilis</i>	Herb	21.4%	0.2	0–2
<i>Euphorbia exstipulata</i>	Herb	21.4%	0.1	0–1
<i>Pellaea ternifolia</i>	Herb	21.4%	0.1	0–1
<i>Pellaea</i> sp.	Herb	21.4%	0.1	0–1
<i>Ipomoea</i> sp.	Herb	21.4%	0.1	0–1





Photo 29. Bull Muhly Montane Grassland, along Emory Peak Trail, showing recent *Pinus cembroides* mortality (BIBEAA0293). Photo by Jeff Renfrow.



Photo 30. Bull Muhly Montane Grassland, along Southwest Rim Trail, showing recent *Pinus cembroides* mortality in distance (BIBEAA0450). Photo by Kelon Crawford.



### ***Finestem Needlegrass Montane Grassland***

#### Local Type Concept:

Mostly herbaceous vegetation, strongly dominated by *Nassella tenuissima* (finestem needlegrass), at middle to high elevations in the Chisos Mountains.

#### Vegetation:

*Nassella tenuissima* (finestem needlegrass) is dominant and usually strongly so, apparently excluding many other species; composition is otherwise variable and not diverse. *Bouteloua gracilis* (blue grama) and *Acourtia wrightii* (brownfoot) were the most constant herbaceous associates; many other infrequent species were recorded (see synthesis table). *Artemisia dracunculus* (wild tarragon) occurs at high cover in one plot. A sparse shrub stratum may be present, with *Juniperus deppeana* (alligator juniper), *Quercus grisea* (gray oak), *Viguiera stenoloba* (skeletonleaf goldeneye), *Opuntia chisosensis* (Chisos Mountain pricklypear), and *Rhus trilobata* var. *pilosissima* (skunkbush sumac) the most frequently observed species. Stratum and substrate cover for Finestem Needlegrass Montane Grassland are shown in Table D-31.

**Table D-31.** Stratum and substrate cover recorded for Finestem Needlegrass Montane Grassland at Big Bend National Park (# plots=6).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–2
	Tall Shrub	2	0–10
	Short Shrub	3	0–11
	Herb	90	79–100
Substrate	Bedrock	31	0–75
	Large/Small Rocks	34	5–84
	Litter/Duff	26	1–74

#### Environment:

This is a type that evidently is scattered throughout the Chisos Mountains, but is somewhat limited in distribution. Two stands occur along the Pinnacles Trail and one in the Laguna Meadows area, (elevation range of these is 5824 to 6,644); one stand is at 5,030 in Green Gulch.

#### USNVC Translation:

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)

USNVC Alliance: *Muhlenbergia emersleyi* – *Muhlenbergia setifolia* – *Hesperostipa neomexicana*  
 Madrean Lower Montane Grassland Alliance (A3206)  
 NPS Association: *Nassella tenuissima* Herbaceous Vegetation Association (NPSBIBE003)

BIBE Classification Plots Included in Concept:

BIBE0024, BIBE0050, BIBE0152, BIBE0318, BIBE0328, BIBE0385.

Most frequent plant taxa recorded in Finestem Needlegrass Montane Grassland are shown in Table D-32.

**Table D-32.** Synthesis table for all plant taxa recorded in Finestem Needlegrass Montane Grassland at Big Bend National Park (# plots=6).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Juniperus deppeana</i>	Shrub	50.0%	0.3	0–1
<i>Quercus grisea</i>	Shrub / Tree	33.3%	0.8	0–5
<i>Viguiera stenoloba</i>	Shrub	33.3%	0.4	0–2
<i>Opuntia chisosensis</i>	Shrub	33.3%	0.3	0–2
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	33.3%	0.0	0–trace
<i>Vachellia constricta</i>	Shrub	16.7%	0.3	0–2
<i>Senegalia roemeriana</i>	Shrub	16.7%	0.3	0–2
<i>Juniperus flaccida</i>	Shrub	16.7%	0.3	0–2
<i>Juniperus coahuilensis</i> / <i>J. coahuilensis</i> × <i>pinchotii</i>	Shrub / Tree	16.7%	0.3	0–2
<i>Bouvardia ternifolia</i>	Shrub	16.7%	0.1	0–1
<i>Dasyllirion leiophyllum</i>	Shrub	16.7%	0.1	0–1
<i>Nolina erumpens</i>	Shrub	16.7%	0.1	0–1
<i>Quercus emoryi</i>	Shrub	16.7%	0.1	0–trace
<i>Juniperus monosperma</i>	Shrub	16.7%	0.1	0–trace
<i>Nassella tenuissima</i>	Herb	100.0%	81.3	25–100
<i>Bouteloua gracilis</i>	Herb	50.0%	1.6	0–10
<i>Acourtia wrightii</i>	Herb	33.3%	0.2	0–1
<i>Artemisia dracunculus</i>	Herb	16.7%	6.3	0–50
<i>Bouteloua hirsuta</i>	Herb	16.7%	1.3	0–10
<i>Elymus</i> sp.	Herb	16.7%	0.6	0–5
<i>Blepharoneuron tricholepis</i>	Herb	16.7%	0.3	0–2
<i>Bothriochloa laguroides</i>	Herb	16.7%	0.3	0–2
<i>Heteropogon contortus</i>	Herb	16.7%	0.3	0–2
<i>Muhlenbergia rigida</i>	Herb	16.7%	0.3	0–2
<i>Rhynchosia senna</i>	Herb	16.7%	0.3	0–2
<i>Acourtia nana</i>	Herb	16.7%	0.1	0–1

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Allium kunthii</i>	Herb	16.7%	0.1	0–1
<i>Asclepias asperula</i>	Herb	16.7%	0.1	0–1
<i>Bommeria hispida</i>	Herb	16.7%	0.1	0–1
<i>Bouteloua curtipendula</i>	Herb	16.7%	0.1	0–1
<i>Bouteloua ramosa</i>	Herb	16.7%	0.1	0–1
<i>Cheilanthes bonariensis</i>	Herb	16.7%	0.1	0–1
<i>Cheilanthes eatonii</i>	Herb	16.7%	0.1	0–1
<i>Chamaesyce prostrata</i>	Herb	16.7%	0.1	0–1
<i>Chamaesyce serpyllifolia</i>	Herb	16.7%	0.1	0–1
<i>Cheilanthes wrightii</i>	Herb	16.7%	0.1	0–1
<i>Hieracium schultzei</i>	Herb	16.7%	0.1	0–1
<i>Lycurus setosus</i>	Herb	16.7%	0.1	0–1
<i>Mirabilis linearis</i>	Herb	16.7%	0.1	0–1
<i>Muhlenbergia dubia</i>	Herb	16.7%	0.1	0–1
<i>Muhlenbergia emersleyi</i>	Herb	16.7%	0.1	0–1
<i>Piptochaetium fimbriatum</i>	Herb	16.7%	0.1	0–1
<i>Schizachyrium scoparium</i>	Herb	16.7%	0.1	0–1
<i>Solanum elaeagnifolium</i>	Herb	16.7%	0.1	0–1
<i>Sporobolus airoides</i>	Herb	16.7%	0.1	0–1
<i>Tragia ramosa</i>	Herb	16.7%	0.1	0–1
<i>Cheilanthes</i> sp.	Herb	16.7%	0.1	0–1



Photo 31. Finestem Needlegrass Montane Grassland, Juniper Flat in Chisos Basin (BIBE0024). Photo by Christian Skorik.



Photo 32. Finestem Needlegrass Montane Grassland, Laguna Meadows (BIBE0050). Photo by Christian Skorik.

## ***Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation***

### Local Type Concept:

Shrublands or shrubby herbaceous vegetation in exposed and relatively xeric settings with shallow soil and, usually, exposed bedrock in montane settings. Shrub cover is modest and is contributed by a relatively diverse number of species. The herbaceous cover is moderate to high cover and *Selaginella peruviana* (Peruvian spikemoss) usually is the leading dominant. Smaller cacti, ferns, and other drought tolerant species usually are well represented.

### Vegetation:

No single shrub species consistently occurs at high cover, but the shrub stratum is relatively species rich and even. Species that are relatively constant at low (< 5%) cover and occasionally at higher cover are *Agave lechuguilla* (lechuguilla), *Viguiera stenoloba* (skeletonleaf goldeneye), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Fouquieria splendens* (ocotillo), *Dasyllirion leiophyllum* (green sotol), *Rhus virens* (evergreen sumac), *Chrysactinia mexicana* (damianita), and *Quercus grisea* (gray oak). *Nolina erumpens* (foothill beargrass), *Agave havardiana* (Havard's century plant), *Dalea formosa* (featherplume), *Bouvardia ternifolia* (firecrackerbush), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Fraxinus greggii* (littleleaf ash) and/or *Gymnosperma glutinosum* (gumhead) may also be present. The presence of smaller cactus species, including *Echinocereus stramineus* (strawberry hedgehog cactus), *E. coccineus* (scarlet hedgehog cactus), *E. russanthus* (rusty hedgehog cactus), *Mammillaria meiacantha* (little nipple cactus), and/or *Escobaria dasyacantha* (desert pincushion cactus) is characteristic. *Selaginella peruviana* (Peruvian spikemoss) is both the most constant and, often, the most abundant herb, and its presence in quantity is fairly diagnostic of this type. Several grasses are relatively constant, but contribute relatively little cover individually or collectively; these include *Heteropogon contortus* (tanglehead), *Muhlenbergia emersleyi* (bull muhly), *Bouteloua curtipendula* (sideoats grama), *Lycurus setosus* (bristly wolfstail), and *Leptochloa dubia* (sprangletop). A diversity of fern species contributes a modest amount of cover. These include *Bommeria hispida* (copper fern), *Astrolepis sinuata* (wavyleaf cloak fern), *Astrolepis cochisensis* (Cochise scaly cloak fern), *Notholaena standleyi* (star cloak fern), *Cheilanthes bonariensis* (golden lip fern), and/or *Cheilanthes wrightii* (Wright's lip fern). Stratum and substrate cover for Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation are shown in Table D-33.

**Table D-33.** Stratum and substrate cover recorded for Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation at Big Bend National Park (# plots=13).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	1	0–2
	Tall Shrub	8	0–10
	Short Shrub	24	0–11
	Herb	35	79–100
Substrate	Bedrock	31	0–90
	Large/Small Rocks	42	5–75
	Litter/Duff	18	1–47

Environment:

Within the montane zone of the Chisos Mountains, this vegetation occupies the driest sites that still exhibit some surface soil (i.e., excluding areas of cliffs and talus). The topographic position usually is on middle to upper slopes in relatively steep settings. Exposed bedrock is usually present. As opposed to the also xeric Montane Talus and Cliff Rocky Sparse Shrubland, which is likely to occur on lower slopes and at cliff bases and often on talus, this type is more likely to occupy middle to upper slopes and often over shallow bedrock. Most known stands assigned to the Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation are in the general vicinity of the Chisos Basin, including Green Gulch, Oak Canyon, and Lost Mine Peak. Elevations range from 4,500 to 6,200 feet. One anomalously high elevation site that appears to fit within this concept was found at about 7,400 feet near the Colima Trail during the map accuracy assessment.

USNVC Translation:

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)

USNVC Alliance: *Dasyllirion* spp. – *Bouteloua curtipendula* – *Muhlenbergia setifolia* Foothill Desert Grassland Alliance (A3205)

NPS Association: *Agave lechuguilla* – *Viguiera stenoloba* / *Selaginella peruviana* – *Bommeria hispida* – *Muhlenbergia emersleyi* Shrub Herbaceous Vegetation Association (NPSBIBE006)

BIBE Classification Plots Included in Concept:

BIBE0160, BIBE0161, BIBE0162, BIBE0166, BIBE0170, BIBE0202, BIBE0207, BIBE0210, BIBE0220, BIBE0221, BIBE0222, BIBE0224, BIBE0226.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0449, BIBEAA0465, BIBEAA0489, BIBEAA0493, BIBEAA0495, BIBEAA0891, BIBEAA0939, BIBEAA1258.

Most frequent plant taxa recorded in Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation are shown in Table D-34.

**Table D-34.** Synthesis table for the most frequent plant taxa recorded in Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation at Big Bend National Park (# plots=13).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Agave lechuguilla</i>	Shrub	92.3%	2.2	0–10
<i>Viguiera stenoloba</i>	Shrub	92.3%	2.0	0–7
<i>Opuntia chisosensis</i>	Shrub	84.6%	1.0	0–5
<i>Fouquieria splendens</i>	Shrub	69.2%	5.9	0–56
<i>Dasylirion leiophyllum</i>	Shrub	69.2%	2.9	0–25
<i>Rhus virens</i>	Shrub	69.2%	1.3	0–10
<i>Chrysactinia mexicana</i>	Shrub	61.5%	0.7	0–5
<i>Quercus grisea</i>	Shrub	53.8%	2.4	0–21
<i>Nolina erumpens</i>	Shrub	53.8%	0.4	0–10
<i>Echinocereus stramineus</i>	Shrub	53.8%	0.3	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	53.8%	0.2	0–1
<i>Mammillaria meiacantha</i>	Shrub	53.8%	0.2	0–1
<i>Agave havardiana</i>	Shrub	46.2%	0.5	0–4
<i>Gutierrezia</i> sp.	Shrub	46.2%	0.4	0–2
<i>Dalea formosa</i>	Shrub	46.2%	0.3	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	38.5%	0.4	0–3
<i>Bouvardia ternifolia</i>	Shrub	38.5%	0.2	0–1
<i>Echinocereus rusanthus</i>	Shrub	38.5%	0.2	0–1
<i>Escobaria dasyacantha</i>	Shrub	38.5%	0.1	0–1
<i>Aloysia wrightii</i>	Shrub	30.8%	3.4	0–50
<i>Pinus cembroides</i>	Shrub / Tree	30.8%	0.7	0–10
<i>Quercus emoryi</i>	Shrub	30.8%	0.6	0–6
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	30.8%	0.4	0–5
<i>Prunus havardii</i>	Shrub	30.8%	0.3	0–3
<i>Tecoma stans</i>	Shrub	30.8%	0.2	0–2
<i>Echinocereus rusanthus</i>	Shrub	30.8%	0.2	0–1
<i>Selaginella peruviana</i>	Shrub	100.0%	22.9	trace–95
<i>Muhlenbergia emersleyi</i>	Shrub	92.3%	2.8	0–10
<i>Bommeria hispida</i>	Herb	92.3%	0.5	0–2
<i>Bouteloua curtipendula</i>	Herb	84.6%	0.8	0–2
<i>Heteropogon contortus</i>	Herb	76.9%	1.7	0–10
<i>Astrolepis sinuata</i>	Herb	61.5%	1.0	0–5
<i>Astrolepis cochisensis</i>	Herb	61.5%	0.4	0–2
<i>Eriogonum</i> sp.	Herb	61.5%	0.3	0–1
<i>Notholaena standleyi</i>	Herb	46.2%	0.3	0–2



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Cheilanthes</i> sp.	Herb	46.2%	0.3	0–2
<i>Chamaesyce</i> sp.	Herb	46.2%	0.2	0–1
<i>Cheilanthes bonariensis</i>	Herb	38.5%	1.2	0–10
<i>Cheilanthes wrightii</i>	Herb	38.5%	0.2	0–1
<i>Ipomoea costellata</i>	Herb	38.5%	0.2	0–1
<i>Phemeranthus longipes</i>	Herb	38.5%	0.2	0–1
<i>Desmanthus glandulosus</i>	Herb	30.8%	0.5	0–10
<i>Schizachyrium scoparium</i>	Herb	30.8%	0.2	0–2
<i>Panicum</i> sp.	Herb	30.8%	0.2	0–2
<i>Senna lindheimeriana</i>	Herb	30.8%	0.2	0–2
<i>Bouteloua hirsuta</i>	Herb	30.8%	0.2	0–1
<i>Phemeranthus aurantiacus</i>	Herb	30.8%	0.2	0–1
<i>Ipomoea</i> sp.	Herb	30.8%	0.2	0–1



Photo 33. Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation, in Green Gulch (BIBE0170).  
Photo by Sarah King.



Photo 34. Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation, on Mount Huffman (BIBE0224). Photo by Matthew Yarbrough.

## ***Montane Talus and Cliff Rocky Sparse Shrubland***

### Local Type Concept:

Shrublands to herbaceous vegetation in low montane settings with sparse to modest plant cover, mostly on talus (occasionally on cliff faces or other bedrock outcrops).

### Local Type Concept:

Talus slopes, generally north to east facing, with patchy shrub cover and sparse herbaceous cover at low to middle montane elevations on igneous talus.

### Vegetation:

Because of the large elevation range and the stochastic nature of vegetation establishment on talus and scree, the composition of vegetation is variable. Shrub stratum cover can range from almost none to sparse, but dense in patches. Herbaceous stratum cover ranges from almost none to continuous and moderate. The composition is fairly similar to that of the Montane Mixed Chaparral, with which this type intergrades, with the main differences being that the Montane Talus and Cliff Rocky Sparse Shrubland has sparser cover and an increased frequency of xeric and/or disturbance-favored species. The most constant shrub species of the Montane Talus and Cliff Rocky Sparse Shrubland are *Rhus virens* (evergreen sumac) and *Viguiera stenoloba* (skeletonleaf goldeneye). While somewhat less constant, the occurrence of *Fouquieria splendens* (ocotillo) in these montane settings is fairly characteristic. Other fairly frequent shrub species are *Agave lechuguilla* (lechuguilla), *Fraxinus greggii* (littleleaf ash), *Opuntia chisosensis* (Chisos Mountain pricklypear), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Ungnadia speciosa*, (Mexican buckeye), *Dasyllirion leiophyllum* (green sotol), *Senegalia roemeriana* (Roemer's catclaw), *Agave havardiana* (Havard's century plant) and *Echinocereus coccineus* var. *paucispinus* (Texas Claret-cup cactus). *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel) may occur in higher elevation or north-facing stands. Stratum and substrate cover for Montane Talus and Cliff Rocky Sparse Shrubland are shown in Table D-35.

**Table D-35.** Stratum and substrate cover recorded for Montane Talus and Cliff Rocky Sparse Shrubland at Big Bend National Park (# plots=8).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	<1	0–3
	Tall Shrub	8	0–30
	Short Shrub	19	1–63
	Herb	4	1–10
Substrate	Bedrock	12	0–95
	Large/Small Rocks	68	45–100
	Litter/Duff	6	0–30

Grasses, including *Bouteloua curtipendula* (sideoats grama) and *Heteropogon contortus* (tanglehead), tend to occur at low cover, although *Leptochloa dubia* (sprangletop) may be denser in



patches. Pteridophytes, including *Notholaena standleyi* (star cloak fern), *Astrolepis* spp. (cloak ferns), *Cheilanthes* spp. (lip ferns), and *Selaginella* spp. (spikemosses) characteristically comprise a high proportion of the herbaceous stratum.

#### Environment:

Most stands are on talus or scree on varying substrate stability on steep to very steep slopes of the Chisos Mountains and, probably the Sierra Quemada. They often are embedded within a matrix of Montane Mixed Chaparral or, on north to east-facing slopes as a mixed mosaic with Graves' oak dominated talus forest or tall shrublands that would be assigned to the Graves' Oak – Emory Oak Canyon Forest or the High Chisos Oak – Pine Forest. One stand with vegetation consistent with this concept was observed on thin soil over stable bedrock on and near a cliff face. This vegetation occurs throughout the Chisos, mostly between 4,300 and 5,700 feet. One higher elevation stand (7,200 feet), observed below Emory Peak during the map accuracy assessment, may represent a different type, but is assigned to this association based on the floristic information currently available.

#### USNVC Translation:

USNVC Class: Semi & Semi-Desert (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland (D039)

USNVC Macrogroup: North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)

USNVC Group: North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation Group (G569)

USNVC Alliance: Sparsely Vegetated Clay Flats, Hills & Badlands Alliance (A4023)

NPS Association: *Fouquieria splendens* – *Dasyilirion leiophyllum* / *Bouteloua curtipendula* – *Notholaena standleyi* Rocky Sparse Shrubland (NPSBIBE020)

NPS Association: *Rhus virens* – *Garrya ovata* ssp. *goldmanii* – *Viguiera stenoloba* – *Ungnadia speciosa* / *Cheilanthes* spp. Sparse Shrubland (NPSBIBE035)

#### Comments:

This vegetation has not been sampled intensively, and the unit might be comprised of multiple types based on elevation and/or slope aspect (e.g., northern versus southern). The unit is internally heterogeneous, as the floristic composition of any particular stand tends to resemble more closely the non-talus shrublands and grasslands of similar elevations than it does talus-based stands of different elevation or aspect settings.

#### BIBE Classification Plots Included in Concept:

BIBE0153, BIBE0154, BIBE0179, BIBE0190, BIBE0204, BIBE0208, BIBE0363, BIBE0460.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0093, BIBEAA0094, BIBEAA0095, BIBEAA0096, BIBEAA0097, BIBEAA0098, BIBEAA0099, BIBEAA0100, BIBEAA0101, BIBEAA0102, BIBEAA0103, BIBEAA0105, BIBEAA0106, BIBEAA0107, BIBEAA0108, BIBEAA0112, BIBEAA0113, BIBEAA0313, BIBEAA0492, BIBEAA0710, BIBEAA1271.

Most frequent plant taxa recorded in Montane Talus and Cliff Rocky Sparse Shrubland are shown in Table D-36.

**Table D-36.** Synthesis table for all plant taxa recorded in Montane Talus and Cliff Rocky Sparse Shrubland at Big Bend National Park (# plots=8).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Viguiera stenoloba</i>	Shrub	87.5%	1.7	0–10
<i>Rhus virens</i>	Shrub	75.0%	8.7	0–76
<i>Dasyllirion leiophyllum</i>	Shrub	75.0%	0.7	0–5
<i>Fouquieria splendens</i>	Shrub	62.5%	2.1	0–11
<i>Agave lechuguilla</i>	Shrub	62.5%	0.4	0–2
<i>Opuntia chisosensis</i>	Shrub	62.5%	0.4	0–2
<i>Rhus trilobata</i> var. <i>pilosissima</i>	Shrub	37.5%	1.0	0–10
<i>Ungradia speciosa</i>	Shrub	37.5%	0.6	0–6
<i>Gutierrezia</i> sp.	Shrub	37.5%	0.2	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	37.5%	<0.1	0–trace
<i>Escobaria dasyacantha</i>	Shrub	37.5%	<0.1	0–trace
<i>Garrya ovata</i> ssp. <i>goldmanii</i> ssp.	Shrub	25.0%	2.4	0–25
<i>Quercus emoryi</i>	Shrub	25.0%	0.6	0–5
<i>Quercus grisea</i>	Shrub	25.0%	0.6	0–4
<i>Fraxinus greggii</i>	Shrub	25.0%	0.5	0–6
<i>Bouvardia ternifolia</i>	Shrub	25.0%	0.2	0–1
<i>Agave havardiana</i>	Shrub	25.0%	0.1	0–1
<i>Opuntia rufida</i>	Shrub	25.0%	0.1	0–1
<i>Tecoma stans</i>	Shrub	25.0%	0.1	0–1
<i>Echinocereus russanthus</i>	Shrub	25.0%	<0.1	0–trace
<i>Senegalia greggii</i>	Shrub	25.0%	<0.1	0–trace
<i>Bouteloua curtipendula</i>	Herb	87.5%	0.4	0–1
<i>Notholaena standleyi</i>	Herb	75.0%	0.3	0–1
<i>Cheilanthes</i> sp.	Herb	62.5%	0.4	0–2
<i>Astrolepis sinuata</i>	Herb	50.0%	0.2	0–1
<i>Heteropogon contortus</i>	Herb	37.5%	0.2	0–1
<i>Eriogonum</i> sp.	Herb	37.5%	0.2	0–1
<i>Croton</i> sp.	Herb	37.5%	0.2	0–1
<i>Aristida</i> sp.	Herb	25.0%	0.3	0–2
<i>Ipomoea</i> sp.	Herb	25.0%	0.1	0–0
<i>Astrolepis cochisensis</i>	Herb	25.0%	0.1	0–1
<i>Astrolepis windhamii</i>	Herb	25.0%	0.1	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Linum</i> sp.	Herb	25.0%	0.1	0–1
<i>Selaginella lepidophylla</i>	Herb	25.0%	0.1	0–1
<i>Selaginella mutica</i>	Herb	25.0%	0.1	0–1
<i>Tradescantia brevifolia</i>	Herb	25.0%	0.1	0–1



Photo 35. Montane Talus and Cliff Rocky Sparse Shrubland, west side of Vernon Bailey Peak (BIBEAA0098). Photo by Jeff Renfrow.



Photo 36. Montane Talus and Cliff Rocky Sparse Shrubland, Blue Creek Canyon (BIBEAA0313). Photo by Jeff Renfrow.



## ***Yucca* – Sotol Calcareous Shrub Grassland**

### Local Type Concept:

Shrub grassland (steppe) at the higher elevations of mountain ranges dominated by calcareous (limestone) substrates, with *Yucca faxoniana* (giant dagger), *Yucca thompsoniana* (Thompson's yucca) and *Nolina erumpens* (foothill beargrass) characteristic, and generally with a mixture of grasses dominant, including *Bouteloua* spp. (gramas), *Aristida* spp. (threeawns), and/or *Tridens muticus* (slim tridens).

### BIBE Classification Plots Included in Concept:

BIBE0468, BIBE0469.

### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA1182, BIBEAA1183, BIBEAA1184, BIBEAA1185, BIBEAA1186, BIBEAA1187, BIBEAA1189, BIBEAA1190, BIBEAA1191, BIBEAA1192, BIBEAA1193, BIBEAA1194, BIBEAA1195, BIBEAA1196, BIBEAA1197, BIBEAA1198, BIBEAA1199, BIBEAA1200, BIBEAA1201, BIBEAA1203, BIBEAA1204, BIBEAA1205, BIBEAA1206, BIBEAA1207, BIBEAA1208, BIBEAA1209, BIBEAA1210, BIBEAA1211.

### Vegetation:

Because of the access challenges in reaching the habitat of this vegetation within BIBE, this vegetation was not sampled during the classification and was recognized and mapped based on Sotol-Yucca Grassland concept of Fenstermacher (2007). Subsequently, two classification plots were sampled during the mapping accuracy assessment, and the description is further augmented by accuracy assessment observations.

This vegetation fundamentally is grassland, but usually has significant (up to 40%) amounts of shrub cover. There is much overlap in major species with the Calcareous Chaparral association, and the most obvious difference in the latter type is its much higher proportion of shrub stratum cover, relative to herbaceous stratum cover.

Short to tall and emergent (up to 5 meters) individuals of *Yucca faxoniana* (giant dagger) are regularly scattered, usually at 2 to 8% cover. *Yucca thompsoniana* (Thompson's yucca) also is frequent, but is less constant and abundant. *Dasyllirion leiophyllum* (green sotol) is a ubiquitous, lower-statured associate. Other constant shrubs include *Quercus pungens* (sandpaper oak), *Nolina erumpens* (foothill beargrass), *Viguiera stenoloba* (skeletonleaf goldeneye), *Agave lechuguilla* (lechuguilla), *Agave lechuguilla* (lechuguilla), *Rhus virens* (evergreen sumac), and *Leucophyllum minus* (Big Bend silverleaf), and *Cercocarpus montanus* (alderleaf mountain mahogany). *Juniperus pinchotii* (Pinchot juniper), *Ephedra aspera* (rough jointfir), *Dalea formosa* (featherplume), *Opuntia camanchica* (Comanche pricklypear), *Fraxinus greggii* (littleleaf ash), *Gymnosperma glutinosum* (gumhead), *Hechtia texensis* (Texas false agave) (locally numerous on rockier, more exposed sites), *Garrya ovata* ssp. *goldmanii* (Goldman's silktassel), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Vauquelinia corymbosa* ssp. *angustifolia* (slimleaf rosewood), *Chrysactinia mexicana* (damianita), *Quercus grisea* (grey oak), *Parthenium incanum* (mariola), *Senegalia roemeriana* (Roemer's catclaw), *Bernardia obovata* (desert myrtlecroton), *Argythamnia*

*serrata* (Yuma silverbush), *Mahonia trifoliolata* (agarita), *Fouquieria splendens* (ocotillo), and *Dalea formosa* (featherplume) are less constant shrub species. While not always constant, *Parthenium argentatum* (guayule), *Purshia ericifolia* (heath cliffrose), and *Zinnia acerosa* (spinyleaf zinnia) are characteristic of this association within BIBE. *Coryphantha echinus* (sea urchin cactus), *Echinocereus dasyacanthus* (Texas rainbow cactus), and *Neolloydia conoidea* (Texas cone cactus) are small cacti that often are present.

The herbaceous stratum is moderately dense to dense and usually dominated by some combination of the five grass species *Bouteloua curtipendula* (sideoats grama), *Bouteloua hirsuta* (hairy grama), *Tridens muticus* (slim tridens), *Aristida purpurea* (purple threeawn), and/or *Panicum hallii* (Hall's panicgrass). With the exception of *Heteropogon contortus*, which appears not to occur in this association, this is the same suite of grass species that is characteristic of the low montane shrub grasslands of the Chisos Mountains. Fenstermacher (2007) noted *Enneapogon desvauxii* (feather pappusgrass), *Leptochloa dubia* (green sprangletop), and *Muhlenbergia tenuifolia* (mesa muhly) in this vegetation. Frequent pteridophytes and forbs include *Astrolepis cochisensis* (Cochise scaly cloak fern), *Selaginella lepidophylla* (resurrection plant), *Selaginella wrightii* (Wright's spikemoss), *Lesquerella purpurea* (rose bladderpod), and *Chamaesyce* sp. (sandmats). Stratum and substrate cover for Yucca – Sotol Calcareous Shrub Grassland are shown in Table D-37.

**Table D-37.** Stratum and substrate cover recorded for Yucca – Sotol Calcareous Shrub Grassland at Big Bend National Park (# plots=2).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	21	1–40
	Short Shrub	40	25–55
	Herb	32	9–55
Substrate	Bedrock	0	0–0
	Large/Small Rocks	73	60–85
	Litter/Duff	23	5–40

The Calcareous Mixed Desert Scrub occurs just below the Yucca – Sotol Calcareous Shrub Grassland (up to about 4,800 feet) in the Dead Horse Mountains, and its higher elevation stands may have some of the same shrub species, including *Yucca faxoniana*. The best differential condition between the two associations where they may overlap is the relative abundance and usual leading dominance of *Bouteloua ramosa* (chino grama) among grass species in the Calcareous Mixed Scrub versus its replacement by the more cold-tolerant species listed above for the Yucca – Sotol Calcareous Shrub Grassland.

#### Environment:

Fenstermacher (2007) described the corresponding vegetation as the dominant vegetation above 5,000 feet in the Dead Horse Mountains (these elevations are reached on Sue Peaks and on the

Stuarts Peak ridge). During the accuracy assessment, it was observed from about 4,800 feet to the summits of the Sue Peaks at about 5,800 feet (the highest part of the Dead Horse Mountains in BIBE). The bedrock of these areas is mapped as Santa Elena Limestone. Within BIBE, this association appears to be limited to the high Dead Horse Mountains. It is likely to occur in Mexico in the Sierra del Carmen.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)

USNVC Alliance: *Dasyllirion* spp. – *Bouteloua curtipendula* – *Muhlenbergia setifolia* Foothill Desert Grassland Alliance (A3205)

NPS Association: *Yucca faxoniana* – *Yucca thompsoniana* – *Dasyllirion leiophyllum* / *Nolina erumpens* – *Bouteloua curtipendula* Shrub Grassland Association (NPS040)

#### Comments:

The species accounted for by the USNVC *Yucca faxoniana* / *Bouteloua hirsuta* – *Bouteloua gracilis* – *Bouteloua eriopoda* Shrub Herbaceous Vegetation Association (CEGL004248), attributed to the Dead Horse Mountains and the most similar association recognized by the USNVC (2017), apparently describes vegetation of somewhat lower elevations, perhaps from the Black Gap Wildlife Management Area. While there is some overlap in species, the concept of CEL004248 does not match the vegetation observed by this project or by Fenstermacher (2007), and two of its four nominal species were not seen by either of the latter studies. Therefore, the BIBE vegetation association is not translated to any currently published USNVC type. Most frequent plant taxa recorded in *Yucca* – Sotol Calcareous Shrub Grassland are shown in Table D-38.

**Table D-38.** Synthesis table for the most frequent plant taxa recorded in *Yucca* – Sotol Calcareous Shrub Grassland at Big Bend National Park (# plots=2).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Juniperus pinchotii</i>	Shrub	100.0%	10.1	1–28
<i>Parthenium argentatum</i>	Shrub	100.0%	9.5	1–25
<i>Nolina erumpens</i>	Shrub	100.0%	7.5	5–10
<i>Dasyllirion leiophyllum</i>	Shrub	100.0%	4.5	1–10
<i>Yucca faxoniana</i>	Shrub	100.0%	3.9	few–10
<i>Viguiera stenoloba</i>	Shrub	100.0%	2.5	1–5
<i>Ephedra aspera</i>	Shrub	100.0%	1.7	few–4
<i>Gutierrezia</i> sp.	Shrub	100.0%	1.0	few–2
<i>Krameria</i> sp.	Shrub	100.0%	1.0	few–2

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Echinocereus dasyacanthus</i>	Shrub	100.0%	0.1	trace
<i>Rhus microphylla</i>	Shrub	50.0%	38.4	0–51
<i>Rhus virens</i>	Shrub	50.0%	4.9	0–7
<i>Mahonia trifoliolata</i>	Shrub	50.0%	3.5	0–5
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	50.0%	3.5	0–5
<i>Diospyros texana</i>	Shrub	50.0%	3.0	0–3
<i>Koeberlinia spinosa</i>	Shrub	50.0%	1.5	0–2
<i>Senegalia</i> sp.	Shrub	50.0%	1.5	0–2
<i>Vachellia constricta</i>	Shrub	50.0%	1.5	0–2
<i>Agave lechuguilla</i>	Shrub	50.0%	0.5	0–1
<i>Zinnia acerosa</i>	Shrub	50.0%	0.5	0–1
<i>Bernardia obovata</i>	Shrub	50.0%	0.1	0–trace
<i>Condalia</i> sp.	Shrub	50.0%	0.1	0–trace
<i>Coryphantha echinus</i>	Shrub	50.0%	0.1	0–trace
<i>Dalea frutescens</i>	Shrub	50.0%	0.1	0–trace
<i>Fouquieria splendens</i>	Shrub	50.0%	0.1	0–trace
<i>Fraxinus greggii</i>	Shrub	50.0%	0.1	0–trace
<i>Yucca torreyi</i>	Shrub	50.0%	0.1	0–trace
<i>Aristida</i> sp.	Herb	100.0%	4.0	few–10
<i>Bouteloua curtipendula</i>	Herb	100.0%	3.5	2–5
<i>Chamaesyce</i> sp.	Herb	100.0%	0.3	trace–few
<i>Lesquerella purpurea</i>	Herb	100.0%	0.3	trace–few
<i>Bouteloua hirsuta</i>	Herb	50.0%	37.5	0–50
<i>Tridens muticus</i>	Herb	50.0%	37.5	0–50
<i>Bouteloua</i> sp.	Herb	50.0%	1.5	0–2
<i>Hilaria</i> sp.	Herb	50.0%	1.5	0–2
<i>Astrolepis</i> sp.	Herb	50.0%	0.5	0–1
<i>Selaginella</i> sp.	Herb	50.0%	0.5	0–1
<i>Thelesperma</i> sp.	Herb	50.0%	0.5	0–1
<i>Thymophylla</i> sp.	Herb	50.0%	0.5	0–1
<i>Castilleja rigida</i>	Herb	50.0%	0.1	0–trace
<i>Thamnosma texana</i>	Herb	50.0%	0.1	0–trace



Photo 37. Yucca – Sotol Calcareous Shrub Grassland, west slope of Sue Peaks, Dead Horse Mountains (BIBEAA1199). Photo by Jeff Renfrow.



Photo 38. Yucca – Sotol Calcareous Shrub Grassland, west slope of Sue Peaks, Dead Horse Mountains (BIBEAA1204). Photo by Rebecca Evans.

## **Sotol – Lechuguilla Foothills Shrub Grassland**

### Local Type Concept:

Shrub grassland (steppe) at lower elevations of mountains and their associated bajadas, with *Dasyllirion leiophyllum* (green sotol) and *Agave lechuguilla* (lechuguilla) the dominant shrubs and various grasses, including *Bouteloua* spp. (gramas), *Heteropogon contortus* (tanglehead)) *Aristida* spp. (purple threeawn), and/or *Panicum hallii* (Hall's panicgrass), dominant in the herbaceous stratum.

### Vegetation:

This association is a grassland with variable shrub cover (sparse and scattered to moderately dense). It is characterized by dominance of one or more of several lower montane grass species, including (in order of constancy and abundance): *Bouteloua curtipendula* (sideoats grama), *Heteropogon contortus* (tanglehead), *Bouteloua ramosa* (chino grama), *Aristida purpurea* (purple threeawn), *Panicum hallii* (Hall's panicgrass), *Leptochloa dubia* (sprangletop), and/or *Bouteloua hirsuta* (hairy grama). Less constant grass species that may contribute significant cover locally include *Bothriochloa barbinodis* (cane bluestem), *Tridens muticus* (slim tridens), *Bouteloua eriopoda* (black grama), *Digitaria californica* (Arizona cottontop), *Erioneuron pilosum* (hairy woollygrass), and *Aristida ternipes* (spidergrass). Various forbs and ferns have minor amounts of cover.

The shrub stratum, which almost always comprises less cover than the herbaceous stratum, is also variable. *Dasyllirion leiophyllum* (green sotol) and *Agave lechuguilla* (lechuguilla) are the most constant species, and both often are present. Other fairly constant species include *Viguiera stenoloba* (skeletonleaf goldeneye), *Fouquieria splendens* (ocotillo), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Parthenium incanum* (mariola), *Forestiera angustifolia* (desert olive), *Vachellia constricta* (whitethorn acacia), *Tecoma stans* (yellow trumpetbush), *Senegalia greggii* (Gregg's catclaw), *Cylindropuntia imbricata* (tree cholla), *Dalea formosa* (featherplume), *Acaciella angustissima* (prairie acacia), and *Gymnosperma glutinosum* (gumhead). Species that occur sporadically but are more characteristic of higher elevation include *Fraxinus greggii* (littleleaf ash) and *Rhus virens* (evergreen sumac), while *Larrea tridentata* (creosotebush) and *Jatropha dioica* (leatherstem) are desert scrub species that may occur and may contribute locally significant cover. Stratum and substrate cover for Sotol – Lechuguilla Foothills Shrub Grassland are shown in Table D-39.



**Table D-39.** Stratum and substrate cover recorded for Sotol – Lechuguilla Foothills Shrub Grassland at Big Bend National Park (# plots=30).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	6	0–60
	Short Shrub	33	5–90
	Herb	30	5–90
Substrate	Bedrock	4	0–69
	Large/Small Rocks	56	13–94
	Litter/Duff	23	0–89

#### Environment:

This association is the primary vegetation of non-calcareous (volcanic and sedimentary) substrates between about 3,600 feet and 5,100 feet in elevation, occurring on all aspects. Outlier stands extend down to about 3,000 feet and up to about 5,500 feet. It often is the matrix vegetation of the foothills of the Chisos Mountains, sometimes extending outward from the mountains onto upper bajadas and inward up the lower elevations of canyons. It also covers much of the Sierra Quemada and likely is common in the Rosillos Mountains. The Sotol – Lechuguilla Foothills Shrub Grassland generally prefers somewhat higher elevations than the Chino Grama Shrub Grassland, although these types do intermingle, often with the former occupying slopes of less solar exposure (*e.g.*, north-facing), while the latter dominating warmer (south-facing) slopes at a given elevation of sympatry.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)

USNVC Alliance: *Dasyllirion* spp. – *Bouteloua curtipendula* – *Muhlenbergia setifolia* Foothill Desert Grassland Alliance (A3205)

NPS Association: *Dasyllirion leiophyllum* – *Agave lechuguilla* / *Bouteloua curtipendula* – *Heteropogon contortus* Shrubland Association (NPSBIBE030)

#### Comments:

The USNVC recognizes two associations for the Trans-Pecos that whose nominal shrub species reflect important species in this BIBE entity: *Dasyllirion leiophyllum* – *Agave lechuguilla* / *Bouteloua hirsuta* – *Bouteloua gracilis* – *Bouteloua eriopoda* Shrubland Association (CEGL004245) and the *Dasyllirion leiophyllum* – *Viguiera stenoloba* – *Agave lechuguilla* / *Bouteloua ramosa* Shrubland Association CEGL004604. The two most constant and abundant grass species at BIBE are *Bouteloua curtipendula* (sideoats grama) and *Heteropogon contortus* (tanglehead). Although the nominal shrub



species describe the BIBE stands well, the herbaceous nominal species do not include the most abundant and constant species at BIBE. It is possible that the USNVC concepts conceptually overlap (but apparently do not cover), this BIBE vegetation.

BIBE Classification Plots Included in Concept:

BIBE0004, BIBE0019, BIBE0025, BIBE0053, BIBE0055, BIBE0058, BIBE0059, BIBE0060, BIBE0061, BIBE0131, BIBE0176, BIBE0188, BIBE0191, BIBE0193, BIBE0205, BIBE0227, BIBE0230, BIBE0231, BIBE0232, BIBE0233, BIBE0387, BIBE0389, BIBE0410, BIBE0455, BIBE0456, BIBE0457, BIBE0459, BIBE0461, BIBE0462, BIBE0463.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0087, BIBEAA0088, BIBEAA0089, BIBEAA0109, BIBEAA0192, BIBEAA0383, BIBEAA0385, BIBEAA0386, BIBEAA0393, BIBEAA0398, BIBEAA0399, BIBEAA0400, BIBEAA0401, BIBEAA0405, BIBEAA0406, BIBEAA0440, BIBEAA0441, BIBEAA0442, BIBEAA0443, BIBEAA0444, BIBEAA0446, BIBEAA0470, BIBEAA0498, BIBEAA0499, BIBEAA0500, BIBEAA0501, BIBEAA0502, BIBEAA0504, BIBEAA0505, BIBEAA0507, BIBEAA0509, BIBEAA0510, BIBEAA0512, BIBEAA0513, BIBEAA0514, BIBEAA0568, BIBEAA0576, BIBEAA0673, BIBEAA0675, BIBEAA0695, BIBEAA0716, BIBEAA0717, BIBEAA0718, BIBEAA0719, BIBEAA0720, BIBEAA0724, BIBEAA0733, BIBEAA0743, BIBEAA0744, BIBEAA0815, BIBEAA0820, BIBEAA0860, BIBEAA0864, BIBEAA0874, BIBEAA0877, BIBEAA0878, BIBEAA0879, BIBEAA0918, BIBEAA0921, BIBEAA0922, BIBEAA0924, BIBEAA0925, BIBEAA0926, BIBEAA0927, BIBEAA0928, BIBEAA0932, BIBEAA0933, BIBEAA0934, BIBEAA0935, BIBEAA0936, BIBEAA0938, BIBEAA1284.

Most frequent plant taxa recorded in Sotol – Lechuguilla Foothills Shrub Grassland are shown in Table D-40.

**Table D-40.** Synthesis table for the most frequent plant taxa recorded in Sotol – Lechuguilla Foothills Shrub Grassland in Big Bend National Park (# plots=30).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Agave lechuguilla</i>	Shrub	90.0%	6.9	0–50
<i>Dasylirion leiophyllum</i>	Shrub	90.0%	6.0	0–50
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	86.7%	3.3	0–30
<i>Viguiera stenoloba</i>	Shrub	76.7%	3.4	0–50
<i>Vachellia constricta</i>	Shrub	66.7%	2.1	0–35
<i>Cylindropuntia imbricata</i>	Shrub	53.3%	0.6	0–6
<i>Parthenium incanum</i>	Shrub	43.3%	1.5	0–25
<i>Dalea formosa</i>	Shrub	40.0%	0.4	0–5
<i>Fouquieria splendens</i>	Shrub	36.7%	0.8	0–16
<i>Echinocereus stramineus</i>	Shrub	36.7%	0.2	0–2
<i>Forestiera angustifolia</i>	Shrub	33.3%	0.3	0–2

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Senegalia greggii</i>	Shrub	33.3%	0.3	0–5
<i>Senegalia roemeriana</i>	Shrub	30.0%	0.6	0–2
<i>Opuntia camanchica</i>	Shrub	30.0%	0.2	0–2
<i>Prosopis glandulosa</i>	Shrub	26.7%	0.4	0–5
<i>Rhus virens</i>	Shrub	26.7%	0.4	0–10
<i>Krameria grayi</i>	Shrub	26.7%	0.2	0–2
<i>Tecoma stans</i>	Shrub	26.7%	0.2	0–2
<i>Mammillaria lasiacantha</i>	Shrub	23.3%	0.1	0–2
<i>Echinocereus dasyacanthus</i>	Shrub	26.7%	0.1	0–1
<i>Croton pottsii</i>	Shrub	26.7%	0.1	–
<i>Guaiaacum angustifolium</i>	Shrub	23.3%	1.0	0–35
<i>Larrea tridentata</i>	Shrub	23.3%	0.9	0–25
<i>Mammillaria meiacantha</i>	Shrub	23.3%	0.1	0–1
<i>Opuntia</i> sp.	Shrub	20.0%	0.8	0–12
<i>Gutierrezia</i> sp.	Shrub	20.0%	0.3	0–6
<i>Jatropha dioica</i>	Shrub	20.0%	0.2	0–2
<i>Echinocereus russanthus</i>	Shrub	20.0%	0.1	0–1
<i>Mimosa aculeaticarpa</i> var. <i>biuncifera</i>	Shrub	20.0%	0.1	0–1
<i>Rhus microphylla</i>	Shrub	19.2%	0.2	0–5
<i>Jefea brevifolia</i>	Shrub	16.7%	0.7	0–25
<i>Leucophyllum frutescens</i>	Shrub	16.7%	0.4	0–3
<i>Aloysia wrightii</i>	Shrub	16.7%	0.2	0–4
<i>Acaciella angustissima</i>	Shrub	16.7%	0.2	0–2
<i>Flourensia cernua</i>	Shrub	16.7%	0.1	0–3
<i>Hibiscus denudatus</i>	Shrub	16.7%	0.1	0–1
<i>Ephedra aspera</i>	Shrub	16.7%	0.1	0–1
<i>Heteropogon contortus</i>	Herb	83.3%	4.8	0–50
<i>Bouteloua curtipendula</i>	Herb	80.0%	5.6	0–50
<i>Bouteloua ramosa</i>	Herb	50.0%	3.9	0–75
<i>Panicum hallii</i>	Herb	43.3%	0.8	0–2
<i>Aristida purpurea</i>	Herb	33.3%	1.6	0–25
<i>Croton</i> sp.	Herb	33.3%	0.2	0–1
<i>Astrolepis cochisensis</i>	Herb	30.0%	0.3	0–5
<i>Cathastecum erectum</i>	Herb	26.7%	2.3	0–25
<i>Bouteloua eriopoda</i>	Herb	23.3%	3.2	0–50
<i>Bouteloua hirsuta</i>	Herb	20.0%	0.5	0–5
<i>Tridens muticus</i>	Herb	20.0%	0.3	0–5



Photo 39. Sotol – Lechuguilla Foothills Shrub Grassland, near Government Spring along Grapevine Hills Road (BIBEAA0743). Photo by Chris Lea.



Photo 40. Sotol – Lechuguilla Foothills Shrub Grassland, along Dodson Trail near Smoky Creek / Blue Creek divide, with *Heteropogon contortus* dominant (BIBEAA0925). Photo by Kelon Crawford.

## Chino Grama Shrub Grassland

### Local Type Concept:

Desert grasslands (grasses mixed with xeromorphic shrubs) with the common environmental influences of the highest elevations within the desert scrub zone of BIBE (typically, 3,000 to 4,000 feet) and non-calcareous substrates. *Bouteloua ramosa* (chino grama) has moderate to high cover. A mix of shrub species typical of both desert scrub and steppe grasslands is present, but usually does not attain high cover (the shrub stratum tends to have lower cover than the herbaceous stratum). *Larrea tridentata* (creosotebush) is inconstant and usually relatively unimportant.

### Vegetation:

A sparse to moderate shrub stratum is usually dominated by *Agave lechuguilla* (lechuguilla), with a variety of other desert scrub/steppe species contributing [usually] low cover. *Bouteloua ramosa* (chino grama) is strongly dominant in the herbaceous stratum and the species usually exceeds 10% cover. Other grass species that may occur at significant cover include *Heteropogon contortus* (tanglehead), *Bouteloua curtipendula* (sideoats grama), *Panicum hallii* (Hall's panicgrass), *Dasyochloa pulchella* (fluffgrass), and *Digitaria californica* (Arizona cottontop). *Tiquilia canescens* (woody crinklemat) is a frequent forb or subshrub.

The most constant species of the shrub stratum are *Agave lechuguilla* (lechuguilla), *Viguiera stenoloba* (skeletonleaf goldeneye) and *Fouquieria splendens* (ocotillo). Others that may contribute significant cover, at least locally, are *Larrea tridentata* (creosotebush) *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Dasyilirion leiophyllum* (green sotol) and *Parthenium incanum* (mariola). Less constant, and, usually, low cover, species include *Guaiacum angustifolium* (guayacan), *Jatropha dioica* (leatherstem), *Opuntia camanchica* (Comanche pricklypear), *Ephedra aspera* (rough jointfir), *Senegalia greggii* (Gregg's catclaw), *Forestiera angustifolia* (desert olive), *Vachellia constricta* (whitethorn acacia), *Tecoma stans* (yellow trumpetbush) *Cylindropuntia imbricata* (tree cholla), *Opuntia rufida* (blind pricklypear), *Prosopis glandulosa* (honey mesquite), and *Echinocereus stramineus* (strawberry hedgehog cactus). Stratum and substrate cover for Chino Grama Shrub Grassland are shown in Table D-41.

**Table D-41.** Stratum and substrate cover recorded for Chino Grama Shrub Grassland at Big Bend National Park (# plots=19).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	2	0–30
	Short Shrub	22	5–40
	Herb	36	10–60
Substrate	Bedrock	2	0–20
	Large/Small Rocks	81	25–99
	Litter/Duff	5	1–15

### Environment:

This association covers significant areas of the foothills of the Chisos Mountains and is most abundant between about 3,000 feet and 4,000 feet in elevation. It extends up to at least 5,200 feet on warmer (south to west facing) exposures and down to about 2,500 feet on northern exposures. It also occurs throughout the Sierra Quemada and likely occurs in the Rosillos Mountains.

The Chino Grama Shrub Grassland generally prefers somewhat lower elevations than the Sotol – Lechuguilla Foothills Shrub Grassland. Where the types intermingle, the former often occurs on warmer (*e.g.*, south-facing) slopes, while the latter dominates more shaded (north-facing) slopes.

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Desert Foothill-Piedmont & Lower Montane Grassland Group (G490)

USNVC Alliance: *Dasyllirion* spp. – *Bouteloua curtipendula* – *Muhlenbergia setifolia* Foothill Desert Grassland Alliance (A3205)

USNVC Association: *Dasyllirion leiophyllum* – *Viguiera stenoloba* – *Agave lechuguilla* / *Bouteloua ramosa* Shrubland Association (CEGL004604)

### Comments:

*Bouteloua ramosa* appears to be cold-sensitive and experiences considerable mortality acute and prolonged cold winter periods. In many stands where plants have recently died, *Heteropogon contortus* (tanglehead) often opportunistically and quickly replaces *B. ramosa*.

The USNVC (2017) *Dasyllirion leiophyllum* – *Viguiera stenoloba* – *Agave lechuguilla* / *Bouteloua ramosa* Shrubland (CEGL004604) was employed for the translation. The USNVC (2017) description has no useful information, other than the name and the attribution to Texas. However, the nominal species fit the BIBE vegetation well; therefore, it is employed for the USNVC translation.

Considering available data, it is recommended that *Dasyllirion leiophyllum*, which is not as constant in BIBE stands as the other nominal species and is more characteristic of higher elevation vegetation, be dropped from the name. If needed, *Fouquieria splendens* is a more constant and abundant species (at BIBE) that could serve as a replacement.

### BIBE Classification Plots Included in Concept:

BIBE0005, BIBE0006, BIBE0014, BIBE0030, BIBE0086, BIBE0098, BIBE0123, BIBE0124, BIBE0125, BIBE0126, BIBE0196, BIBE0362, BIBE0364, BIBE0365, BIBE0406, BIBE0407, BIBE0418, BIBE0450, BIBE0453.

### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0084, BIBEAA0086, BIBEAA0090, BIBEAA0091, BIBEAA0110, BIBEAA0111, BIBEAA0118, BIBEAA0121, BIBEAA0122, BIBEAA0126, BIBEAA0136, BIBEAA0387,



BIBEEA0388, BIBEEA0389, BIBEEA0392, BIBEEA0396, BIBEEA0397, BIBEEA0402, BIBEEA0403, BIBEEA0404, BIBEEA0445, BIBEEA0506, BIBEEA0511, BIBEEA0515, BIBEEA0516, BIBEEA0517, BIBEEA0578, BIBEEA0579, BIBEEA0581, BIBEEA0665, BIBEEA0694, BIBEEA0715, BIBEEA0919, BIBEEA0920, BIBEEA0923, BIBEEA0929, BIBEEA0930, BIBEEA0931, BIBEEA0937.

Most frequent plant taxa recorded in Chino Grama Shrub Grassland are shown in Table D-42.

**Table D-42.** Synthesis table for the most frequent plant taxa recorded in Chino Grama Shrub Grassland at Big Bend National Park (# plots=19).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Agave lechuguilla</i>	Shrub	90.0%	6.3	0–25
<i>Viguiera stenoloba</i>	Shrub	85.0%	2.1	0–25
<i>Guaiaacum angustifolium</i>	Shrub	60.0%	0.8	0–9
<i>Opuntia camanchica</i>	Shrub	60.0%	0.5	0–7
<i>Fouquieria splendens</i>	Shrub	55.0%	1.4	0–25
<i>Opuntia engelmannii</i> var <i>engelmannii</i>	Shrub	55.0%	0.5	0–6
<i>Parthenium incanum</i>	Shrub	50.0%	0.9	0–10
<i>Dasylirion leiophyllum</i>	Shrub	50.0%	0.8	0–11
<i>Ephedra aspera</i>	Shrub	45.0%	0.3	0–3
<i>Echinocereus stramineus</i>	Shrub	45.0%	0.2	0–1
<i>Prosopis glandulosa</i>	Shrub	40.0%	0.2	0–2
<i>Echinocereus dasyacanthus</i>	Shrub	40.0%	0.2	0–1
<i>Tiquilia greggii</i>	Shrub	35.0%	1.1	0–25
<i>Leucophyllum frutescens</i>	Shrub	35.0%	0.4	0–3
<i>Menodora scabra</i>	Shrub	35.0%	0.2	0–1
<i>Echinocactus horizonthalonius</i>	Shrub	35.0%	0.1	0–1
<i>Jatropha dioica</i>	Shrub	30.0%	0.6	0–10
<i>Flourensia cernua</i>	Shrub	30.0%	0.3	0–25
<i>Opuntia rufida</i>	Shrub	25.0%	1.9	0–25
<i>Cylindropuntia leptocaulis</i>	Shrub	25.0%	0.4	0–6
<i>Krameria grayi</i>	Shrub	25.0%	0.2	0–2
<i>Mammillaria lasiacantha</i>	Shrub	25.0%	0.1	0–1
<i>Larrea tridentata</i>	Shrub	20.0%	1.1	0–25
<i>Senegalia roemeriana</i>	Shrub	20.0%	0.3	0–3
<i>Forestiera angustifolia</i>	Shrub	20.0%	0.2	0–2
<i>Ziziphus obtusifolia</i>	Shrub	20.0%	0.1	0–1
<i>Krameria erecta</i>	Shrub	15.0%	0.2	0–2
<i>Tecoma stans</i>	Shrub	15.0%	0.2	0–2



<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Senegalia greggii</i>	Shrub	15.0%	0.1	0–2
<i>Cylindropuntia imbricata</i>	Shrub	15.0%	0.1	0–2
<i>Bouteloua ramosa</i>	Herb	100.0%	26.5	5–75
<i>Tiquilia canescens</i>	Herb	45.0%	0.3	0–2
<i>Croton</i> sp.	Herb	40.0%	0.2	0–2
<i>Heteropogon contortus</i>	Herb	35.0%	1.1	0–25
<i>Panicum hallii</i>	Herb	35.0%	0.2	0–1
<i>Chamaesyce</i> sp.	Herb	35.0%	0.2	0–1
<i>Dasyochloa pulchella</i>	Herb	30.0%	1.0	0–25
<i>Bouteloua curtipendula</i>	Herb	25.0%	0.5	0–5
<i>Selaginella lepidophylla</i>	Herb	25.0%	0.2	0–2
<i>Aristida</i> sp.	Herb	20.0%	0.1	0–2
<i>Astrolepis</i> sp.	Herb	20.0%	0.1	0–1
<i>Bahia absinthifolia</i>	Herb	20.0%	0.1	0–1
<i>Trixis californica</i>	Herb	20.0%	0.1	0–1
<i>Aristida arizonica</i>	Herb	15.0%	0.2	0–2
<i>Thymophylla acerosa</i>	Herb	15.0%	0.2	0–5
<i>Astrolepis integerrima</i>	Herb	15.0%	0.1	0–1
<i>Chamaesyce cinerascens</i>	Herb	15.0%	0.1	0–1



Photo 41. Chino Grama Shrub Grassland, Pine Creek Canyon (BIBEAA0084). Photo by Jeff Renfrow.



Photo 42. Chino Grama Shrub Grassland, east slope of Kit Mountain along Ross Maxwell Scenic Drive (BIBEAA0118). Photo by Rebecca Evans.

## ***Tobosa Grass Desert Grassland***

### Local Type Concept:

Grasslands dominated (usually strongly so) by *Pleuraphis mutica* (tobosa grass).

### Vegetation:

*Pleuraphis mutica* (tobosa grass) is strongly dominant. Associated grasses and forbs, usually occurring at low cover, include *Bothriochloa* spp. (beardgrass), *Croton* spp. (croton), *Pennisetum ciliare* (buffelgrass), *Salsola tragus* (Russian thistle), and *Sorghum halepense* (Johnson grass). There usually is a modest level of shrub cover (up to 15%), with *Prosopis glandulosa* (honey mesquite) and *Larrea tridentata* (creosotebush) fairly constant. *Ziziphus obtusifolia* (lotebush), *Atriplex canescens* (fourwing saltbush), *Cylindropuntia leptocaulis* (Christmas cactus), *Flourensia cernua* (American tarbush), and/or *Argythamnia serrata* (Yuma silverbush) are occasional as scattered shrubs. Species richness typically is low. Stratum and substrate cover for Tobosa Grass Desert Grassland are shown in Table D-43.

**Table D-43.** Stratum and substrate cover recorded for Tobosa Grass Desert Grassland at Big Bend National Park (# plots=6).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	1	0–5
	Short Shrub	6	2–10
	Herb	81	60–90
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–0
	Litter/Duff	26	0–85

### Environment:

This association occurs in relatively small patches within a mosaic of desert scrub that would be classified either as Big Bend Lowlands Creosotebush Desert Scrub or as the Mesquite – Creosotebush Desert Scrub. In fact, because of the apparent absence of floristic and environment differences where *Pleuraphis mutica* occurs (other than the abundance of *P. mutica*), it might well be considered patches or stands of *P. mutica* that are embedded within the shrubland types. It is recognized here as an association because of the established UNSVC (2017) concept.

Most of this vegetation in BIBE occurs scattered along extensive flats with fine-textured soils in the broad valley north of Panther Junction within the drainages of Tornillo Creek and Nine Point Draw, at elevations from about 2,300 to 3,000 feet. It also occurs in drainages, particularly along the western side of the Chisos (up to 4,300 feet) and on flats along the Rio Grande (as low as 2,000 feet).

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)  
 USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)  
 USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)  
 USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)  
 USNVC Group: Chihuahuan Semi-Desert Lowland Grassland Group (G489)  
 USNVC Alliance: *Pleuraphis mutica* Lowland Grassland Alliance (A3185)  
 USNVC Association: *Pleuraphis mutica* Monotype Herbaceous Vegetation Association (CEGL001637)

Comments:

The choice for the USNVC (2017) translation to CEGL001637 (in Group G489) provides a more consistent USNVC group level fit than does *Larrea tridentata* / *Pleuraphis mutica* Shrub Herbaceous Vegetation (CEGL001542) (in Group G490), since the BIBE stands are closely associated with desert scrub and not at all with foothills and montane grasslands (as G490 represents).

BIBE Classification Plots Included in Concept:

BIBE0010, BIBE0339, BIBE0344, BIBE0354, BIBE0357, BIBE0401.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0058, BIBEAA0060, BIBEAA0346, BIBEAA0412, BIBEAA0413, BIBEAA0425, BIBEAA0426, BIBEAA0429, BIBEAA0430, BIBEAA0431, BIBEAA0437, BIBEAA0529, BIBEAA0547, BIBEAA0549, BIBEAA0714, BIBEAA0783, BIBEAA0813.

Most frequent plant taxa recorded in Tobosa Grass Desert Grassland are shown in Table D-44.

**Table D-44.** Synthesis table for all plant taxa recorded in Tobosa Grass Desert Grassland at Big Bend National Park (# plots=6).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Larrea tridentata</i>	Shrub	100.0%	1.2	trace–5
<i>Prosopis glandulosa</i>	Shrub	83.3%	3.8	0–20
<i>Cylindropuntia leptocaulis</i>	Shrub	33.3%	0.2	0–2
<i>Parthenium incanum</i>	Shrub	33.3%	0.2	0–1
<i>Atriplex canescens</i>	Shrub	33.3%	0.1	0–1
<i>Vachellia neovernicosa</i>	Shrub	16.7%	0.1	0–1
<i>Atriplex obovata</i>	Shrub	16.7%	0.1	0–1
<i>Cylindropuntia imbricata</i>	Shrub	16.7%	0.1	0–1
<i>Echinocereus enneacanthus</i>	Shrub	16.7%	0.1	0–1
<i>Vachellia constricta</i>	Shrub	16.7%	0.1	0–trace
<i>Pleuraphis mutica</i>	Herb	100.0%	68.3	50–100
<i>Sporobolus</i> sp.	Herb	33.3%	1.2	0–5
<i>Aristida purpurea</i>	Herb	33.3%	0.8	0–5

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Bouteloua barbata</i>	Herb	33.3%	0.3	0–2
<i>Pennisetum ciliare</i>	Herb	33.3%	0.3	0–2
<i>Panicum hallii</i>	Herb	33.3%	0.2	0–1
<i>Calliandra humilis</i>	Herb	33.3%	0.1	0–1
<i>Leptochloa panicea</i> ssp. <i>mucronata</i>	Herb	16.7%	0.6	0–5
<i>Chloris verticillata</i>	Herb	16.7%	0.3	0–2
<i>Malvella leprosa</i>	Herb	16.7%	0.3	0–2
<i>Sorghum halepense</i>	Herb	16.7%	0.1	0–1
<i>Kallstroemia parviflora</i>	Herb	16.7%	0.1	0–1
<i>Thymophylla acerosa</i>	Herb	16.7%	0.1	0–1
<i>Allionia incarnata</i>	Herb	16.7%	0.1	0–1
<i>Pectis angustifolia</i>	Herb	16.7%	0.1	0–1
<i>Verbesina encelioides</i>	Herb	16.7%	0.1	0–1
<i>Dyssodia</i> sp.	Herb	16.7%	0.1	0–1
<i>Heliotropium molle</i>	Herb	16.7%	0.1	0–1
<i>Pappophorum bicolor</i>	Herb	16.7%	0.1	0–1
<i>Panicum obtusum</i>	Herb	16.7%	0.1	0–1
<i>Phemeranthus aurantiacus</i>	Herb	16.7%	0.1	0–1





Photo 43. Tobosa Grass Desert Grassland, Tornillo Flat (BIBEAA0425). Photo by Rebecca Evans.



Photo 44. Tobosa Grass Desert Grassland, near Woodson's Camp along Rio Grande (BIBEAA0813). Photo by Rebecca Evans.

### ***Johnson Grass – Russian Thistle Desert Grassland***

#### Local Type Concept:

Grasslands dominated (usually strongly so) by *Sorghum halepense* (Johnson grass) and, less frequently by *Salsola tragus* (Russian thistle).

#### Vegetation:

In most stands, the non-native *Sorghum halepense* (Johnson grass) is strongly dominant, often nearly monotypically. *Salsola tragus* (Russian thistle) is a fairly constant associate and may be an alternative dominant in some stands, in which other ruderal forbs provide some of the cover, including *Sphaeralcea angustifolia* (copper globemallow), *Conyza canadensis* (Canadian horseweed), *Helianthus annuus* (common sunflower), and others. Grass taxa that may be present at lower cover include the two non-native species *Pennisetum ciliare* (buffelgrass) and *Eragrostis lehmanniana* (Lehmann lovegrass), as well as native *Bothriochloa* spp. (beardgrasses), *Aristida* spp. (threeawns), and/or *Sporobolus* spp. (dropseeds). *Prosopis glandulosa* (honey mesquite) is a constant shrub that is present at low cover and occasionally at high enough cover to produce an open shrubland physiognomy. *Larrea tridentata* (creosotebush), *Ziziphus obtusifolia* (lotebush) and *Atriplex canescens* (fourwing saltbush) are occasional as scattered shrubs. Species richness typically is low.

Stands along the Rio Grande have associated species more typical of that riparian zone, including *Arundo donax* (giant cane), *Baccharis salicifolia* (seepwillow), and others.

Stratum and substrate cover for Johnson Grass – Russian Thistle Desert Grassland are shown in Table D-45.

**Table D-45.** Stratum and substrate cover recorded for Johnson Grass – Russian Thistle Desert Grassland at Big Bend National Park (# plots=5).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	0	0–1
	Short Shrub	7	0–25
	Herb	90	75–96
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–2
	Litter/Duff	0	87–100

#### Environment:

This association occurs, syntopically with the Tobosa Grass Desert Grassland, in relatively small patches within a mosaic of desert scrub that would be classified as either Big Bend Lowlands Creosotebush Desert Scrub or the Mesquite – Creosotebush Desert Scrub. Most of this vegetation in BIBE occurs scattered along extensive flats with fine-textured soils in the broad valley north of

Panther Junction within the drainages of Tornillo Creek and Nine Point Draw, where it was observed at elevations from about 2,600 to 3,000 feet. It also occurs less frequently scattered along the Rio Grande floodplain down to at least 1,850 feet in elevation (*e.g.*, at San Vicente Crossing) and is likely in small patches in dry washes elsewhere at low elevations within BIBE.

Stands of Johnson grass may occupy sites that were formerly used for cattle roundup or penning (J. Sirotnak, pers. comm.).

During the map accuracy assessment, stands that lacked or had at best, a small component of either *P. mutica* or *S. halepense*, but were instead dominated by the annual forb *Salsola tragus*, with other ruderal forbs, were observed. There were signs of fairly heavy use of these areas by mule deer and elk in the winter. It is speculated here be that ungulate grazing that might be concentrated in some areas decreases the occurrence of *P. mutica*, and perhaps the invasive *S. halepense*, as well, and promotes the more ruderal species.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm Desert Ruderal Scrub & Grassland Macrogroup (M512)

USNVC Group: North American Warm Desert Ruderal Grassland Group (G677)

USNVC Alliance: *Eragrostis lehmanniana* – *Eragrostis curvula* Ruderal Desert Grassland Alliance (A2687)

NPS Association: *Sorghum halepense* Chihuahuan Desert Herbaceous Vegetation Association (NPSBIBE018)

#### Comments:

This association clearly represents alternative (non-native) dominance in settings otherwise conducive to stands of the native *Pleuraphis mutica* (tobosa grass) and which are attributed to the Tobosa Grass Desert Grassland, within this classification. The two associations share essentially the same associated species and habitat within the Tornillo and Nine Point Draw “flats”.

The Johnson Grass – Russian Thistle Desert Grassland appears somewhat more distinct as a type than does the Tobosa Grass Desert Grassland, in part, because the aggressively rhizomatous growth of *S. halepense* appears to exclude more effectively other species and, therefore, *S. halepense* tends to occur occurs in more monotypic stands. Otherwise, as with the Tobosa Grass Desert Grassland, the Johnson Grass – Russian Thistle Desert Grassland also might be interpreted as patch dominance by a grass species within desert scrub. Rather than create another association to accommodate stands dominated by *S. tragus* and other forbs in settings that were essentially identical, the concept of the *S. halepense* dominated association was expanded to accommodate alternative dominance patterns, at least as observed at BIBE.

The USNVC (2017) *Sorghum halepense* Herbaceous Vegetation (CEGL004108), an association in G583 (Southeastern Old Field Group) of the southeastern U.S., is an inappropriate translation for *Sorghum halepense* stands in the arid southwestern U.S. In general, semi-natural grasslands dominated by exotic species do not appear to be included in the USNVC hierarchy for the western United States, outside of California; therefore this unit is provided as a local provisional unit to cover similar situations in the Chihuahuan Desert region.

BIBE Classification Plots Included in Concept:

BIBE0012, BIBE0149, BIBE0150, BIBE0356, BIBE0361.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0344, BIBEAA0349, BIBEAA0350, BIBEAA0416, BIBEAA0417, BIBEAA0418, BIBEAA0423, BIBEAA0424, BIBEAA0433, BIBEAA0434, BIBEAA0438, BIBEAA0597, BIBEAA1254, BIBEAA1255.

Most frequent plant taxa recorded in Johnson Grass – Russian Thistle Desert Grassland are shown in Table D-46.

**Table D-46.** Synthesis table for all plant taxa recorded in Johnson Grass – Russian Thistle Desert Grassland at Big Bend National Park (# plots=5).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Prosopis glandulosa</i>	Shrub	80.0%	4.1	0–27
<i>Larrea tridentata</i>	Shrub	60.0%	0.5	0–2
<i>Aloysia gratissima</i>	Shrub	40.0%	0.2	0–1
<i>Parthenium incanum</i>	Shrub	20.0%	0.4	0–2
<i>Atriplex canescens</i>	Shrub	20.0%	0.3	0–2
<i>Buddleja marubifolium</i>	Shrub	20.0%	0.1	0–1
<i>Sphaeralcea angustifolia</i>	Herb	20.0%	0.1	0–1
<i>Viguiera stenoloba</i>	Shrub	20.0%	0.1	0–1
<i>Cylindropuntia imbricata</i>	Shrub	20.0%	0.1	0–trace
<i>Lycium berlandieri</i>	Shrub	20.0%	0.1	0–trace
<i>Krameria</i> sp.	Shrub	20.0%	0.1	0–trace
<i>Sorghum halepense</i>	Herb	100.0%	90.0	75–100
<i>Pleuraphis mutica</i>	Herb	40.0%	0.8	0–5
<i>Kallstroemia parviflora</i>	Herb	20.0%	0.1	0–1
<i>Calliandra</i> sp.	Herb	20.0%	0.1	0–1
<i>Laennecia coulteri</i>	Herb	20.0%	0.1	0–1
<i>Nyctaginia capitata</i>	Herb	20.0%	0.1	0–1
<i>Solanum elaeagnifolium</i>	Herb	20.0%	0.1	0–1
<i>Verbesina encelioides</i>	Herb	20.0%	0.1	0–1



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Linum</i> sp.	Herb	20.0%	0.1	0–trace



Photo 45. Johnson Grass – Russian Thistle Desert Grassland, Tornillo Flat (BIBE0012). Photo by Christian Skorik.



Photo 46. Johnson Grass – Russian Thistle Desert Grassland, Tornillo Flat (BIBE0356). Photo by Jill Breeden.



## ***Upland Ruderal Herbaceous Vegetation***

### Local Type Concept:

A placeholder for grasslands or herbaceous forb vegetation characterized by ruderal native and/or non-native species that have become established by significant anthropogenic disturbance and/or are maintained by regular human activities.

### Vegetation:

The Upland Ruderal Herbaceous Vegetation is primarily herbaceous vegetation of areas that have been significantly disturbed in the recent past by human activity (construction, *etc.*) and/or that are maintained by ongoing maintenance (*e.g.*, regular mowing). It is dominated by a number of ruderal native or non-native species, including, but not limited to, *Heteropogon contortus* (tanglehead), *Eragrostis lehmanniana* (Lehmann lovegrass), *Pennisetum ciliare* (buffelgrass), *Conyza canadensis* (Canadian horseweed), *Salsola tragus* (Russian thistle), *Helianthus annuus* (common sunflower), and others.

### Environment:

This vegetation includes much of the mowed roadside strips and other maintained areas throughout BIBE, as well as vegetation in areas of significant soil disturbance around buildings or representing sites of relatively recent construction.

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm Desert Ruderal Scrub & Grassland Macrogroup (M512)

USNVC Group: North American Warm Desert Ruderal Grassland Group (G677)

USNVC Alliance: *Eragrostis lehmanniana* – *Eragrostis curvula* Ruderal Desert Grassland Alliance (A2687)

NPS Association: (*Heteropogon contortus*, *Pennisetum ciliare*, *Eragrostis lehmanniana*) – Mixed Forbs) Chihuahuan Ruderal Herbaceous Vegetation Association (NPSBIBE046)

### Comments:

This concept excludes vegetation dominated by ruderal species that are maintained by natural disturbances, such as herbaceous vegetation of alluvial bars, banks and floodplains (which is covered by the concept of the Rio Grande Alluvial Herbaceous Vegetation) and wash shrublands that are dominated by ruderal invasive species such as *Pennisetum ciliare* (buffelgrass), *Eragrostis lehmanniana* (Lehmann lovegrass), or *Sorghum halepense* (Johnson grass) (which would be considered invaded variants of otherwise natural vegetation associations such as the Big Bend Lowland Wash Channel Shrubland or the Foothills Wash Channel Shrubland).

### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA1281.



Photo 47. Upland Ruderal Herbaceous Vegetation, Big Bend National Park landfill (BIBE1281). Photo by Chris Lea.

## ***Badlands Sparse Vegetation***

### Local Type Concept:

Very sparse to moderately dense vegetation of variable composition on clay “badlands”. The perennial grass *Cathestecum erectum* (false grama) is somewhat characteristic, but variable from stand to stand in occurrence and abundance. Other than this species, total plant cover is usually low, often less than 15% total cover.

### Vegetation:

Total plant cover averages about 20%, but is quite variable, and is often less than 15%. *Larrea tridentata* (creosotebush), *Prosopis glandulosa* (honey mesquite), and/or *Cylindropuntia leptocaulis* (Christmas cactus) are the most constant species of a sparse (average 5% total cover) shrub stratum. *Atriplex canthocarpa* (tuberled saltbush) is a characteristic subshrub. Other (less constant) shrub species include *Opuntia camanchica* (Comanche pricklypear) *Grusonia aggeria* (Big Bend dog cholla), *Fouquieria splendens* (ocotillo), *Krameria grayi* (white ratany), *Atriplex canescens* (fourwing saltbush), *Echinocereus enneacanthus* var. *enneacanthus* (pitaya cactus), *Echinocereus stramineus* (strawberry hedgehog cactus), *Coryphantha macromeris* (little beehive cactus), and *Echinocereus dasyacanthus* (Texas rainbow cactus). The recently described Big Bend endemic *Grusonia densispina* (dense-spined dog cholla) occurs in this association. The herbaceous stratum has variable and sometimes patchy cover. It usually is sparse, but *Cathestecum erectum* (false grama), the most constant species, may contribute locally high cover. Less constant grass species include the perennials *Bouteloua ramosa* (chino grama) *Dasyochloa pulchella* (fluffgrass), *Bouteloua trifida* (red grama), and (non-native) *Pennisetum ciliare* (buffelgrass), and the annual *Bouteloua barbata* (sixweeks grama). Forbs, which include *Chamaesyce albomarginata* (whitemargin sandmat) *Bahia absinthifolia* (hairyseed bahia), and *Tidestromia carnosa* (fleshy honeysweet), usually are sparse. Stratum and substrate cover for Badlands Sparse Vegetation are shown in Table D-47.

**Table D-47.** Stratum and substrate cover recorded for Badlands Sparse Vegetation at Big Bend National Park (# plots=15).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	1	0–7
	Short Shrub	6	0–15
	Herb	22	0–90
Substrate	Bedrock	1	0–10
	Large/Small Rocks	82	34–99
	Litter/Duff	2	0–7

### Environment:

Stands ranged from 1900 to 2700 feet in elevation and were usually recorded as occurring on badlands. These are areas of eroded sedimentary deposits with locally high soil clay content and

often have a surface layer of abundant small rocks. Sites are scattered throughout the western and southern parts of BIBE and include the conspicuous badlands near the Maverick park entrance, near Rattlesnake Mountain, near Terlingua Abajo, along Ross Maxwell Scenic Drive south of Mule Ear Overlook, on the lower slopes of Talley Mountain, and scattered sites near the Rio Grande along River Road East. Sites often are mapped as the Aguja Formation or the Pen Formation.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm Semi-Desert Cliff, Scree, & Rock Vegetation Macrogroup (M117)

USNVC Group: North American Warm Semi-Desert Cliff, Scree, & Pavement Sparse Vegetation Group (G569)

USNVC Alliance: *Tiquilia hispidissima* / *Sporobolus nealleyi* – *Tidestromia carnosa* Gypsum Outcrop & Alluvial Flat Desert Scrub Alliance (A3243)

USNVC Association: *Atriplex obovata* / *Tidestromia carnosa* Dwarf-shrubland (CEGL004575)

#### Comments:

In analysis, the plots clustered into two groups: those with relatively high cover and *Cathestecum erectum* (false grama) and those with low cover and without *C. erectum*. When *C. erectum* is eliminated from the analysis, composition is very similar between the clusters, with overall [non-*Cathestecum erectum*] plant cover low. This appears to be due to the patchy occurrence of *C. erectum* at the plot scale and wide spacing of plants in otherwise fairly homogeneous vegetation.

The USNVC association to which the translation is made is reported from badlands in southern Brewster County and appears to fit this BIBE vegetation, if not derived from it. The floristic composition at BIBE is probably more variable than the nominal species or the description suggest.

#### BIBE Classification Plots Included in Concept:

BIBE0022, BIBE0023, BIBE0211, BIBE0212, BIBE0213, BIBE0214, BIBE0215, BIBE0216, BIBE0240, BIBE0241, BIBE0242, BIBE0340, BIBE0341, BIBE0368, BIBE0414, BIBE0420.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0997, BIBEAA1222, BIBEAA1228, BIBEAA1231, BIBEAA1235.

Most frequent plant taxa recorded in Badlands Sparse Vegetation are shown in Table D-48.

**Table D-48.** Synthesis table for all plant taxa recorded in Badlands Sparse Vegetation at Big Bend National Park (# plots=16).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Larrea tridentata</i>	Shrub	75.0%	1.0	0–6
<i>Opuntia camanchica</i>	Shrub	68.8%	0.2	0–1
<i>Prosopis glandulosa</i>	Shrub	62.5%	0.8	0–6
<i>Grusonia aggeria</i>	Shrub	56.3%	0.3	0–2
<i>Cylindropuntia leptocaulis</i>	Shrub	50.0%	0.4	0–5
<i>Krameria grayi</i>	Shrub	31.3%	0.2	0–2
<i>Echinocereus dasyacanthus</i>	Shrub	25.0%	0.1	0–1
<i>Echinocereus stramineus</i>	Shrub	25.0%	0.1	0–2
<i>Fouquieria splendens</i>	Shrub	25.0%	0.1	0–1
<i>Agave lechuguilla</i>	Shrub	18.8%	0.8	0–10
<i>Leucaena retusa</i>	Shrub	18.8%	0.5	0.5
<i>Echinocactus horizonthalonius</i>	Shrub	18.8%	0.1	0–1
<i>Cylindropuntia imbricata</i>	Shrub	18.8%	0.0	0–1
<i>Ephedra aspera</i>	Shrub	18.8%	0.0	0–1
<i>Atriplex obovata</i>	Shrub	12.5%	0.3	0–5
<i>Vachellia neovernicosa</i>	Shrub	12.5%	0.2	0–3
<i>Jatropha dioica</i>	Shrub	12.5%	0.1	0–2
<i>Yucca torreyi</i>	Shrub	12.5%	0.1	0–2
<i>Atriplex canescens</i>	Shrub	12.5%	0.1	0–2
<i>Echinocereus enneacanthus</i>	Shrub	12.5%	0.1	0–1
<i>Echinocereus russanthus</i>	Shrub	12.5%	0.1	0–1
<i>Cathastecum erectum</i>	Herb	43.8%	13.8	0–95
<i>Bouteloua ramosa</i>	Herb	43.8%	1.9	0–25
<i>Dasyochloa pulchella</i>	Herb	37.5%	0.2	0–1
<i>Chamaesyce albomarginata</i>	Herb	31.3%	0.2	0–1
<i>Croton</i> sp.	Herb	18.8%	0.1	0–1
<i>Bouteloua trifida</i>	Herb	12.5%	1.6	0–25
<i>Boerhavia intermedia</i>	Herb	12.5%	0.1	0–2
<i>Bouteloua</i> sp.	Herb	12.5%	0.1	0–2
<i>Panicum hallii</i>	Herb	12.5%	0.1	0–1
<i>Trianthema portulacastrum</i>	Herb	12.5%	0.1	0–1
<i>Bahia absinthifolia</i>	Herb	12.5%	0.0	0–1





Photo 48. Badlands Sparse Vegetation, along Old Maverick Road (BIBE0022). Photo by Christian Skorik.



Photo 49. Badlands Sparse Vegetation, just east of Maverick Park Entrance (BIBE0216). Photo by Matthew Yarbrough.



## ***Alkaline Clay Flat Shrubland***

### Local Type Concept:

Grasslands or shrublands with somewhat sparse to moderately dense cover on relatively level sites with high soil clay content and likely alkaline (possibly gypseous), with *Suaeda suffrutescens* (desert seepweed) present in the shrub stratum and *Sporobolus pyramidatus* (whorled dropseed) and/or other alkaline-preferring or gypsophilous species in the herbaceous stratum.

### Vegetation:

The observations indicate a fairly distinctive floristic composition, unique within BIBE. The subshrub *Suaeda suffrutescens* (desert seepweed) is consistently present, although at widely ranging cover levels (from less than 1% to 60%). The subshrub *Atriplex acanthocarpa* (tuberclad saltbush) and the taller *Prosopis glandulosa* (honey mesquite) are also fairly constant. The herbaceous stratum is grassy and may be sparse to moderately dense, with *Sporobolus pyramidatus* (whorled dropseed) and the annual *Bouteloua barbata* (sixweeks grama), the most constant species. Other species observed at multiple sites include *Coryphantha macromeris* (little beehive cactus), *Trichloris crinita* (false Rhodes grass), *Trianthema portulacastrum* (desert horsepurslane), and *Echinochloa crus-galli* (barnyardgrass). Stratum and substrate cover for Alkaline Clay Flat Shrubland are shown in Table D-49.

**Table D-49.** Stratum and substrate cover recorded for Alkaline Clay Flat Shrubland at Big Bend National Park (# plots=2).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	1	0–1
	Short Shrub	27	20–35
	Herb	25	20–30
Substrate	Bedrock	0	0–0
	Large/Small Rocks	36	0–71
	Litter/Duff	5	4–5

### Environment:

This association appears to be localized and uncommon within BIBE. The stands from which the two classification plots and three accuracy assessment observations were recorded are generally on gentle slopes in zones near active wash or river channels, but not immediately adjacent to them. Soils were observed to have high clay content and would be characterized as clay loams or clays. All stands occur where either on the Aguja or Pen Formations or on alluvial deposits immediately next to one of these units are mapped as geologic units. The preferences of the dominant species suggest that the substrate is alkaline and perhaps gypseous. Recorded elevations ranged from 1,870 feet to 2,650 feet in elevation. Sites include flats in the Indian Head Trail area near Maverick Mountain along a tributary to Rough Run, in similar settings near Alamo Creek along Old Maverick Road, along an

unnamed tributary to the Rio Grande near San Vicente, and on the Rio Grande floodplain near the Sublette Farm (two sites or, possibly, one larger stand).

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Semi-Desert Grassland Macrogroup (M087)

USNVC Group: Chihuahuan Gypsophilous Grassland Group (G492)

USNVC Alliance: *Tiquilia hispidissima* / *Sporobolus nealleyi* – *Tidestromia carnosa* Gypsum Outcrop & Alluvial Flat Desert Scrub Alliance (A3243)

NPS Association: *Suaeda suffrutescens* / *Sporobolus pyramidatus* Shrubland Association (NPSBIBE027)

#### Comments:

The most abundant and constant shrub species and the most abundant and constant herbaceous species are said to occur on gypseous clays and shales in the trans-Pecos (Powell 1994, Powell 1998).

#### BIBE Classification Plots Included in Concept:

BIBE0020, BIBE0029.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA1224, BIBEAA1227, BIBEAA1250.

Most frequent plant taxa recorded in Alkaline Clay Flat Shrubland are shown in Table D-50.

**Table D-50.** Synthesis table for all plant taxa recorded in Alkaline Clay Flat Shrubland at Big Bend National Park (# plots=2).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Suaeda suffrutescens</i>	Shrub	100.0%	12.6	1–35
<i>Prosopis glandulosa</i>	Shrub	100.0%	0.5	few–1
<i>Atriplex acanthocarpa</i>	Shrub	50.0%	3.8	0–10
<i>Cylindropuntia leptocaulis</i>	Shrub	50.0%	0.8	0–2
<i>Tamarix ramosissima</i>	Shrub	50.0%	0.3	0–1
<i>Grusonia aggeria</i>	Shrub	50.0%	0.3	0–1
<i>Coryphantha macromeris</i>	Shrub	50.0%	0.3	0–1
<i>Sporobolus pyramidatus</i>	Herb	100.0%	12.5	5–25
<i>Bouteloua barbata</i>	Herb	100.0%	0.5	few–1
<i>Trianthema portulacastrum</i>	Herb	100.0%	0.5	few–1
<i>Echinochloa crus-galli</i>	Herb	100.0%	0.5	few–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Trichloris crinita</i>	Herb	50.0%	8.8	0–25
<i>Leptochloa panicea</i> ssp. <i>mucronata</i>	Herb	50.0%	0.8	0–2
<i>Pennisetum ciliare</i>	Herb	50.0%	0.3	0–1
<i>Tidestromia carnosa</i>	Herb	50.0%	0.3	0–1
<i>Bahia absinthifolia</i>	Herb	50.0%	0.3	0–1
<i>Chamaesyce albomarginata</i>	Herb	50.0%	0.3	0–1
<i>Digitaria californica</i>	Herb	50.0%	0.3	0–1
<i>Pleuraphis mutica</i>	Herb	50.0%	0.3	0–1



Photo 50. Alkaline Clay Flat Shrubland, Rio Grande floodplain near Sublette Farm (BIBE0020). Photo by Christian Skorik.



Photo 51. Alkaline Clay Flat Shrubland, southeast of Maverick Mountain (BIBE0029). Photo by Christian Skorik.

## Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub

### Local Type Concept:

Desert scrub with the common environmental influences of middle elevations within the desert scrub zone of BIBE (typically, 2,500 to 3,200 feet) and on substrates that are non-calcareous (usually, of igneous origin). The shrub stratum usually is dominated by some mix of *Fouquieria splendens* (ocotillo), *Larrea tridentata* (creosotebush), and/or *Agave lechuguilla* (lechuguilla), and calcareous substrate indicators are generally absent. *Bouteloua ramosa* (chino grama) is constant, but usually does not attain high cover.

### Vegetation:

Some mix of *Fouquieria splendens* (ocotillo), *Larrea tridentata* (creosotebush), and/or *Agave lechuguilla* (lechuguilla) dominates the shrub stratum, with, usually, at least two, and, often, all three, species present. Many other shrub species contribute modest cover, among the most constant are *Prosopis glandulosa* (honey mesquite), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Parthenium incanum* (mariola), *Viguiera stenoloba* (skeletonleaf goldeneye), *Opuntia camanchica* (Comanche pricklypear), *Senegalia greggii* (Gregg's catclaw), *Guaiaacum angustifolium* (guayacan), *Opuntia azurea* var. *parva* (Big Bend purplish pricklypear), *Yucca torreyi* (Torrey's yucca), *Opuntia rufida* (blind pricklypear), *Jatropha dioica* (leatherstem), *Leucophyllum frutescens* (cenizo), *Echinocereus stramineus* (strawberry hedgehog cactus), *Cylindropuntia leptocaulis* (Christmas cactus), *Flourensia cernua* (American tarbush), *Vachellia constricta* (whitethorn acacia), *Tiquilia greggii* (plumed crinklemat), *Echinocereus enneacanthus* var. *enneacanthus* (pitaya cactus), and *Krameria erecta* (littleleaf ratany). The herbaceous stratum has sparse to moderate cover, with the grasses *Bouteloua ramosa* (chino grama) and *Dasyochloa pulchella* (fluffgrass) the most constant species. Other moderately constant grass species include *Heteropogon contortus* (tanglehead), *Aristida purpurea* (purple threeawn), *Digitaria californica* (Arizona cottontop), *Cathastecum erectum* (false grama), and *Panicum hallii* (Hall's panicgrass). Forbs include *Bahia absinthifolia* (hairyseed bahia), *Senna durangensis* (Durango senna), *Chamaesyce* spp. (sandmats), *Boerhavia* spp. (spiderlings), and *Croton* spp. (crotons). Annual forbs appearing in spring include *Lupinus havardii* (Big Bend bluebonnet) and *Phacelia* spp. (phacelias). Stratum and substrate cover for Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub are shown in Table D-51.

**Table D-51.** Stratum and substrate cover recorded for Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub at Big Bend National Park (# plots=38).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	4	0–20
	Short Shrub	20	8–60
	Herb	15	1–80
Substrate	Bedrock	2	0–40
	Large/Small Rocks	72	11–99
	Litter/Duff	7	0–60



### Environment:

This association is frequent over large areas on non-calcareous substrates from about 2,500 to about 4,200 feet in elevation, and sparingly as low as 1,800 feet. It occurs mostly on the upper to middle parts of alluvial fans around the periphery of the Chisos Mountains and other igneous ranges in BIBE. It is one of the more widespread associations of BIBE.

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)

USNVC Group: Chihuahuan Creosotebush-Mixed Desert Scrub Group (G288)

USNVC Alliance: *Larrea tridentata* Chihuahuan Desert Scrub Alliance (A3164)

NPS Association: *Larrea tridentata* – *Fouquieria splendens* – *Agave lechuguilla* – *Leucophyllum frutescens* Shrubland Association (NPSBIBE044)

### Comments:

Stands that have a limited number of calciphiles (calcareous indicators) (usually, *Euphorbia antispyhilitica* and *Leucophyllum candidum*) and that are, therefore, intermediate between Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub and the Calcareous Mixed Desert Scrub of limestone substrates, occur west of Chilicotal Mountain and in the vicinity of Juniper Draw, where limestone is neither mapped nor evident. Because of the overall greater similarity with the former association, they are treated as a variant of it. These stands have *Leucophyllum frutescens* (cenizo), a shrub species that tends to be absent from limestone substrates within BIBE (although, paradoxically, it gradually becomes abundant on limestone along the Rio Grande to the east of BIBE). It is speculated that this area may be underlain by calcium-rich volcanic or other substrates, which explain the presence of the calciphiles.

Assignment of this unit to an existing USNVC (2017) association assignment is problematic because this type has a mixed dominance of some combination of *Larrea tridentata* (creosotebush), *Fouquieria splendens* (ocotillo), and *Agave lechuguilla* (lechuguilla). Within BIBE, *F. splendens* is a good character species for this type of primarily non-calcareous (igneous rock derived) substrates, attaining higher frequency and cover in this type than in other desert scrub types. It displays a reduction in constancy and abundance in calcareous desert scrub types and lower elevation desert scrub types at BIBE. However, recognized USNVC associations for the Chihuahuan Desert that have *F. splendens* as a nominal do not include appropriate companion species to describe this unit. The *Larrea tridentata* – *Agave lechuguilla* Shrubland (CEGL004562) is problematic because the published record lacks any description and because these two nominal species occur in some abundance in most of the BIBE desert scrub types.

### BIBE Classification Plots Included in Concept:

BIBE0003, BIBE0011, BIBE0015, BIBE0018, BIBE0021, BIBE0067, BIBE0070, BIBE0076, BIBE0077, BIBE0078, BIBE0083, BIBE0097, BIBE0099, BIBE0127, BIBE0129, BIBE0130,



BIBE0144, BIBE0187, BIBE0192, BIBE0197, BIBE0198, BIBE0243, BIBE0244, BIBE0351, BIBE0352, BIBE0353, BIBE0358, BIBE0359, BIBE0402, BIBE0403, BIBE0404, BIBE0405, BIBE0411, BIBE0443, BIBE0446, BIBE0447, BIBE0449, BIBE0458.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0008, BIBEAA0014, BIBEAA0017, BIBEAA0019, BIBEAA0027, BIBEAA0063, BIBEAA0085, BIBEAA0114, BIBEAA0116, BIBEAA0117, BIBEAA0119, BIBEAA0120, BIBEAA0127, BIBEAA0128, BIBEAA0129, BIBEAA0130, BIBEAA0137, BIBEAA0131, BIBEAA0138, BIBEAA0139, BIBEAA0140, BIBEAA0380, BIBEAA0382, BIBEAA0384, BIBEAA0390, BIBEAA0407, BIBEAA0408, BIBEAA0526, BIBEAA0531, BIBEAA0536, BIBEAA0553, BIBEAA0554, BIBEAA0556, BIBEAA0557, BIBEAA0558, BIBEAA0561, BIBEAA0562, BIBEAA0565, BIBEAA0566, BIBEAA0567, BIBEAA0569, BIBEAA0570, BIBEAA0571, BIBEAA0572, BIBEAA0573, BIBEAA0577, BIBEAA0580, BIBEAA0582, BIBEAA0656, BIBEAA0661, BIBEAA0662, BIBEAA0664, BIBEAA0667, BIBEAA0669, BIBEAA0670, BIBEAA0674, BIBEAA0677, BIBEAA0678, BIBEAA0679, BIBEAA0682, BIBEAA0683, BIBEAA0736, BIBEAA0737, BIBEAA0738, BIBEAA0739, BIBEAA0747, BIBEAA0759, BIBEAA0760, BIBEAA0761, BIBEAA0764, BIBEAA0771, BIBEAA0773, BIBEAA0777, BIBEAA0778, BIBEAA0779, BIBEAA0782, BIBEAA0786, BIBEAA0859, BIBEAA0861, BIBEAA0867, BIBEAA0868, BIBEAA0869, BIBEAA0982, BIBEAA1214, BIBEAA1219, BIBEAA1220, BIBEAA1223, BIBEAA1272, BIBEAA1273, BIBEAA1285, BIBEAA1288.

Most frequent plant taxa recorded in Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub are shown in Table D-52.

**Table D-52.** Synthesis table for the most frequent plant taxa recorded in Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub at Big Bend National Park (# plots=38).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Larrea tridentata</i>	Shrub	79.5%	4.0	0–25
<i>Fouquieria splendens</i>	Shrub	76.9%	3.1	0–35
<i>Agave lechuguilla</i>	Shrub	71.8%	2.6	0–25
<i>Echinocereus stramineus</i>	Shrub	61.5%	0.3	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	51.3%	0.4	0–10
<i>Parthenium incanum</i>	Shrub	48.7%	0.6	0–30
<i>Viguiera stenoloba</i>	Shrub	48.7%	0.6	0–7
<i>Opuntia camanchica</i>	Shrub	41.0%	0.3	0–2
<i>Tiquilia greggii</i>	Shrub	38.5%	0.4	0–5
<i>Cylindropuntia leptocaulis</i>	Shrub	33.3%	0.3	0–6
<i>Leucophyllum frutescens</i>	Shrub	28.2%	1.2	0–30
<i>Yucca torreyi</i>	Shrub	28.2%	0.2	0–12
<i>Prosopis glandulosa</i>	Shrub	28.2%	0.1	0–5

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Echinocactus horizonthalonius</i>	Shrub	28.2%	0.1	0–1
<i>Ephedra aspera</i>	Shrub	25.6%	0.2	0–3
<i>Senegalia roemeriana</i>	Shrub	23.1%	0.4	0–5
<i>Dalea formosa</i>	Shrub	23.1%	0.2	0–1
<i>Hibiscus denudatus</i>	Shrub	23.1%	0.2	0–5
<i>Dasyllirion leiophyllum</i>	Shrub	23.1%	0.1	0–5
<i>Jatropha dioica</i>	Shrub	20.5%	0.6	0–12
<i>Krameria erecta</i>	Shrub	20.5%	0.3	0–7
<i>Janusia gracilis</i>	Shrub	20.5%	0.2	0–10
<i>Cylindropuntia imbricata</i>	Shrub	20.5%	0.2	0–2
<i>Krameria grayi</i>	Shrub	17.9%	0.3	0–5
<i>Opuntia rufida</i>	Shrub	17.9%	0.2	0–4
<i>Vachellia constricta</i>	Shrub	17.9%	0.2	0–3
<i>Menodora scabra</i>	Shrub	17.9%	0.1	0–1
<i>Echinocereus enneacanthus</i>	Shrub	17.9%	0.1	0–1
<i>Echinocereus dasyacanthus</i>	Shrub	17.9%	0.1	0–1
<i>Opuntia</i> sp.	Shrub	15.4%	0.2	0–3
<i>Guaiaacum angustifolium</i>	Shrub	15.4%	0.1	0–3
<i>Jefea brevifolia</i>	Shrub	15.4%	0.1	0–1
<i>Forestiera angustifolia</i>	Shrub	12.8%	0.1	0–2
<i>Grusonia aggeria</i>	Shrub	12.8%	0.1	0–2
<i>Senegalia greggii</i>	Shrub	12.8%	0.1	0–2
<i>Dasyochloa pulchella</i>	Herb	69.2%	0.4	0–2
<i>Bouteloua ramosa</i>	Herb	66.7%	2.1	0–25
<i>Panicum hallii</i>	Herb	33.3%	0.2	0–2
<i>Chamaesyce</i> sp.	Herb	33.3%	0.2	0–1
<i>Cathastecum erectum</i>	Herb	30.8%	5.1	0–75
<i>Boerhavia</i> sp.	Herb	25.6%	0.5	0–10
<i>Aristida purpurea</i>	Herb	23.1%	0.3	0–15
<i>Croton</i> sp.	Herb	23.1%	0.1	0–1
<i>Heteropogon contortus</i>	Herb	20.5%	0.2	0–5
<i>Tiquilia canescens</i>	Herb	20.5%	0.1	0–1
<i>Senna durangensis</i>	Herb	18.8%	0.1	0–2
<i>Argythamnia neomexicana</i>	Herb	15.4%	0.1	0–1
<i>Aristida</i> sp.	Herb	15.4%	0.1	0–1



Photo 52. Creosotebush – Ocotillo – Lechuguilla Desert Scrub, near Dugout Wells (BIBEAA0570). Photo by Jeff Renfrow.



Photo 53. Creosotebush – Ocotillo – Lechuguilla Desert Scrub, Grapevine Hills (BIBEAA0777). Photo by Jeff Renfrow.

### **Big Bend Lowlands Creosotebush Desert Scrub**

#### Local Type Concept:

Desert scrub in the lower elevations within BIBE and on non-calcareous substrates. *Larrea tridentata* (creosotebush) is constant and usually a dominant or co-dominant species, although absolute cover of all species may be quite low. Species that are indicators of calcareous substrates generally are absent, and *Agave lechuguilla* (lechuguilla) is consistently absent. Overall plant cover and species richness is lower than in other desert scrub types.

#### Vegetation:

Both shrub and herbaceous strata are sparse to moderate in cover. *Larrea tridentata* (creosotebush) is almost always the leading dominant shrub, and usually has much of the relative cover in this stratum. *Fouquieria splendens* (ocotillo), *Cylindropuntia leptocaulis* (Christmas cactus), *Prosopis glandulosa* (honey mesquite), *Jatropha dioica* (leatherstem), *Grusonia aggeria* (Big Bend dog cholla), and *Vachellia constricta* (whitethorn acacia), have relatively high constancy, usually at low cover, but occasionally abundant enough to be co-dominant with *L. tridentata*. Other shrubs include *Echinocereus enneacanthus* var. *enneacanthus* (pitaya cactus), *Krameria grayi* (white ratany), *Krameria erecta* (littleleaf ratany), *Opuntia camanchica* (Comanche pricklypear), and *Yucca torreyi* (Torrey's yucca). The herbaceous stratum is mostly sparse, although the grass *Cathestecum erectum* (false grama) may provide significant cover in a minority of stands. *Dasyochloa pulchella* (fluffgrass) is more constant, but less abundant, than *C. erectum*. Other herbaceous species include *Aristida purpurea* (purple threeawn), *Senna durangensis* (Durango senna), *Bahia absinthifolia* (hairyseed bahia), and, occasionally, the non-native and invasive *Pennisetum ciliare* (buffelgrass).

Compared to the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub, which is the analogous desert scrub association of higher elevation non-calcareous desert settings at BIBE, the Big Bend Lowlands Creosotebush Desert Scrub has a lower level of shrub stratum species diversity (both less species richness and less species evenness), with stronger dominance by *Larrea tridentata* over comparable areas. Notably, *Agave lechuguilla* (lechuguilla), a constant and often dominant species in most other desert scrub associations at BIBE, is absent over large areas of the Big Bend Lowlands Creosotebush Desert Scrub, and its presence in much quantity is a contra-indicator of this association. Other species that are less constant and/or less important in the Big Bend Lowlands Creosotebush Desert Scrub include those that are more typical of the foothills, including *Bouteloua ramosa* (chino grama), *Dasyllirion leiophyllum* (green sotol), and *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear). Conversely, species such as *Cylindropuntia leptocaulis*, *Grusonia aggeria*, *Vachellia constricta* (whitethorn acacia), and *Cathestecum erectum* are relatively more constant and abundant in this low elevation association. Stratum and substrate cover for Big Bend Lowlands Creosotebush Desert Scrub are shown in Table D-53.

**Table D-53.** Stratum and substrate cover recorded for Big Bend Lowlands Creosotebush Desert Scrub at Big Bend National Park (# plots=31).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	3	0–25
	Short Shrub	13	2–40
	Herb	14	0–60
Substrate	Bedrock	0	0–5
	Large/Small Rocks	66	0–100
	Litter/Duff	5	0–50

#### Environment:

This association is the dominant desert scrub type in much of the low elevation parts of BIBE, particularly between the Chisos Mountains and the Rio Grande. It also occupies large areas of the somewhat higher, relatively level areas of the “flats” of the Tornillo Creek and Ninepoint Draw drainages. It occurs on non-calcareous surfaces, usually on extensive alluvial fans and flats, from near the lowest elevations of BIBE (recorded at 1660 feet), up to about 2,900 feet, and occasionally to 3,300 feet. The differences in floristic composition between this association and the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub may be due to soil conditions as well as to the lower elevation (and hotter climate). The Big Bend Lowlands Creosotebush Desert Scrub generally occurs on the often finer-textured soils of lower and older alluvial fans, where conditions may become droughty more readily. This may explain some diversity differences between the two types.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)

USNVC Group: Chihuahuan Creosotebush-Mixed Desert Scrub Group (G288)

USNVC Alliance: *Larrea tridentata* Chihuahuan Desert Scrub Alliance (A3164)

NPS Association: *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathestecum erectum* Shrubland Association (NPSBIBE031)

#### BIBE Classification Plots Included in Concept:

BIBE0007, BIBE0037, BIBE0046, BIBE0047, BIBE0065, BIBE0066, BIBE0075, BIBE0082, BIBE0088, BIBE0092, BIBE0107, BIBE0109, BIBE0110, BIBE0114, BIBE0133, BIBE0134, BIBE0245, BIBE0265, BIBE0333, BIBE0336, BIBE0337, BIBE0342, BIBE0355, BIBE0366, BIBE0367, BIBE0394, BIBE0422, BIBE0425, BIBE0427, BIBE0429, BIBE0431, BIBE0433



BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0001, BIBEAA0002, BIBEAA0003, BIBEAA0004, BIBEAA0005, BIBEAA0006, BIBEAA0007, BIBEAA0009, BIBEAA0010, BIBEAA0011, BIBEAA0012, BIBEAA0013, BIBEAA0015, BIBEAA0016, BIBEAA0020, BIBEAA0021, BIBEAA0022, BIBEAA0023, BIBEAA0024, BIBEAA0025, BIBEAA0026, BIBEAA0028, BIBEAA0029, BIBEAA0055, BIBEAA0056, BIBEAA0057, BIBEAA0062, BIBEAA0064, BIBEAA0065, BIBEAA0068, BIBEAA0070, BIBEAA0071, BIBEAA0072, BIBEAA0073, BIBEAA0074, BIBEAA0075, BIBEAA0076, BIBEAA0078, BIBEAA0079, BIBEAA0081, BIBEAA0082, BIBEAA0083, BIBEAA0115, BIBEAA0123, BIBEAA0124, BIBEAA0125, BIBEAA0132, BIBEAA0133, BIBEAA0135, BIBEAA0141, BIBEAA0142, BIBEAA0351, BIBEAA0352, BIBEAA0353, BIBEAA0354, BIBEAA0355, BIBEAA0356, BIBEAA0357, BIBEAA0394, BIBEAA0411, BIBEAA0419, BIBEAA0420, BIBEAA0421, BIBEAA0422, BIBEAA0427, BIBEAA0428, BIBEAA0435, BIBEAA0436, BIBEAA0439, BIBEAA0524, BIBEAA0528, BIBEAA0530, BIBEAA0532, BIBEAA0533, BIBEAA0534, BIBEAA0535, BIBEAA0538, BIBEAA0546, BIBEAA0550, BIBEAA0555, BIBEAA0574, BIBEAA0575, BIBEAA0636, BIBEAA0637, BIBEAA0640, BIBEAA0641, BIBEAA0642, BIBEAA0643, BIBEAA0644, BIBEAA0645, BIBEAA0646, BIBEAA0647, BIBEAA0648, BIBEAA0649, BIBEAA0650, BIBEAA0651, BIBEAA0652, BIBEAA0658, BIBEAA0659, BIBEAA0680, BIBEAA0755, BIBEAA0756, BIBEAA0769, BIBEAA0775, BIBEAA0784, BIBEAA0785, BIBEAA0787, BIBEAA0789, BIBEAA0797, BIBEAA0798, BIBEAA0799, BIBEAA0805, BIBEAA0806, BIBEAA0940, BIBEAA0963, BIBEAA0964, BIBEAA0977, BIBEAA0981, BIBEAA0991, BIBEAA0992, BIBEAA1001, BIBEAA1008, BIBEAA1088, BIBEAA1166, BIBEAA1167, BIBEAA1168, BIBEAA1170, BIBEAA1171, BIBEAA1172, BIBEAA1173, BIBEAA1174, BIBEAA1175, BIBEAA1176, BIBEAA1177, BIBEAA1178, BIBEAA1179, BIBEAA1212, BIBEAA1213, BIBEAA1215, BIBEAA1216, BIBEAA1217, BIBEAA1218, BIBEAA1225, BIBEAA1226, BIBEAA1229, BIBEAA1230, BIBEAA1232, BIBEAA1233, BIBEAA1234, BIBEAA1236, BIBEAA1237, BIBEAA1238, BIBEAA1259, BIBEAA1260.

Most frequent plant taxa recorded in Big Bend Lowlands Creosotebush Desert Scrub are shown in Table D-54.

**Table D-54.** Synthesis table for the most frequent plant taxa recorded in Big Bend Lowlands Creosotebush Desert Scrub at Big Bend National Park (# plots=31).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Larrea tridentata</i>	Shrub	100.0%	4.7	0–50
<i>Fouquieria splendens</i>	Shrub	60.0%	2.1	0–26
<i>Grusonia aggeria</i>	Shrub	53.3%	0.7	0–10
<i>Jatropha dioica</i>	Shrub	43.3%	0.7	0–6
<i>Krameria grayi</i>	Shrub	43.3%	0.3	0–3
<i>Cylindropuntia leptocaulis</i>	Shrub	36.7%	0.4	0–3
<i>Yucca torreyi</i>	Shrub	36.7%	0.3	0–4



<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Vachellia constricta</i>	Shrub	33.3%	0.4	0–7
<i>Opuntia camanchica</i>	Shrub	30.0%	0.2	0–4
<i>Menodora scabra</i>	Shrub	26.7%	0.2	0–2
<i>Echinocereus enneacanthus</i>	Shrub	23.3%	0.1	0–1
<i>Echinocereus stramineus</i>	Shrub	23.3%	0.1	0–1
<i>Prosopis glandulosa</i>	Shrub	26.7%	0.1	0–2
<i>Echinocactus horizonthalonius</i>	Shrub	16.7%	0.1	0–1
<i>Viguiera stenoloba</i>	Shrub	13.3%	0.6	0–25
<i>Echinocereus dasyacanthus</i>	Shrub	13.3%	<0.1	0–1
<i>Coryphantha macromeris</i>	Shrub	13.3%	<0.1	0–trace
<i>Grusonia densispina</i>	Shrub	10.0%	0.2	0–5
<i>Parthenium incanum</i>	Shrub	10.0%	0.2	0–5
<i>Senegalia roemeriana</i>	Shrub	10.0%	0.1	0–5
<i>Krameria erecta</i>	Shrub	10.0%	<0.1	0–1
<i>Opuntia rufida</i>	Shrub	10.0%	<0.1	0–1
<i>Tiquilia greggii</i>	Shrub	10.0%	<0.1	0–1
<i>Dasyochloa pulchella</i>	Herb	60.0%	1.5	0–50
<i>Cathastecum erectum</i>	Herb	50.0%	7.3	0–75
<i>Senna durangensis</i>	Herb	46.7%	0.2	0–1
<i>Croton</i> sp.	Herb	23.3%	0.1	0–2
<i>Tiquilia canescens</i>	Herb	23.3%	0.1	0–2
<i>Bahia absinthifolia</i>	Herb	20.0%	0.1	0–1
<i>Aristida</i> sp.	Herb	16.7%	0.1	0–1
<i>Bouteloua ramosa</i>	Herb	16.7%	0.1	0–10
<i>Bouteloua trifida</i>	Herb	13.3%	0.8	0–25
<i>Pennisetum ciliare</i>	Herb	13.3%	0.6	0–25
<i>Tiquilia hispidissima</i>	Herb	13.3%	0.1	0–1
<i>Boerhavia</i> sp.	Herb	10.0%	0.1	0–1
<i>Cevallia sinuata</i>	Herb	10.0%	0.1	0–1
<i>Chamaesyce</i> sp.	Herb	10.0%	0.1	0–1
<i>Dalea</i> sp.	Herb	10.0%	0.1	0–1
<i>Hibiscus denudatus</i>	Herb	10.0%	0.1	0–1
<i>Senna bauhinoides</i>	Herb	10.0%	0.1	0–1
<i>Argythamnia neomexicana</i>	Herb	10.0%	<0.1	0–1



Photo 54. Big Bend Lowlands Creosotebush Desert Scrub, north of Ross Maxwell Scenic Drive, east of Alamo Creek (BIBEAA0010). Photo by Bobski Gray.



Photo 55. Big Bend Lowlands Creosotebush Desert Scrub, near Woodson's Camp along Rio Grande (BIBEAA0636). Photo by Kelsey Wogan.

## **Mesquite – Creosotebush Desert Scrub**

### Local Type Concept:

Desert scrub with some combination of *Prosopis glandulosa* (honey mesquite) and *Larrea tridentata* (creosotebush) present and with one or both dominant, occurring on gentle slopes with finer-textured soils. *Flourensia cernua* (American tarbush) may occur and is diagnostic when present in quantity.

### Vegetation:

*Prosopis glandulosa* (honey mesquite) and *Larrea tridentata* (creosotebush) are both constant and one or the other, or both, are dominant as a tall or short shrub. *P. glandulosa* height tends to be 1.5 to 3 meters (*i.e.*, relatively short, compared to its normal stature in the Rio Grande Riparian Mesquite Bosque), while *L. tridentata* height tends to be 1 to 2 meters (*i.e.*, relatively tall, compared to its normal stature in other desert scrub associations at BIBE). Some stands lack *L. tridentata*. *Flourensia cernua* (American tarbush) is present in about half of the stands observed, occasionally is co-dominant with the other species, and is fairly diagnostic of this association at BIBE, when it is present in quantity. *Senegalia greggii* (Gregg's catclaw) often is present as a low cover tall shrub, while *Parthenium incanum* (mariola) and *Cylindropuntia leptocaulis* (Christmas cactus) are moderately constant short shrubs. Less constant shrub species include *Agave lechuguilla* (lechuguilla), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Ziziphus obtusifolia* (lotebush), *Gutierrezia sarothrae* (broom snakeweed), *Atriplex canescens* (fourwing saltbush), *Vachellia constricta* (whitethorn acacia), *Koeberlinia spinosa* (althorn), and *Echinocereus enneacanthus* var. *enneacanthus* (pitaya cactus). The herbaceous stratum typically is sparse to virtually absent. Occasionally, locally dense patches of the native *Pleuraphis mutica* (tobosa grass) or the non-native *Pennisetum ciliare* (buffelgrass) may occur. Stratum and substrate cover for Mesquite – Creosotebush Desert Scrub are shown in Table D-55.

**Table D-55.** Stratum and substrate cover recorded for Mesquite – Creosotebush Desert Scrub at Big Bend National Park (# plots=9).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	2	0–10
	Short Shrub	32	2–80
	Herb	4	1–15
Substrate	Bedrock	0	0–0
	Large/Small Rocks	51	1–85
	Litter/Duff	11	0–20

### Environment:

The Mesquite – Creosotebush Desert Scrub occupies several types of settings at BIBE. It occurs in extensive stands on flats and lower, finer-textured parts of extensive alluvial fans whose upper portions support the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub. It also occupies

gentle slopes in the vicinity of washes, often for some distance from the wash although often not immediately along the banks (the primary habitat of the Mixed Tall Shrubs Wash Shrubland or the Acacia – Mesquite Wash Shrubland). Finally, it may be in narrow strips along incipient (headwater) drainages and even roadside ditches. The common factor of these settings appears to be relatively poor soil drainage (among desert scrub types). Stands range from 1,800 to 3,700 feet in elevation, with one at 4,100 feet, and occurred throughout BIBE. Large stands occurred in the “flats” in the drainages of upper Tornillo Creek and Ninepoint Draw.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)

USNVC Group: Chihuahuan Creosotebush-Mixed Desert Scrub Group (G288)

USNVC Alliance: *Larrea tridentata* Chihuahuan Desert Scrub Alliance (A3164)

NPS Association: *Prosopis glandulosa* – *Larrea tridentata* – (*Flourensia cernua*, *Parthenium incanum*) Shrubland Association (NPS0025)

#### Comments:

Following the classification sampling phase for BIBE, this vegetation was conceived as a primarily *Prosopis glandulosa* dominated type of uplands or “quasi-riparian” settings, with *Larrea tridentata* constant and *Flourensia cernua* and *Parthenium incanum* occasionally important. During the accuracy assessment, the concept expanded somewhat to recognize a continuum of desert scrub that covered large areas of lower (older) alluvial fans that have finer-textured soils, as well as gentle slopes near drainages, and that have combinations of *Prosopis glandulosa*, *Larrea tridentata*, *Flourensia cernua*, and *Parthenium incanum*.

The *Larrea tridentata* – *Prosopis glandulosa* Shrubland (CEGL001275), reported for New Mexico and Texas USNVC (2017) might include this vegetation, but there is no description for the unit (it appears as a name only).

#### BIBE Classification Plots Included in Concept:

BIBE0104, BIBE0147, BIBE0343, BIBE0386, BIBE0390, BIBE0393, BIBE0413, BIBE0415, BIBE0452.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0061, BIBEAA0188, BIBEAA0345, BIBEAA0347, BIBEAA0348, BIBEAA0410, BIBEAA0414, BIBEAA0415, BIBEAA0432, BIBEAA0523, BIBEAA0525, BIBEAA0527, BIBEAA0537, BIBEAA0539, BIBEAA0540, BIBEAA0541, BIBEAA0542, BIBEAA0543, BIBEAA0544, BIBEAA0545, BIBEAA0548, BIBEAA0551, BIBEAA0552, BIBEAA0560, BIBEAA0563, BIBEAA0564, BIBEAA0654, BIBEAA0660, BIBEAA0681, BIBEAA0757, BIBEAA0758, BIBEAA0762, BIBEAA0763, BIBEAA0765, BIBEAA0766, BIBEAA0767, BIBEAA0768, BIBEAA0770, BIBEAA0772, BIBEAA0774, BIBEAA0776, BIBEAA0780,

BIBEEA0781, BIBEEA0788, BIBEEA0795, BIBEEA0796, BIBEEA0802, BIBEEA0809, BIBEEA0810, BIBEEA0812, BIBEEA0849, BIBEEA0855, BIBEEA0856, BIBEEA0955, BIBEEA0956, BIBEEA0957, BIBEEA0965, BIBEEA0966, BIBEEA0967, BIBEEA0974, BIBEEA0975, BIBEEA0976, BIBEEA0998, BIBEEA0999, BIBEEA1089, BIBEEA1090, BIBEEA1099, BIBEEA1252, BIBEEA1283.

Most frequent plant taxa recorded in Mesquite – Creosotebush Desert Scrub are shown in Table D-56.

**Table D-56.** Synthesis table for the most frequent plant taxa recorded in Mesquite – Creosotebush Desert Scrub at Big Bend National Park (# plots=9).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Prosopis glandulosa</i>	Shrub	100.0%	13.6	1–55
<i>Larrea tridentata</i>	Shrub	88.9%	7.0	0–27
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	66.7%	1.9	0–15
<i>Parthenium incanum</i>	Shrub	66.7%	0.9	0–5
<i>Flourensia cernua</i>	Shrub	55.6%	2.2	0–12
<i>Cylindropuntia leptocaulis</i>	Shrub	55.6%	0.7	0–4
<i>Guaiacum angustifolium</i>	Shrub	33.3%	0.6	0–6
<i>Yucca torreyi</i>	Shrub	33.3%	0.2	0–2
<i>Atriplex canescens</i>	Shrub	33.3%	0.1	0–1
<i>Senegalia roemeriana</i>	Shrub	33.3%	0.1	0–1
<i>Agave lechuguilla</i>	Shrub	22.2%	1.2	0–10
<i>Cylindropuntia imbricata</i>	Shrub	22.2%	0.3	0–3
<i>Ephedra aspera</i>	Shrub	22.2%	0.2	0–2
<i>Echinocereus enneacanthus</i>	Shrub	22.2%	0.1	0–1
<i>Ibervillea tenuisecta</i>	Shrub	22.2%	0.1	0–1
<i>Koeberlinia spinosa</i>	Shrub	22.2%	0.1	0–1
<i>Opuntia camanchica</i>	Shrub	22.2%	0.1	0–1
<i>Viguiera stenoloba</i>	Shrub	11.1%	4.2	0–51
<i>Krameria erecta</i>	Shrub	11.1%	4.2	0–50
<i>Aloysia gratissima</i>	Shrub	11.1%	0.2	0–3
<i>Opuntia</i> sp.	Shrub	11.1%	0.2	0–3
<i>Rhamnus serrata</i>	Shrub	11.1%	0.2	0–2
<i>Dasyllirion leiophyllum</i>	Shrub	11.1%	0.1	0–1
<i>Echinocereus coccineus</i> var. <i>paucispinus</i>	Shrub	11.1%	0.1	0–1
<i>Echinocereus dasyacanthus</i>	Shrub	11.1%	0.1	0–1
<i>Echinocereus stramineus</i>	Shrub	11.1%	0.1	0–1
<i>Gutierrezia</i> sp.	Shrub	11.1%	0.1	0–1

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Krameria grayi</i>	Shrub	11.1%	0.1	0–1
<i>Lycium berlandieri</i>	Shrub	11.1%	0.1	0–1
<i>Mortonia scabra</i>	Shrub	11.1%	0.1	0–1
<i>Heteropogon contortus</i>	Herb	77.8%	0.4	0–1
<i>Bouteloua ramosa</i>	Herb	55.6%	0.9	0–5
<i>Kallstroemia parviflora</i>	Herb	22.2%	7.0	0–75
<i>Bouteloua barbata</i>	Herb	22.2%	0.1	0–1
<i>Sporobolus</i> sp.	Herb	22.2%	0.1	0–1
<i>Chloris virgata</i>	Herb	11.1%	0.4	0–5
<i>Blepharoneuron tricholepis</i>	Herb	11.1%	0.2	0–2
<i>Helianthus petiolaris</i>	Herb	11.1%	0.2	0–2
<i>Pleuraphis mutica</i>	Herb	11.1%	0.2	0–2
<i>Bothriochloa laguroides</i>	Herb	11.1%	0.1	0–1
<i>Bouteloua curtipendula</i>	Herb	11.1%	0.1	0–1
<i>Dasyochloa pulchella</i>	Herb	11.1%	0.1	0–1
<i>Eragrostis</i> sp.	Herb	11.1%	0.1	0–1
<i>Funastrum cynanchoides</i>	Herb	11.1%	0.1	0–1
<i>Muhlenbergia schreberi</i>	Herb	11.1%	0.1	0–1
<i>Panicum hallii</i>	Herb	11.1%	0.1	0–1
<i>Pennisetum ciliare</i>	Herb	11.1%	0.1	0–1
<i>Proboscidea louisianica</i>	Herb	11.1%	0.1	0–1





Photo 56. Mesquite – Creosotebush Desert Scrub, along Paint Gap Road (BIBEAA0540). Photo by Rebecca Evans.



Photo 57. Mesquite – Creosotebush Desert Scrub, near Gano Spring along Ross Maxwell Scenic Drive (BIBEAA0955). Photo by Rebecca Evans.

## **Boquillas Basin Calcareous Cresotebush Desert Scrub**

### Local Type Concept:

Desert scrub with common environmental influences of the lowest upland elevations within BIBE and calcareous substrates. *Larrea tridentata* (creosotebush) is constant and usually is a dominant or co-dominant species. Species that are indicators of calcareous substrates, including *Opuntia* × *spinosibacca* (spiny-fruited pricklypear), *Leucophyllum candidum* (Boquillas silverleaf), and *Hechtia texensis* (Texas false agave), are present, often at low cover.

### Vegetation:

The shrub stratum has sparse to moderate cover. *Larrea tridentata* (creosotebush) is constant and usually is the leading dominant or is co-dominant with other constant species, such as *Agave lechuguilla* (lechuguilla), *Opuntia* × *spinosibacca* (spiny-fruited pricklypear), *Fouquieria splendens* (ocotillo), *Leucophyllum candidum* (Boquillas silverleaf), and/or *Hechtia texensis* (Texas false agave). *O.* × *spinosibacca* and *L. candidum* are fairly useful diagnostic species for this vegetation because of their restriction to calcareous substrates and affinity for lower elevations. Fairly constant low cover shrub species include *Echinocactus horzonthalonius* (eagle-claw cactus), *Krameria grayi* (white ratany), and *Krameria erecta* (littleleaf ratany). *Tiquilia* spp. (crinklemats), including *T. greggii*, *T. hispidissima*, *T. canescens*, *T. mexicana*, and/or *T. gossypina* are characteristic low cover subshrubs. Less constant shrubs include *Euphorbia antisyphilitica* (candelilla), *Jatropha dioica* (leatherstem), *Vachellia constricta* (whitethorn acacia), *Opuntia rufida* (blind pricklypear), *Yucca torreyi* (Torrey's yucca), *Escobaria tuberculosa* (cob cactus), *Argythamnia serrata* (Yuma silverbush), *Echinocereus stramineus* (strawberry hedgehog cactus), *Guaiacum angustifolium* (guayacan), *Grusonia aggeria* (Big Bend dog cholla), and *Hibiscus denudatus* (paleface rosemallow). Herbaceous cover typically is sparse (typically, 0–10% cover); the grasses *Bouteloua ramosa* (chino grama) and *Dasyochloa pulchella* (fluffgrass) are the most constant and abundant species. Other species include *Selaginella lepidophylla* (resurrection plant), *Senna durangensis* (Durango senna), *Tridens muticus* (slim tridens), *Panicum hallii* (Hall's panicgrass), *Bouteloua trifida* (red grama), *Aristida purpurea* (purple threeawn), and *Allionia incarnata* (trailing windmills). Stratum and substrate cover for Boquillas Basin Calcareous Cresotebush Desert Scrub are shown in Table D-57.

**Table D-57.** Stratum and substrate cover recorded for Boquillas Basin Calcareous Cresotebush Desert Scrub at Big Bend National Park (# plots=15).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	0	0–25
	Short Shrub	13	3–40
	Herb	6	3–10
Substrate	Bedrock	14	0–90
	Large/Small Rocks	73	1–99
	Litter/Duff	2	0–20

#### Environment:

Stands were observed from 1,750 to 2,650 feet in elevation. They occur on calcareous substrates (limestones) and the association is mostly restricted to the southeastern corner of BIBE, west to the west side of Mariscal Mountain.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)

USNVC Group: Chihuahuan Creosotebush-Mixed Desert Scrub Group (G288)

USNVC Alliance: *Larrea tridentata* Chihuahuan Desert Scrub Alliance (A3164)

NPS Association: *Larrea tridentata* – *Agave lechuguilla* – *Hechtia texensis* – *Echinocactus horizonthalonius* Sparse Shrubland Association (NPSBIBE011)

#### Comments:

This association is the low elevation analog vegetation to the Calcareous Mixed Desert Scrub of higher elevation limestone settings. It also is the calcareous analog to the Big Bend Lowlands Creosotebush Desert Scrub of low elevation non-calcareous substrates. It shares the presence of calciphiles with the former and stronger relative dominance by *Larrea tridentata* (creosotebush) (and lower species richness, compared to higher desert elevation scrub) of the latter.

Originally named the Low Elevation Calcareous Creosotebush Desert Scrub for its context within BIBE, this association was given the more geographically relevant name Boquillas Basin Calcareous Cresotebush Desert Scrub in reference to its known center of distribution. The low elevation desert scrub associations of the eastern Chihuahuan region along the Rio Grande in Brewster, Terrell, and Val Verde Counties tend to sort themselves geographically from west to east.

Interestingly, it was noted during this study that, while *Agave lechuguilla* (lechuguilla) often is absent over large areas of Big Bend Lowlands Creosotebush Desert Scrub, it attains abundance comparable to that of higher elevation desert scrub on limestone-derived soils in similarly low, hot settings (*i.e.*, in Boquillas Basin Calcareous Cresotebush Desert Scrub described here). It is speculated that *A. lechuguilla* persistence may be somehow limited in these low elevation flat settings (perhaps from heat stress from continuous sun exposure or by fine soil textures), but that high calcium soils in similar settings may provide some compensation for this stress.

#### BIBE Classification Plots Included in Concept:

BIBE0016, BIBE0068, BIBE0069, BIBE0079, BIBE0080, BIBE0093, BIBE0094, BIBE0096, BIBE0115, BIBE0116, BIBE0137, BIBE0138, BIBE0332, BIBE0423.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0030, BIBEAA0031, BIBEAA0032, BIBEAA0033, BIBEAA0034, BIBEAA0036, BIBEAA0037, BIBEAA0038, BIBEAA0039, BIBEAA0040, BIBEAA0041, BIBEAA0042,

BIBEEA0043, BIBEEA0044, BIBEEA0045, BIBEEA0046, BIBEEA0047, BIBEEA0049, BIBEEA0050, BIBEEA0051, BIBEEA0052, BIBEEA0053, BIBEEA0054, BIBEEA0066, BIBEEA0067, BIBEEA0069, BIBEEA0080, BIBEEA1002, BIBEEA1004, BIBEEA1005, BIBEEA1007, BIBEEA1221, BIBEEA1275.

Most frequent plant taxa recorded in Boquillas Basin Calcareous Cresotebush Desert Scrub are shown in Table D-58.

**Table D-58.** Synthesis table for the most frequent plant taxa recorded in Boquillas Basin Calcareous Cresotebush Desert Scrub at Big Bend National Park (# plots=15).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Larrea tridentata</i>	Shrub	93.3%	1.9	0–7
<i>Echinocactus horizonthalonius</i>	Shrub	73.3%	0.3	0–1
<i>Agave lechuguilla</i>	Shrub	66.7%	2.4	0–25
<i>Fouquieria splendens</i>	Shrub	60.0%	0.5	0–5
<i>Jatropha dioica</i>	Shrub	60.0%	0.4	0–2
<i>Menodora scabra</i>	Shrub	60.0%	0.4	0–2
<i>Grusonia aggeria</i>	Shrub	53.3%	0.3	0–1
<i>Echinocereus dasyacanthus</i>	Shrub	53.3%	0.2	0–1
<i>Hechtia texensis</i>	Shrub	46.7%	1.4	0–8
<i>Opuntia</i> × <i>spinosibacca</i>	Shrub	46.7%	0.4	0–3
<i>Cylindropuntia leptocaulis</i>	Shrub	46.7%	0.2	0–2
<i>Echinocereus stramineus</i>	Shrub	46.7%	0.2	0–1
<i>Ariocarpus fissuratus</i>	Shrub	46.7%	0.2	0–1
<i>Opuntia rufida</i>	Shrub	40.0%	0.3	0–3
<i>Tiquilia greggii</i>	Shrub	40.0%	0.2	0–1
<i>Escobaria tuberculosa</i>	Shrub	40.0%	0.2	0–1
<i>Vachellia constricta</i>	Shrub	33.3%	0.2	0–2
<i>Prosopis glandulosa</i>	Shrub	33.3%	0.1	0–1
<i>Leucophyllum minus</i>	Shrub	26.7%	0.4	0–6
<i>Euphorbia antisyphilitica</i>	Shrub	26.7%	0.3	0–3
<i>Viguiera stenoloba</i>	Shrub	26.7%	0.1	0–1
<i>Coryphantha echinus</i>	Shrub	26.7%	0.1	0–1
<i>Krameria erecta</i>	Shrub	26.7%	0.1	0–1
<i>Ephedra aspera</i>	Shrub	20.0%	0.1	0–2
<i>Hibiscus denudatus</i>	Shrub	20.0%	0.1	0–1
<i>Cylindropuntia imbricata</i>	Shrub	13.3%	0.1	0–2
<i>Krameria grayi</i>	Shrub	13.3%	0.1	0–1
<i>Leucophyllum candidum</i>	Shrub	13.3%	0.0	0–1



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Bouteloua ramosa</i>	Herb	86.7%	1.3	0–10
<i>Dasyochloa pulchella</i>	Herb	80.0%	0.6	0–5
<i>Tiquilia canescens</i>	Herb	73.3%	0.4	0–2
<i>Selaginella lepidophylla</i>	Herb	40.0%	0.3	0–2
<i>Aristida purpurea</i>	Herb	33.3%	0.2	0–2
<i>Tiquilia hispidissima</i>	Herb	33.3%	0.2	0–1
<i>Allionia incarnata</i>	Herb	26.7%	0.1	0–1
<i>Cathastecum erectum</i>	Herb	26.7%	0.1	0–1
<i>Polygala macradenia</i>	Herb	26.7%	0.1	0–1
<i>Aristida</i> sp.	Herb	20.0%	0.1	0–1
<i>Senna durangensis</i>	Herb	20.0%	0.1	0–1
<i>Bahia absinthifolia</i>	Herb	20.0%	0.1	0–1
<i>Mandevilla macrosiphon</i>	Herb	20.0%	0.1	0–1
<i>Echinomastus warnockii</i>	Herb	13.3%	0.1	0–1
<i>Selaginella peruviana</i>	Herb	13.3%	0.1	0–1
<i>Tetraneuris scaposa</i>	Herb	13.3%	0.1	0–1



Photo 58. Boquillas Basin Calcareous Cresotebush Desert Scrub, along River Road East near Gravel Pit (BIBEA0043). Photo by Rebecca Evans.



Photo 59. Boquillas Basin Calcareous Cresotebush Desert Scrub, along Hot Springs Canyon Rim Trail (BIBEAA0050). Photo by Rebecca Evans.



## **Calcareous Mixed Desert Scrub**

### Local Type Concept:

Desert scrub with the common environmental influences of middle elevations within the desert scrub zone of BIBE (typically, 2,500 to 4,000 feet) and calcareous substrates. The shrub stratum is dominated by a mix of generalist desert scrub species, with several calcareous substrate indicators.

*Bouteloua ramosa* (chino grama) is constant. It is the calcareous substrates analog to the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub.

### Vegetation:

The shrub stratum is relatively species rich, with *Agave lechuguilla* (lechuguilla), *Larrea tridentata* (creosotebush), *Dasyllirion leiophyllum* (green sotol), and *Euphorbia antisiphilitica* (candelilla) the most constant and, overall, the most abundant species. Other relatively important shrub species are *Hechtia texensis* (Texas false agave) (which can be locally abundant), *Ephedra aspera* (rough jointfir), *Fouquieria splendens* (ocotillo), *Viguiera stenoloba* (skeletonleaf goldeneye), *Leucophyllum minus* (Big Bend silverleaf), *Leucophyllum candidum* (Boquillas silverleaf), *Opuntia camanchica* (Comanche pricklypear), *Guaiacum angustifolium* (guayacan), *Jatropha dioica* (leatherstem), *Tiquilia greggii* (plumed crinklemat), *Yucca torreyi* (Torrey's yucca), *Opuntia rufida* (blind pricklypear), *Forestiera angustifolia* (desert olive), and *Dalea formosa* (featherplume) are relatively constant. *Yucca faxoniana* (giant dagger) and *Y. thompsoniana* (Thompson's yucca) may occur prominently and sporadically within this association (as they do around Dagger Flats), but these tall yuccas are more characteristic of higher elevation calcareous grasslands. Smaller cactus flora includes *Echinocereus dasyacanthus* (Texas rainbow cactus), *Echinocactus horizonthalonius* (eagle-claw cactus), *Ariocarpus fissuratus* (living rock cactus), and *Escobaria tuberculosa* (cob cactus). Subshrubs are represented by *Thymophylla acerosa* (pricklyleaf dogweed) and by several species of subshrubs of the genus *Tiquilia* (crinklemats), including *T. hispidissima*, *T. canescens*, *T. mexicana*, and *T. gossypina*. Among herbaceous species, *Bouteloua ramosa* (chino grama) is the most constant and abundant species of the herbaceous stratum. It becomes progressively more abundant with elevation and may achieve up to 50% cover. Other constant herbaceous species include *Selaginella lepidophylla* (resurrection plant), *Selaginella wrightii* (Wright's spikemoss), *Dasyochloa pulchella* (fluffgrass), *Aristida purpurea* (purple threeawn), *Tridens muticus* (slim tridens), *Panicum hallii* (Hall's panicgrass), *Polygala macradenia* (glandleaf milkwort), and *Bahia absinthifolia* (hairyseed bahia). *Nerisyrenia camporum* (bicolor fanmustard) is a frequent spring-flowering annual forb. Stratum and substrate cover for Calcareous Mixed Desert Scrub are shown in Table D-59.

**Table D-59.** Stratum and substrate cover recorded for Lechuguilla – (Candelilla, False Agave)  
Calcareous Mixed Desert Scrub at Big Bend National Park (# plots=44) (plot BIBE0142 not included).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	2	0–25
	Short Shrub	27	2–50
	Herb	18	3–50
Substrate	Bedrock	24	0–99
	Large/Small Rocks	60	1–96
	Litter/Duff	7	0–40

#### Environment:

This association occurs generally above 2,450 feet (occasionally as low as 2,200 feet). It was observed to range to about 4,800 feet in the Dead Horse Mountains (elevations similar to those made by Fenstermacher (2007)). One small and marginal stand was seen at about 5,300 feet in the Sierra Quemada during the map accuracy assessment. It occurs almost exclusively on surfaces that are mapped as and/or observed to be limestone.

The largest concentration of this association occurs in and around the Dead Horse Mountains; it is also found on the Mesa de Anguila, the higher parts of Mariscal Mountain, and in isolated patches of the foothills of the Chisos and Rosillos Mountains.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)

USNVC Group: Chihuahuan Desert Succulent Desert Scrub Group (G286)

USNVC Alliance: *Agave lechuguilla* – *Euphorbia antisiphilitica* Chihuahuan Desert Succulent Scrub Alliance (A3157)

NPS Association: *Agave lechuguilla* – *Euphorbia antisiphilitica* – *Ephedra aspera* / *Bouteloua ramosa* Shrubland Association (NPSBIBE010)

#### Comments:

This association is the analogous vegetation on limestone to the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub association and the Chino Grama Shrub Grassland association of igneous substrates. Strong and fairly constant indicators of calcareous substrates at BIBE include *Euphorbia antisiphilitica* (candelilla), *Hechtia texensis* (Texas false agave), *Leucophyllum candidum* (Boquillas silverleaf), *Yucca faxoniana* (giant dagger), *Y. thompsoniana* (Thompson's yucca), *Ariocarpus fissuratus* (living rock cactus), *Escobaria tuberculosa* (cob cactus), *Tiquilia hispidissima*,

*T. mexicana*, *T. gossypina* (crinklemats), and (at low elevations) *Opuntia* ×*spinosibacca* (spiny-fruited pricklypear). *Leucophyllum minus* (Big Bend silverleaf) and *Selaginella lepidophylla* (resurrection plant) are moderately strong calcareous indicators.

Fenstermacher (2007) observed that the relatively clear progression with increasing elevation from desert scrub vegetation to grasslands that occurs on igneous substrates cannot be applied as readily to limestone in BIBE. This pattern was observed in this study and is reflected in this classification. On igneous substrates, such as in the Chisos Mountains, the progression of desert scrub to grass, usually with an increase in the abundance of *Bouteloua ramosa* (chino grama) is relatively abrupt, and it is feasible to model this in a classification as a categorical shift from the Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub association to the Chino Grama Shrub Grassland association. In the Dead Horse Mountains, there is a similar increase in *B. ramosa* with elevation. However, because of both the more gradual nature of the progression and the relative constancy of lower elevation shrub species composition (up to about 4,800) feet on limestone precludes finding an obvious discontinuity on which the split the Calcareous Mixed Desert Scrub association further. Thus, the “chino grama grasslands” that occur on limestone are contained within the concept of this desert scrub association.

BIBE Classification Plots Included in Concept:

BIBE0009, BIBE0034, BIBE0072, BIBE0073, BIBE0090, BIBE0091, BIBE0102, BIBE0103, BIBE0117, BIBE0118, BIBE0119, BIBE0120, BIBE0122, BIBE0132, BIBE0139, BIBE0140, BIBE0141, BIBE0142, BIBE0143, BIBE0145, BIBE0229, BIBE0331, BIBE0345, BIBE0347, BIBE0348, BIBE0349, BIBE0350, BIBE0395, BIBE0396, BIBE0397, BIBE0398, BIBE0399, BIBE0416, BIBE0417, BIBE0419, BIBE0421, BIBE0434, BIBE0435, BIBE0436, BIBE0437, BIBE0438, BIBE0439, BIBE0440, BIBE0441, BIBE0442.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0035, BIBEAA0048, BIBEAA0381, BIBEAA0391, BIBEAA0409, BIBEAA0497, BIBEAA0559, BIBEAA0583, BIBEAA0584, BIBEAA0585, BIBEAA0586, BIBEAA0587, BIBEAA0588, BIBEAA0589, BIBEAA0590, BIBEAA0591, BIBEAA0592, BIBEAA0593, BIBEAA0594, BIBEAA0595, BIBEAA0596, BIBEAA0598, BIBEAA0599, BIBEAA0600, BIBEAA0601, BIBEAA0602, BIBEAA0603, BIBEAA0604, BIBEAA0605, BIBEAA0672, BIBEAA0970, BIBEAA1239, BIBEAA1240, BIBEAA1274, BIBEAA1287.

Most frequent plant taxa recorded in Calcareous Mixed Desert Scrub are shown in Table D-60.

**Table D-60.** Synthesis table for the most frequent plant taxa recorded in Calcareous Mixed Desert Scrub at Big Bend National Park (# plots=44) (plot BIBE0142 not included).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Agave lechuguilla</i>	Shrub	90.9%	5.0	0–50
<i>Ephedra aspera</i>	Shrub	77.3%	0.5	0–3
<i>Dasyllirion leiophyllum</i>	Shrub	75.0%	2.6	0–26
<i>Euphorbia antisyphilitica</i>	Shrub	68.2%	4.7	0–51
<i>Leucophyllum minus</i>	Shrub	65.9%	1.3	0–11
<i>Echinocereus dasyacanthus</i>	Shrub	63.6%	0.3	0–1
<i>Opuntia camanchica</i>	Shrub	56.8%	0.4	0–3
<i>Larrea tridentata</i>	Shrub	50.0%	1.4	0–32
<i>Hechtia texensis</i>	Shrub	45.5%	2.7	0–25
<i>Viguiera stenoloba</i>	Shrub	45.5%	0.5	2.5
<i>Jatropha dioica</i>	Shrub	45.5%	0.4	0–3
<i>Tiquilia greggii</i>	Shrub	43.2%	0.4	0–5
<i>Fouquieria splendens</i>	Shrub	38.6%	0.5	0–7
<i>Senegalia greggii</i>	Shrub	38.6%	0.3	0–3
<i>Thymophylla acerosa</i>	Shrub	36.4%	0.2	0–2
<i>Echinocereus stramineus</i>	Shrub	36.4%	0.2	0–1
<i>Menodora scabra</i>	Shrub	36.4%	0.2	0–1
<i>Opuntia rufida</i>	Shrub	34.1%	0.2	0–3
<i>Forestiera angustifolia</i>	Shrub	31.8%	0.3	0–3
<i>Tiquilia canescens</i>	Shrub	31.8%	0.2	0–2
<i>Dalea formosa</i>	Shrub	29.5%	0.3	0–10
<i>Jefea brevifolia</i>	Shrub	29.5%	0.2	0–5
<i>Yucca thompsoniana</i>	Shrub	29.5%	0.1	0–2
<i>Escobaria tuberculosa</i>	Shrub	29.5%	0.1	0–1
<i>Ariocarpus fissuratus</i>	Shrub	29.5%	0.1	0–1
<i>Parthenium incanum</i>	Shrub	27.3%	0.7	0–25
<i>Guaiaacum angustifolium</i>	Shrub	22.7%	0.1	0–2
<i>Cylindropuntia leptocaulis</i>	Shrub	22.7%	0.1	0–2
<i>Echinocactus horizontalis</i>	Shrub	22.7%	0.1	0–1
<i>Opuntia</i> sp.	Shrub	22.7%	0.1	0–2
<i>Tiquilia hispidissima</i>	Shrub	20.5%	0.1	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	20.5%	0.1	0–3
<i>Flourensia cernua</i>	Shrub	15.9%	0.1	0–3
<i>Grusonia aggeria</i>	Shrub	15.9%	0.1	0–1
<i>Prosopis glandulosa</i>	Shrub	15.9%	0.0	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Bouteloua ramosa</i>	Herb	95.5%	11.8	0–50
<i>Selaginella lepidophylla</i>	Herb	50.0%	1.8	0–25
<i>Croton</i> sp.	Herb	36.4%	0.2	0–1
<i>Aristida</i> sp.	Herb	31.8%	0.2	0–2
<i>Polygala macradenia</i>	Herb	29.5%	0.1	0–1
<i>Selaginella wrightii</i>	Herb	27.3%	0.3	0–5
<i>Dasyochloa pulchella</i>	Herb	27.3%	0.2	0–2
<i>Bouteloua curtipendula</i>	Herb	18.2%	0.5	0–25
<i>Aristida arizonica</i>	Herb	18.2%	0.2	0–2
<i>Astrolepis cochisensis</i>	Herb	18.2%	0.1	0–1
<i>Chamaesyce</i> sp.	Herb	15.9%	0.1	0–1



Photo 60. Calcareous Mixed Desert Scrub, along Terlingua Ranch Road south of East Corazones Draw (BIBEAA0587). Photo by Kelon Crawford.



Photo 61. Calcareous Mixed Desert Scrub, along Old Ore Road near Willow Tank (BIBEAA0601). Photo by Kelon Crawford.



## ***Alkali Sacaton Riparian Grassland***

### Local Type Concept:

Grassland dominated by *Sporobolus airoides* (alkali sacaton), with sparse shrub cover.

### Vegetation:

*Sporobolus airoides* (alkali sacaton) is strongly dominant in the herbaceous stratum, and few other species are present. A sparse shrub stratum usually is present, with *Atriplex canescens* (fourwing saltbush) the most constant species. Occasional saplings of *Populus fremontii* ssp. *mesetae* (Arizona cottonwood) and individual tall shrubs of *Prosopis glandulosa* (honey mesquite), *Ziziphus obtusifolia* (lotebush), *Larrea tridentata* (creosotebush), and/or *Baccharis salicifolia* (seepwillow) may be present. Stratum and substrate cover for Alkali Sacaton Riparian Grassland are shown in Table D-61.

**Table D-61.** Stratum and substrate cover recorded for Alkali Sacaton Riparian Grassland at Big Bend National Park (# plots=1).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	1	1–1
	Tall Shrub	20	20–20
	Short Shrub	4	3–4
	Herb	70	70–70
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–0
	Litter/Duff	60	60–60

### Environment:

This association is a small patch and localized type known at BIBE from apparent former impoundments in the Rio Grande Village area. The species composition suggests highly alkaline conditions, possibly induced by water collection during precipitation or high flood water events and subsequent evaporation and accumulation of precipitated salts.

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: Chihuahuan Desert Scrub Macrogroup (M086)

USNVC Group: Chihuahuan Lowland Basin Semi-Desert Scrub Group (G299)

USNVC Alliance: *Atriplex canescens* Lowland Basin Desert Scrub Alliance (A3151)

NPS Association: *Atriplex canescens* – *Suaeda suffrutescens* / *Sporobolus airoides* Shrub Herbaceous Vegetation Association (NPSBIBE026)

Comments:

Most associations with a combination of *Atriplex canescens* (fourwing saltbush) and/or *Sporobolus airoides* (alkali sacaton) important that are recognized by the USNVC (2017) are from cooler regions (e.g., the Great Basin or the Great Plains. For the BIBE occurrence, the use of *Suaeda suffrutescens* (desert seepweed) as a nominal species distinguishes this type as a warm semi-desert entity.

BIBE Classification Plots Included in Concept:

BIBE0038.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0342, BIBEAA0343, BIBEAA1023.

Most frequent plant taxa recorded in Alkali Sacaton Riparian Grassland are shown in Table D-62.

**Table D-62.** Synthesis table for the most frequent plant taxa recorded in Alkali Sacaton Riparian Grassland at Big Bend National Park (# plots=1).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Populus fremontii</i> ssp. <i>mesetae</i>	Tree	100.0%	0.5	0–1
<i>Atriplex canescens</i>	Shrub	100.0%	8.9	5–10
<i>Ziziphus obtusifolia</i>	Shrub	100.0%	7.5	5–10
<i>Nicotiana glauca</i>	Shrub	100.0%	3.5	2–5
<i>Suaeda suffrutescens</i>	Shrub	100.0%	3.5	2–5
<i>Baccharis salicifolia</i>	Shrub	100.0%	0.5	few–1
<i>Sporobolus airoides</i>	Herb	100.0%	62.5	50–75



Photo 62. Alkali Sacaton Riparian Grassland, near Rio Grande Village campground (BIBE0038). Photo by Christian Skorik.



Photo 63. Alkali Sacaton Riparian Grassland, near Rio Grande Village campground (BIBEAA1023). Photo by Rebecca Evans.

## ***Big Bend Lowland Wash Channel Shrubland***

### Local Type Concept:

Shrublands or sparse shrublands in the channels of large washes, generally below 2,900 feet in elevation and with shrub stratum composition involving some combination of *Hymenoclea monogyra* (singlewhorl burrobrush), *Chilopsis linearis* (desertwillow), and/or *Porophyllum scoparium* (shrubby poreleaf).

### Vegetation:

A shrub stratum, usually from about 1 to 3 meters tall, is sparse to moderately dense. *Hymenoclea monogyra* (singlewhorl burrobrush) is the most constant and, usually the most abundant shrub species and is highly diagnostic of the type. *Chilopsis linearis* (desertwillow) and *Prosopis glandulosa* (honey mesquite) are other constant, and sometimes, dominant or co-dominant species. *Porophyllum scoparium* (shrubby poreleaf) is a characteristic shorter-statured (usually to 0.5 meter tall) shrub. Scattered *Larrea tridentata* (creosotebush) and *Vachellia constricta* (whitethorn acacia) often are present. Less constant shrubs include *Tamarix ramosissima* (tamarisk), *Senegalia greggii* (Gregg's catclaw), and *Yucca elata* (soaptree yucca). Herbaceous stratum cover is sparse, except when densely invaded by non-native grasses such as *Pennisetum ciliare* (buffelgrass) or, less often, *Sorghum halepense* (Johnson grass), as frequently happens. Native species that may occur include *Bouteloua barbata* (sixweeks grama), *Dasyochloa pulchella* (fluffgrass), and others. Stratum and substrate cover for Big Bend Lowland Wash Channel Shrubland are shown in Table D-63.

**Table D-63.** Stratum and substrate cover recorded for Big Bend Lowland Wash Channel Shrubland at Big Bend National Park (# plots=16).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	9	0–40
	Short Shrub	16	2–73
	Herb	6	1–18
Substrate	Bedrock	0	0–0
	Large/Small Rocks	17	2–47
	Litter/Duff	3	0–10

### Environment:

Sampled stands generally occur in the channels of large to moderately large washes throughout BIBE. Some occurrences along named tributaries are along Tornillo Creek, Ninepoint Draw, Terlingua Creek, Rough Run, Ash Creek, Cottonwood Creek, Alamo Creek, and Blue Creek. The association also occurs sporadically along alluvial bars within the Rio Grande channel; in these settings *Porophyllum scoparium* often is more prominent than *Hymenoclea monogyra*, and *Chilopsis linearis* usually is absent.

The Big Bend Lowland Wash Channel Shrubland generally occurs below 3,000 feet in elevation (occasionally as high as 3,400 feet). In general, it occurs at lower elevations than does the Foothills Wash Channel Shrubland. The elevation differences may be a function of an ultimate factor of stream order, rather than strictly elevation and climate. The Big Bend Lowland Wash Channel Shrubland tends to occur in larger washes or in the lower reaches of wash systems (generally, along reaches with more than about 2,000 hectares (5,000 acres) of drainage area), whereas the Foothills Wash Channel Shrubland seems along reaches with in smaller watersheds with narrower channels.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm-Desert Xero-Riparian Scrub Macrogroup (M092)

USNVC Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541)

USNVC Alliance: *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262)

NPS Association: *Hymenoclea monogyra* – *Chilopsis linearis* – *Porophyllum scoparium* Shrubland Association (NPSBIBE014)

#### Comments:

The USNVC (2017) *Brickellia laciniata* – *Hymenoclea monogyra* Shrubland Association (CEGL001953), attributed to New Mexico and Texas, is likely to be conceptually similar or include the concept might include the local entity. However, no descriptive information on this association is given by USNVC (2017). Moreover, the distribution of the two nominal species within BIBE, as documented by this project's plots shows almost complete separation of occurrences of the two species ( $n[Brickellia laciniata] = 6$ ;  $n[Hymenoclea monogyra] = 12$ ) by elevation, with only a narrow zone of overlap at about 3,300 feet. At BIBE, *B. laciniata* (splitleaf brickellia) appears to be a more a species of foothill (piedmont) and lower montane zone washes and canyons, and the USNVC name applied to the local concept is likely to be misleading. CEGL001953 is said to “intersect” a *Hymenoclea monogyra* / Sparse Herbs Association”, a concept attributed to New Mexico, along with a distinct *Brickellia laciniata* / Sparse Herbs Association (Dick-Peddie 1993). The Dick-Peddie name is a better fit for this BIBE concept than is that of the USNVC CEGL001953 and is used as the basis for the BIBE association name. The term “Sparse Herbs” is not used for the BIBE association name, in anticipation that it may becoming misleading as dense invasion of this vegetation by non-native grasses tends to progress.

#### BIBE Classification Plots Included in Concept:

BIBE0008, BIBE0036, BIBE0043, BIBE0100, BIBE0105, BIBE0108, BIBE0136, BIBE0324, BIBE0325, BIBE0334, BIBE0335, BIBE0338, BIBE3024, BIBE3029, BIBE3031.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0185, BIBEAA0485, BIBEAA0657, BIBEAA0663, BIBEAA0791, BIBEAA0792, BIBEAA0793, BIBEAA0800, BIBEAA0811, BIBEAA0942, BIBEAA0952, BIBEAA0972,

BIBEAA0984, BIBEAA0985, BIBEAA0986, BIBEAA0988, BIBEAA0989, BIBEAA0990, BIBEAA0995, BIBEAA0996, BIBEAA1044, BIBEAA1045, BIBEAA1046, BIBEAA1050, BIBEAA1180, BIBEAA1181, BIBEAA1043, BIBEAA1053, BIBEAA1064, BIBEAA1065, BIBEAA1131, BIBEAA1289.

Most frequent plant taxa recorded in Big Bend Lowland Wash Channel Shrubland are shown in Table D-64.

**Table D-64.** Synthesis table for the most frequent plant taxa recorded in Big Bend Lowland Wash Channel Shrubland at Big Bend National Park (# plots=15).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Hymenoclea monogyra</i>	Shrub	66.7%	4.1	0–25
<i>Porophyllum scoparium</i>	Shrub	66.7%	2.6	0–25
<i>Prosopis glandulosa</i>	Shrub	66.7%	0.4	0–1
<i>Chilopsis linearis</i>	Shrub	46.7%	4.1	0–38
<i>Vachellia constricta</i>	Shrub	46.7%	1.0	0–10
<i>Cylindropuntia leptocaulis</i>	Shrub	33.3%	0.2	0–1
<i>Baccharis salicifolia</i>	Shrub	26.7%	0.6	0–10
<i>Senegalia roemeriana</i>	Shrub	26.7%	0.3	0–5
<i>Selinocarpus parvifolius</i>	Shrub	26.7%	0.1	0–1
<i>Senegalia roemeriana</i>	Shrub	20.0%	0.3	0–5
<i>Yucca elata</i>	Shrub	20.0%	0.2	0–2
<i>Larrea tridentata</i>	Shrub	20.0%	0.2	0–2
<i>Salix gooddingii</i>	Shrub	20.0%	0.2	0–2
<i>Grusonia aggeria</i>	Shrub	13.3%	0.1	0–1
<i>Isocoma pluriflora</i>	Shrub	13.3%	<0.1	0–1
<i>Lycium berlandieri</i>	Shrub	13.3%	<0.1	0–1
<i>Atriplex canescens</i>	Shrub	13.3%	<0.1	0–1
<i>Opuntia camanchica</i>	Shrub	13.3%	<0.1	0–1
<i>Pennisetum ciliare</i>	Herb	60.0%	4.9	0–75
<i>Sorghum halepense</i>	Herb	40.0%	0.5	0–5
<i>Bouteloua barbata</i>	Herb	40.0%	0.2	0–1
<i>Croton</i> sp.	Herb	33.3%	0.4	0–1
<i>Cynodon dactylon</i>	Herb	26.7%	1.8	0–25
<i>Allionia incarnata</i>	Herb	26.7%	0.2	0–1
<i>Boerhavia intermedia</i>	Herb	26.7%	0.1	0–1
<i>Dasyochloa pulchella</i>	Herb	26.7%	0.1	0–1
<i>Xanthium strumarium</i>	Herb	26.7%	0.1	0–1
<i>Aristida purpurea</i>	Herb	20.0%	0.1	0–1



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Bahia absinthifolia</i>	Herb	20.0%	0.1	0–1
<i>Nerisyrenia camporum</i>	Herb	20.0%	0.1	0–1
<i>Pectis angustifolia</i>	Herb	20.0%	0.1	0–1
<i>Poa</i> sp.	Herb	20.0%	0.1	0–1
<i>Bothriochloa ischaemum</i>	Herb	13.3%	0.1	0–10
<i>Bothriochloa laguroides</i>	Herb	20.0%	0.1	0–1
<i>Chamaesyce fendleri</i>	Herb	13.3%	0.1	0–1
<i>Sporobolus airoides</i>	Herb	13.3%	0.1	0–1
<i>Thelesperma megapotamicum</i>	Herb	13.3%	0.1	0–1
<i>Tidestromia carnosa</i>	Herb	13.3%	0.1	0–1
<i>Dalea neomexicana</i>	Herb	13.3%	<0.1	0–1
<i>Senna durangensis</i>	Herb	13.3%	<0.1	0–1
<i>Kallstroemia parviflora</i>	Herb	13.3%	<0.1	0–trace



Photo 64. Big Bend Lowland Wash Channel Shrubland, Tornillo Creek, south of Exhibit Ridge (BIBE0008), with *Hymenoclea monogyra* the dominant shrub. Photo by Christian Skorik.



Photo 65. Big Bend Lowland Wash Channel Shrubland, Terlingua Creek at Terlingua Abajo (BIBE0105), with *Hymenoclea monogyra* the dominant shrub. Photo by Jenny Goucher.

## ***Foothills Wash Channel Shrubland***

### Local Type Concept:

Shrublands or sparse shrublands in the channels of large washes, generally above 2,900 feet in elevation.

### Vegetation:

The vegetation occurs as medium to tall height shrublands or sparse shrublands. *Chilopsis linearis* (desertwillow) is the most constant and abundant species; its occurrence in quantity above about 2,900 feet is fairly diagnostic of this type, but individual stands may have lower overall cover (or locally low cover) of *C. linearis*, probably because of the stochastic nature of species occurrences and abundances within wash channels. Other constant species include *Senegalia roemeriana* (Roemer's catclaw), *Porophyllum scoparium* (shrubby poreleaf), *Viguiera stenoloba* (skeletonleaf goldeneye), and/or *Yucca torreyi* (Torrey's yucca). While less constant, *Fallugia paradoxa* (Apache plume) and *Brickellia laciniata* (splitleaf brickellia) are fairly diagnostic shrubs. In contrast to the composition of the Big Bend Lowland Wash Channel Shrubland, *Hymenoclea monogyra* (singlewhorl burrobrush) is absent or relatively unimportant.

The herbaceous stratum is usually sparse and grass dominated. *Heteropogon contortus* (tanglehead) is the most constant and, often, the most abundant, species. *Bouteloua curtipendula* (sideoats grama) and/or *Bothriochloa laguroides* (silver bluestem) may occur at low cover. In some cases, non-native grasses, such as *Eragrostis lehmanniana* (Lehmann lovegrass) and, less frequently, *Pennisetum ciliare* (buffelgrass) may invade the vegetation and occur at moderately dense to dense cover.

Stratum and substrate cover for Foothills Wash Channel Shrubland are shown in Table D-65.

**Table D-65.** Stratum and substrate cover recorded for Foothills Wash Channel Shrubland at Big Bend National Park (# plots=6).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–2
	Tall Shrub	19	1–40
	Short Shrub	14	1–30
	Herb	13	5–30
Substrate	Bedrock	0	0–0
	Large/Small Rocks	61	12–90
	Litter/Duff	12	1–50

### Environment:

The Foothills Wash Channel Shrubland occurs in the channels of ephemeral washes, usually in reaches of watersheds that have less than 2,000 hectares (5,000 acres) of drainage area. This places the type upstream from the Big Bend Lowland Wash Channel Shrubland in watersheds large enough to support both. The Foothills Wash Channel Shrubland typically occurs from 2,900 to about 4,000

feet in elevation (one site is as low as 2,300 feet). It is often sympatric with the Mixed Tall Shrubs Wash Shrubland, which occupies the banks and floodplains, rather than the channel. The Foothills Wash Channel Shrubland occurs throughout BIBE in suitable settings in small and/or linear patches. Specific locations include upper Javelina Wash, the lower part of the Cattail Canyon wash, Oak Creek, Hannold Draw, and Fresno Creek.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm-Desert Xero-Riparian Scrub Macrogroup (M092)

USNVC Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541)

USNVC Alliance: *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262)

NPS Association: *Chilopsis linearis* – *Yucca torreyi* – (*Brickellia laciniata*) Shrubland Association (NPSBIBE042)

#### Comments:

Translation to an existing USNVC (2017) association is problematic partly because a number of recognized associations involving *Chilopsis linearis* and its associates and habitat are more applicable to the Sonoran and/or Mojave Desert regions and inappropriate for the Chihuahuan region. The current USNVC *Chilopsis linearis* / *Brickellia laciniata* Scrub (CEGL004933) association is probably the conceptually closest entity, but the description is minimal and some species are inappropriate for BIBE. Because locally described and named BIBE-specific units have been created for other wash associations observed during this project, it seems best to continue this approach, to allow the local unit relationships to relate to each other better and to not conflate these relationships by introducing incomplete concepts that were developed elsewhere.

#### BIBE Classification Plots Included in Concept:

BIBE0028, BIBE0064, BIBE0085, BIBE0128, BIBE0195, BIBE0424.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0668, BIBEAA0865, BIBEAA0961, BIBEAA0969, BIBEAA0983.

Most frequent plant taxa recorded in Foothills Wash Channel Shrubland are shown in Table D-66.

**Table D-66.** Synthesis table for the most frequent plant taxa recorded in Foothills Wash Channel Shrubland at Big Bend National Park (# plots=6).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Chilopsis linearis</i>	Shrub	100.0%	21.9	few–55
<i>Senegalia roemeriana</i>	Shrub	83.3%	1.5	0–5
<i>Porophyllum scoparium</i>	Shrub	66.7%	1.5	0–10
<i>Viguiera stenoloba</i>	Shrub	66.7%	0.7	0–2
<i>Celtis ehrenbergiana</i>	Shrub	50.0%	0.3	0–3
<i>Yucca torreyi</i>	Shrub	50.0%	0.2	0–1
<i>Fallugia paradoxa</i>	Shrub	33.3%	0.9	0–10
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	33.3%	0.3	0–3
<i>Parthenium incanum</i>	Shrub	33.3%	0.2	0–1
<i>Larrea tridentata</i>	Shrub	33.3%	0.2	0–1
<i>Stenaria nigricans</i>	Shrub	33.3%	0.2	0–1
<i>Senegalia greggii</i>	Shrub	33.3%	0.1	0–1
<i>Dasyllirion leiophyllum</i>	Shrub	33.3%	0.1	0–1
<i>Hymenoclea monogyra</i>	Shrub	16.7%	1.3	0–10
<i>Diospyros texana</i>	Shrub	16.7%	0.6	0–5
<i>Rhus virens</i>	Shrub	16.7%	0.6	0–5
<i>Baccharis salicifolia</i>	Shrub	16.7%	0.6	0–5
<i>Prosopis glandulosa</i>	Shrub	16.7%	0.3	0–2
<i>Leucophyllum frutescens</i>	Shrub	16.7%	0.3	0–2
<i>Clematis drummondii</i>	Vine	33.3%	0.3	0–2
<i>Heteropogon contortus</i>	Herb	83.3%	4.4	0–25
<i>Bouteloua curtipendula</i>	Herb	66.7%	0.3	0–1
<i>Bothriochloa laguroides</i>	Herb	50.0%	0.2	0–1
<i>Eragrostis lehmanniana</i>	Herb	33.3%	3.0	0–25
<i>Aristida purpurea</i>	Herb	33.3%	0.2	0–1
<i>Bouteloua ramosa</i>	Herb	33.3%	0.2	0–1
<i>Dasyochloa pulchella</i>	Herb	33.3%	0.2	0–1
<i>Aristida arizonica</i>	Herb	33.3%	0.2	0–1
<i>Boerhavia intermedia</i>	Herb	33.3%	0.2	0–1
<i>Pennisetum ciliare</i>	Herb	33.3%	0.1	0–1
<i>Trixis californica</i>	Herb	33.3%	0.0	0–trace
<i>Setaria</i> sp.	Herb	33.3%	0.0	0–trace
<i>Setaria leucopila</i>	Herb	16.7%	0.6	0–5
<i>Pappophorum bicolor</i>	Herb	16.7%	0.3	0–2





Photo 66. Foothills Wash Channel Shrubland, Oak Creek at Maverick – Panther Junction Road, with *Chilopsis linearis* (BIBE0028). Photo by Christian Skorik.



Photo 67. Foothills Wash Channel Shrubland, Javelina Wash below Burro Mesa Pouroff (BIBE0128). Photo by Jenny Goucher.



### **Mixed Tall Shrubs Wash Shrubland**

#### Local Type Concept:

Moderately dense to dense tall shrublands with mixed and variable dominance on banks and riparian terraces associated with washes located on upper elevations of alluvial fans and in foothills.

#### Vegetation:

A tall (generally, 1.5 to 4 meters tall) and dense shrub stratum is dominated by a relatively even and diverse mix of species. The most constant and abundant tall shrub species are *Diospyros texana* (Texas persimmon), *Rhus microphylla* (littleleaf sumac), *Prosopis glandulosa* (honey mesquite), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), and tall *Larrea tridentata* (creosotebush). Less constant tall shrub species include *Senegalia roemeriana* (Roemer's catclaw), *Senegalia greggii* (Gregg's catclaw), *Mahonia trifoliolata* (agarito), *Yucca torreyi* (Torrey's yucca), *Ziziphus obtusifolia* (lotebush), *Celtis ehrenbergiana* (= *Celtis pallida*) (spiny hackberry), *Vachellia constricta* (whitethorn acacia), *Eysenhardtia texana* (Texas kidneywood), and *Aloysia gratissima* (whitebrush), with the last species occasionally abundant where past anthropogenic disturbance (e.g., former ranching operations, current nearby NPS facilities) has occurred. A short (< 1 meter tall) shrub stratum also may be fairly dense, with *Parthenium incanum* (mariola) and *Viguiera stenoloba* (skeletonleaf goldeneye) the most constant species and with *Dasyllirion leiophyllum* (green sotol), *Ephedra aspera* (rough jointfir), and *Cylindropuntia leptocaulis* (Christmas cactus) *Argythamnia serrata* (Yuma silverbush), *Opuntia camanchica* (Comanche pricklypear), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Acaciella angustissima* (prairie acacia), *Gymnosperma glutinosum* gumhead), and others often present. The herbaceous stratum usually has sparse to moderate cover, with the grasses *Bouteloua curtipendula* (sideoats grama) and *Heteropogon contortus* (tanglehead) most frequent. Other relatively constant species include *Setaria leucopila* (streambed bristlegrass), *Digitaria californica* (Arizona cottontop), and the non-native *Eragrostis lehmanniana* (Lehmann lovegrass). Stratum and substrate cover for Mixed Tall Shrubs Wash Shrubland are shown in Table D-67.

**Table D-67.** Stratum and substrate cover recorded for Mixed Tall Shrubs Wash Shrubland at Big Bend National Park (# plots=12).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	26	2–60
	Short Shrub	32	3–55
	Herb	14	1–40
Substrate	Bedrock	4	0–25
	Large/Small Rocks	44	1–91
	Litter/Duff	24	5–60

### Environment:

The Mixed Tall Shrubs Wash Shrubland occurs along washes of upper elevations of alluvial fans and in foothills, where it occupies the banks and floodplains, rather than the channel, which typically supports one of the two channel associations: the Foothills Wash Channel Shrubland or the Big Bend Lowland Wash Channel Shrubland. The Mixed Tall Shrubs Wash Shrubland has been observed throughout BIBE, mostly at elevations from 2,600 to about 4,500 feet in elevation (more exceptionally at 2,300 and at 4,700 feet). Plot sampled stands are in watersheds of Smoky Creek, Javelina Wash (Burro Mesa area), upper Alamo Creek (Burro Mesa area), drainage of Panther Spring, Hannold Draw, Dugout Draw (in the vicinity of the Dugout Wells picnic area), the drainage of Grapevine Spring, the upper Avery Canyon drainage, Nine Point Draw (Dog Canyon area) (2 plots, limestone site), and Javelina Creek (limestone site). There is an exceptionally large stand along Cottonwood Creek north and west of the Sam Nail Ranch. At lower elevations, the Mixed Tall Shrubs Wash Shrubland it is replaced in the wash bank and floodplain setting by the less species-rich Acacia – Mesquite Wash Shrubland.

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm-Desert Xero-Riparian Scrub Macrogroup (M092)

USNVC Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541)

USNVC Alliance: *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262)

NPS Association: *Diospyros texana* – *Forestiera angustifolia* – *Prosopis glandulosa* – (*Rhus microphylla*) Shrubland Association (NPSBIBE029)

### Comments:

This association is approximately equivalent to the Desert Arroyo vegetation type of the Dead Horse Mountains described by Fenstermacher (2007). Occurrences on limestone seem consistent with those of igneous substrates. Some differences are an apparent increase in the relative importance of species such as *Diospyros texana*, *Eysenhardtia texana*, and *Leucaena retusa* (littleleaf leadtree) on limestone, along with the absence or reduced importance of *Rhus microphylla*.

The similar Persimmon – Littleleaf Ash Foothills Shrubland is analogous to the Mixed Tall Shrubs Wash Shrubland as a tall shrub streambank association of slightly higher elevations and also represents transitional vegetation between the Mixed Tall Shrubs Wash Shrubland and the higher elevation Montane Mixed Chaparral of non-riparian settings. The Persimmon – Littleleaf Ash Foothills Shrubland has a predominance of higher elevation species that extend in a facultative manner into upland chaparral (predominantly, *Fraxinus greggii* and *Rhus virens*) and a smaller component of the thorny desert scrub species that is characteristic of the Mixed Tall Shrubs Wash Shrubland.

In general USNVC (2017) Macrogroup M092 and Group G541 (generalized wash units for the Mojave, Sonoran, and Chihuahuan Desert regions) lack Chihuahuan Desert alliances and associations and need alliance units that cover denser floodplain and bank vegetation, as well as channel bottom vegetation. The only available reasonable alliance, the *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262) is an awkward fit for the BIBE vegetation.

BIBE Classification Plots Included in Concept:

BIBE0013, BIBE0035, BIBE0063, BIBE0071, BIBE0084, BIBE0101, BIBE0346, BIBE0400, BIBE0409, BIBE0412, BIBE0448, BIBE0451.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0189, BIBEAA0193, BIBEAA0196, BIBEAA0214, BIBEAA0395, BIBEAA0520, BIBEAA0666, BIBEAA0702, BIBEAA0862, BIBEAA0870, BIBEAA0871, BIBEAA0872, BIBEAA0875, BIBEAA0876, BIBEAA0880, BIBEAA0881, BIBEAA0882, BIBEAA0883, BIBEAA0884, BIBEAA0885, BIBEAA0886, BIBEAA0887, BIBEAA0888, BIBEAA0954, BIBEAA0958, BIBEAA0959, BIBEAA0968, BIBEAA0969, BIBEAA0971, BIBEAA0973, BIBEAA0978, BIBEAA0979, BIBEAA1278.

Most frequent plant taxa recorded in Mixed Tall Shrubs Wash Shrubland are shown in Table D-68.

**Table D-68.** Synthesis table for the most frequent plant taxa recorded in Mixed Tall Shrubs Wash Shrubland at Big Bend National Park (# plots=12).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Diospyros texana</i>	Shrub	90.9%	5.3	0–30
<i>Forestiera angustifolia</i>	Shrub	81.8%	1.8	0–5
<i>Viguiera stenoloba</i>	Shrub	81.8%	1.5	0–5
<i>Prosopis glandulosa</i>	Shrub	72.7%	2.3	0–11
<i>Senegalia roemeriana</i>	Shrub	72.7%	1.9	0–7
<i>Parthenium incanum</i>	Shrub	72.7%	1.0	0–3
<i>Mahonia trifoliolata</i>	Shrub	72.7%	0.5	0–2
<i>Rhus microphylla</i>	Shrub	63.6%	5.0	0–26
<i>Ziziphus obtusifolia</i>	Shrub	63.6%	1.2	0–10
<i>Cylindropuntia leptocaulis</i>	Shrub	63.6%	0.5	0–3
<i>Ephedra aspera</i>	Shrub	63.6%	0.4	0–2
<i>Celtis ehrenbergiana</i>	Shrub	54.5%	3.9	0–51
<i>Aloysia gratissima</i>	Shrub	54.5%	1.2	0–10
<i>Larrea tridentata</i>	Shrub	54.5%	0.6	0–5
<i>Rhus virens</i>	Shrub	45.5%	1.8	0–15
<i>Dasyliiron leiophyllum</i>	Shrub	45.5%	1.4	0–11
<i>Guaiaacum angustifolium</i>	Shrub	45.5%	1.4	0–12
<i>Yucca torreyi</i>	Shrub	45.5%	0.4	0–2

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Senegalia greggii</i>	Shrub	36.4%	2.0	0–26
<i>Opuntia camanchica</i>	Shrub	36.4%	0.1	0–1
<i>Echinocereus stramineus</i>	Shrub	36.4%	0.1	0–1
<i>Fallugia paradoxa</i>	Shrub	27.3%	0.9	0–6
<i>Vachellia constricta</i>	Shrub	27.3%	0.7	0–5
<i>Porophyllum scoparium</i>	Shrub	27.3%	0.7	0–7
<i>Anisacanthus linearis</i>	Shrub	27.3%	0.5	0–5
<i>Koeberlinia spinosa</i>	Shrub	27.3%	0.2	0–2
<i>Mimosa aculeaticarpa</i> var. <i>biuncifera</i>	Shrub	27.3%	0.2	0–2
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	27.3%	0.1	0–1
<i>Cylindropuntia imbricata</i>	Shrub	27.3%	0.1	0–1
<i>Leucaena retusa</i>	Shrub	18.2%	3.5	0–52
<i>Eysenhardtia texana</i>	Shrub	18.2%	2.2	0–35
<i>Brickellia laciniata</i>	Shrub	18.2%	1.7	0–25
<i>Leucophyllum frutescens</i>	Shrub	18.2%	1.6	0–25
<i>Ungradia speciosa</i>	Shrub	18.2%	1.0	0–11
<i>Chilopsis linearis</i>	Shrub	18.2%	0.6	0–5
<i>Dalea formosa</i>	Shrub	18.2%	0.5	0–6
<i>Fraxinus greggii</i>	Shrub	18.2%	0.3	0–3
<i>Aloysia wrightii</i>	Shrub	18.2%	0.3	0–2
<i>Clematis drummondii</i>	Vine	45.5%	0.2	0–1
<i>Bouteloua curtipendula</i>	Herb	63.6%	2.6	0–25
<i>Heteropogon contortus</i>	Herb	45.5%	2.3	0–25
<i>Kallstroemia parviflora</i>	Herb	27.3%	0.2	0–2
<i>Artemisia ludoviciana</i>	Herb	27.3%	0.1	0–1
<i>Menodora scabra</i>	Herb	27.3%	0.1	0–1
<i>Eragrostis lehmanniana</i>	Herb	18.2%	3.4	0–50
<i>Muhlenbergia schreberi</i>	Herb	18.2%	1.0	0–10



Photo 68. Mixed Tall Shrubs Wash Shrubland, dry wash below Rough Spring (BIBE0013). Photo by Christian Skorik.



Photo 69. Mixed Tall Shrubs Wash Shrubland, dry wash on Burro Mesa (BIBE0409). Photo by Matthew Yarbrough.



## **Persimmon – Littleleaf Ash Foothills Shrubland**

### Local Type Concept:

Somewhat open to dense tall shrublands with mixed dominance by *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), and/or *Rhus virens* (evergreen sumac) associated with washes or ravines and lower slopes in foothills settings.

### Vegetation:

A combination of the tall shrubs *Fraxinus greggii* (littleleaf ash) *Diospyros texana* (Texas persimmon), and *Rhus virens* (evergreen sumac) typically dominate a tall shrub stratum. Other tall shrubs that are less constant, contribute smaller amounts of cover include *Senegalia roemeriana* (Roemer's catclaw), *Senegalia greggii* (Gregg's catclaw), *Forestiera angustifolia* (desert olive), *Ungnadia speciosa* (Mexican buckeye), *Rhus microphylla* (littleleaf sumac), *Sophora secundiflora* (mescal bean), *Guaiacum angustifolium* (guayacan), *Mimosa aculeaticarpa* var. *biuncifera* (catclaw mimosa), *Vachellia constricta* (whitethorn acacia), *Aloysia gratissima* (whitebrush), *Celtis ehrenbergiana* (= *Celtis pallida*) (spiny hackberry), and *Fouquieria splendens* (ocotillo). A component of shorter shrubs includes *Dasylirion leiophyllum* (green sotol), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), *Viguiera stenoloba* (skeletonleaf goldeneye), *Yucca torreyi* (Torrey's yucca), *Cylindropuntia imbricata* (tree cholla), *Parthenium incanum* (mariola), and *Gymnosperma glutinosum* (gumhead). The herbaceous stratum usually has sparse to moderate cover, with the grasses *Bouteloua curtipendula* (sideoats grama) and *Heteropogon contortus* (tanglehead) most frequent. Other grass species include *Panicum hallii* (Hall's panic grass), *Leptochloa dubia* (sprangletop), *Aristida ternipes* (spidergrass), and *Setaria leucopila* (streambed bristlegrass). Cloak ferns (*Notholaena standleyi*, *Astrolepis cochisensis*, and *Astrolepis sinuata*) often are present at low cover. Stratum and substrate cover for Persimmon – Littleleaf Ash Foothills Shrubland are shown in Table D-69.

**Table D-69.** Stratum and substrate cover recorded for Persimmon – Littleleaf Ash Foothills Shrubland at Big Bend National Park (# plots=8).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	14	0–60
	Tall Shrub	24	4–50
	Short Shrub	31	3–60
	Herb	11	5–20
Substrate	Bedrock	4	0–20
	Large/Small Rocks	56	7–80
	Litter/Duff	20	0–53



### Environment:

The Persimmon – Littleleaf Ash Foothills Shrubland occurs in more mesic settings within a matrix of drier shrub grassland (usually, the Sotol – Lechuguilla Foothills Shrub Grassland) from 3,800 feet to 5,500 feet in elevation, in the Sierra Quemada and the western Chisos Mountains foothills. These settings include ravines, lower slopes, and draws. It also replaces the Mixed Tall Shrubs Wash Shrubland as the primary vegetation of wash banks and floodplains near the upper end of that association's elevation range (beginning about 4,000 to 4,500 feet).

### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm-Desert Xero-Riparian Scrub Macrogroup (M092)

USNVC Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541)

USNVC Alliance: *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262)

NPS Association: *Fraxinus greggii* – *Diospyros texana* – *Rhus virens* – *Senegalia* spp. Shrubland Association (NPSBIBE013)

### Comments:

In concept, the Persimmon – Littleleaf Ash Foothills Shrubland can be regarded both as a higher elevation analog to the Mixed Tall Shrubs Wash Shrubland and as a transition from that association to the non-riparian Montane Mixed Chaparral). It appears to be less constrained to washes than is the Mixed Tall Shrubs Wash Shrubland, and it extends from alluvial zones into the lower slopes of wash valleys and into non-alluvial ravines. The two types are similar in many of the tall moisture-limited species that occur; the primary difference is that the Persimmon – Littleleaf Ash Foothills Shrubland has a component of higher elevation species that extend in a facultative manner into upland chaparral species (predominantly, *Fraxinus greggii* and *Rhus virens*). It has a smaller component of the tall, thorny desert scrub species that is characteristic of the Mixed Tall Shrubs Wash Shrubland.

This association has floristic and environmental components of both xeromorphic scrub (with thorny and/or microphyllous shrubs) and of chaparral (with sclerophyllous shrubs) and is somewhat transitional between the higher elevation end of the former and the more mesic end of the latter. It is placed in the USNVC Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) of the USNVC Semi-Desert Class, although placement in the Eastern Madrean Chaparral Group (G280) of the USNVC Shrubland and Grassland Class (2) might be warranted.

In general USNVC (2017) Macrogroup M092 and Group G541 (generalized wash units for the Mojave, Sonoran, and Chihuahuan Desert regions) lack Chihuahuan Desert alliances and associations and need alliance units that cover denser floodplain and bank vegetation, as well as channel bottom vegetation. The only available reasonable alliance, the *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262) is an awkward fit for the BIBE vegetation.

BIBE Classification Plots Included in Concept:

BIBE0189, BIBE0194, BIBE0388, BIBE0408, BIBE0454, BIBE0464, BIBE0465, BIBE0466.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0197, BIBEAA0671, BIBEAA0817, BIBEAA0827, BIBEAA0828, BIBEAA0863, BIBEAA0960.

Most frequent plant taxa recorded in Persimmon – Littleleaf Ash Foothills Shrubland are shown in Table D-70.

**Table D-70.** Synthesis table for the most frequent plant taxa recorded in Persimmon – Littleleaf Ash Foothills Shrubland at Big Bend National Park (# plots=8).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Diospyros texana</i>	Shrub	100.0%	10.0	few–61
<i>Fraxinus greggii</i>	Shrub	87.5%	10.6	0–50
<i>Dasyliroia leiophyllum</i>	Shrub	87.5%	3.7	0–11
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	87.5%	1.6	0–6
<i>Viguiera stenoloba</i>	Shrub	75.0%	2.2	0–12
<i>Rhus virens</i>	Shrub	62.5%	2.0	0–15
<i>Celtis ehrenbergiana</i>	Shrub	62.5%	1.2	0–11
<i>Guaiaacum angustifolium</i>	Shrub	62.5%	1.2	0–7
<i>Senegalia greggii</i>	Shrub	62.5%	0.9	0–5
<i>Yucca torreyi</i>	Shrub	62.5%	0.5	0–10
<i>Vachellia constricta</i>	Shrub	50.0%	2.6	0–25
<i>Fouquieria splendens</i>	Shrub	50.0%	1.0	0–10
<i>Cylindropuntia imbricata</i>	Shrub	50.0%	0.3	0–2
<i>Parthenium incanum</i>	Shrub	50.0%	0.7	0–6
<i>Sophora secundiflora</i>	Shrub	37.5%	1.9	0–16
<i>Mimosa aculeaticarpa</i> var. <i>biuncifera</i>	Shrub	37.5%	1.8	0–10
<i>Mammillaria lasiocantha</i>	Shrub	37.5%	0.6	0–10
<i>Agave lechuguilla</i>	Shrub	37.5%	0.4	0–2
<i>Ephedra aspera</i>	Shrub	37.5%	0.4	0–2
<i>Agave havardiana</i>	Shrub	37.5%	0.2	0–2
<i>Rhus microphylla</i>	Shrub	37.5%	0.1	0–1
<i>Ziziphus obtusifolia</i>	Shrub	37.5%	0.1	0–1
<i>Brickellia laciniata</i>	Shrub	25.0%	2.3	0–25
<i>Leucophyllum frutescens</i>	Shrub	25.0%	1.5	0–11
<i>Chilopsis linearis</i>	Shrub	25.0%	1.2	0–11
<i>Fallugia paradoxa</i>	Shrub	25.0%	0.9	0–6
<i>Eysenhardtia texana</i>	Shrub	25.0%	0.9	0–5

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Ungradia speciosa</i>	Shrub	25.0%	0.5	0–10
<i>Gutierrezia</i> sp.	Shrub	25.0%	0.5	0–6
<i>Janusia gracilis</i>	Shrub	25.0%	0.3	0–2
<i>Forestiera angustifolia</i>	Shrub	25.0%	0.3	0–2
<i>Aloysia wrightii</i>	Shrub	25.0%	0.3	0–2
<i>Porophyllum scoparium</i>	Shrub	25.0%	0.3	0–6
<i>Jefea brevifolia</i>	Shrub	25.0%	0.2	0–2
<i>Dalea formosa</i>	Shrub	25.0%	0.2	0–2
<i>Bouteloua curtipendula</i>	Herb	100.0%	2.8	0–10
<i>Panicum hallii</i>	Herb	75.0%	0.4	0–1
<i>Heteropogon contortus</i>	Herb	62.5%	1.3	0–10
<i>Astrolepis cochisensis</i>	Herb	62.5%	0.3	0–1
<i>Chamaesyce</i> sp.	Herb	50.0%	0.3	0–1
<i>Selaginella lepidophylla</i>	Herb	50.0%	0.3	0–1
<i>Aristida</i> sp.	Herb	37.5%	0.4	0–2
<i>Astrolepis sinuata</i>	Herb	37.5%	0.3	0–2
<i>Notholaena standleyi</i>	Herb	37.5%	0.2	0–1
<i>Bouteloua ramosa</i>	Herb	25.0%	0.3	0–2
<i>Ipomoea</i> sp.	Herb	25.0%	0.3	0–2
<i>Bothriochloa laguroides</i>	Herb	28.6%	0.1	0–1



Photo 70. Persimmon – Littleleaf Ash Foothills Shrubland, along Dodson Trail, upper Smoky Creek drainage (BIBEAA0197). Photo by Kelon Crawford.



Photo 71. Persimmon – Littleleaf Ash Foothills Shrubland, along Blue Creek (BIBEAA0827). Photo by Kelon Crawford.



## **Acacia – Mesquite Wash Shrubland**

### Local Type Concept:

Moderately dense to somewhat open tall shrublands dominated by *Vachellia constricta*, *Senegalia* spp., *Prosopis glandulosa*, and/or other riparian shrubs on banks and terraces of large washes and in the channel of smaller washes.

### Vegetation:

Both shrub and herbaceous strata are sparse to moderate in cover. A moderately dense to somewhat open tall shrub stratum is dominated by some combination of *Prosopis glandulosa* (honey mesquite), *Senegalia greggii* (Gregg's catclaw), *Vachellia constricta* (whitethorn acacia), and/or *Larrea tridentata* (creosotebush). *Yucca elata* (soaptree yucca) is a characteristic low cover species. Species that are more typical of channels, including *Hymenoclea monogyra* (singlewhorl burrobrush), *Chilopsis linearis* (desertwillow), and/or *Porophyllum scoparium* (shrubby poreleaf) may occur in small amounts. *Vachellia vernicosa* (viscid acacia) and *Salazaria mexicana* (bladdersage) are two species of limited distribution within BIBE that may occur. *Dasyochloa pulchella* (fluffgrass), *Croton* spp. (crotons), *Senna durangensis* (Durango senna), and the exotic grass *Pennisetum ciliare* (buffelgrass) are the most constant herbaceous stratum species, which is usually very sparse, with the exception of occasional dense invasions of *P. ciliare*. Stratum and substrate cover for Acacia – Mesquite Wash Shrubland are shown in Table D-71.

**Table D-71.** Stratum and substrate cover recorded for Acacia – Mesquite Wash Shrubland at Big Bend National Park (# plots=2).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	15	5–25
	Short Shrub	25	25–25
	Herb	33	15–50
Substrate	Bedrock	0	0–0
	Large/Small Rocks	3	1–5
	Litter/Duff	20	10–29

### Environment:

The Acacia – Mesquite Wash Shrubland occurs in linear stands along banks and floodplains of low elevation washes, and typically occurs in association with the Big Bend Lowland Wash Channel Shrubland, which is the dominant vegetation of the channel itself. The Acacia – Mesquite Wash Shrubland also occurs in wider stands across areas of braided (partially channelized) flow across the lower parts of alluvial fans or in channel beds of infrequent flow, where it represents a transitional between riparian wash channel vegetation and non-alluvial upland scrub. Elevations of observed stands range from 1,850 to 2,600 feet.

#### USNVC Translation

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm-Desert Xero-Riparian Scrub Macrogroup (M092)

USNVC Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541)

USNVC Alliance: *Hymenoclea monogyra* – *Brickellia laciniata* Chihuahuan – Sonoran Desert Wash Alliance (A3262)

NPS Association: *Vachellia* spp. – *Senegalia greggii* – *Prosopis glandulosa* – *Yucca elata* Shrubland Association (NPSBIBE043)

#### Comments:

This vegetation was developed from the need to classify wash bank vegetation that analogous to the Mixed Tall Shrubs Wash Shrubland but which occurs at lower elevations and lacks the species-rich character of that association. It was marginally sampled by classification plots. While it has elements of the Big Bend Lowlands Creosotebush Desert Scrub and the Mesquite – Creosotebush Desert Scrub, it is more strictly associated with washes than those associations.

#### BIBE Classification Plots Included in Concept:

BIBE0428, BIBE0432.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0077, BIBEAA0653, BIBEAA0655, BIBEAA0676, BIBEAA0790, BIBEAA0794, BIBEAA0801, BIBEAA0803, BIBEAA0804, BIBEAA0807, BIBEAA0808, BIBEAA0987, BIBEAA0993, BIBEAA0994, BIBEAA1000, BIBEAA1047, BIBEAA1169, BIBEAA1170.

Most frequent plant taxa recorded in Acacia – Mesquite Wash Shrubland are shown in Table D-72.



**Table D-72.** Synthesis table for all plant taxa recorded in Acacia – Mesquite Wash Shrubland at Big Bend National Park (# plots=2).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Vachellia constricta</i>	Shrub	100.0%	5.2	0–10
<i>Larrea tridentata</i>	Shrub	100.0%	1.8	0–3
<i>Viguiera stenoloba</i>	Shrub	100.0%	1.7	0–3
<i>Prosopis glandulosa</i>	Shrub	100.0%	1.6	0–5
<i>Yucca elata</i>	Shrub	100.0%	1.1	0–3
<i>Krameria grayi</i>	Shrub	100.0%	0.3	0–1
<i>Aloysia gratissima</i>	Shrub	50.0%	9.0	0–26
<i>Senegalia roemeriana</i>	Shrub	50.0%	5.0	0–15
<i>Salazaria mexicana</i>	Shrub	50.0%	1.5	0–6
<i>Lycium berlandieri</i>	Shrub	50.0%	1.3	0–5
<i>Aloysia wrightii</i>	Shrub	50.0%	0.8	0–2
<i>Leucophyllum frutescens</i>	Shrub	50.0%	0.3	0–1
<i>Cylindropuntia imbricata</i>	Shrub	50.0%	<0.1	0–trace
<i>Gutierrezia</i> sp.	Shrub	50.0%	<0.1	0–trace
<i>Parthenium incanum</i>	Shrub	50.0%	<0.1	0–trace
<i>Cuscuta</i> sp.	Vine	50.0%	0.3	0–1
<i>Pennisetum ciliare</i>	Herb	100.0%	19.5	0–25
<i>Heteropogon contortus</i>	Herb	100.0%	4.0	0–50
<i>Poa</i> sp.	Herb	100.0%	1.5	few–5
<i>Amaranthus</i> sp.	Herb	50.0%	0.8	0–2
<i>Desmanthus glandulosus</i>	Herb	50.0%	0.3	0–1
<i>Argythamnia humilis</i>	Herb	50.0%	0.3	0–1
<i>Boerhavia intermedia</i>	Herb	50.0%	0.3	0–1
<i>Euphorbia exstipulata</i>	Herb	50.0%	0.3	0–1
<i>Helianthus petiolaris</i>	Herb	50.0%	0.3	0–1
<i>Ibervillea tenuisecta</i>	Herb	50.0%	0.3	0–1
<i>Kallstroemia grandiflora</i>	Herb	50.0%	0.3	0–1
<i>Kallstroemia parviflora</i>	Herb	50.0%	0.3	0–1
<i>Pectis angustifolia</i>	Herb	50.0%	0.3	0–1
<i>Proboscidea louisianica</i>	Herb	50.0%	0.3	0–1
<i>Senna durangensis</i>	Herb	50.0%	0.3	0–1
<i>Sporobolus</i> sp.	Herb	50.0%	0.3	0–1
<i>Tetradlea coulteri</i>	Herb	50.0%	0.3	0–1



Photo 72. Acacia – Mesquite Wash Shrubland, unnamed tributary to Rio Grande near Johnsons Ranch (BIBE0432). Photo by Matthew Yarbrough.



Photo 73. Acacia – Mesquite Wash Shrubland, Alamo Creek at Old Maverick Road (BIBEAA0077). Photo by Bobski Gray.

## ***Low Elevation Talus and Dune Sparse Vegetation***

### Local Type Concept:

Talus slopes, generally below 4,500 feet in elevation, on various geologic substrates. The vegetation also in very limited patches on small sand dunes near the Rio Grande.

### Vegetation:

Vegetation cover is comprised of sparse herbs and short shrubs, with only *Jatropha dioica* (leatherstem) and *Opuntia rufida* (blind pricklypear) constant in both plots. Other species present include *Viguiera stenoloba* (skeletonleaf goldeneye), *Prosopis glandulosa* (honey mesquite), *Echinocereus dasyacanthus* (Texas rainbow cactus), *Opuntia camanchica* (Comanche pricklypear), *Yucca torreyi* (Torrey's yucca), *Cathastecum erectum* (false grama), *Cevallia sinuata* (stinging cevallia), *Heteropogon contortus* (tanglehead), and *Bouteloua ramosa* (chino grama) in the talus stand and *Larrea tridentata* (creosotebush), *Opuntia engelmannii* var. *engelmannii* (Engelmann's pricklypear), and *Pennisetum ciliare* (buffelgrass) in the dune stand. Stratum and substrate cover for Low Elevation Talus and Dune Sparse Vegetation are shown in Table D-73.

**Table D-73.** Stratum and substrate cover recorded for Low Elevation Talus and Dune Sparse Vegetation (# plots=2).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	0	0–0
	Short Shrub	6	3–7
	Herb	4	4–4
Substrate	Bedrock	0	0–1
	Large/Small Rocks	50	1–99
	Litter/Duff	0	0–0

### Environment:

One plot is on talus at 2,860 feet elevation near the Mule Ear overlook. The other is on a small dune (possibly an aeolian redeposit of water carried sand) along the Rio Grande near the Rio Grande Village at 1,885 feet elevation.

### USNVC Translation:

USNVC Class: Semi & Semi-Desert Class (3)

USNVC Subclass: Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass (3.A)

USNVC Formation: Warm Desert & Semi-Desert Scrub & Grassland Formation (3.A.2)

USNVC Division: North American Warm Desert Scrub & Grassland Division (D039)

USNVC Macrogroup: North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Macrogroup (M117)

USNVC Group: North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation Group (G569)

USNVC Alliance: Sparsely Vegetated Clay Flats, Hills & Badlands Alliance (A4023)

NPS Association: *Jatropha dioica* – *Opuntia rufida* Sparse Vegetation Association (NPSBIBE036)

Comments:

This is a “placeholder” unit intended to represent vegetation on all low elevation talus. It may not be worthy of separate association, since the composition of low elevation talus tends to resemble that of the surrounding scrub, and such stands might be regarded as low cover expressions of more widespread vegetation. Since the overall diversity is low, and the same two species with the highest cover were recorded from a single sample plot recorded from a small sand dune along the Rio Grande, the talus and dune stands are considered to be the same generalized sparse type of naturally disturbed, unstable sandy to rocky felsic settings. Most talus in BIBE is in the montane zone, and this is clearly not a widespread vegetation type.

BIBE Classification Plots Included in Concept:

BIBE0095, BIBE0111

Most frequent plant taxa recorded in Low Elevation Talus and Dune Sparse Vegetation are shown in Table D-74.

**Table D-74.** Synthesis table for all plant taxa recorded in Low Elevation Talus and Dune Sparse Vegetation at Big Bend National Park (# plots=2).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Jatropha dioica</i>	Shrub	100.0%	2.0	1–3
<i>Opuntia rufida</i>	Shrub	100.0%	1.0	few–2
<i>Echinocereus dasyacanthus</i>	Shrub	50.0%	0.3	0–1
<i>Larrea tridentata</i>	Shrub	50.0%	0.3	0–1
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	50.0%	0.3	0–1
<i>Opuntia camanchica</i>	Shrub	50.0%	0.3	0–1
<i>Opuntia</i> sp.	Shrub	50.0%	0.3	0–1
<i>Prosopis glandulosa</i>	Shrub	50.0%	0.3	0–1
<i>Viguiera stenoloba</i>	Shrub	50.0%	0.3	0–1
<i>Yucca torreyi</i>	Shrub	50.0%	0.1	0–trace
<i>Pennisetum ciliare</i>	Herb	50.0%	1.8	1.8
<i>Cathastecum erectum</i>	Herb	50.0%	0.3	0.3
<i>Cevallia sinuata</i>	Herb	50.0%	0.3	0.3
<i>Heteropogon contortus</i>	Herb	50.0%	0.3	0.3
<i>Bouteloua ramosa</i>	Herb	50.0%	0.1	0.1
<i>Croton</i> sp.	Herb	50.0%	0.1	0.1





Photo 74. Low Elevation Talus and Dune Sparse Vegetation, along Boquillas Canyon Trail (BIBE0095). Photo by Sarah King.



Photo 75. Low Elevation Talus and Dune Sparse Vegetation, base of Trap Mountain near Mule Ear Overlook (BIBE0111). Photo by Jenny Goucher

## ***Montane Igneous Outcrop Lichen Vegetation***

### Local Type Concept:

Nonvascular (primarily saxicolous lichen) and sparse vascular vegetation on cliffs and other bedrock outcrops, generally above 4,500 feet in elevation on igneous geologic substrates.

### Vegetation:

No species data were collected. Vegetation would be comprised of saxicolous lichens and sparse vascular plants (likely among those from List A of field key) mostly limited to crevices.

### Environment:

Cliffs and other bedrock outcrops above 4,500 feet in elevation on igneous substrates.

### USNVC Translation:

USNVC Class: Open Rock Vegetation Class (6)

USNVC Subclass: Temperate & Boreal Open Rock Vegetation Subclass (6.B)

USNVC Formation: Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation (6.B.1)

USNVC Division: Western North American Temperate & Boreal Cliff, Scree & Rock Vegetation Division (D052)

USNVC Macrogroup: Western North American Cliff, Scree & Rock Vegetation MG (M887)

USNVC Group: Western North American Cliff, Scree & Rock Vegetation Group (G565)

USNVC Alliance: Undefined

NPS Association: Madrean Igneous Outcrop Lichen Vegetation Association (NPSBIBE037)

### Comments:

This is a “placeholder” unit intended to represent nonvascular and sparse vascular vegetation on all montane igneous cliffs and other bedrock outcrops, for mapping.

### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0092, BIBEAA1270.



Photo 76. Montane Igneous Outcrop Lichen Vegetation, Blue Creek Canyon. Photo by Chris Lea.



### ***Low Elevation Non-Calcareous Outcrop Lichen Vegetation***

#### Local Type Concept:

Nonvascular (primarily saxicolous lichen) and sparse vascular vegetation on cliffs and other bedrock outcrops, generally below 4,500 feet in elevation on igneous or sedimentary substrates.

#### Vegetation:

No plot data. Vegetation would be comprised of saxicolous lichens and sparse vascular plants (probably common desert scrub species) that would be mostly limited to crevices.

#### Environment:

Cliffs and other outcrops below 4,500 feet in elevation on igneous or sedimentary substrates.

#### USNVC Translation:

USNVC Class: Open Rock Vegetation Class (6)

USNVC Subclass: Temperate & Boreal Open Rock Vegetation Subclass (6.B)

USNVC Formation: Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation (6.B.1)

USNVC Division: Western North American Temperate & Boreal Cliff, Scree & Rock Vegetation Division (D052)

USNVC Macrogroup: Western North American Cliff, Scree, & Rock Vegetation Macrogroup (M887)

USNVC Group: Western North American Cliff, Scree, & Rock Vegetation Group (G565)

USNVC Alliance: Undefined

NPS Association: Chihuahuan Desert Non-calcareous Outcrop Lichen Vegetation Association (NPSBIBE038)

#### Comments:

This is a “placeholder” unit intended to represent nonvascular and sparse vascular vegetation on all low elevation igneous and sedimentary cliffs and other bedrock outcrops, for mapping.



Photo 77. Low Elevation Non-calcareous Outcrop Lichen Vegetation, west side of Cerro Castellan. Photo by Kelsey Wogan.

### ***Calcareous Outcrop Lichen Vegetation***

#### Local Type Concept:

Nonvascular (primarily saxicolous lichen) and sparse vascular vegetation on cliffs and other bedrock outcrops, on calcareous (usually, limestone) geologic substrates.

#### Vegetation:

No plot data. Vegetation would be comprised of saxicolous lichens and sparse vascular plants mostly limited to crevices. Vascular species would likely be those present in the Calcareous Mixed Desert Scrub. Species of the genus *Perityle* (rockdaisy) may occur and be characteristic.

#### Environment:

Cliffs and other bedrock outcrops on calcareous substrates (limestone, *etc.*) at all elevations.

#### USNVC Translation:

USNVC Class: Open Rock Vegetation Class (6)

USNVC Subclass: Temperate & Boreal Open Rock Vegetation Subclass (6.B)

USNVC Formation: Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation (6.B.1)

USNVC Division: Western North American Temperate & Boreal Cliff, Scree & Rock Vegetation Division (D052)

USNVC Macrogroup: Western North American Cliff, Scree, & Rock Vegetation Macrogroup (M887)

USNVC Group: Western North American Cliff, Scree, & Rock Vegetation Group (G565)

USNVC Alliance: Undefined

NPS Association: Chihuahuan Desert Calcareous Outcrop Lichen Vegetation Association (NPSBIBE039)

#### Comments:

This is a “placeholder” unit intended to represent nonvascular and sparse vascular vegetation on all calcareous cliffs and other bedrock outcrops, for mapping.



Photo 78. Calcareous Outcrop Lichen Vegetation, near Maravillas Canyon (RIGR). Photo by Jeff Renfrow.

## **Cottonwood – Goodding Willow Spring Woodland**

### Local Type Concept:

Closed to open (forest to woodland, occasionally tall shrubland) stands of *Populus fremontii* ssp. *mesetae* (Arizona cottonwood) and/or *Salix gooddingii* (Goodding willow) providing much higher relative cover than other tree species along the Rio Grande and tributaries of the Rio Grande.

### Vegetation:

In the tree stratum, a combination of *Populus fremontii* ssp. *mesetae* (Arizona cottonwood) and/or *Salix gooddingii* (Goodding willow) is dominant. Although *P. fremontii* ssp. *mesetae* often is more prominent, *S. gooddingii* is the more constant species, and *P. fremontii* ssp. *mesetae* generally is absent in stands that are more than 3,700 feet in elevation. *Prosopis pubescens* (screwbean mesquite) is not as constant as the other species, but is characteristic and may co-dominate. When present, *P. fremontii* and *P. pubescens* are fairly good indicators of this association within BIBE. *Carya illinoensis* (pecan), probably planted, is co-dominant in one stand. *S. gooddingii*, *P. pubescens*, *Prosopis glandulosa* (honey mesquite), *Baccharis salicifolia* (seepwillow), and *Diospyros texana* (Texas persimmon) are the most constant shrubs in a tall (usually 2 to 5 meters) shrub stratum. Herb stratum composition is variable; this heterogeneity may represent some vegetation from surrounding vegetation habitats (floodplain, dry wash) being included with the spring-influenced species. *Andropogon glomeratus* (bushy bluestem), *Bothriochloa ischaemum* (yellow bluestem), *Bothriochloa laguroides* (silver bluestem), and *Sporobolus airoides* (alkali sacaton) are the most constant species. *Clematis drummondii* (Drummond's clematis) and *Maurandella antirrhiniflora* (climbing snapdragon) are occasionally occurring vines. Stratum and substrate cover for Cottonwood – Goodding Willow Spring Woodland are shown in Table D-75.

**Table D-75.** Stratum and substrate cover recorded for Cottonwood – Goodding Willow Spring Woodland at Big Bend National Park (# plots=15).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	48	0–100
	Tall Shrub	15	5–50
	Short Shrub	9	1–31
	Herb	23	4–85
Substrate	Bedrock	0	0–2
	Large/Small Rocks	12	0–70
	Litter/Duff	44	2–93

A variant of this association, representing the higher elevation stands, occurs along the west side of the Chisos Mountains at Ward Spring and at Oak Creek near Oak Spring. This variant lacks cottonwood and is transitional to the Persimmon – Littleleaf Ash Foothills Shrubland, with both sites having the characteristic species *Diospyros texana* (Texas persimmon), *Fraxinus greggii* (littleleaf ash), and *Rhus virens* (evergreen sumac). These two observations may represent a closely embedded

mix of the two types (a spring-associated woodland and a dry wash shrubland), where a groundwater emergence occurs within a dry wash. The elements that are not typical of the Persimmon – Littleleaf Ash Foothills Shrubland are consistent with Cottonwood – Goodding Willow Spring Woodland. *Juglans microcarpa* (littleleaf walnut), uncommon at BIBE, is an element of the tree and tall shrub strata at one of the sites.

#### Environment:

This association occurs at low elevations throughout BIBE, in small patches around springs and other groundwater emergences, which often occur within otherwise dry washes. It occurs along Rio Grande tributaries as large as Terlingua Creek, but usually not on the Rio Grande floodplain. Elevations for stands that have cottonwood range from 1,840 to 3,300 feet; the higher elevation variant stands extend as high as 4,400 feet. This association and the related Coyote Willow Spring Shrubland and Seepwillow – Bushy Bluestem Spring Vegetation are the only known true wetland vegetation types in this classification of BIBE vegetation that occur away from the immediate banks of the Rio Grande.

#### USNVC Translation

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Temperate Flooded & Swamp Forest Formation (1.B.3)

USNVC Division: Western North American Interior Flooded Forest Division (D013)

USNVC Macrogroup: Interior Warm & Cool Desert Riparian Forest Macrogroup (M036)

USNVC Group: Western Interior Riparian Forest & Woodland Group (G797)

USNVC Alliance: *Populus fremontii* – *Fraxinus velutina* – *Salix gooddingii* Flooded Forest & Woodland Alliance (A3803)

USNVC Association: *Populus fremontii* – *Salix gooddingii* Riparian Woodland Association (CEGL000944)

#### Comments:

Overall, this unit is somewhat heterogeneous in floristic composition, but further segregation would leave a number of clusters with few plots, each of which seems difficult to interpret. It is possible that some variability within plots assigned to this unit may be due to some plots being placed across hydrological gradients, where the water source is limited in extent.

A number of associations within the USNVC (2017) *Populus fremontii* – *Fraxinus velutina* – *Salix gooddingii* Flooded Forest & Woodland Alliance (A3803) may fit this BIBE vegetation, at least in part. The translation to the *Populus fremontii* – *Salix gooddingii* Riparian Woodland (CEGL000944) was made because it includes the occurrence of both of the most constant tree species. However, that association is a somewhat awkward biogeographical fit because of its extension into the Colorado Plateau. The *Salix gooddingii* / *Muhlenbergia rigens* Riparian Woodland (CEGL005982), attributed to southeastern New Mexico, may fit the BIBE vegetation better on phytogeographic criteria.

BIBE Classification Plots Included in Concept:

BIBE0042, BIBE0087, BIBE0089, BIBE0121, BIBE0146, BIBE0322, BIBE0323, BIBE0360, BIBE0392, BIBE0444, BIBE3009, BIBE3022, BIBE3023, BIBE3026.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0183, BIBEAA0184, BIBEAA0186, BIBEAA0187, BIBEAA0213.

Most frequent plant taxa recorded in Cottonwood – Goodding Willow Spring Woodland are shown in Table D-76.

**Table D-76.** Synthesis table for the most frequent plant taxa recorded in Cottonwood – Goodding Willow Spring Woodland at Big Bend National Park (# plots=15).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Salix gooddingii</i>	Tree / Shrub	86.7%	17.4	0–50
<i>Populus fremontii</i> ssp. <i>mesetae</i>	Tree	66.7%	18.9	0–75
<i>Prosopis glandulosa</i>	Shrub/Tree	86.7%	3.2	0–25
<i>Baccharis salicifolia</i>	Shrub	80.0%	8.2	0–45
<i>Tamarix ramosissima</i>	Shrub / Tree	66.7%	3.6	0–25
<i>Prosopis pubescens</i>	Shrub / Tree	53.3%	10.4	0–50
<i>Ziziphus obtusifolia</i>	Shrub	46.7%	0.3	0–2
<i>Diospyros texana</i>	Shrub	26.7%	0.4	0–2
<i>Guaiaacum angustifolium</i>	Shrub	26.7%	0.3	0–1
<i>Larrea tridentata</i>	Shrub	20.0%	0.1	0–1
<i>Nicotiana glauca</i>	Shrub	20.0%	0.1	0–1
<i>Hymenoclea monogyra</i>	Shrub	13.3%	1.3	0–5
<i>Rhus virens</i>	Shrub	13.3%	0.7	0–5
<i>Celtis ehrenbergiana</i>	Shrub	13.3%	0.1	0–2
<i>Senegalia roemeriana</i>	Shrub	13.3%	0.1	0–1
<i>Rhus microphylla</i>	Shrub	13.3%	0.1	0–1
<i>Viguiera stenoloba</i>	Shrub	13.3%	<0.1	0–1
<i>Clematis drummondii</i>	Vine	20.0%	0.1	0–2
<i>Maurandella antirrhiniflora</i>	Vine	20.0%	0.1	0–1
<i>Andropogon glomeratus</i>	Herb	26.7%	1.3	0–25
<i>Nicotiana obtusifolia</i>	Herb	26.7%	0.1	0–1
<i>Cynodon dactylon</i>	Herb	20.0%	6.0	0–95
<i>Bothriochloa ischaemum</i>	Herb	20.0%	4.5	0–75
<i>Bothriochloa laguroides</i>	Herb	20.0%	2.3	0–50
<i>Adiantum capillus-veneris</i>	Herb	20.0%	0.4	0–2
<i>Sporobolus airoides</i>	Herb	20.0%	0.2	0–2
<i>Sorghum halepense</i>	Herb	13.3%	4.3	0–75



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Thelypteris ovata</i> var. <i>lindheimeri</i>	Herb	13.3%	1.3	0–25
<i>Toxicodendron radicans</i>	Herb	13.3%	0.4	0–10
<i>Imperata brevifolia</i>	Herb	13.3%	0.3	0–5
<i>Samolus ebracteatus</i>	Herb	13.3%	0.1	0–1
<i>Aristida purpurea</i>	Herb	13.3%	0.1	0–1
<i>Eustoma exaltatum</i>	Herb	13.3%	0.1	0–1
<i>Teucrium laciniatum</i>	Herb	13.3%	0.1	0–1
<i>Verbesina encelioides</i>	Herb	13.3%	0.1	0–1
<i>Heliotropium curassavicum</i>	Herb	13.3%	<0.1	0–1



Photo 79. Cottonwood – Goodding Willow Spring Woodland, Glenn Spring (BIBE0087). Photo by Sarah King.





Photo 80. Cottonwood – Goodding Willow Spring Woodland, Trap Spring (BIBE0444). Photo by Travis Gallo.

## ***Rio Grande Willow Riparian Bosque***

### Local Type Concept:

Stands dominated or co-dominated by *Salix* spp. that occur within the zone of flooding influence of the Rio Grande.

### Vegetation:

Either *Salix gooddingii* (Goodding willow) or *Salix thurberi* (Thurber's willow) (= *Salix exigua*, in the broad sense, in part), is dominant in a tall shrub stratum (occasionally, a short tree stratum, especially for *S. gooddingii*). Infrequently, both species may be present. *Tamarix ramosissima* (tamarisk) and *Baccharis salicifolia* (seepwillow) usually are present and, occasionally, may co-dominate that stratum. Low cover woody species may include *Nicotiana glauca* (tree tobacco), *Prosopis glandulosa* (honey mesquite), and/or *Parkinsonia aculeata* (retama). The herbaceous stratum cover varies from either sparse to dense. *Cynodon dactylon* (Bermuda grass), *Phragmites australis* (common reed) and/or *Arundo donax* (giant cane) may occur at fairly dense cover; otherwise, the herbaceous stratum tends to be sparse, with a wide variety of [usually ruderal] species possibly present in small amounts. Stratum and substrate cover for Rio Grande Willow Riparian Bosque are shown in Table D-77.

**Table D-77.** Stratum and substrate cover recorded for Rio Grande Willow Riparian Bosque at Big Bend National Park and Rio Grande Wild and Scenic River (# plots=9).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	60	0–100
	Tall Shrub	28	0–98
	Short Shrub	3	0–8
	Herb	26	2–85
Substrate	Bedrock	4	0–35
	Large/Small Rocks	4	0–35
	Litter/Duff	26	3–60

### Environment:

This vegetation was recorded from the Rio Grande corridor throughout BIBE. It usually occurs on alluvial bars and banks, at similar elevations above water level to that of the Common Reed Riparian Herbaceous Vegetation and the Rio Grande Seepwillow Riparian Shrubland.

### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Warm Desert Lowland Freshwater Marsh, Meadow & Shrubland Macrogroup (M076)

USNVC Group: North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)

USNVC Alliance: *Salix exigua* – *Forestiera pubescens* Warm Desert Wet Shrubland Alliance (A0947)

NPS Association: *Salix (gooddingii, thurberi)* Rio Grande Woodland Association (NPSBIBE019)

Comments:

Because of few stands sampled early in the project, a broadly-defined Rio Grande willow shrubland type was applied to cover all combinations of willow species (*e.g.*, *Salix gooddingii*, *Salix thurberi*, *Salix exigua*) and both shrubland and woodland physiognomies. Since the two primary species along the Rio Grande, *S. gooddingii* and *S. thurberi*, seem largely not to co-occur, it may be best to split this unit into two associations, one for each species, when dominant. Either species may occur as a tall shrub or tree; *S. gooddingii* is more likely to grow to tree stature (> 5 meters tall).

This association is more related floristically to other alluvial shrubland and woodland associations along the Rio Grande than it is to the Thurber's Willow Spring Shrubland, which occurs near groundwater emergences along smaller drainages.

*Salix gooddingii* (Goodding willow) previously has been subsumed under the closely related and more eastern *Salix nigra*. (*e.g.*, Turner et al. 2003). This alternative taxonomic treatment probably accounts for reports of *S. nigra* from BIBE. Powell and Worthington (2018) concluded that most Trans-Pecos willows from this complex are either *S. gooddingii* or hybrids between *S. gooddingii* and *S. nigra* (in the narrow sense). In its pure form, the latter taxon is sporadic in the Trans-Pecos and, when present, is usually in the most southeastern portion.

*Salix thurberi* is closely related to and similar to *Salix exigua*, and, traditionally, the two entities have been subsumed under a broad concept of *S. exigua*. For purposes of this classification, *S. thurberi* is segregated as a distinct species, and is the primary member of the *S. exigua* complex in southern Texas and northeastern Mexico (Argus 2007, 2010). Most BIBE and RIGR plants of this taxonomic complex appear to be *S. thurberi*, although the two taxa are found in proximity in the Trans-Pecos, and *S. exigua* (in the narrow sense) has been recorded from Terlingua Creek (Powell and Worthington (2018). The distribution of *S. thurberi* and *S. exigua* (in the narrow sense) within BIBE could use further elucidation.

BIBE Classification Plots Included in Concept:

BIBE0430, BIBE3013, BIBE3021.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0907.

Most frequent plant taxa recorded in Rio Grande Willow Riparian Bosque are shown in Table D-78.

**Table D-78.** Synthesis table for all plant taxa recorded in Rio Grande Willow Riparian Bosque at Big Bend National Park (# plots=9).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Salix thurberi</i>	Shrub	66.7%	75.9	0–100
<i>Baccharis salicifolia</i>	Shrub	66.7%	11.8	0–27
<i>Tamarix ramosissima</i>	Shrub	66.7%	6.8	0–40
<i>Nicotiana glauca</i>	Shrub	66.7%	0.9	0–5
<i>Prosopis glandulosa</i>	Shrub	44.4%	0.7	0–2
<i>Salix gooddingii</i>	Shrub	33.3%	56.0	0–85
<i>Vachellia farnesiana</i>	Shrub	22.2%	8.8	0–25
<i>Tamarix aphylla</i>	Shrub	11.1%	1.5	0–2
<i>Celtis laevigata</i> var. <i>reticulata</i>	Shrub	11.1%	1.0	0–2
<i>Fraxinus berlandieriana</i>	Shrub	11.1%	0.5	0–1
<i>Ziziphus obtusifolia</i> var. <i>obtusifolia</i>	Shrub	11.1%	0.5	0–1
<i>Arundo donax</i>	Herb	88.9%	10.9	0–50
<i>Cynodon dactylon</i>	Herb	77.8%	12.4	0–50
<i>Phragmites australis</i>	Herb	44.4%	10.5	0–50
<i>Heliotropium curassavicum</i>	Herb	22.2%	0.3	0–1
<i>Schoenoplectus pungens</i> var. <i>longispicatus</i>	Herb	11.1%	37.5	0–50
<i>Typha domingensis</i>	Herb	11.1%	17.5	0–25
<i>Bothriochloa ischaemum</i>	Herb	11.1%	0.5	0–1
<i>Eustoma exaltatum</i>	Herb	11.1%	0.5	0–1
<i>Pennisetum ciliare</i>	Herb	11.1%	0.5	0–1
<i>Phyla nodiflora</i>	Herb	11.1%	0.5	0–1
<i>Polygonum</i>	Herb	11.1%	0.5	0–1
<i>Polypogon monspeliensis</i>	Herb	11.1%	0.5	0–1
<i>Sorghum halepense</i>	Herb	11.1%	0.5	0–1
<i>Allionia incarnata</i>	Herb	11.1%	0.1	0–trace
<i>Baileya multiradiata</i>	Herb	11.1%	0.1	0–trace
<i>Boerhavia coccinea</i>	Herb	11.1%	0.1	0–trace
<i>Bolboschoenus maritimus</i> ssp. <i>paludosus</i>	Herb	11.1%	0.1	0–trace
<i>Centaurium calycosum</i>	Herb	11.1%	0.1	0–trace
<i>Chenopodium</i>	Herb	11.1%	0.1	0–trace
<i>Clematis drummondii</i>	Herb	11.1%	0.1	0–trace
<i>Cyperus laevigatus</i>	Herb	11.1%	0.1	0–trace
<i>Helenium amarum</i>	Herb	11.1%	0.1	0–trace
<i>Machaeranthera</i>	Herb	11.1%	0.1	0–trace
<i>Nama havardii</i>	Herb	11.1%	0.1	0–trace



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Nerisyrenia camporum</i>	Herb	11.1%	0.1	0–trace
<i>Oenothera curtiflora</i>	Herb	11.1%	0.1	0–trace
<i>Orobanche cooperi</i>	Herb	11.1%	0.1	0–trace
<i>Perityle vaseyi</i>	Herb	11.1%	0.1	0–trace
<i>Rumex crispus</i>	Herb	11.1%	0.1	0–trace
<i>Rumex maritimus</i>	Herb	11.1%	0.1	0–trace
<i>Solanum</i>	Herb	11.1%	0.1	0–trace
<i>Sphaeralcea angustifolia</i>	Herb	11.1%	0.1	0–trace
<i>Thymophylla aurea</i> var. <i>aurea</i>	Herb	11.1%	0.1	0–trace
<i>Verbena neomexicana</i> var. <i>hirtella</i>	Herb	11.1%	0.1	0–trace
<i>Xanthium strumarium</i>	Herb	11.1%	0.1	0–trace



Photo 81. Rio Grande Willow Riparian Bosque, Rio Grande floodplain near Black Dike campground (BIBE3021). Photo by Karen Clary.



Photo 82. Rio Grande Willow Riparian Bosque, Rio Grande floodplain near Black Dike campground (BIBE0430). Photo by Jill Breeden.



## ***Tamarisk – (Tree Tobacco) Riparian Shrubland***

### Local Type Concept:

Stands dominated or co-dominated by tamarisk (*Tamarix ramosissima* (tamarisk) and, occasionally by *Tamarix aphylla* (athel tamarisk) and/or tree tobacco (*Nicotiana glauca*), occurring in the riparian zone of Rio Grande River or larger tributaries.

### Vegetation:

A combination of *Tamarix ramosissima* (tamarisk) and/or *Nicotiana glauca* (tree tobacco), separately or in some combination, dominates a rather open to mostly closed tall shrub stratum. In most cases, *N. glauca* is a minor species. *Tamarix aphylla* (athel tamarisk) may occur as scattered trees or taller shrubs, but is not consistently present. The most constant tall shrub associates are *Baccharis salicifolia* (seepwillow), *Prosopis glandulosa* (honey mesquite), and *Parkinsonia aculeata* (retama). *Chloracantha spinosa* (devilweed) and *Porophyllum scoparium* (shrubby poreleaf) are occasional short shrubs. The herbaceous stratum varies from rather sparse to dense. It usually is dominated by ruderal non-native species, any of which may be locally dominant. These include *Cynodon dactylon* (Bermuda grass), *Arundo donax* (giant cane), and *Salsola tragus* (Russian thistle). Somewhat less constant and less abundant herbaceous species are *Rumex crispus* (curly dock), *Phragmites australis* (common reed), *Pennisetum ciliare* (buffelgrass), *Sorghum halepense* (Johnson grass), and *Sphaeralcea angustifolia* (copper globemallow). Stratum and substrate cover for Tamarisk – (Tree Tobacco) Riparian Shrubland are shown in Table D-79.

**Table D-79.** Stratum and substrate cover recorded for Tamarisk – (Tree Tobacco) Riparian Shrubland at Big Bend National Park and Rio Grande Wild and Scenic River (n=16, 13 observation points, 3 plots).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	31	2–60
	Short Shrub	34	4–64
	Herb	8	5–10
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–0
	Litter/Duff	25	20–30

### Environment:

The type is distributed along banks and floodplains of the Rio Grande throughout BIBE. It may extend up larger tributary streams (e.g., Terlingua and Tornillo Creeks) a short distance, but plot sampling and mapping suggest that stands with *Tamarix* (tamarisk) dominance are infrequent away from the Rio Grande. This vegetation tends to occur on higher bars and low floodplains, at similar elevations above water level to that of the Bermuda Grass Riparian Herbaceous Vegetation.

#### USNVC Translation

USNVC Class: Forest & Woodland Class (1)

USNVC Subclass: Temperate and Boreal Forest & Woodland Subclass (1.B)

USNVC Formation: Temperate Flooded & Swamp Forest Formation (1.B.3)

USNVC Division: Western North American Interior Flooded Forest Division (D013)

USNVC Macrogroup: Interior West Ruderal Flooded & Swamp Forest Macrogroup (M298)

USNVC Group: Interior West Ruderal Riparian Forest & Scrub Group (G510)

USNVC Alliance: *Tamarix* spp. Ruderal Riparian Scrub Alliance (A0842)

USNVC Association: *Tamarix* spp. Temporarily Flooded Semi-natural Shrubland Association (CEGL003114)

#### Comments:

This vegetation type recently has decreased in terms of both the size and abundance of stands within BIBE, evidently due to releases and rapid population increases of tamarisk beetles (*Diorhabda* spp.) and subsequent *Tamarix* mortality. This phenomenon was observed during the map accuracy assessment, with a number of tamarisk stands that were mapped just a few years earlier found to be in decline. The type is probably widely distributed along the zone of flooding influence by the Rio Grande. It may extend up larger tributary streams (*e.g.*, Terlingua and Tornillo Creeks), but plot sampling suggests that stands with *Tamarix* (tamarisk) dominance are infrequent away from the Rio Grande.

#### BIBE Classification Plots Included in Concept:

BIBE0057, BIBE0238, BIBE3004.

#### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0358, BIBEAA0360, BIBEAA0361, BIBEAA0366, BIBEAA0478, BIBEAA0479, BIBEAA0480, BIBEAA0903, BIBEAA0905, BIBEAA0941, BIBEAA0945, BIBEAA0946, BIBEAA0952.

Most frequent plant taxa recorded in Tamarisk – (Tree Tobacco) Riparian Shrubland are shown in Table D-80.

**Table D-80.** Synthesis table for all plant taxa recorded in Tamarisk – (Tree Tobacco) Riparian Shrubland at Big Bend National Park (#plots=3).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Baccharis salicifolia</i>	Shrub	100.0%	12.2	few–28
<i>Tamarix ramosissima</i>	Shrub	66.7%	33.6	0–78
<i>Tamarix aphylla</i>	Tree /Shrub	66.7%	14.6	0–60
<i>Prosopis glandulosa</i>	Shrub	66.7%	6.0	0–25
<i>Nicotiana glauca</i>	Shrub	66.7%	0.2	0–1
<i>Chloracantha spinosa</i>	Shrub	33.3%	0.2	0–1
<i>Selinocarpus angustifolius</i>	Shrub	33.3%	0.2	0–1
<i>Chrysothamnus baileyi</i>	Shrub	33.3%	<0.1	0–trace
<i>Cynodon dactylon</i>	Herb	66.7%	13.0	0–50
<i>Arundo donax</i>	Herb	66.7%	1.2	0–5
<i>Sphaeralcea angustifolia</i>	Herb	66.7%	0.7	0–2
<i>Heliotropium curassavicum</i>	Herb	66.7%	0.2	0–1
<i>Eustoma exaltatum</i>	Herb	33.3%	1.2	0–5
<i>Helenium microcephalum</i>	Herb	33.3%	0.5	0–2
<i>Salsola tragus</i>	Herb	33.3%	0.5	0–2
<i>Allionia incarnata</i>	Herb	33.3%	0.2	0–1
<i>Bouteloua trifida</i>	Herb	33.3%	0.2	0–1
<i>Machaeranthera pinnatifida</i>	Herb	33.3%	0.2	0–1
<i>Machaeranthera tanacetifolia</i>	Herb	33.3%	0.2	0–1
<i>Nerisyrenia camporum</i>	Herb	33.3%	0.2	0–1
<i>Pectis angustifolia</i>	Herb	33.3%	0.2	0–1
<i>Phragmites australis</i>	Herb	33.3%	0.2	0–1
<i>Schoenoplectus pungens</i> var. <i>longispicatus</i>	Herb	33.3%	0.2	0–1
<i>Sorghum halepense</i>	Herb	33.3%	0.2	0–1
<i>Sporobolus cryptandrus</i>	Herb	33.3%	0.2	0–1
<i>Xanthium strumarium</i>	Herb	33.3%	0.2	0–1
<i>Cirsium texanum</i>	Herb	33.3%	<0.1	0–trace
<i>Helianthus annuus</i>	Herb	33.3%	<0.1	0–trace
<i>Sonchus</i> sp.	Herb	33.3%	<0.1	0–trace
<i>Thymophylla pentachaeta</i>	Herb	33.3%	<0.1	0–trace



Photo 83. Tamarisk Riparian Shrubland, Rio Grande floodplain near Boquillas Canyon Overlook (BIBE0238). Photo by Matthew Yarbrough.



Photo 84. Tamarisk Riparian Shrubland, Rio Grande floodplain below Gauging Station (BIBEAA0905), with tree leaves showing stress, apparently from Diorhabda beetles. Photo by Rebecca Evans.



## ***Thurber's Willow Spring Shrubland***

### Local Type Concept:

Stands with *Salix thurberi* (Thurber's willow) and/or *Salix exigua* (coyote willow) dominant in a short tree or tall shrub stratum along ephemeral streams or washes (*i.e.*, not including *S. thurberi* / *exigua* dominated stands that may occur along the Rio Grande).

### Vegetation:

*Salix thurberi* (Thurber's willow) and/or *Salix exigua* (coyote willow) is dominant in a tall shrub or short tree stratum. In the single plot observed *Salix gooddingii* (Goodding willow) was present at lower cover. *Hymenoclea monogyra* was dominant in the shrub stratum. A number of tall shrub species, consistent with the composition of the Mixed Tall Shrubs Wash Shrubland, occurred at low cover *Senegalia greggii* (Gregg's catclaw), *Diospyros texana* (Texas persimmon), *Forestiera angustifolia* (desert olive), *Guaiacum angustifolium* (guayacan), *Prosopis glandulosa* (honey mesquite), *Condalia warnockii* (Warnock's snakewood), *Eysenhardtia texana* (Texas kidneywood), and *Rhus microphylla* (littleleaf sumac). Shorter shrubs included *Dasyllirion leiophyllum* (green sotol) and *Gymnosperma glutinosum* gumhead). The herbaceous stratum is sparse. Species observed (all at low cover) include *Acalypha monostachya* (round copperleaf), *Andropogon glomeratus* (bushy bluestem), *Bothriochloa laguroides* (silver bluestem), *Bouteloua curtipendula* (sideoats grama), *Eragrostis lehmanniana* (Lehmann lovegrass), *Heteropogon contortus* (tanglehead), *Phyllanthus ericoides* mum (heather leaf-flower), *Polygala scoparioides* (broom milkwort), *Setaria leucopila* (streambed bristlegrass), *Stenaria nigricans* (diamond-flowers), *Sorghum halepense* (Johnson grass), and *Thelesperma megapotamicum* (Hopi tea greenthread). The vine *Clematis drummondii* (Drummond's clematis) was also observed. Stratum and substrate cover for Thurber's Willow Spring Shrubland are shown in Table D-81.

**Table D-81.** Stratum and substrate cover recorded for Thurber's Willow Spring Shrubland at Big Bend National Park (# plots=1).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	73	70–80
	Tall Shrub	20	20–20
	Short Shrub	4	2–4
	Herb	4	4–4
Substrate	Bedrock	1	1–1
	Large/Small Rocks	8	8–8
	Litter/Duff	49	49–49

### Environment:

The single known stand is located along the main channel of the McKinney Spring drainage, at an elevation of 2911 feet, near a groundwater emergence. This association and the related the Cottonwood – Goodding Willow Spring Woodland and Seepwillow – Bushy Bluestem Spring

Vegetation are the only known true wetland vegetation types in this classification of BIBE vegetation that occur away from the immediate banks of the Rio Grande.

USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Warm Desert Lowland Freshwater Marsh, Meadow & Shrubland Macrogroup (M076)

USNVC Group: North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)

USNVC Alliance: *Salix exigua* – *Forestiera pubescens* Warm Desert Wet Shrubland Alliance (A0947)

USNVC Association: *Salix exigua* – *Baccharis salicifolia* Shrubland Association (CEGL005980)

Comments:

The single plot attributable to this type does not cluster closely with others in analysis. It may represent vegetation with individual moisture-limited species that are consistent with spring vegetation of the Cottonwood – Goodding Willow Spring Woodland (*e.g.*, the two *Salix* species and small amounts of *Andropogon glomeratus*) being closely embedded within dry wash vegetation consistent with the Mixed Tall Shrubs Wash Shrubland.

In the absence of more data, *S. thurberi* or *S. exigua* dominated stands that may be encountered along the Rio Grande are assigned to the generalized Rio Grande Willow Riparian Bosque (NPSBIBE019).

*Salix thurberi* is closely related to and similar to *Salix exigua*, and, traditionally, the two entities have been subsumed under a broad concept of *S. exigua*. For purposes of this classification, *S. thurberi* is segregated as a distinct species, and is the primary member of the *S. exigua* complex in southern Texas and northeastern Mexico (Argus 2007, 2010). Most BIBE and Rio Grande Wild and Scenic River (RIGR) plants of this taxonomic complex appear to be *S. thurberi*, although the two taxa are found in proximity in the Trans-Pecos, and *S. exigua* (in the narrow sense) has been recorded from Terlingua Creek (Powell and Worthington (2018). Since the nominal willow species in the most similar USNVC association is identified as *S. exigua* (likely used by the USNVC in the broad sense), the USNVC translation and the park name refer to *S. exigua* and coyote willow, both in the broad sense. The distribution of *S. thurberi* and *S. exigua* (in the narrow sense) within BIBE could use further elucidation.

BIBE Classification Plots Included in Concept:

BIBE0033.

Most frequent plant taxa recorded in Thurber's Willow Spring Shrubland are shown in Table D-82.



**Table D-82.** Synthesis table for all plant taxa recorded in Thurber's Willow Spring Shrubland at Big Bend National Park (# plots=1).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Salix thurberi</i> (= <i>Salix exigua</i> in the broad sense)	Tree	100.0%	62.5	50–75
<i>Salix gooddingii</i>	Tree	100.0%	7.5	5–10
<i>Hymenoclea monogyra</i>	Shrub	100.0%	17.5	10–25
<i>Senegalia greggii</i>	Shrub	100.0%	1.5	1–2
<i>Diospyros texana</i>	Shrub	100.0%	1.5	1–2
<i>Forestiera angustifolia</i>	Shrub	100.0%	1.5	1–2
<i>Guaiaacum angustifolium</i>	Shrub	100.0%	1.5	1–2
<i>Prosopis glandulosa</i>	Shrub	100.0%	1.5	1–2
<i>Condalia warnockii</i>	Shrub	100.0%	0.5	few–1
<i>Dasyllirion leiophyllum</i>	Shrub	100.0%	0.5	few–1
<i>Eysenhardtia texana</i>	Shrub	100.0%	0.5	few–1
<i>Gymnosperma glutinosum</i>	Shrub	100.0%	0.5	few–1
<i>Rhus microphylla</i>	Shrub	100.0%	0.5	few–1
<i>Clematis drummondii</i>	Vine	100.0%	0.5	few–1
<i>Acalypha monostachya</i>	Herb	100.0%	0.5	few–1
<i>Andropogon glomeratus</i>	Herb	100.0%	0.5	few–1
<i>Bothriochloa laguroides</i>	Herb	100.0%	0.5	few–1
<i>Bouteloua curtipendula</i>	Herb	100.0%	0.5	few–1
<i>Eragrostis lehmanniana</i>	Herb	100.0%	0.5	few–1
<i>Heteropogon contortus</i>	Herb	100.0%	0.5	few–1
<i>Phyllanthus ericoides</i>	Herb	100.0%	0.5	few–1
<i>Polygala scoparioides</i>	Herb	100.0%	0.5	few–1
<i>Setaria leucopila</i>	Herb	100.0%	0.5	few–1
<i>Sorghum halepense</i>	Herb	100.0%	0.5	few–1
<i>Stenaria nigricans</i>	Herb	100.0%	0.5	few–1
<i>Thelesperma megapotamicum</i>	Herb	100.0%	0.5	few–1



Photo 85. Thurber's Willow Spring Shrubland, McKinney Spring (BIBE0033). Photo by Christian Skorik.



Photo 86. Thurber's Willow Spring Shrubland, McKinney Spring (BIBE0033). Photo by Christian Skorik.

### ***Seepwillow – Bushy Bluestem Spring Vegetation***

#### Local Type Concept:

Shrublands or lightly wooded herbaceous vegetation, characterized by *Andropogon glomeratus* (bushy bluestem) and other wetland species (hydrophytes) in the herbaceous stratum. Associated with spring runs with relatively permanent surface water and/or consistently saturated soils.

#### Vegetation:

*Baccharis salicifolia* (seepwillow) and *Prosopis glandulosa* (honey mesquite) are constant shrubs at low cover that are present at all sampled three sites, with *B. salicifolia* a good indicator of saturated soil near the ground surface. *Forestiera angustifolia* (desert olive) and *Isocoma pluriflora* (southern goldenbush) each are present at two sites. The herbaceous stratum is moderately dense to dense. *Andropogon glomeratus* (bushy bluestem), present at all three sampled sites, is the most abundant and characteristic herb. Herbaceous species that occur at two of the three sites include *Adiantum capillus-veneris* (common maidenhair fern), *Lobelia cardinalis* (cardinal flower), *Fuirena simplex* (western umbrella-sedge), *Typha domingensis* (southern cattail), *Samolus ebracteatus* (limewater brookweed), and *Eleocharis* sp. (spikerush). All of these herbaceous species require consistently saturated soil. In general, hydrophytes (e.g., plant species with National Wetland Indicator ranks of FAC, FACW, and/or OBL for the U.S. Army Corps of Engineers Arid West Region) comprise a significant component of the overall composition. Stratum and substrate cover for Seepwillow – Bushy Bluestem Spring Vegetation are shown in Table D-83.

**Table D-83.** Stratum and substrate cover recorded for Seepwillow – Bushy Bluestem Spring Vegetation at Big Bend National Park (# plots=3).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	2	1–4
	Tall Shrub	16	2–30
	Short Shrub	8	2–11
	Herb	28	15–50
Substrate	Bedrock	43	0–75
	Large/Small Rocks	1	0–2
	Litter/Duff	8	1–20

#### Environment:

This vegetation is associated with springs that occurs in small patches and is relatively infrequent in BIBE. Elevations range from 2,600 to 3,300 feet. Some locations include Buttrill Spring near the Rosillos Mountains, Mule Ear Spring near the Chisos Mountains, and Indian Head Spring. This association and the related Cottonwood – Goodding Willow Spring Woodland and Thurber's Willow Spring Shrubland are the only known true wetland vegetation types in this classification of BIBE vegetation that occur away from the immediate banks of the Rio Grande.

#### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Warm Desert Lowland Freshwater Marsh, Meadow & Shrubland Macrogroup (M076)

USNVC Group: North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)

USNVC Alliance: *Baccharis salicifolia* Wet Shrubland Alliance (A0933)

NPS Association: *Baccharis salicifolia* / *Andropogon glomeratus* Shrub Herbaceous Vegetation Association (NPSBIBE016)

#### Comments:

The USNVC association (CEGL003549) *Baccharis salicifolia* Riparian Shrubland Association is the closest USNVC translation and is analogous in environmental setting and some floristic elements to the vegetation described here for BIBE. It covers seepwillow dominated shrublands both along spring runs and in dry washes. It is applied by the USNVC to arid areas in California, Arizona and New Mexico, but is problematic to apply at BIBE because of the specificity of the description to cismontane California and the Colorado River desert region.

This association essentially is a shrubland to herbaceous version of the tree-dominated Cottonwood – Goodding Willow Spring Woodland. On the other hand, it is considerably different from the other shrubland association that has *B. salicifolia* characteristic, the Rio Grande Seepwillow Riparian Shrubland of low riverbanks along the Rio Grande.

#### BIBE Classification Plots Included in Concept:

BIBE0135, BIBE0148, BIBE0445.

Most frequent plant taxa recorded in Seepwillow – Bushy Bluestem Spring Vegetation are shown in Table D-84.



**Table D-84.** Synthesis table for the most frequent plant taxa recorded in Seepwillow – Bushy Bluestem Spring Vegetation at Big Bend National Park (# plots=3).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Salix gooddingii</i>	Tree	33.3%	1.2	0–5
<i>Tamarix ramosissima</i>	Tree	33.3%	0.3	0–2
<i>Baccharis salicifolia</i>	Shrub	100.0%	6.8	few–27
<i>Prosopis glandulosa</i>	Shrub	100.0%	2.2	few–7
<i>Forestiera angustifolia</i>	Shrub	66.7%	2.7	0–10
<i>Isocoma pluriflora</i>	Shrub	66.7%	0.5	0–1
<i>Vachellia constricta</i>	Shrub	33.3%	2.5	0–10
<i>Diospyros texana</i>	Shrub	33.3%	1.5	0–7
<i>Porophyllum scoparium</i>	Shrub	33.3%	1.2	0–5
<i>Senegalia roemeriana</i>	Shrub	33.3%	0.5	0–2
<i>Dasyllirion leiophyllum</i>	Shrub	33.3%	0.5	0–2
<i>Ungradia speciosa</i>	Shrub	33.3%	0.5	0–2
<i>Viguiera stenoloba</i>	Shrub	33.3%	0.5	0–2
<i>Celtis ehrenbergiana</i>	Shrub	33.3%	0.5	0–2
<i>Aloysia wrightii</i>	Shrub	33.3%	0.2	0–1
<i>Echinocereus stramineus</i>	Shrub	33.3%	0.2	0–1
<i>Leucophyllum frutescens</i>	Shrub	33.3%	0.2	0–1
<i>Rhamnus serrata</i>	Shrub	33.3%	0.2	0–1
<i>Rhus microphylla</i>	Shrub	33.3%	0.2	0–1
<i>Clematis drummondii</i>	Vine	33.3%	0.2	0–1
<i>Cissus trifoliata</i>	Vine	33.3%	0.2	0–1
<i>Andropogon glomeratus</i>	Herb	100.0%	15.5	1–50
<i>Cynodon dactylon</i>	Herb	66.7%	1.7	0–5
<i>Adiantum capillus-veneris</i>	Herb	66.7%	1.3	0–5
<i>Fuirena simplex</i>	Herb	66.7%	1.3	0–5
<i>Typha domingensis</i>	Herb	66.7%	1.3	0–5
<i>Muhlenbergia</i> sp.	Herb	66.7%	0.7	0–2
<i>Samolus ebracteatus</i>	Herb	66.7%	0.7	0–2
<i>Lobelia cardinalis</i>	Herb	66.7%	0.5	0–2
<i>Eleocharis</i> sp.	Herb	66.7%	0.3	0–1
<i>Bothriochloa laguroides</i>	Herb	33.3%	0.5	0–2
<i>Imperata brevifolia</i>	Herb	33.3%	0.5	0–2
<i>Setaria</i> sp.	Herb	33.3%	0.5	0–2
<i>Galium</i> sp.	Herb	33.3%	0.2	0–1
<i>Heteropogon contortus</i>	Herb	33.3%	0.2	0–1

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Menodora longiflora</i>	Herb	33.3%	0.2	0–1
<i>Nicotiana obtusifolia</i>	Shrub	33.3%	0.2	0–1
<i>Teucrium laciniatum</i>	Herb	33.3%	0.2	0–1



Photo 87. Seepwillow – Bushy Bluestem Spring Vegetation, Buttrill Spring area (BIBE0148). Photo by Sarah King.





Photo 88. Seepwillow – Bushy Bluestem Spring Vegetation, Mule Ear Spring (BIBE0445). Photo by Matthew Yarbrough.

## ***Rio Grande Seepwillow Riparian Shrubland***

### Local Type Concept:

Sparse to moderately dense shrublands on banks and alluvial bars of the Rio Grande River *Baccharis salicifolia* (seepwillow) dominant.

### Vegetation:

*Baccharis salicifolia* (seepwillow) is the dominant shrub species in a short to somewhat tall shrub stratum that varies from somewhat sparse to dense. *Tamarix ramosissima* (tamarisk) is a constant shrub stratum associate and may co-dominate stands with *B. salicifolia*. *Parkinsonia aculeata* (retama), *Prosopis glandulosa* (honey mesquite), *Nicotiana glauca* (tree tobacco), and *Salix thurberi* (Thurber's willow) are frequent low to moderate cover tall shrub species. The herbaceous stratum cover varies from sparse to dense and is comprised of a variety of native and non-native ruderal species. *Cynodon dactylon* (Bermuda grass) is usually present and often is the most abundant herbaceous species. Other constant species include *Xanthium strumarium* (rough cocklebur), *Rumex maritimus* (golden dock), *Phragmites australis* (common reed), *Schoenoplectus pungens* var. *longispicatus* (threesquare bulrush), *Polypogon monspeliensis* (annual rabbitsfoot grass), *Arundo donax* (giant cane), *Salsola tragus* (Russian thistle), *Verbesina encelioides* (golden crownbeard), *Eustoma exaltatum* (catchfly prairie gentian), *Leptochloa fusca* ssp. *uninervia* (Mexican sprangletop), *Pennisetum ciliare* (buffelgrass), and *Heliotropium curassavicum* (salt heliotrope). Stratum and substrate cover for Rio Grande Seepwillow Riparian Shrubland are shown in Table D-85.

**Table D-85.** Stratum and substrate cover recorded for Rio Grande Seepwillow Riparian Shrubland at Big Bend National Park and Rio Grande Wild and Scenic River (n=14, 5 observation points, 9 plots).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	<1	0–5
	Tall Shrub	23	0–90
	Short Shrub	11	0–35
	Herb	13	0–30
Substrate	Bedrock	0	0–0
	Large/Small Rocks	8	5–12
	Litter/Duff	40	5–92

### Environment:

This vegetation was recorded from the Rio Grande corridor throughout BIBE. It tends to occur on alluvial bars and banks, at similar elevations above water level to that of the Common Reed Riparian Herbaceous Vegetation and the Rio Grande Willow Riparian Bosque. It usually occurs in linear stands that are too small or too narrow to be mapped effectively.

### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Warm Desert Lowland Freshwater Marsh, Meadow & Shrubland Macrogroup (M076)

USNVC Group: North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)

USNVC Alliance: *Baccharis salicifolia* Wet Shrubland Alliance (A0933)

NPS Association: *Baccharis salicifolia* / (*Phragmites australis*) Chihuahuan Riparian Shrubland Association (NPSBIBE047)

Comments:

This association is an alluvial vegetation type that is environmentally and compositionally different from the other shrubland association that has *B. salicifolia* characteristic, the Seepwillow – Bushy Bluestem Spring Vegetation of non-alluvial groundwater emergences.

BIBE Classification Plots Included in Concept:

BIBE3000, BIBE3002, BIBE3005, BIBE3011, BIBE3020, BIBE3025.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0904, BIBEAA0948, BIBEAA0949, BIBEAA0951, BIBEAA1123.

Most frequent plant taxa recorded in Rio Grande Seepwillow Riparian Shrubland are shown in Table D-86.

**Table D-86.** Synthesis table for the most frequent plant taxa recorded in Rio Grande Seepwillow Riparian Shrubland at Big Bend National Park (# plots=9).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Baccharis salicifolia</i>	Shrub	100.0%	42.0	10–100
<i>Tamarix ramosissima</i>	Shrub	88.9%	10.1	0–50
<i>Chloracantha spinosa</i>	Shrub	44.4%	2.2	0–25
<i>Prosopis glandulosa</i>	Shrub	44.4%	0.7	0–5
<i>Parkinsonia aculeata</i>	Shrub	22.2%	0.1	0–1
<i>Isocoma pluriflora</i>	Shrub	11.1%	0.8	0–10
<i>Ziziphus obtusifolia</i> var. <i>obtusifolia</i>	Shrub	11.1%	0.4	0–5
<i>Salix thurberi</i>	Shrub	11.1%	0.4	0–5
<i>Guaiaacum angustifolium</i>	Shrub	11.1%	0.1	0–1
<i>Salix gooddingii</i>	Shrub	11.1%	0.0	0–trace
<i>Nicotiana glauca</i>	Shrub	11.1%	0.0	0–trace
<i>Fraxinus berlandieriana</i>	Shrub	11.1%	0.0	0–trace

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Prosopis pubescens</i>	Shrub	11.1%	0.0	0–trace
<i>Selinocarpus angustifolius</i>	Shrub	11.1%	0.0	0–trace
<i>Vachellia farnesiana</i>	Shrub	11.1%	0.0	0–trace
<i>Vachellia rigidula</i>	Shrub	11.1%	0.0	0–trace
<i>Cynodon dactylon</i>	Herb	88.9%	12.2	0–50
<i>Xanthium strumarium</i>	Herb	55.6%	4.3	0–50
<i>Rumex maritimus</i>	Herb	44.4%	0.3	0–2
<i>Phragmites australis</i>	Herb	33.3%	3.2	0–25
<i>Schoenoplectus pungens</i> var. <i>longispicatus</i>	Herb	33.3%	1.1	0–10
<i>Polypogon monspeliensis</i>	Herb	33.3%	0.1	0–1
<i>Arundo donax</i>	Herb	22.2%	0.4	0–1
<i>Eustoma exaltatum</i>	Herb	22.2%	0.2	0–2
<i>Rumex</i>	Herb	22.2%	0.1	0–1
<i>Heliotropium curassavicum</i> var. <i>curassavicum</i>	Herb	22.2%	0.0	0–trace
<i>Bacopa monnieri</i>	Herb	11.1%	0.2	0–2
<i>Helenium microcephalum</i> var. <i>microcephalum</i>	Herb	11.1%	0.2	0–2
<i>Phyla nodiflora</i>	Herb	11.1%	0.1	0–1
<i>Bolboschoenus maritimus</i> ssp. <i>paludosus</i>	Herb	11.1%	0.1	0–1
<i>Cyperus odoratus</i>	Herb	11.1%	0.1	0–1
<i>Eleocharis</i>	Herb	11.1%	0.1	0–1
<i>Machaeranthera tanacetifolia</i>	Herb	11.1%	0.1	0–1
<i>Polygonum lapathifolium</i>	Herb	11.1%	0.1	0–1
<i>Rumex crispus</i>	Herb	11.1%	0.1	0–1
<i>Symphyotrichum expansum</i>	Herb	11.1%	0.1	0–1
<i>Thelesperma ambiguum</i>	Herb	11.1%	0.1	0–1
<i>Tiquilia canescens</i> var. <i>canescens</i>	Herb	11.1%	0.1	0–1
<i>Chamaesyce serpens</i>	Herb	11.1%	0.0	0–trace
<i>Chilopsis linearis</i>	Herb	11.1%	0.0	0–trace
<i>Juncus torreyi</i>	Herb	11.1%	0.0	0–trace
<i>Lupinus havardii</i>	Herb	11.1%	0.0	0–trace
<i>Lygodesmia texana</i>	Herb	11.1%	0.0	0–trace
<i>Oenothera curtiflora</i>	Herb	11.1%	0.0	0–trace
<i>Oligomeris linifolia</i>	Herb	11.1%	0.0	0–trace
<i>Pennisetum ciliare</i>	Herb	11.1%	0.0	0–trace
<i>Sesuvium verrucosum</i>	Herb	11.1%	0.0	0–trace
<i>Sisymbrium</i>	Herb	11.1%	0.0	0–trace





Photo 89. Rio Grande Seepwillow Riparian Shrubland, Rio Grande floodplain at Buenos Aires (BIBEAA951). Photo by Kelsey Wogan.



Photo 90. Rio Grande Seepwillow Riparian Shrubland, Rio Grande floodplain at Rio Grande Village (BIBE3011). Photo by Karen Clary.

## ***Rio Grande Mesquite Riparian Bosque***

### Local Type Concept:

Shrublands or woodlands on low elevation floodplains or alluvial terraces with *Prosopis glandulosa* (honey mesquite) dominant in the uppermost stratum.

### Vegetation:

*Prosopis glandulosa* (honey mesquite) is (usually) strongly dominant in a short tree or tall shrub stratum that ranges from about 15% to 70% cover. Species that are present as low cover tall shrubs include, in descending order of constancy, *Tamarix ramosissima* (tamarisk), *Baccharis salicifolia* (seepwillow), *Ziziphus obtusifolia* (lotebush), *Larrea tridentata* (creosotebush), *Celtis ehrenbergiana* (= *C. pallida*, spiny hackberry), *Nicotiana glauca* (tree tobacco), *Parkinsonia aculeata* (retama), *Vachellia farnesiana* (huisache) (mostly from San Vicente downstream), and *Tamarix aphylla* (athel tamarisk). The latter two species may reach tree stature. The herbaceous stratum usually is sparse, but occasionally may have moderate to quite dense cover, where either *Arundo donax* (giant cane), or *Cynodon dactylon* (Bermuda grass) may be well-established. Lower cover and less constant herbaceous species include *Pennisetum ciliare* (buffelgrass), *Sphaeralcea angustifolia* (copper globemallow), and *Verbesina encelioides* (golden crownbeard). Stratum and substrate cover for Rio Grande Mesquite Riparian Bosque are shown in Table D-87.

**Table D-87.** Stratum and substrate cover recorded for Rio Grande Mesquite Riparian Bosque at Big Bend National Park and Rio Grande Wild and Scenic River (n=17, 8 observation points, 9 plots).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	11	0–60
	Tall Shrub	14	0–50
	Short Shrub	15	1–50
	Herb	14	1–70
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–1
	Litter/Duff	25	1–55

### Environment:

This vegetation was recorded from the Rio Grande corridor throughout BIBE. It tends to occur on floodplains (occasionally higher terraces), at similar elevations above water level to (or slightly higher than) that of the Giant Cane Riparian Herbaceous Vegetation.

### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)



USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Warm Desert Lowland Freshwater Marsh, Meadow & Shrubland Macrogroup (M076)

USNVC Group: North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)

USNVC Alliance: *Prosopis glandulosa* – *Prosopis velutina* – *Prosopis pubescens* Wet Scrub Alliance (A3877)

USNVC Association: *Prosopis glandulosa* Wet Scrub Association (CEGL004934)

Comments:

The USNVC (2017) concept of *Prosopis glandulosa* Wet Scrub (CEGL004934) has no floristic description and very little information, but is focused on arid regions of Texas and, so, is used for the USNVC translation.

BIBE Classification Plots Included in Concept:

BIBE0017, BIBE0106, BIBE0236, BIBE0237, BIBE0263, BIBE0369, BIBE0391, BIBE3016, BIBE3028.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0190, BIBEAA0191, BIBEAA0194, BIBEAA0195, BIBEAA0362, BIBEAA0367, BIBEAA0376, BIBEAA0377, BIBEAA0378, BIBEAA0477, BIBEAA0844, BIBEAA0845, BIBEAA0846, BIBEAA0847, BIBEAA0848, BIBEAA0850, BIBEAA0853, BIBEAA0854, BIBEAA0857, BIBEAA0858, BIBEAA0943, BIBEAA0944, BIBEAA0947, BIBEAA0950, BIBEAA0953, BIBEAA1028, BIBEAA1037, BIBEAA1038, BIBEAA1042, BIBEAA1091, BIBEAA1093, BIBEAA1094, BIBEAA1096, BIBEAA1097, BIBEAA1098, BIBEAA1104, BIBEAA1117, BIBEAA1119, BIBEAA1120, BIBEAA1127, BIBEAA1128, BIBEAA1132, BIBEAA1133, BIBEAA1134, BIBEAA1135, BIBEAA1253.

Most frequent plant taxa recorded in Rio Grande Mesquite Riparian Bosque are shown in Table D-88.

**Table D-88.** Synthesis table for the most frequent plant taxa recorded in Rio Grande Mesquite Riparian Bosque at Big Bend National Park (# plots=9).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Prosopis glandulosa</i>	Shrub / Tree	100.0%	35.2	6–75
<i>Larrea tridentata</i>	Shrub	44.4%	4.2	0–35
<i>Tamarix ramosissima</i>	Shrub	33.3%	2.5	0–25
<i>Ziziphus obtusifolia</i>	Shrub	33.3%	0.6	0–5
<i>Baccharis salicifolia</i>	Shrub	33.3%	0.5	0–5
<i>Echinocereus enneacanthus</i>	Shrub	22.2%	0.9	0–10
<i>Opuntia camanchica</i>	Shrub	22.2%	0.8	0–10
<i>Atriplex canescens</i>	Shrub	22.2%	0.4	0–2
<i>Cylindropuntia leptocaulis</i>	Shrub	22.2%	0.1	0–1
<i>Vachellia farnesiana</i>	Shrub / Tree	11.1%	0.8	0–10
<i>Opuntia engelmannii</i> var. <i>engelmannii</i>	Shrub	11.1%	0.3	0–6
<i>Salix gooddingii</i>	Shrub	11.1%	0.2	0–2
<i>Tamarix aphylla</i>	Shrub / Tree	11.1%	0.1	0–2
<i>Guaiaacum angustifolium</i>	Shrub	11.1%	0.1	0–1
<i>Chloracantha spinosa</i>	Shrub	11.1%	0.1	0–1
<i>Coryphantha macromeris</i>	Shrub	11.1%	0.1	0–1
<i>Salix thurberi</i> (= <i>Salix exigua</i> in the broad sense)	Shrub	11.1%	0.1	0–1
<i>Chrysothamnus</i> sp.	Shrub	11.1%	<0.1	0–trace
<i>Ferocactus hamatacanthus</i>	Shrub	11.1%	<0.1	0–trace
<i>Nicotiana glauca</i>	Shrub	11.1%	<0.1	0–trace
<i>Clematis drummondii</i>	Vine	11.1%	0.4	0–7
<i>Funastrum cynanchoides</i>	Vine	11.1%	0.4	0–7
<i>Pennisetum ciliare</i>	Herb	44.4%	7.1	0–75
<i>Arundo donax</i>	Herb	33.3%	1.8	0–10
<i>Heteropogon contortus</i>	Herb	22.2%	0.1	0–1
<i>Nicotiana obtusifolia</i>	Herb	22.2%	0.1	0–1
<i>Sphaeralcea angustifolia</i>	Herb	22.2%	0.1	0–1
<i>Cynodon dactylon</i>	Herb	11.1%	0.8	0–10
<i>Erigeron modestus</i>	Herb	11.1%	0.1	0–1
<i>Machaeranthera tanacetifolia</i>	Herb	11.1%	0.1	0–1
<i>Phragmites australis</i>	Herb	11.1%	0.1	0–1
<i>Senna bauhinioides</i>	Herb	11.1%	0.1	0–1
<i>Setaria leucopila</i>	Herb	11.1%	0.1	0–1
<i>Nerisyrenia camporum</i>	Herb	11.1%	<0.1	0–trace



Photo 91. Rio Grande Mesquite Riparian Bosque, Rio Grande floodplain west of La Clocha (BIBEAA0190). Photo by Rebecca Evans.



Photo 92. Rio Grande Mesquite Riparian Bosque, Rio Grande floodplain at San Vicente Crossing (BIBEAA1127). Photo by Jeff Renfrow.

## ***Giant Cane Riparian Herbaceous Vegetation***

### Local Type Concept:

Tall herbaceous (somewhat woody) thickets with high cover of *Arundo donax* (giant cane) in the Rio Grande River corridor, with low cover by all other species.

### Vegetation:

*Arundo donax* (giant cane), a somewhat woody grass, is dominant and usually strongly so in a very tall herbaceous stratum. Cover contributed by other species is typically very low. The most frequent woody stratum species are *Prosopis glandulosa* (honey mesquite), *Tamarix ramosissima* (tamarisk), *Baccharis salicifolia* (seepwillow), *Parkinsonia aculeata* (retama), and *Tamarix aphylla* (athel tamarisk). Among the few herbaceous species that are competitive enough to become established, even at low cover are the non-native *Pennisetum ciliare* (buffelgrass) and *Cynodon dactylon* (Bermuda grass). Stratum and substrate cover for Giant Cane Riparian Herbaceous Vegetation are shown in Table D-89.

**Table D-89.** Stratum and substrate cover recorded for Giant Cane Riparian Herbaceous Vegetation at Big Bend National Park and Rio Grande Wild and Scenic River (n=8, 2 observation points, 6 plots).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	0	0–0
	Short Shrub	1	0–2
	Herb	94	90–100
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–0
	Litter/Duff	51	1–99

### Environment:

This vegetation was recorded from the Rio Grande corridor. It tends to occur on floodplains, at similar elevations above water level to, or slightly lower than, that of the Rio Grande Mesquite Riparian Bosque.

### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Western North American Ruderal Marsh, Wet Meadow & Shrubland Macrogroup (M301)

USNVC Group: Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524)  
 USNVC Alliance: *Phragmites australis* – *Arundo donax* – *Alopecurus pratensis* Ruderal Marsh Alliance (A3847)  
 USNVC Association: *Arundo donax* Riverbank Herbaceous Vegetation Association (CEGL004101)

BIBE Classification Plots Included in Concept:

BIBE0056, BIBE0113, BIBE0239, BIBE0261, BIBE1105, BIBE3006.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0359, BIBEAA0363, BIBEAA0364, BIBEAA0365, BIBEAA0368, BIBEAA0369, BIBEAA0370, BIBEAA0371, BIBEAA0372, BIBEAA0373, BIBEAA0374, BIBEAA0375, BIBEAA0379, BIBEAA0899, BIBEAA0900, BIBEAA0901, BIBEAA0906, BIBEAA1034, BIBEAA1035, BIBEAA1039, BIBEAA1040, BIBEAA1055, BIBEAA1092, BIBEAA1126,

Most frequent plant taxa recorded in Giant Cane Riparian Herbaceous Vegetation are shown in Table D-90.

**Table D-90.** Synthesis table for all plant taxa recorded in Giant Cane Riparian Herbaceous Vegetation at Big Bend National Park (# plots=6).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Tamarix ramosissima</i>	Shrub	83.3%	3.4	0–25
<i>Baccharis salicifolia</i>	Shrub	33.3%	0.7	0–5
<i>Nicotiana glauca</i>	Shrub	33.3%	0.3	0–2
<i>Baccharis havardii</i>	Shrub	16.7%	0.3	0–2
<i>Chloracantha spinosa</i>	Shrub	16.7%	0.3	0–2
<i>Prosopis glandulosa</i>	Shrub	16.7%	0.3	0–2
<i>Arundo donax</i>	Herb	100.0%	83.3	25–100
<i>Cynodon dactylon</i>	Herb	33.3%	1.7	0–10
<i>Phragmites australis</i>	Herb	16.7%	2.9	0–25
<i>Xanthium strumarium</i>	Herb	16.7%	0.6	0–5
<i>Chenopodium incanum</i>	Herb	16.7%	0.3	0–2
<i>Nerisyrenia camporum</i>	Herb	16.7%	0.3	0–2
<i>Nicotiana obtusifolia</i>	Herb	16.7%	0.3	0–2
<i>Heliotropium curassavicum</i>	Herb	16.7%	0.1	0–2
<i>Machaeranthera tanacetifolia</i>	Herb	16.7%	0.1	0–1
<i>Mentzelia multiflora</i>	Herb	16.7%	0.1	0–1
<i>Salsola tragus</i>	Herb	16.7%	0.1	0–1
<i>Solanum elaeagnifolium</i>	Herb	16.7%	0.1	0–1
<i>Sphaeralcea angustifolia</i>	Herb	16.7%	0.1	0–1
<i>Verbesina encelioides</i>	Herb	16.7%	0.1	0–1



Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Oenothera curtiflora</i> (= <i>Gaura parviflora</i> )	Herb	16.7%	<0.1	0–trace
<i>Matelea reticulata</i>	Herb	16.7%	<0.1	0–trace



Photo 93. Giant Cane Riparian Herbaceous Vegetation, Rio Grande floodplain at Gravel Pit (BIBE0056).  
Photo by Christian Skorik.





Photo 94. Giant Cane Riparian Herbaceous Vegetation, Rio Grande floodplain near Santa Elena Overlook (BIBE0261). Photo by Travis Gallo.

## **Common Reed Riparian Herbaceous Vegetation**

### Local Type Concept:

Tall herbaceous stands with high relative cover, and, usually, high absolute cover of *Phragmites australis* (common reed) in the Rio Grande River corridor. *P. australis* exceeds all other species in cover, except (occasionally) *Cynodon dactylon* (Bermuda grass).

### Vegetation:

*Phragmites australis* (common reed) is strongly dominant in a tall herbaceous stratum and exceeds 25% cover, except for stands that may have low overall herbaceous cover. *Cynodon dactylon* (Bermuda grass) and *Arundo donax* (giant cane) are often present. The abundance of *C. dactylon* is variable, and it may form a secondary dominant low herbaceous stratum. The cover of *A. donax*, which appears to favor less saturated soils than does *P. australis*, may be moderately high, but it never exceeds that of *P. australis*. Other herbaceous stratum members are generally ruderal species present at low cover and with lower constancy; these include several species of *Rumex* (docks) and of *Typha* (cattails), *Polypogon monspeliensis* (annual rabbitsfoot grass), *Xanthium strumarium* (rough cocklebur), *Helenium microcephalum* (smallhead sneezeweed), and *Symphotrichum expansum* (southwestern annual saltmarsh aster). *Baccharis salicifolia* (seepwillow), which appears to have similar hydrologic regime preferences to those of *P. australis*, usually is present in a low cover tall shrub stratum. Other shrubs that may be present include *Tamarix ramosissima* (tamarisk) and *Chloracantha spinosa* (devilweed). Stratum and substrate cover for Common Reed Riparian Herbaceous Vegetation are shown in Table D-91.

**Table D-91.** Stratum and substrate cover recorded for Common Reed Riparian Herbaceous Vegetation at Big Bend National Park and Rio Grande Wild and Scenic River (n=13, 7 observation points, 6 plots).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	3	0–10
	Short Shrub	0	0–0
	Herb	74	50–98
Substrate	Bedrock	0	0–0
	Large/Small Rocks	0	0–0
	Litter/Duff	1	0–10

### Environment:

This vegetation was recorded from the Rio Grande corridor throughout BIBE. It tends to occur on alluvial bars and banks, at similar elevations above water level to that of the Rio Grande Seepwillow Riparian Shrubland and the Rio Grande Willow Riparian Bosque. It usually is a small patch type that often occurs in stands that are too small to be mapped.

#### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Western North American Ruderal Marsh, Wet Meadow & Shrubland Macrogroup (M301)

USNVC Group: Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524)

USNVC Alliance: *Phragmites australis* – *Arundo donax* – *Alopecurus pratensis* Ruderal Marsh Alliance (A3847)

USNVC Association: *Phragmites australis* Chihuahuan Desert Riparian Herbaceous Vegetation (NPSBIBE023)

#### Comments:

Generally, *Phragmites australis* (common reed) is considered a native species along the Rio Grande (subspecies *berlandieri*). However, Powell and Worthington (2018) note that all Trans-Pecos collections at the Sul Ross Herbarium (SRSC), including those from BIBE, appear to represent the non-native subspecies *australis*. A local unit was created in lieu of a translation to the USNVC *Phragmites australis* ssp. *berlandieri* Riverbank Wet Meadow (CEGL004115) because of some uncertainty as to the subspecies of *P. australis* and further uncertainty as to whether a primarily Gulf Coast concept such as CEGL004115 would apply well to vegetation of the Chihuahuan Desert.

#### BIBE Classification Plots Included in Concept:

BIBE0112, BIBE0426, BIBE3001, BIBE3007, BIBE3010, BIBE3012.

Most frequent plant taxa recorded in Common Reed Riparian Herbaceous Vegetation are shown in Table D-92.

**Table D-92.** Synthesis table for all plant taxa recorded in Common Reed Riparian Herbaceous Vegetation at Big Bend National Park (# plots=6).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Baccharis salicifolia</i>	Shrub	83.3%	3.1	0–10
<i>Tamarix ramosissima</i>	Shrub	66.7%	0.6	0–2
<i>Chloracantha spinosa</i>	Shrub/Herb	33.3%	0.1	0–1
<i>Prosopis glandulosa</i>	Shrub	16.7%	0.3	0–2
<i>Salix thurberi</i> (= <i>Salix exigua</i> in the broad sense)	Shrub	16.7%	0.3	0–2
<i>Nicotiana glauca</i>	Shrub	16.7%	<0.1	0–trace
<i>Parkinsonia aculeata</i>	Shrub	16.7%	<0.1	0–trace
<i>Phragmites australis</i>	Herb	100.0%	53.8	25–95
<i>Cynodon dactylon</i>	Herb	83.3%	4.4	0–25
<i>Rumex</i> sp.	Herb	66.7%	0.4	0–2
<i>Arundo donax</i>	Herb	50.0%	3.8	0–25
<i>Xanthium strumarium</i>	Herb	50.0%	0.4	0–2
<i>Helenium microcephalum</i>	Herb	50.0%	0.1	0–1
<i>Woodsia</i> sp.	Herb	33.3%	3.5	0–25
<i>Polypogon monspeliensis</i>	Herb	33.3%	0.1	0–1
<i>Symphyotrichum expansum</i>	Herb	33.3%	0.1	0–1
<i>Eclipta prostrata</i>	Herb	16.7%	0.1	0–1
<i>Pennisetum ciliare</i>	Herb	16.7%	0.1	0–1
<i>Ambrosia psilostachya</i>	Herb	16.7%	<0.1	0–trace
<i>Eustoma exaltatum</i>	Herb	16.7%	<0.1	0–trace
<i>Oenothera curtiflora</i> (= <i>Gaura parviflora</i> )	Herb	16.7%	<0.1	0–trace
<i>Leptochloa fusca</i> ssp. <i>uninervia</i>	Herb	16.7%	<0.1	0–trace
<i>Senna bauhinioides</i>	Herb	16.7%	<0.1	0–trace
<i>Sonchus</i> sp.	Herb	16.7%	<0.1	0–trace
<i>Sphaeralcea angustifolia</i>	Herb	16.7%	<0.1	0–trace





Photo 95. Common Reed Riparian Herbaceous Vegetation, Rio Grande floodplain at Gravel Pit (BIBE0112). Photo by Jenny Goucher.



Photo 96. Common Reed Riparian Herbaceous Vegetation, Rio Grande floodplain near Solis Landing (BIBE0426). Photo by Jill Breeden.

### ***Bermuda Grass Riparian Herbaceous Vegetation***

#### Local Type Concept:

Herbaceous vegetation associated with riparian or other moist sites, with *Cynodon dactylon* (Bermuda grass) dominant.

#### Vegetation:

*Cynodon dactylon* (Bermuda grass) is dominant or strongly dominant in the herbaceous stratum, which can vary in cover from 5% in more scoured alluvial bar settings to nearly 100% on floodplains (*i.e.*, Bermuda grass “meadows”). *Pennisetum ciliare* (buffelgrass) frequently occurs and occasionally co-dominates with *C. dactylon*. Less frequent herbaceous stratum species include *Arundo donax* (giant cane), *Sorghum halepense* (Johnson grass), *Verbesina encelioides* (golden crownbeard), *Xanthium strumarium* (rough cocklebur), and *Solanum elaeagnifolium* (silverleaf nightshade). A sparse shrub stratum (up to about 15% cover) may be present, with *Prosopis glandulosa* (honey mesquite), *Tamarix ramosissima* (tamarisk), *Baccharis salicifolia* (seepwillow) occurring as fairly constant woody species and *Hymenoclea monogyra* (singlewhorl burrobrush), *Parkinsonia aculeata* (retama), and *Tamarix aphylla* (athel tamarisk) less frequent. Stratum and substrate cover for Bermuda Grass Riparian Herbaceous Vegetation are shown in Table D-93.

**Table D-93.** Stratum and substrate cover recorded for Bermuda Grass Riparian Herbaceous Vegetation at Big Bend National Park and Rio Grande Wild and Scenic River (n=15, 10 observation points, 5 plots).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	1	1–1
	Short Shrub	2	1–2
	Herb	80	80–80
Substrate	Bedrock	0	0–0
	Large/Small Rocks	12	12–12
	Litter/Duff	1	1–1

#### Environment:

This vegetation was recorded from the Rio Grande corridor throughout BIBE. It tends to occur on higher bars and low floodplains, at similar elevations above water level to that of the Tamarisk – (Tree Tobacco) Riparian Shrubland.

#### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)



USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Western North American Ruderal Marsh, Wet Meadow & Shrubland Macrogroup (M301)

USNVC Group: Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524)

USNVC Alliance: *Phragmites australis* – *Arundo donax* – *Alopecurus pratensis* Ruderal Marsh Alliance (A3847)

NPS Association: *Cynodon dactylon* Arid Southwest Herbaceous Vegetation Association (NPSBIBE017)

Comments:

The USNVC association CEG004701 (*Cynodon dactylon* Herbaceous Vegetation), an association in G583 (Southeastern Old Field Group) of the southeastern U.S., is probably inappropriate for *Cynodon dactylon* (Bermuda grass) stands in the arid southwestern U.S. Therefore, a local type with a globally appropriate name is employed for the translation.

BIBE Classification Plots Included in Concept:

BIBE0048, BIBE3008, BIBE3018, BIBE3019, BIBE3027.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0481, BIBEAA0482, BIBEAA0484, BIBEAA0638, BIBEAA0639, BIBEAA0902, BIBEAA1048, BIBEAA1049, BIBEAA1105, BIBEAA1118, BIBEAA1121, BIBEAA1122, BIBEAA1130, BIBEAA1251.

Most frequent plant taxa recorded in Bermuda Grass Riparian Herbaceous Vegetation are shown in Table D-94.

**Table D-94.** Synthesis table for the most frequent plant taxa recorded in Bermuda Grass Riparian Herbaceous Vegetation at Big Bend National Park (# plots=5).

<b>Species Latin Name</b>	<b>Primary Stratum</b>	<b>Constancy</b>	<b>Mean Cover (%)</b>	<b>Range Cover (%)</b>
<i>Prosopis glandulosa</i>	Shrub	100.0%	2.6	0–10
<i>Tamarix ramosissima</i>	Shrub	80.0%	2.3	0–10
<i>Baccharis salicifolia</i>	Shrub	60.0%	0.7	0–2
<i>Larrea tridentata</i>	Shrub	40.0%	0.1	0–1
<i>Chloracantha spinosa</i>	Shrub	40.0%	0.1	0–1
<i>Salix gooddingii</i>	Shrub	20.0%	2.1	0–1
<i>Vachellia farnesiana</i>	Shrub	20.0%	0.7	0–1
<i>Chilopsis linearis</i>	Shrub	20.0%	0.3	0–1
<i>Hymenoclea monogyra</i>	Shrub	20.0%	0.1	0–1
<i>Nicotiana glauca</i>	Shrub	20.0%	0.1	0–1
<i>Aloysia gratissima</i>	Shrub	20.0%	<0.1	0–trace
<i>Parkinsonia aculeata</i>	Shrub	20.0%	<0.1	0–trace
<i>Cynodon dactylon</i>	Herb	100.0%	71.0	25–95
<i>Xanthium strumarium</i>	Herb	60.0%	0.2	0–1
<i>Sphaeralcea angustifolia</i>	Herb	60.0%	0.1	0–1
<i>Leptochloa fusca</i> ssp. <i>uninervia</i>	Herb	40.0%	0.2	0–1
<i>Pennisetum ciliare</i>	Herb	40.0%	0.2	0–1
<i>Phragmites australis</i>	Herb	40.0%	0.2	0–1
<i>Sorghum halepense</i>	Herb	40.0%	0.1	0–1
<i>Cirsium texanum</i>	Herb	40.0%	<0.1	0–trace
<i>Bahia pedata</i>	Herb	20.0%	0.1	0–1
<i>Bouteloua barbata</i>	Herb	20.0%	0.1	0–1
<i>Boerhavia diffusa</i>	Herb	20.0%	0.1	0–1
<i>Bothriochloa ischaemum</i>	Herb	20.0%	0.1	0–1
<i>Eustoma exaltatum</i>	Herb	20.0%	0.1	0–1
<i>Heteropogon contortus</i>	Herb	20.0%	0.1	0–1
<i>Helenium microcephalum</i>	Herb	20.0%	0.1	0–1
<i>Machaeranthera tanacetifolia</i>	Herb	20.0%	0.1	0–1
<i>Nerisyrenia camporum</i>	Herb	20.0%	0.1	0–1
<i>Pectis angustifolia</i>	Herb	20.0%	0.1	0–1
<i>Polypogon monspeliensis</i>	Herb	20.0%	0.1	0–1
<i>Rumex</i> sp.	Herb	20.0%	0.1	0–1
<i>Thelesperma megapotamicum</i>	Herb	20.0%	0.1	0–1
<i>Argemone albiflora</i> ssp. <i>texana</i>	Herb	20.0%	<0.1	0–trace
<i>Baileya multiradiata</i>	Herb	20.0%	<0.1	0–trace

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Oenothera curtiflora</i> (= <i>Gaura parviflora</i> )	Herb	20.0%	<0.1	0–trace
<i>Nama hispidum</i>	Herb	20.0%	<0.1	0–trace
<i>Sonchus</i> sp.	Herb	20.0%	<0.1	0–trace



Photo 97. Bermuda Grass Riparian Herbaceous Vegetation, Rio Grande floodplain near Hot Springs (BIBE0048). Photo by Christian Skorik.



Photo 98. Bermuda Grass Riparian Herbaceous Vegetation, Rio Grande floodplain below Gauging Station (BIBEAA1048). Photo by Kelsey Wogan.

## ***Wet Riverbank Herbaceous Vegetation***

### Local Type Concept:

Herbaceous wetlands along Rio Grande, dominated by hydrophytic species, such as *Schoenoplectus pungens* (threesquare bulrush), *Typha* spp. (cattails), *Polygonum* spp. (smartweeds), and others.

### Vegetation:

In many stands, one species is strongly dominant. This may be *Schoenoplectus pungens* (threesquare bulrush), *Typha domingensis* (southern cattail), or *Polygonum* sp. (smartweed) Other herbaceous species, many to most of them hydrophytes, occur, usually at low cover *Cynodon dactylon* (Bermuda grass), *Symphyotrichum expansum* (southwestern annual saltmarsh aster), and *Polypogon monspeliensis* (annual rabbitsfoot grass) are the most frequently recorded. If present, a shrub stratum is sparse, with *Baccharis salicifolia* (seepwillow) the most constant species. Stratum and substrate cover for Wet Riverbank Herbaceous Vegetation are shown in Table D-95.

**Table D-95.** Stratum and substrate cover recorded for Wet Riverbank Herbaceous Vegetation at Big Bend National Park (# plots=3).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	17	0–100
	Tall Shrub	19	0–95
	Short Shrub	3	0–20
	Herb	37	2–95
Substrate	Bedrock	0	0–0
	Large/Small Rocks	24	0–60
	Litter/Duff	27	0–98

### Environment:

This type was encountered along the Rio Grande near Loop Camp and near the Gravel Pit. Elevations of plots range from 1840 to 2140 feet. It probably occurs throughout the Rio Grande corridor in BIBE. Stands were encountered on river banks and gravel bars where the soil or sediment is saturated to near the surface for extended periods.

### USNVC Translation:

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Arid West Interior Freshwater Marsh Macrogroup (M888)

USNVC Group: Arid West Interior Freshwater Marsh Group (G531)

USNVC Alliance: *Schoenoplectus americanus* – *Schoenoplectus acutus* – *Schoenoplectus californicus* Marsh Alliance (A3895)  
USNVC Association: *Schoenoplectus pungens* Herbaceous Vegetation Association (CEGL001587)

BIBE Classification Plots Included in Concept:  
BIBE3003, BIBE3014, BIBE3017.

Most frequent plant taxa recorded in Wet Riverbank Herbaceous Vegetation are shown in Table D-96.

**Table D-96.** Synthesis table for the most frequent plant taxa recorded in Wet Riverbank Herbaceous Vegetation at Big Bend National Park (# plots=3).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Baccharis salicifolia</i>	Shrub	100.0%	0.8	few–2
<i>Tamarix ramosissima</i>	Shrub	33.3%	0.2	0–1
<i>Nicotiana glauca</i>	Shrub	33.3%	0.0	0–trace
<i>Schoenoplectus pungens</i> var. <i>longispicatus</i>	Herb	100.0%	54.2	25–75
<i>Cynodon dactylon</i>	Herb	100.0%	12.8	2–25
<i>Symphyotrichum expansum</i>	Herb	66.7%	1.0	0–2
<i>Polypogon monspeliensis</i>	Herb	66.7%	0.3	0–1
<i>Juncus torreyi</i>	Herb	33.3%	0.5	0–2
<i>Paspalum distichum</i>	Herb	33.3%	0.5	0–2
<i>Helenium microcephalum</i>	Herb	33.3%	0.2	0–1
<i>Phragmites australis</i>	Herb	33.3%	0.2	0–1
<i>Rumex</i> sp.	Herb	33.3%	0.2	0–1
<i>Eustoma exaltatum</i>	Herb	33.3%	0.1	0–trace
<i>Leptochloa fusca</i> ssp. <i>uninervia</i>	Herb	33.3%	0.1	0–trace
<i>Lythrum californicum</i>	Herb	33.3%	0.1	0–trace
<i>Nerisyrenia camporum</i>	Herb	33.3%	0.1	0–trace
<i>Oligomeris linifolia</i>	Herb	33.3%	0.1	0–trace
<i>Phyla nodiflora</i>	Herb	33.3%	0.1	0–trace





Photo 99. Wet Riverbank Herbaceous Vegetation, along Rio Grande near Loop Camp (BIBE3014). *Schoenoplectus pungens* dominant. Photo by Karen Clary.



Photo 100. Wet Riverbank Herbaceous Vegetation, Rio Grande Lower Canyons, Mile 49 (below La Linda) (RIGROBS0423). *Polygonum* sp. dominant. Photo by Damon Waitt.

## **California Bulrush Herbaceous Vegetation**

### Local Type Concept:

Herbaceous vegetation dominated by California bulrush (*Schoenoplectus californicus*) in anthropogenic and, possibly, natural wetlands.

### Vegetation:

*Schoenoplectus californicus* (California bulrush) is dominant and usually strongly so in dense stands, with associated species usually few and at low cover. Physiognomy is tall (2–3 meters) graminoid herbaceous vegetation.

### Environment:

During the accuracy assessment, a single small stand was observed fringing and within the bed of a sewage treatment pond in Chisos Basin. Its presence here is clearly anthropogenic. Along with *Typha* spp., tall *Schoenoplectus* spp. can be characteristic of both natural and anthropogenic wetlands. The type may occur in more natural settings along the Rio Grande within BIBE, as well as in other anthropogenic wetlands.

### USNVC Translation:

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Arid West Interior Freshwater Marsh Macrogroup (M888)

USNVC Group: Arid West Interior Freshwater Marsh Group (G531)

USNVC Alliance: *Schoenoplectus americanus* – *Schoenoplectus acutus* – *Schoenoplectus californicus* Marsh Alliance (A3895)

NPS Association: *Schoenoplectus californicus* Tamaulipan-Chihuahuan Riparian Herbaceous Vegetation Association (NPSBIBE030)

### Comments:

Stands of *Schoenoplectus californicus* were observed in the BIBE National Recreation Area (BIBE) vegetation classification and mapping project. The BIBE concept is extended to BIBE to include dense stands of *Schoenoplectus californicus*. The BIBE stands were in relatively natural settings within the Rio Grande alluvial zone. The only BIBE stand observed was in a non-alluvial, anthropogenic setting.

### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA1276.





Photo 101. California Bulrush Herbaceous Vegetation, Rio Grande floodplain near Hot Springs (BIBE0048). Photo by Christian Skorik.

## ***Rio Grande Alluvial Herbaceous Vegetation***

### Local Type Concept:

Sparse, primarily herbaceous, vegetation on frequently inundated alluvial bars and river banks to more dense herbaceous vegetation in openings on floodplains of the Rio Grande.

### Vegetation:

A sparse tall or short shrub stratum is often present (more often on floodplain expressions than on alluvial bar and bank expressions). *Tamarix ramosissima* (tamarisk) is the most frequent and abundant species. Less constant, and, generally, lower cover woody species include *Prosopis glandulosa* (honey mesquite), *Baccharis salicifolia* (seepwillow), *Parkinsonia aculeata* (retama), *Hymenoclea monogyra* (singlewhorl burrobrush), *Porophyllum scoparium* (shrubby poreleaf), *Nicotiana glauca* (tree tobacco), and *Chloracantha spinosa* (devilweed). The herbaceous stratum density varies from very sparse (e.g., on recently scoured alluvial bars) to dense (e.g., on infrequently inundated floodplains). The composition is quite variable, depending on geomorphic position and moisture. More frequent species include *Cynodon dactylon* (Bermuda grass), *Arundo donax* (giant cane), *Pennisetum ciliare* (buffelgrass), *Salsola tragus* (Russian thistle), *Machaeranthera pinnatifida* (lacy tansyaster), *Verbesina encelioides* (golden crownbeard), *Rumex* spp. (docks), *Xanthium strumarium* (rough cocklebur), *Sporobolus flexuosus* (mesa dropseed), *Nerisyrenia camporum* (bicolor fanmustard), *Sphaeralcea angustifolia* (copper globemallow), *Solanum elaeagnifolium* (silverleaf nightshade), and *Heliotropium curassavicum* (salt heliotrope). Stratum and substrate cover for Rio Grande Alluvial Herbaceous Vegetation are shown in Table D-97.

**Table D-97.** Stratum and substrate cover recorded for Rio Grande Alluvial Herbaceous Vegetation at Big Bend National Park and Rio Grande wild and Scenic River (# plots=6).

Category	Item	Mean Cover (%)	Range Cover (%)
Stratum	Tree	0	0–0
	Tall Shrub	1	0–3
	Short Shrub	4	0–18
	Herb	13	2–38
Substrate	Bedrock	0	0–0
	Large/Small Rocks	55	0–98
	Litter/Duff	<1	0–1

### Environment:

This vegetation occurs on frequently flooded depositional bars of sand, gravel, cobbles, and/or boulders along the Rio Grande. This rather broad concept also includes areas of floodplain that are relatively free from woody vegetation open due to disturbance (e.g., flooding, grazing).

### USNVC Translation

USNVC Class: Shrub & Herb Vegetation Class (2)

USNVC Subclass: Shrub & Herb Wetland Subclass (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland Formation (2.C.4)

USNVC Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Division (D031)

USNVC Macrogroup: Arid West Interior Freshwater Marsh Macrogroup (M888)

USNVC Group: Arid West Interior Freshwater Marsh Group (G531)

USNVC Alliance: *Schoenoplectus americanus* – *Schoenoplectus acutus* – *Schoenoplectus californicus* Marsh Alliance (A3895)

NPS Association: Arid West Alluvial Shrub Herbaceous Vegetation Association (NPSBIBE024)

Comments:

This concept covers both (often sparse) low bar and bank vegetation and denser vegetation of less frequently flooded floodplains. Vegetation in these two settings probably warrants different associations, but the relative scarcity of data from across this vegetation gradient and its overall heterogeneity necessitate this broad treatment for now.

A USNVC Group applicable to relatively permanent streams and rivers within the Arid West that is analogous to G568 (Great Plains Riverine Scour Group) is probably needed within the USNVC (or the concept of G533 could be expanded).

BIBE Classification Plots Included in Concept:

BIBE0081, BIBE3015, BIBE3030.

BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA0483, BIBEAA0486, BIBEAA0487, BIBEAA1051, BIBEAA1052, BIBEAA1056, BIBEAA1057, BIBEAA1058, BIBEAA1059, BIBEAA1060, BIBEAA1061, BIBEAA1062, BIBEAA1129, BIBEAA1256.

Most frequent plant taxa recorded in Rio Grande Alluvial Herbaceous Vegetation are shown in Table D-98.

**Table D-98.** Synthesis table for all plant taxa recorded in Rio Grande Alluvial Herbaceous Vegetation at Big Bend National Park and Rio Grande wild and Scenic River (# plots=6).

Species Latin Name	Primary Stratum	Constancy	Mean Cover (%)	Range Cover (%)
<i>Tamarix ramosissima</i>	Shrub	83.3%	1.4	0–5
<i>Baccharis salicifolia</i>	Shrub	33.3%	1.2	0–5
<i>Nicotiana glauca</i>	Shrub	33.3%	0.3	0–2
<i>Salix gooddingii</i>	Shrub	16.7%	0.6	0–5
<i>Fraxinus berlandieriana</i>	Shrub	16.7%	0.3	0–2
<i>Prosopis glandulosa</i> var. <i>torreyana</i>	Shrub	16.7%	0.0	0–trace
<i>Vachellia farnesiana</i>	Shrub	16.7%	0.0	0–trace
<i>Cynodon dactylon</i>	Herb	66.7%	4.3	0–10
<i>Heliotropium curassavicum</i>	Herb	50.0%	1.4	0–10
<i>Phragmites australis</i>	Herb	33.3%	0.2	0–1
<i>Sonchus asper</i>	Herb	16.7%	2.9	0–25
<i>Helenium microcephalum</i> var. <i>microcephalum</i>	Herb	16.7%	0.3	0–2
<i>Nama havardii</i>	Herb	16.7%	0.3	0–2
<i>Oligomeris linifolia</i>	Herb	16.7%	0.3	0–2
<i>Amaranthus</i> sp.	Herb	16.7%	0.1	0–1
<i>Argemone albiflora</i> ssp. <i>texana</i>	Herb	16.7%	0.1	0–1
<i>Cyperus</i> sp.	Herb	16.7%	0.1	0–1
<i>Helenium elegans</i>	Herb	16.7%	0.1	0–1
<i>Nama</i> sp.	Herb	16.7%	0.1	0–1
<i>Nama undulatum</i>	Herb	16.7%	0.1	0–1
<i>Parietaria pensylvanica</i>	Herb	16.7%	0.1	0–1
<i>Phyla nodiflora</i>	Herb	16.7%	0.1	0–1
<i>Poa</i> sp.	Herb	16.7%	0.1	0–1
<i>Quincula lobata</i>	Herb	16.7%	0.1	0–1
<i>Rumex crispus</i>	Herb	16.7%	0.1	0–1
<i>Salsola tragus</i>	Herb	16.7%	0.1	0–1
<i>Verbena neomexicana</i> var. <i>hirtella</i>	Herb	16.7%	0.1	0–1
<i>Verbena plicata</i>	Herb	16.7%	0.1	0–1
<i>Bothriochloa ischaemum</i>	Herb	16.7%	0.0	0–trace
<i>Cirsium texanum</i>	Herb	16.7%	0.0	0–trace
<i>Nerisyrenia camporum</i>	Herb	16.7%	0.0	0–trace
<i>Nicotiana obtusifolia</i>	Herb	16.7%	0.0	0–trace
<i>Xanthium strumarium</i>	Herb	16.7%	0.0	0–trace





Photo 102. Rio Grande Alluvial Herbaceous Vegetation, Rio Grande near Gravel Pit (BIBE0081). Photo by Wendy Redding.



Photo 103. Rio Grande Alluvial Herbaceous Vegetation, Rio Grande at Talley (BIBE3030). Photo by Karen Clary.

## ***Mixed Ornamental and Planted Woodland***

### Local Type Concept:

Woodlands of formerly planted trees and shrubs, with highly managed understories (regularly mowed “lawn” areas).

### Vegetation:

An open (usually, 10–40% cover) tree stratum is dominated by tall *Populus fremontii* ssp. *mesetae* (Arizona cottonwood), with possibly *Populus deltoides* ssp. *wislizeni* (Rio Grande cottonwood) present. Shorter trees or saplings include *Fraxinus velutina* (velvet ash), *Vachellia farnesiana* (huisache), *Gleditsia triacanthos* (honey locust) and possibly others. There essentially is no shrub stratum. The herbaceous stratum is strongly dominated by a “lawn” of rhizomatous planted grasses, including *Bothriochloa ischaemum* (yellow bluestem), *Cynodon dactylon* (Bermuda grass) and others.

### Environment:

This vegetation occurs along the Rio Grande floodplain in and around campground and picnic areas at Cottonwood and Rio Grande Village.

### USNVC Translation:

USNVC Class: Agricultural & Developed Vegetation Class (7)

USNVC Subclass: Developed Vegetation Subclass (7.C)

USNVC Formation: Other Developed Vegetation Formation (7.C.2)

USNVC Division: Other Developed Vegetation Division (7.C.1.2)

USNVC Macrogroup: Tree Developed Vegetation Macrogroup (CGR040)

USNVC Group: Temperate Tree Developed Vegetation Group (CSG045)

USNVC Subformation: Other Developed Vegetation Subformation (7.C.2.1)

USNVC Cultural Group: Tree Developed Vegetation Cultural Group (CGR040)

USNVC Cultural Subgroup: Temperate Tree Developed Vegetation Cultural Subgroup (CSG047)

NPS Cultural Type: *Populus* spp. – *Fraxinus* spp. Planted Woodland Cultural Type (NPSBIBE045)

### Comments:

Although not a naturally occurring vegetation type, stands are large enough to be mapped and have some natural vegetation characteristics.

This vegetation provides nesting habitat for the common black hawk (*Buteogallus anthracinus*), a species of conservation concern in Texas.

### BIBE Accuracy Assessment Sites Included in Concept:

BIBEAA1009, BIBEAA1010, BIBEAA1279.





Photo 104. Mixed Ornamental and Planted Woodland, Rio Grande Village (BIBEAA1009). Photo by Rebecca Evans.



Photo 105. Mixed Ornamental and Planted Woodland, Rio Grande Village (BIBEAA1279). Photo by Chris Lea.

# Appendix E: BIBE Mapping Conventions and Visual Key

## Big Bend National Park – Map Units

Appendix E. describes the map units for the Big Bend National Park (BIBE) Vegetation Inventory Project. Its purpose is to:

- Provide a visual key to the BIBE map units;
- Describe the vegetation of each map unit and its corresponding imagery (i.e. photo) signature;
- Provide a representative ground photograph/image for each map unit;
- Describe the link between each map unit and the revised U.S. National Vegetation Classification (rUSNVC);
- Provide visual examples of each map unit with digital overhead images and delineated overlays.

The map units for BIBE were based on a combination of rUSNVC plant associations, local requests (i.e. Park Specials), the limitations of the digital imagery, and land use / land cover classes. The vegetation described in this section reflects the classification designed specifically for this project. Non-vegetated and land-use map units are not described in this key. For more information on the development of the mapping scheme for BIBE please reference the mapping sections of this report and the digital information (i.e. lookup tables, metadata) included in the digital project files.

This key follows the physiognomic grouping of each map unit starting with woodland types. Each map unit is fully described by a variety of characteristics and features. First, the common plant species and rUSNVC crosswalk (if applicable) is presented. Next is a description of the mapping concept and a representative ground photograph. A map of the distribution for each mapping unit across the study area follows along with an example of the 2015 Texas Orthoimagery Program (TOP) 50cm natural color/color infrared basemap ortho-imagery (color infrared bands are shown). The imagery snapshot examples also include representative polygon outlines that highlight the map unit signatures. Many of the map unit descriptions rely heavily on the vegetation field data collected in 2011, and 2010. The sample ground photographs were taken during the 2003, 2008, 2009, 2010 field data collection efforts.



## Forest and Woodlands

**Map Code**      **Arizona Cypress – Graves' Oak – Pinyon Pine Forest**

**W\_ACYP**      ***Hesperocyparis arizonica* – *Quercus gravesii* – *Pinus cembroides* Forest**

---

### Common Species

- Arizona cypress (*Hesperocyparis arizonica*)
- Graves' (Chisos red) oak (*Quercus gravesii*)
- Mexican pinyon pine (*Pinus cembroides*)
- Gray oak (*Quercus grisea*)
- Alligator juniper (*Juniperus deppeana*)
- Pinyon ricegrass (*Piptochaetium fimbriatum*)
- Desert muhly (*Muhlenbergia glauca*)

### rUSNVC Association

– *Hesperocyparis arizonica* / (*Quercus gravesii* – *Pinus cembroides*) / *Piptochaetium fimbriatum*  
Forest (NPSBIBE002) [Provisional]



Representative Ground Photo.

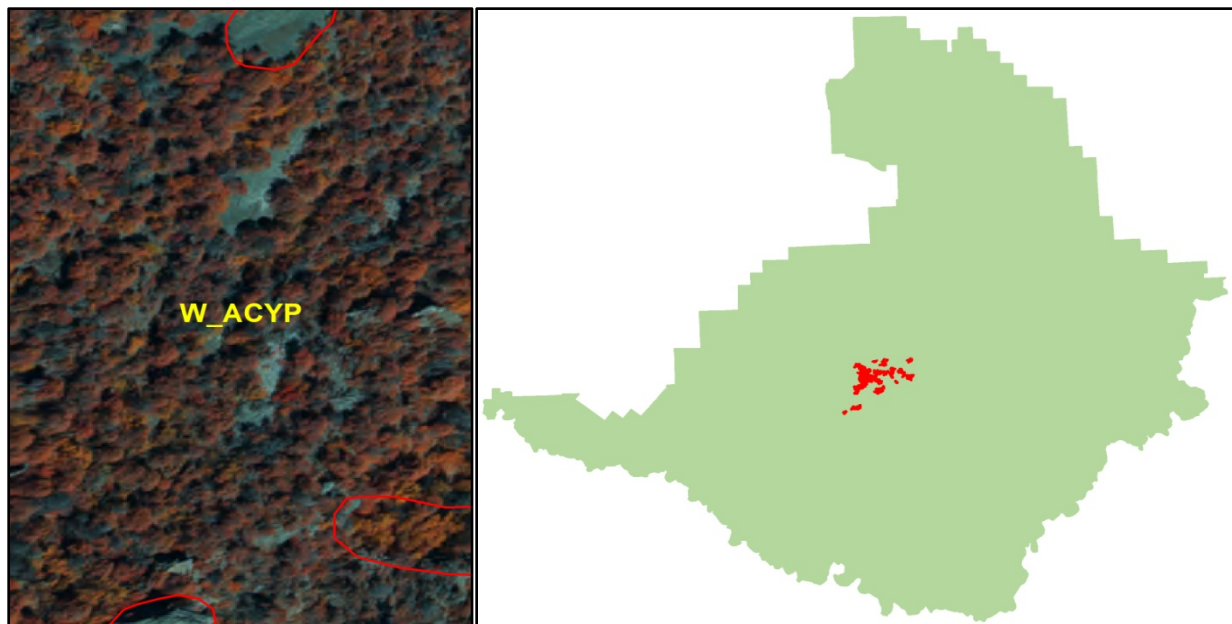
### Description

**Frequency:** Arizona cypress trees with Chisos red oak and pinyon pine trees were restricted to a few large areas in the High Chisos Mountains. **Physiognomy:** W\_ACYP polygons contained moderate to dense stands of medium to tall conifer trees (> 5 meters) with an almost an even mix of slightly smaller deciduous oaks and pinyon pine trees. The understories for this map unit were often diverse and contained mixes of shrubs with pockets of grasses and herbaceous vegetation.

**Condition:** Poor. Arizona cypress trees occurred mostly on mesic slopes or in shaded canyon bottoms that may have helped them against drought conditions. However, in Juniper Canyon, many dead and dying trees were observed in the canopy. Subcanopy and sapling cypress trees have fared better. Drought is probably the primary threat to this type. Fuel loading from fire suppression, wildfires, landslides, and insect infestations are other potential threats.

**CIR Signature:** On the imagery, canopies of W\_ACYP appeared as large brown tuffs (Arizona cypress trees) and orange spots (oak trees). Understories appeared as small brown spots and pockets of talus and rock were gray.

**Mapping Notes:** The W\_ACYP map unit was used to map high elevation Arizona cypress stands that contained high cover of oaks and other associated conifer species. Arizona cypress trees appeared similar to large pinyon pine trees and some confusion may have occurred during the mapping of this type with the W\_MPJ map unit.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Alligator Juniper – Pinyon Pine – Gray Oak Woodland**  
**W\_APJ**        ***Juniperus deppeana* – *Pinus cembroides* – *Quercus grisea* Woodland**

---

Common Species

- Alligator juniper (*Juniperus deppeana*)
- Mexican pinyon pine (*Pinus cembroides*)
- Gray oak (*Quercus grisea*)
- Emory oak (*Quercus emoryi*)
- Weeping juniper (*Juniperus flaccida*)
- Mountain sage (*Salvia regla*)
- Sideoats grama (*Bouteloua curtipendula*)
- Alderleaf mountain mahogany (*Cercocarpus montanus*)
- Graves' (Chisos red) oak (*Quercus gravesii*)

rUSNVC Association

– *Pinus cembroides* – *Quercus grisea* – *Quercus emoryi* – *Juniperus flaccida* / *Salvia regla* / *Bouteloua curtipendula* Woodland (CEGL004597)



Representative Ground Photo.

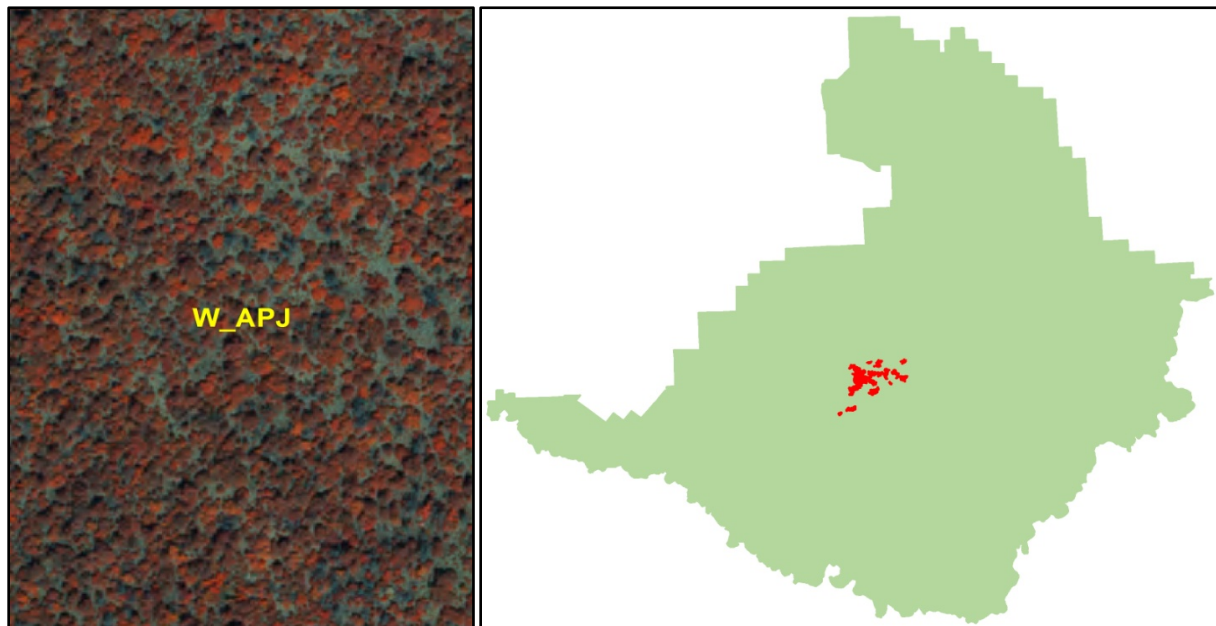
Description

**Frequency:** W\_APJ polygons were common in the montane zone of the Chisos Mountains at lower to mid elevations.

**Physiognomy:** W\_APJ polygons were comprised of moderate to sparse stands of short conifer trees (< 5 meters) with dense understories of mixed evergreen and deciduous shrubs and herbaceous vegetation. Sparse oak trees were a common associate in the canopy layer in some areas.

**Condition:** Good. Alligator juniper trees are widespread in the Chisos Mountains and appear disease free at this time. Drought, climate change, and heavy fuel loading caused by fire suppression, severe wildfires, insect infestations, and invasion by non-native plant species are threats to this type.

**CIR Signature:** On the imagery, canopies of W\_APJ appeared as rounded orange-brown spots (trees) with various colors ranging from gray (bare soil) to light brown (shrubs and herbaceous vegetation) in the canopy openings. **Mapping Notes:** The W\_APJ map unit was very similar in appearance to the W\_EOAK, W\_MPJ, and S\_GOAK types. This map unit shared common species with the S\_MMIX and S\_LMIX map units.



Example photo signature (left) and range and distribution map (right).

**Map Code**     **Arizona Pine – Graves' Oak Forest**  
**W\_APOAK**    ***Pinus arizonica* – *Quercus gravesii* Forest**

---

Common Species

- Arizona pine (*Pinus arizonica*)
- Graves' (Chisos red) oak (*Quercus gravesii*)
- Gray oak (*Quercus grisea*)
- Mexican pinyon pine (*Pinus cembroides*)
- Goldman's silktassel (*Garrya ovata* ssp. *goldmanii*)
- Alligator juniper (*Juniperus deppeana*)
- Alderleaf mountain mahogany (*Cercocarpus montanus*)
- Emory oak (*Quercus emoryi*)
- Arizona white oak (*Quercus arizonica*)

rUSNVC Association

– *Quercus gravesii* – *Pinus (cembroides, arizonica)* / *Quercus grisea* Forest (NPSBIBE004 – Park Special) [Provisional]



Representative Ground Photo.

Description

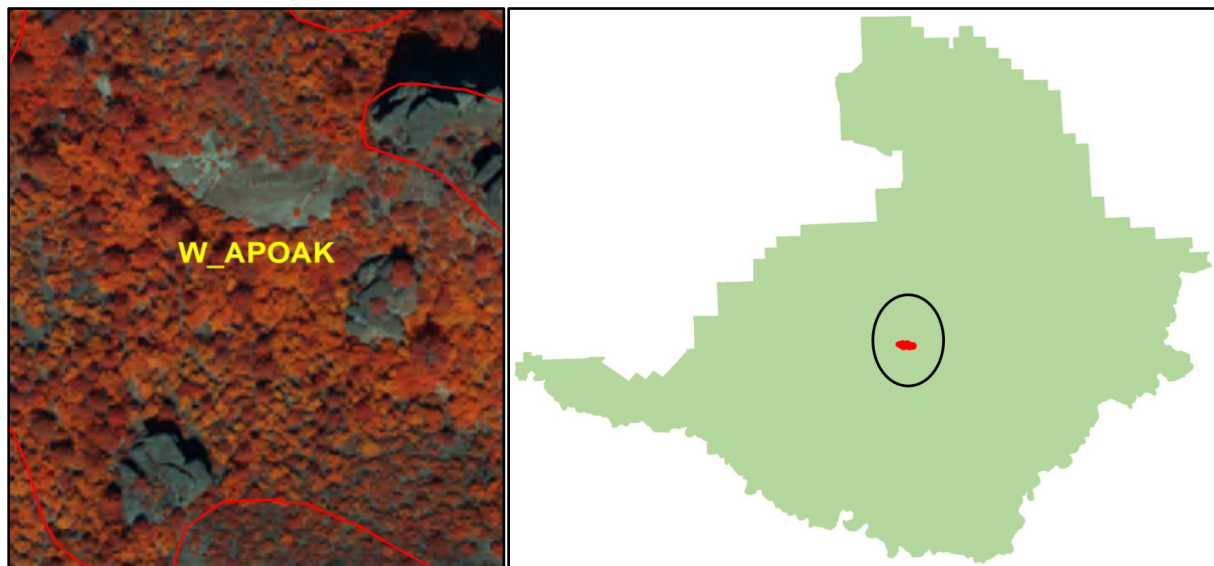
**Frequency:** Arizona pine woodlands were rare and only found in one known location in the upper to mid elevations along the eastern portion of the Chisos Mountains.

**Physiognomy:** W\_APOAK polygons contained dense stands of tall conifer trees (> 10 meters) mixed with deciduous and evergreen oak trees. The understory was made up of shorter trees, junipers, deciduous shrubs, and mesic herbaceous vegetation.

**Condition:** Poor. Arizona pine trees only occurred in one location that may represent the limits of its distribution at BIBE. No evidence of disease or decline was reported but pine trees may be susceptible to drought, climate change, and heavy fuel loading caused by fire suppression, severe wildfires, and insect/pest infestations.

**CIR Signature:** On the imagery, canopies of W\_APOAK appeared as rounded, dark red splotches (trees) with orange spots (oaks) and gray rocks in the canopy openings.

**Mapping Notes:** Polygons of W\_APOAK were mapped where they were known to occur. The W\_APOAK map unit was not treated as separate association in the classification but was included as a park special map unit. This type was very similar to the W\_HOAK type and may be considered as variant of this woodland association.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Cottonwood – Goodding Willow Spring Woodland**  
**W\_CWD**        ***Populus fremontii* – *Salix gooddingii* Spring Woodland**

---

Common Species

- Arizona cottonwood (*Populus fremontii*)
- Goodding willow (*Salix gooddingii*)
- Black willow (*Salix nigra*)
- Seepwillow (Mule-fat) (*Baccharis salicifolia*)
- Screwbean mesquite (*Prosopis pubescens*)
- Honey mesquite (*Prosopis glandulosa*)
- Spiny hackberry (*Celtis ehrenbergiana*)
- Texas persimmon (*Diospyros texana*)
- Silver beardgrass (*Bothriochloa laguroides*)
- Yellow bluestem (*Bothriochloa ischaemum*)

rUSNVC Association

– *Populus fremontii* – *Salix gooddingii* Riparian Woodland (CEGL000944)



Representative Ground Photo.

Description

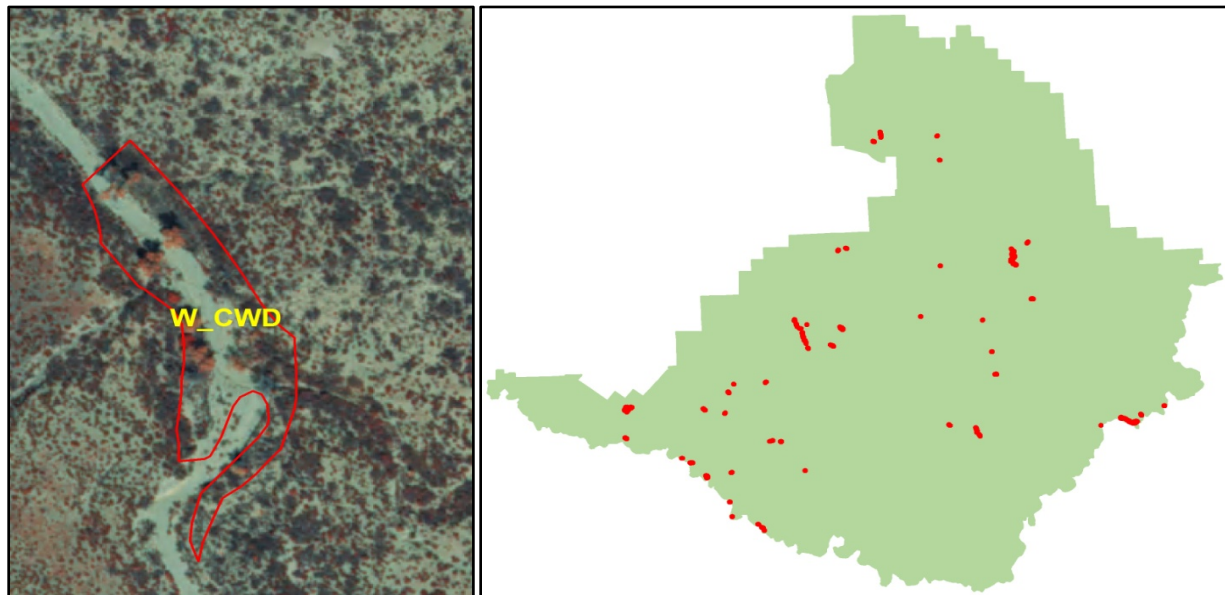
**Frequency:** Cottonwood riparian woodlands were rare and only found near springs, catchments, and seeps, often in riparian settings.

**Physiognomy:** W\_CWD polygons contained sparse to moderate dense stands of tall deciduous trees (3–10 meters) with Goodding willows and other deciduous riparian trees and shrubs. Most sites had thick shrub, grass, and mesic herbaceous vegetation in the understory.

**Condition:** Fair. Cottonwood trees occurring in riparian corridors are likely impacted by flash flooding events and may be threatened by prolonged drought and water shortages. Wildlife usage of springs and seeps may affect cottonwood and willow regeneration.

**CIR Signature:** On the imagery, canopies of W\_CWD appeared as bushy, light red spots (trees). Polygons were usually linear in shape and often contained meandering streams and other obvious drainage features.

**Mapping Notes:** The W\_CWD map unit occurred in mesic and riparian areas that may have contained other dominant deciduous tree species.. Some cottonwood stands along the Rio Grande River were likely included in the larger S\_MRIP and S\_CWIL types.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Emory Oak Woodland**  
**W\_EOAK**      ***Quercus emoryi* Woodland**

---

Common Species

- Emory oak (*Quercus emoryi*)
- Little bluestem (*Schizachyrium scoparium*)
- Arizona white oak (*Quercus arizonica*)
- Alligator juniper (*Juniperus deppeana*)
- Bull muhly grass (*Muhlenbergia emersleyi*)
- Gooseberry currant (*Ribes montigenum*)
- Sideoats grama (*Bouteloua curtipendula*)
- Foothill beargrass (*Nolina erumpens*)
- Green sotol (*Dasylirion leiophyllum*)
- Hairy grama (*Bouteloua hirsuta*)

rUSNVC Association

– *Quercus emoryi* / *Muhlenbergia emersleyi* Scrub Woodland (CEGL000685)



Representative Ground Photo.

Description

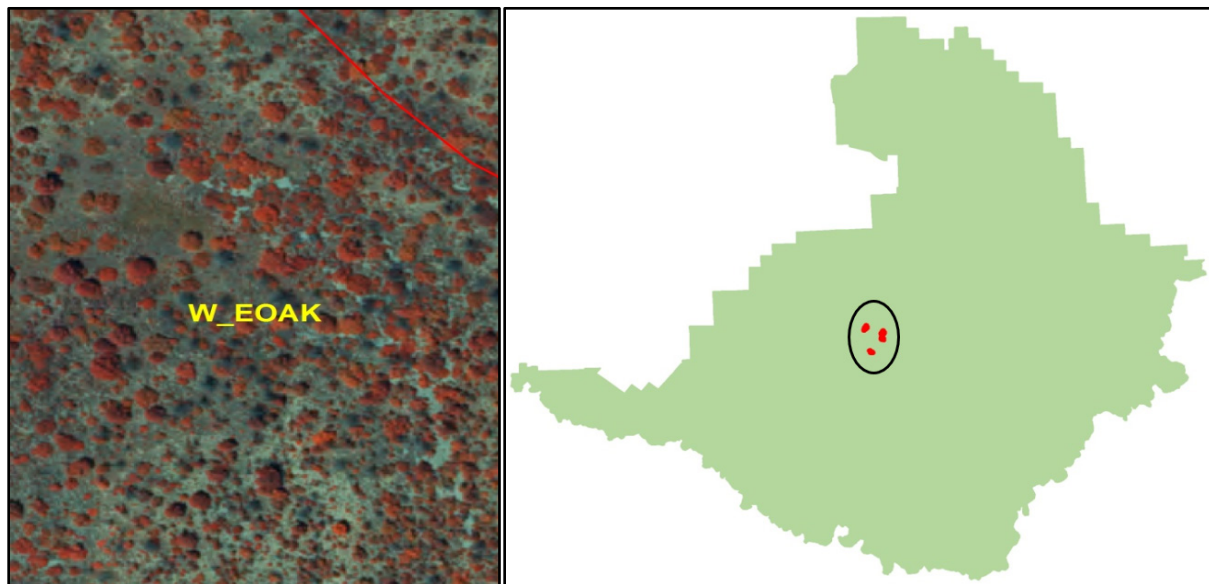
**Frequency:** Sites dominated by Emory oak shrubs and trees only occurred on a few rocky slopes in the lower portions of the Chisos Mountain region of BIBE.

**Physiognomy:** Stands of W\_EOAK were dominated by low to medium-sized, broad-leaved evergreen short trees, and tall shrubs. The understory for this type was thick with grasses and forbs and often contained other shrub and short tree species.

**Condition:** Good-Fair. Emory oak is a common species in the Chisos Mountains but it usually occurred with other species of oaks and pinyon pine and juniper trees. When it did occur as the dominant species, these sites were often small and may be prone to threats from wildfires, drought, insect infestations, and wildlife disturbance.

**CIR Signature:** The W\_EOAK map unit had a distinct signature consisting of widely spaced red and orange splotches. The Emory oak trees appeared smaller than the other oak trees found in the Graves' oak types. Pine and juniper trees appeared as brown spots. Grasses were a smooth tan and pink color. A blue or gray background color was present caused by the reflectance from the soil and rock substrate underneath.

**Mapping Notes:** Emory oak stands were only found in a few locations that overlapped with similar chaparral and pinyon-juniper types, especially S\_RJUN, W\_PJ, and S\_LMIX. Many species in this map unit were also common across multiple map units. More ground-truthing of the Chisos Mountain types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Mixed Ornamental and Planted Woodland**  
**W\_FOR**

---

Common Species

- Arizona cottonwood (*Populus fremontii* ssp. *mesetae*)
- Eastern cottonwood (*Populus deltoides*)
- Velvet ash (*Fraxinus velutina*)
- Huisache (*Vachellia farnesiana*)
- Palm Trees (*Areacaceae* spp.)
- Decorative, Planted, and Cultivated Trees and Shrubs

rUSNVC Association

– *Populus* spp. – *Fraxinus* spp. Planted Woodland Cultural Type (NPSBIBE045) [Provisional]



Representative Ground Photos.

### Description

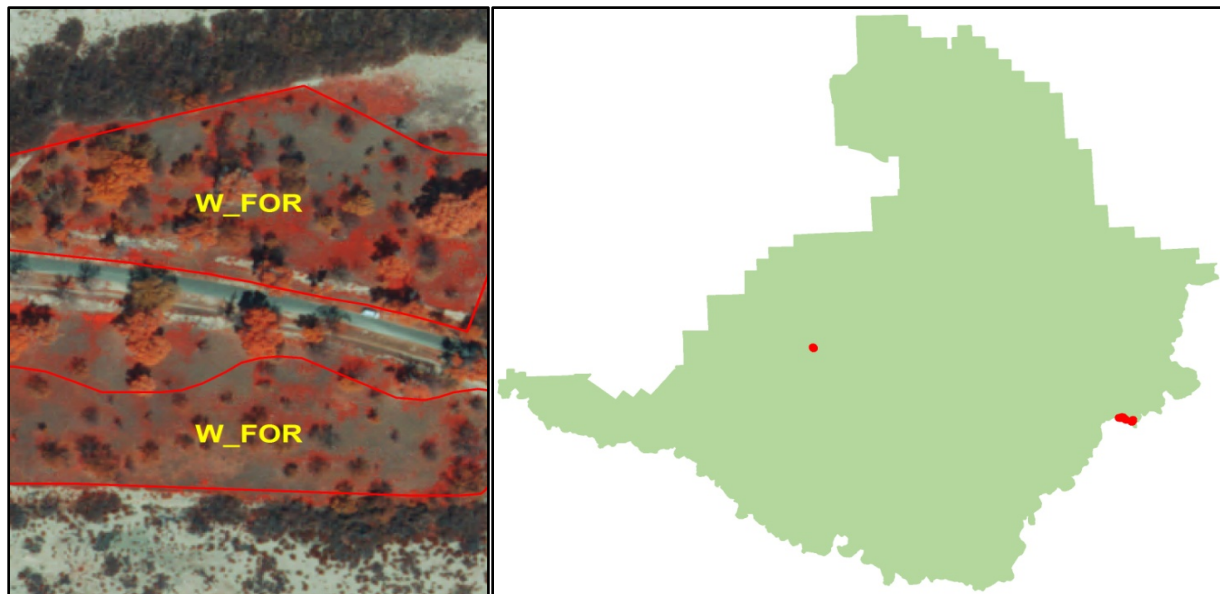
**Frequency:** Various residential, campground, and developed areas in BIBE were found to have trees and tall shrubs that were planted and/or maintained.

**Physiognomy:** W\_FOR polygons contained sparse to moderate stands of trees and shrubs that may contain both native and non-native evergreen and deciduous species. The understories for this map unit were mainly mixes of planted and maintained grasses, shrubs and other landscape plantings.

**Condition:** Poor. Planted and ornamental trees and shrubs likely represent non-native species and species that may spread. Native and natural vegetation may be suppressed or displaced by these plants under the right conditions.

**CIR Signature:** On the imagery, canopies of W\_FOR varied depending on the species present. Most contained red, brown, and orange tuffs with a smooth red color representing lawns. Dead or dormant grass patches appeared as a smooth gray color. Dark shadows from the taller trees were often present.

**Mapping Notes:** The W\_FOR map unit was created to address mostly developed areas in campgrounds, old homesteads, and other park facilities. In some cases they were mixed with native cottonwood (W\_CWD) and mesquite trees. None of these areas were sampled during this project.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Goodding Willow Spring Woodland**  
**W\_GWIL**      ***Salix gooddingii* Spring Woodland**

---

Common Species

- Goodding willow (*Salix gooddingii*)
- Little walnut (*Juglans microcarpa*)
- Evergreen sumac (*Rhus virens*)
- Littleleaf ash (*Fraxinus greggii*)
- Cardinalflower (*Lobelia cardinalis*)
- Eastern poison ivy (*Toxicodendron radicans*)

rUSNVC Association

– *Populus fremontii* – *Salix gooddingii* Woodland (CEGL000944 – Park Special)



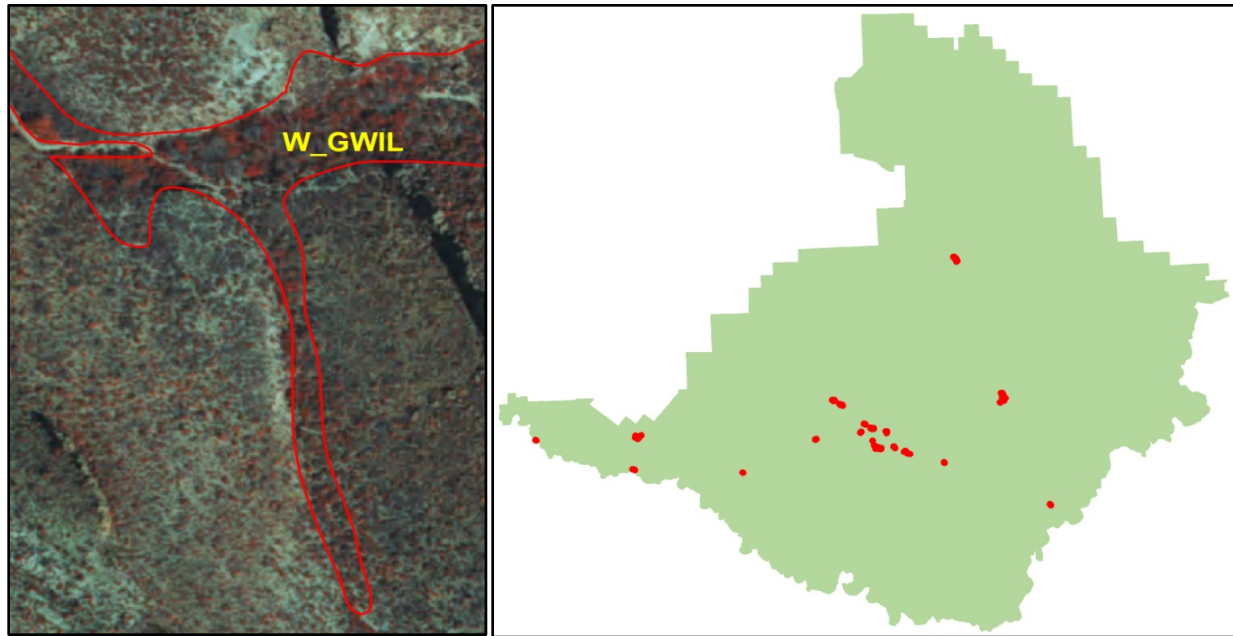
Representative Ground Photo.

Description

**Frequency:** Goodding willow with little walnut woodlands were rare and localized communities only found in a few small riparian settings across BIBE.

**Physiognomy:** W\_GWIL polygons contained mostly short deciduous trees with deciduous shrubs, grasses, and mesic herbaceous vegetation in the understory. **Condition:** Fair. W\_GWIL woodlands were only found along some drainages and streams and may represent relic or localized plant communities. Flash floods, wildlife pressure, drought, and non-native grasses are potential threats **CIR Signature:** On the imagery, W\_GWIL polygons appeared as red spots with smaller brown and gray dots in the canopy openings. Declining trees appeared as gray splotches. Most sites were linear in pattern.

**Mapping Notes:** The W\_GWIL map unit was mapped where it was know to occur. Other areas may have been missed. The similarity in signturate between this type and the S\_FWASH and S\_TMX map units may have led to some confusion during the mapping.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **High Chisos Oak – Pine Forest**  
**W\_HOAK**      ***Quercus gravesii* – *Pinus* spp. Forest**

---

Common Species

- Graves' (Chisos red) oak (*Quercus gravesii*)
- Gray oak (*Quercus grisea*)
- Mexican pinyon pine (*Pinus cembroides*)
- Emory oak (*Quercus emoryi*)
- Arizona white oak (*Quercus arizonica*)
- Goldman's silktassel (*Garrya ovata* ssp. *goldmanii*)
- Alligator juniper (*Juniperus deppeana*)
- Alderleaf mountain mahogany (*Cercocarpus montanus*)

rUSNVC Association

– *Quercus gravesii* – *Pinus* (*cembroides*, *arizonica*) / *Quercus grisea* Forest (NPSBIBE004)  
[Provisional]



Representative Ground Photo.

Description

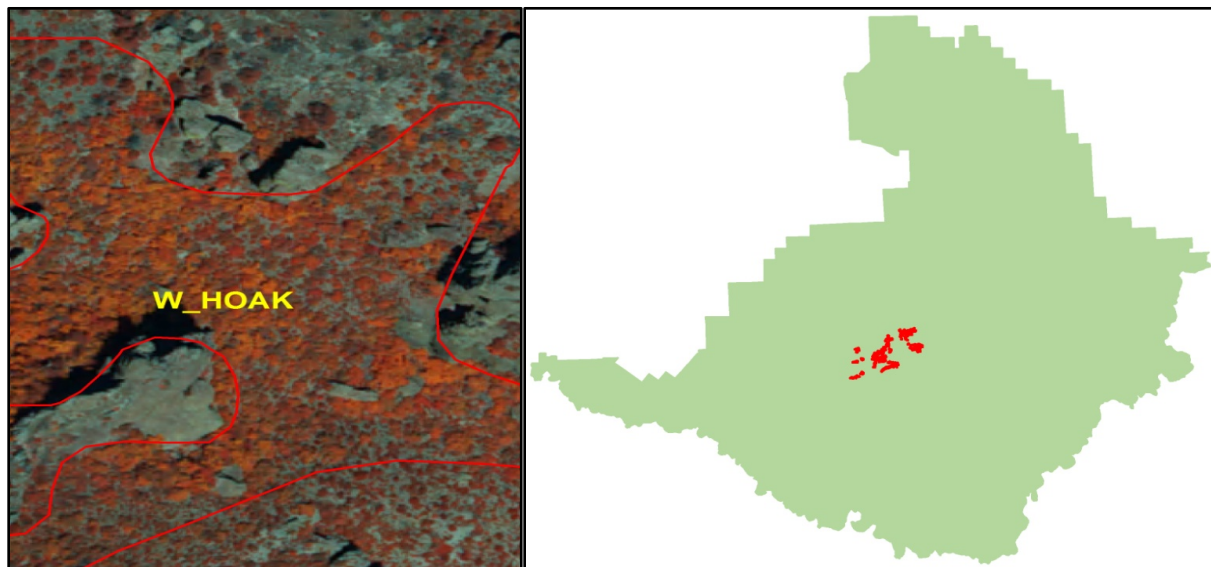
**Frequency:** High Chisos oak stands with some pinyon pine trees were common at the highest elevation of the Chisos Mountains.

**Physiognomy:** W\_HOAK polygons contained moderate to dense stands of 2–5 meters tall oak trees with some scattered evergreen pinyon pine trees. The understories varied from sparse bare rock/talus to others with short (< 1 meter) evergreen and deciduous shrubs in the canopy openings.

**Condition:** Good. High Chisos oak and pinyon juniper woodlands were widespread and one of the more prevalent types in the Chisos Mountains at BIBE. Insect infestations, wildfires, drought, and climate change may be potential threats to this type.

**CIR Signature:** On the imagery, polygons of W\_HOAK were characterized by a dense mix of orange and red splotches (oaks). Canopy openings had light gray rock and talus patches. Shrubs if present were pink and brown dots, pinyon pine trees were scattered brown spots, and grasses were tan and pink colors and smooth in texture.

**Mapping Notes:** The W\_HOAK map unit represents high elevation stands of shorter oak trees than found in the W\_ROKBM and ROKEOK map units. The W\_MPJ map unit had similar species but the pinyon-juniper trees were the dominant species in this type. Most sites were on rocky soils and talus. More ground-truthing of the Chisos Mountain map units may allow for further refinement and increased accuracy. The W\_APOAK type was used to map similar areas with Arizona pine trees.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Lacey's Oak Woodland**  
**W\_LOAK**      ***Quercus laceyi* Woodland**

---

Common Species

- Lacey oak (*Quercus laceyi*)
- Texas persimmon (*Diospyros texana*)
- Evergreen sumac (*Rhus virens*)
- Mexican buckeye (*Ungnadia speciosa*)
- Bluebill (*Clematis pitcheri*)
- Roemer's catclaw (*Senegalia roemeriana*)

rUSNVC Association

– *Quercus laceyi* Madrean Woodland (NPSBIBE012) [Provisional]



Representative Ground Photo.

Description

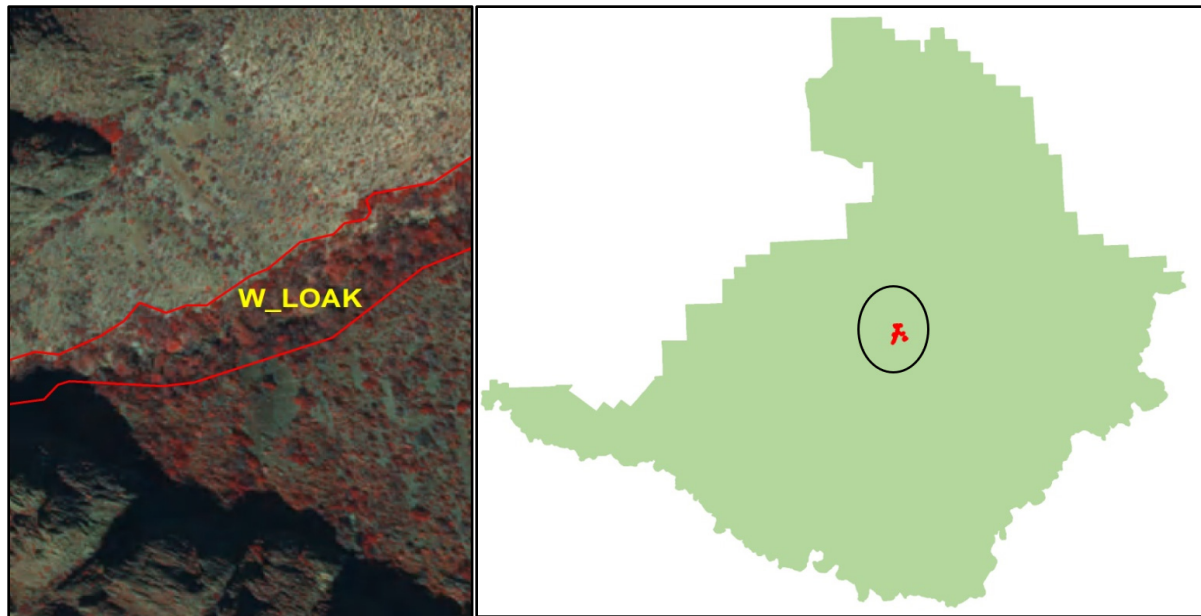
**Frequency:** Lacey's oak woodlands were only found in a few locations directly west of the Panther Junction headquarters and visitor center. In these locations, lacy oak trees were found growing in mesic washes.

**Physiognomy:** W\_LOAK polygons contained moderate to dense stands of short Lacey's oak trees with medium-sized (1–2 meter) deciduous and evergreen shrubs in the canopy openings.

**Condition:** Fair. Lacey's oak woodlands were only found along some drainages and streams and may represent relic or localized plant communities. Flash floods, wildlife pressure, drought, and non-native grasses are potential threats to this type.

**CIR Signature:** On the imagery, W\_LOAK polygons appeared as dark red spots with smaller brown and orange dots in the canopy openings. Declining trees appeared as gray splotches. Most sites were linear in pattern.

**Mapping Notes:** The W\_LOAK map unit was mapped where it was know to occur. Other areas may have been missed. The similarity in signature between this type and the S\_FWASH and S\_TMX map units may have led to some confusion during the mapping.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Dry – Mesic Pinyon Pine – Oak – Juniper Woodland**  
**W\_MPJ**        **Dry – Mesic *Pinus cembroides* – *Quercus* spp. – *Juniperus* spp. Woodland**

---

Common Species

- Mexican pinyon pine (*Pinus cembroides*)
- Alligator juniper (*Juniperus deppeana*)
- Weeping juniper (*Juniperus flaccida*)
- Alderleaf mountain mahogany (*Cercocarpus montanus*)
- Gray oak (*Quercus grisea*)
- Mountain sage (*Salvia regla*)
- Bull muhly grass (*Muhlenbergia emersleyi*)
- Finestem needlegrass (*Nassella tenuissima*)
- Pinyon ricegrass (*Piptochaetium fimbriatum*)
- Pine dropseed (*Blepharoneuron tricholepis*)
- Foothill beargrass (*Nolina erumpens*)
- Pinyon ricegrass (*Piptochaetium fimbriatum*)

rUSNVC Association

– *Pinus cembroides* – *Quercus gravesii* – *Juniperus flaccida* / *Salvia regla* / *Piptochaetium fimbriatum* Woodland (CEGL004600)



Representative Ground Photo.

Description

**Frequency:** Pinyon-juniper woodlands with an oak component were common throughout the middle to high portions of the Chisos Mountains.

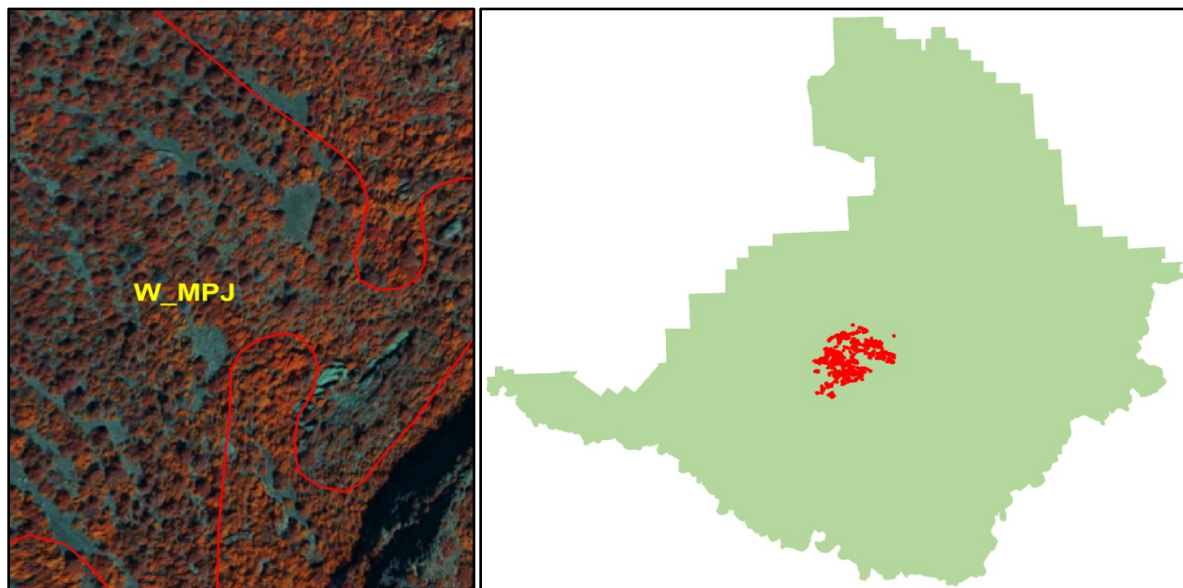


**Physiognomy:** W\_MPJ polygons contained moderate to dense stands of 2–5 meters tall conifer trees with slightly shorter oak trees in the subcanopy. Mesic shrubs, grasses, and forbs occurred in the understory.

**Condition:** Fair. Dry to mesic pinyon-juniper and oak woodlands are widespread and a common woodland types at BIBE. Some locations of this type showed evidence of dead and dying pine trees, likely due to drought conditions and bark beetle infestations. Some regeneration of the pine trees was observed.

**CIR Signature:** On the imagery dense canopies of W\_MPJ appeared as thick, dark brown spots with slightly smaller orange and red dots (oaks) on a gray background (bare ground). Open talus and bare rocks were often present

**Mapping Notes:** The W\_MPJ map unit contained both thick stands of healthy pinyon-juniper and oak trees. Other stands had dead and dying trees and had larger openings in the canopy filled with thick grasses and shrubs. An effort was made during the mapping to designate areas with declining pine trees with a modifier in the GIS layer. The similarity between this type and the W\_PJ map unit may have led to some confusion in the mapping.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Dry Pinyon Pine Woodland**  
**W\_PJ**          **Dry *Pinus cembroides* Woodland**

---

Common Species

- Mexican pinyon pine (*Pinus cembroides*)
- Alligator juniper (*Juniperus deppeana*)
- Weeping juniper (*Juniperus flaccida*)
- Gray oak (*Quercus grisea*)
- Bull muhly grass (*Muhlenbergia emersleyi*)
- Finestem needlegrass (*Nassella tenuissima*)
- Pinyon ricegrass (*Piptochaetium fimbriatum*)
- Pine dropseed (*Blepharoneuron tricholepis*)
- Foothill beargrass (*Nolina erumpens*)
- Pinyon ricegrass (*Piptochaetium fimbriatum*)

rUSNVC Association

– *Pinus cembroides* – *Quercus grisea* – *Juniperus flaccida* / *Salvia regla* / *Muhlenbergia emersleyi*  
Woodland (CEGL004596)



Representative Ground Photo.

Description

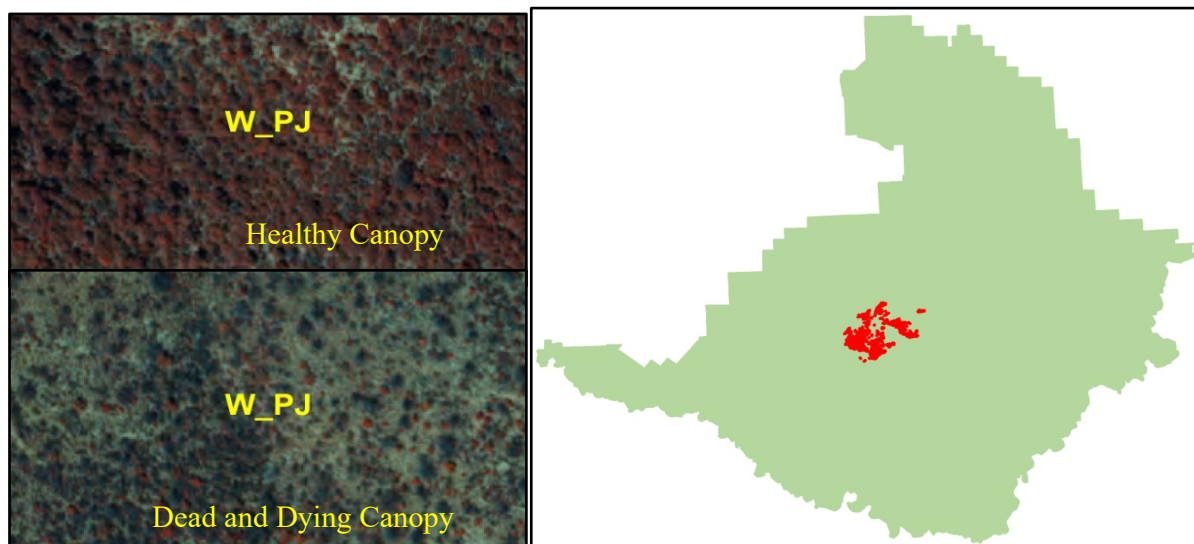
**Frequency:** Pinyon-juniper woodlands with a dry mixed shrub and grass understory were common throughout the mid-elevations of the Chisos Mountains.

**Physiognomy:** W\_PJ polygons contained moderate to dense stands of 2–5 meters tall conifer trees with grass and some evergreen shrubs in the understory.

**Condition:** Fair. Pinyon-juniper woodlands are widespread and one of the more prevalent woodland types at BIBE. Many locations of this type showed evidence of dead and dying pine trees, likely due to drought conditions and bark beetle infestations. Some regeneration of the pine trees was observed.

**CIR Signature:** On the imagery, dense canopies of W\_PJ appeared as thick, dark brown spots on a gray background (bare ground). Understory grasses were a smooth brown or dark gray color. Dead and dying trees appeared as large gray and black splotches.

**Mapping Notes:** The W\_PJ map unit contained both thick stands of healthy pinyon-juniper trees that crowded or shaded out most understory vegetation. Other stands had dead and dying trees and larger openings in the canopy filled with grasses and some shrubs. An effort was made during the mapping to designate areas with declining pine trees with a modifier in the GIS layer. The similarity between this type and the W\_MPJ map unit may have led to some confusion in the mapping.



Example photo signature (left) and range and distribution map (right).

**Map Code**     **Graves' Oak – Bigtooth Maple Forest**  
**W\_ROKBM**   ***Quercus gravesii* – *Acer grandidentatum* Forest**

---

Common Species

- Graves' (Chisos red) oak (*Quercus gravesii*)
- Bigtooth maple (*Acer grandidentatum*)
- Mountain sage (*Salvia regla*)
- Goldman's silktassel (*Garrya ovata* ssp. *goldmanii*)
- Mexican pinyon pine (*Pinus cembroides*)
- Weeping juniper (*Juniperus flaccida*)
- Canyon grape (*Vitis arizonica*)

rUSNVC Association

– *Acer grandidentatum* – *Quercus gravesii* Forest (CEGL004548)



Representative Ground Photo.

Description

**Frequency:** Communities of Graves' oak with tall shrubs were only found in the high Chisos Mountains.

**Frequency:** W\_ROKBM woodlands were restricted to the high Chisos Mountains and primarily occurred in canyons and on very mesic sites.

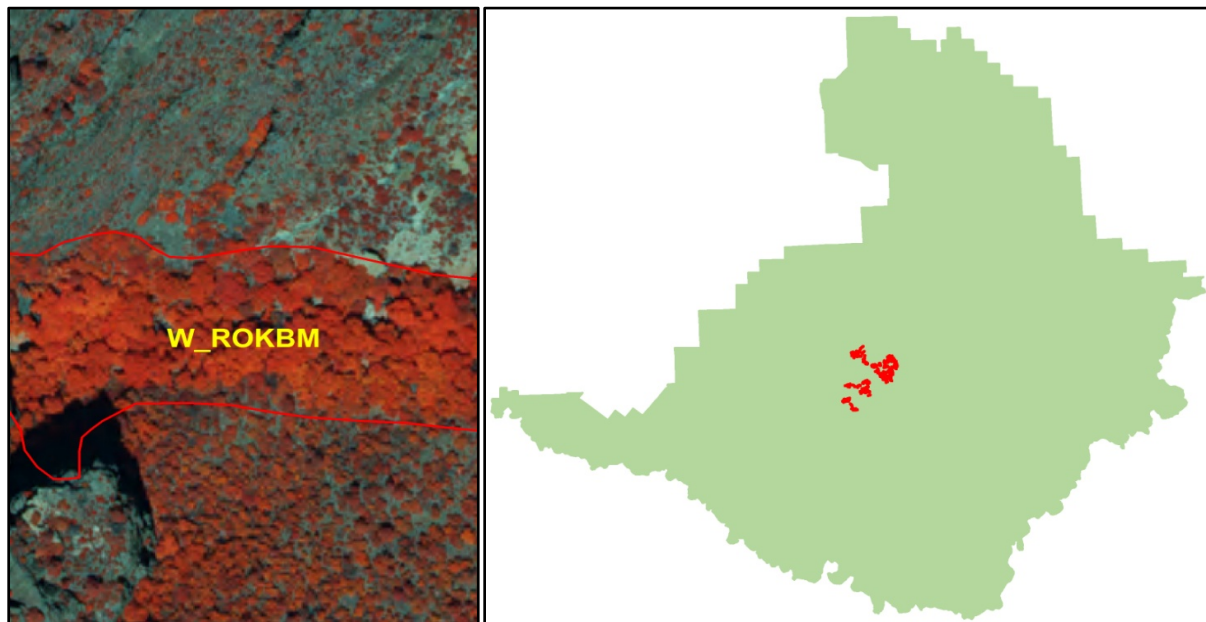
**Physiognomy:** W\_ROKBM polygons contain moderate to dense stands of tall deciduous and evergreen oak trees (> 5 meters) with some pine and juniper trees occurring in the subcanopy. Understories were diverse and often contained tall deciduous shrubs and mesic herbaceous vegetation.



**Condition:** Good Graves' oak trees are widespread at high elevations and appear to be healthy and stable. Insect infestations, wildfires, flash floods, and climate change may be potential threats to this type.

**CIR Signature:** On the imagery canopies of W\_ROKBM appeared as large bushy, orange and red splotches with red dots (shrubs) and a gray to blue background color (bare ground and talus) in the canopy openings.

**Mapping Notes:** The W\_ROKBM map unit was only found in mesic canyons and washes in the high Chisos Mountains. Polygons of this type were usually very dense with tall shrubs. The W\_HOAK type was also similar to this type and some confusion among all of the oak types at BIBE likely occurred during the mapping. More ground-truthing of the Chisos Mountain map units may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).



**Map Code      Graves' Oak – Emory Oak Canyon Forest**  
**W\_ROKEOK *Quercus gravesii* – *Quercus emoryi* Canyon Forest**

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Common Species

- Graves' (Chisos red) oak (*Quercus gravesii*)
- Emory oak (*Quercus emoryi*)
- Gray oak (*Quercus grisea*)
- Arizona white oak (*Quercus arizonica*)
- Goldman's silktassel (*Garrya ovata* ssp. *goldmanii*)
- Mexican pinyon pine (*Pinus cembroides*)
- Arizona pine (*Pinus arizonica*)
- Black cherry (*Prunus serotina*)
- Texas madrone (*Arbutus xalapensis*)
- Evergreen sumac (*Rhus virens*)

rUSNVC Association

– *Quercus gravesii* – *Quercus emoryi* / *Arbutus xalapensis* / *Garrya ovata* Forest (NPSBIBE007)



Representative Ground Photo.

Description

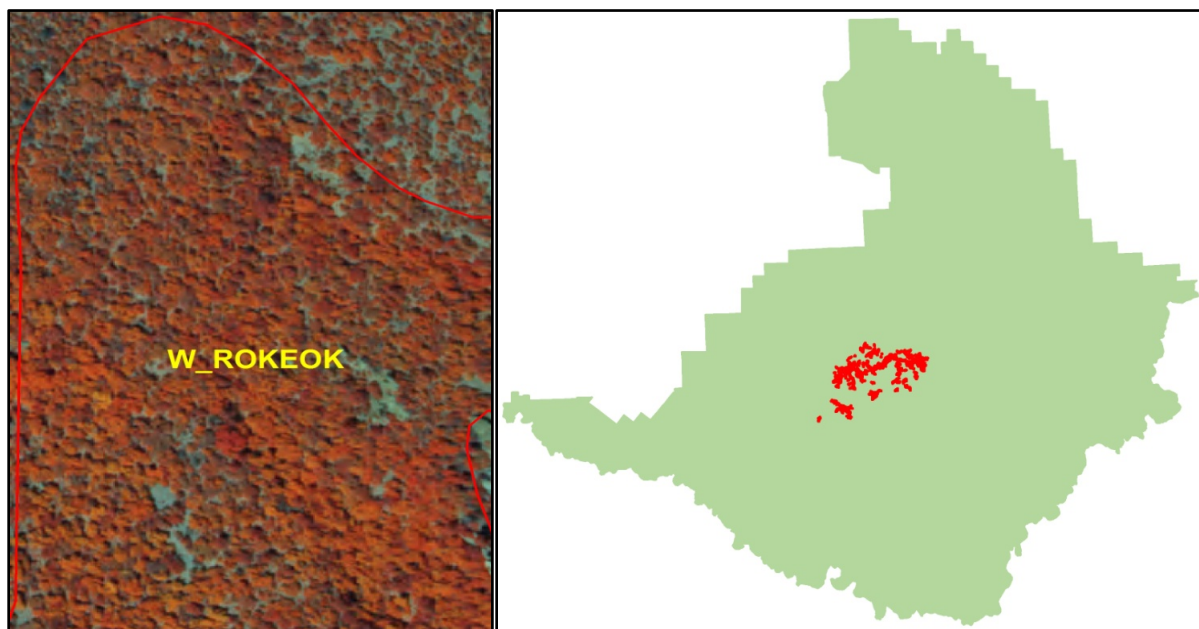
**Frequency:** Mixed Graves' and Emory oak woodlands were common in the high Chisos Mountains on mesic slopes, in small canyons, and along drainages.

**Physiognomy:** W\_ROKEOK polygons contain moderate to dense stands of tall deciduous and evergreen oak trees (> 5 meters) with some pine and juniper trees occurring in the subcanopy. Understories were diverse and often contained mesic herbaceous vegetation and grasses.

**Condition:** Good Graves' oak trees are widespread at high elevations and appear to be healthy and stable. Insect infestations, wildfires, and climate change may be potential threats to this type.

**CIR Signature:** On the imagery canopies of W\_ROKEOK appeared as bushy, orange and light brown spots with red dots (shrubs) and a gray to blue background color (bare ground and talus) in the canopy openings.

**Mapping Notes:** The W\_ROKEOK map unit was the dominant Graves' oak type at BIBE. Polygons of this type usually lacked the associated bigtooth maple and other tall shrubs found in the W\_ROKBM map unit. The W\_HOAK type was also similar to this type and some confusion among all of the oak types at BIBE likely occurred during the mapping. More ground-truthing of the Chisos Mountain map units may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).

## SHRUBLANDS

**Map Code**     **Acacia – Mesquite Wash Shrubland**

**S\_ACAMEQ** *Vachellia* spp. – *Senegalia* spp. – *Prosopis glandulosa* Wash Shrubland

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### Common Species

- Gregg’s catclaw (*Senegalia greggii*)
- Honey mesquite (*Prosopis glandulosa*)
- Soaptree yucca (*Yucca elata*)
- Whitethorn acacia (*Vachellia constricta*)
- Roemer’s catclaw (*Senegalia roemeriana*)
- Whitebrush (*Aloysia gratissima*)
- Spiny hackberry (*Celtis ehrenbergiana*)
- Littleleaf sumac (*Rhus microphylla*)
- Cenizo (*Leucophyllum frutescens*)
- Texas persimmon (*Diospyros texana*)

### rUSNVC Association

– *Vachellia* spp. – *Senegalia greggii* – *Prosopis glandulosa* – *Yucca elata* Shrubland (NPSBIBE43)  
[Provisional]



Representative Ground Photo.

### Description

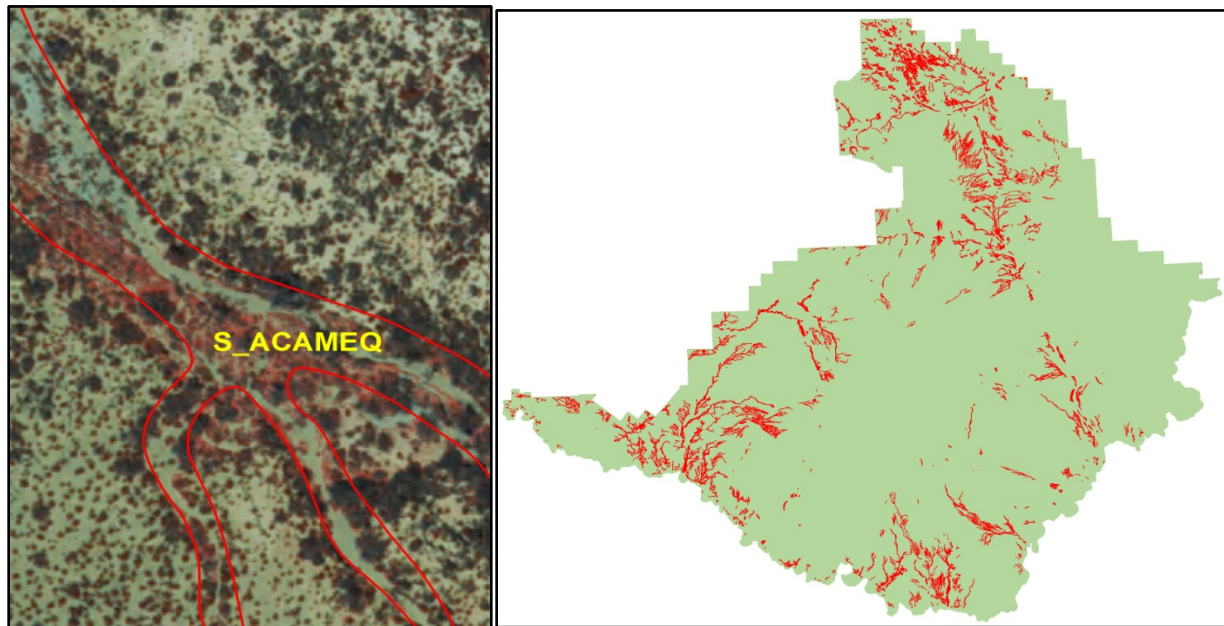
**Frequency:** S\_ACAMEQ was a common type found on mesic sites such as drainages and low washes throughout the low and high desert portions of BIBE.

**Physiognomy:** S\_ACAMEQ contains tall (> 1 meter) evergreen acacia and honey mesquite shrubs with an understory of shorter evergreen shrubs, cacti, succulents, and grasses.

**Condition:** Good. The S\_ACAMEQ type was widespread and appeared healthy and stable. Threats to this map unit include invasion by non-native grasses, prolonged drought, and wildfires.

**CIR Signature:** On the imagery, the acacia and honey mesquite shrubs were large dark brown and black spots against a light blue or white background (bare soil). Linear drainages were common in the S\_ACAMEQ polygons. Grasses and herbaceous understory species had a red and pink color.

**Mapping Notes:** S\_ACAMEQ was very similar in appearance to the S\_TMIX type but lacked the deciduous shrub component. The S\_MEQ map unit contained smaller shrubs and was not usually associated with drainages when compared to the S\_ACAMEQ type.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Creosotebush Desert Scrub**  
**S\_CB**          ***Larrea tridentata* Desert Scrub**

---

Common Species

- Creosote bush (*Larrea tridentata*)
- False grama (*Cathastecum erectum*)
- Fluffgrass (*Dasyochloa pulchella*)
- Lehmann lovegrass (*Eragrostis lehmanniana*)
- Big Bend dog cholla (*Grusonia aggeria*)
- Littleleaf ratany (*Krameria erecta*)
- Engelmann's prickly pear (cactus apple) (*Opuntia engelmannii* var. *engelmannii*)

rUSNVC Association

– *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathastecum erectum*  
Shrubland (NPSBIBE031-Park Special) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Low elevation creosotebush shrublands were widespread throughout the lowest elevations at BIBE.

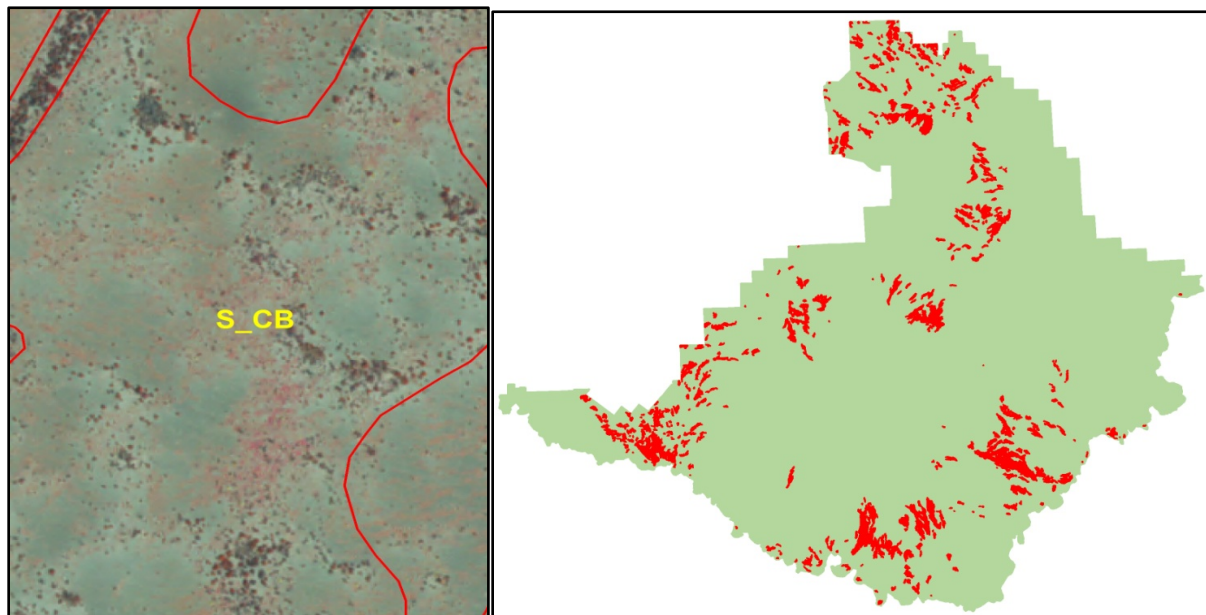
**Physiognomy:** Polygons of S\_CB were dominated by short evergreen shrubs with a sparse understory (if present) of mainly cacti and some grasses and forbs.

**Condition:** Good-Fair. S\_CB polygons were widespread in the lower elevations. Most sites contained very few associated species and contained little species diversity. Wildfires and invasion by non-native grasses are potential threats to this type.



**CIR Signature:** On the imagery, S\_CB polygons were characterized by a smooth light gray, blue, and white background color (bare soils and rocks) with obvious shrub patterns that appeared as brown and red spots. Grasses, if present, appeared as pink and red streaks and splotches.

**Mapping Notes:** As a species, creosotebush was prolific and was found throughout the low and high desert regions of BIBE both as a dominant species and as an associate in other map units. An effort was made during the mapping to separate out nearly monotypic stands of creosotebush at low elevations from those occurring with other species at slightly higher elevations. The S\_CB type also usually lacked ocotillo and lechuguilla and this helped separate it from the similar S\_CBO map unit.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Creosotebush – Ocotillo – Lechuguilla Mixed Desert Scrub**  
**S\_CBO**        ***Larrea tridentata* – *Fouquieria splendens* – *Agave lechuguilla* Mixed Desert Scrub**

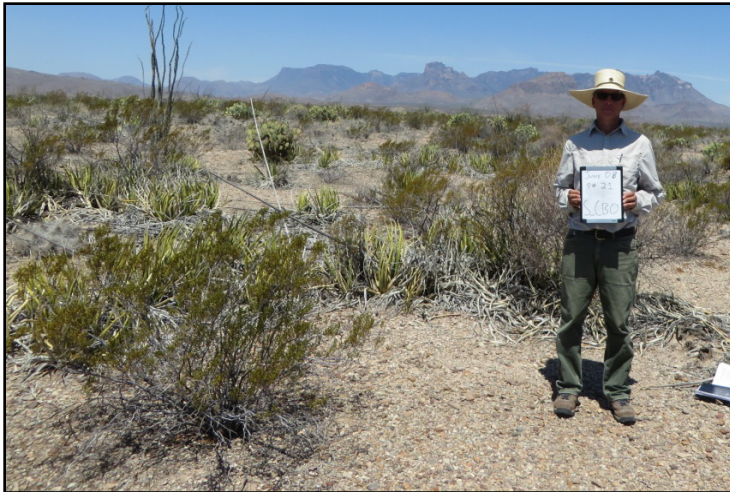
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Common Species

- Creosote bush (*Larrea tridentata*)
- Ocotillo (*Fouquieria splendens*)
- Lechuguilla (*Agave lechuguilla*)
- Chino grama (*Bouteloua ramosa*)
- False grama (*Cathastecum erectum*)
- Viscid acacia (*Vachellia vernicosa*)
- Leatherstem (*Jatropha dioica*)

rUSNVC Association

– *Larrea tridentata* – *Fouquieria splendens* – *Agave lechuguilla* – *Leucophyllum frutescens*  
Shrubland (NPSBIBE044) [Provisional]



Representative Ground Photo.

Description

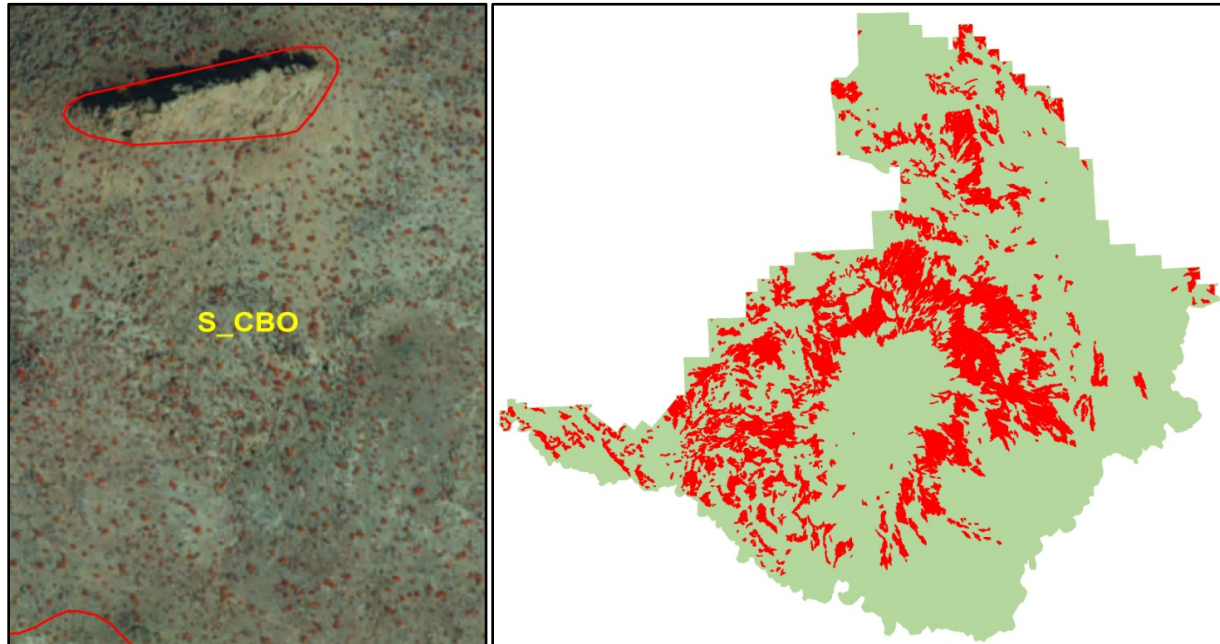
**Frequency:** Mixed creosotebush, ocotillo, and lechuguilla shrublands were widespread throughout the middle elevations and dry desert regions of BIBE.

**Physiognomy:** Polygons of S\_CBO were dominated by short evergreen shrubs and taller ocotillo cacti. Most sites had a prominent understory consisting of succulents, cacti, and some Chino grama grass.

**Condition:** Good-Fair. S\_CBO polygons were widespread throughout BIBE. Most sites appeared healthy but some showed evidence of obvious grass and succulent die-off likely from prolonged freezing. Wildfires and invasion by non-native grasses are potential threats to this type.

**CIR Signature:** On the imagery, S\_CBO polygons were characterized by a smooth light gray, blue, and white background color (bare soils and rocks) with obvious shrub patterns that appeared as brown and red spots. Grasses, appeared as pink and brown streaks and splotches.

**Mapping Notes:** As a species, creosotebush was prolific and was found throughout the low and high desert regions of BIBE. An effort was made during the mapping to separate out the common mix of creosotebush, ocotillo, and lechuguilla from similar sites at lower elevations that were solely dominated by creosotebush.



Example photo signature (left) and range and distribution map (right).

**Map Code      Calcareous Mixed Desert Scrub**  
**S\_CDS**

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Common Species

- Lechuguilla (*Agave lechuguilla*)
- Candelilla (*Euphorbia antispyhilitica*)
- Rough jointfir (*Ephedra aspera*)
- Chino grama (*Bouteloua ramosa*)
- Texas false agave (*Hechtia texensis*)
- Green sotol (*Dasyllirion leiophyllum*)
- Thompson's yucca (*Yucca thompsoniana*)
- Leatherstem (*Jatropha dioica*)
- Big Bend silverleaf (*Leucophyllum minus*)
- Texas rainbow cactus (*Echinocereus dasyacanthus*)

rUSNVC Association

– *Agave lechuguilla* – *Euphorbia antispyhilitica* – *Ephedra aspera* / *Bouteloua ramosa* Shrubland (NPSBIBE010) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Calcareous mixed desert scrublands were common throughout the limestone regions of the park. They were found primarily at low to mid elevations.

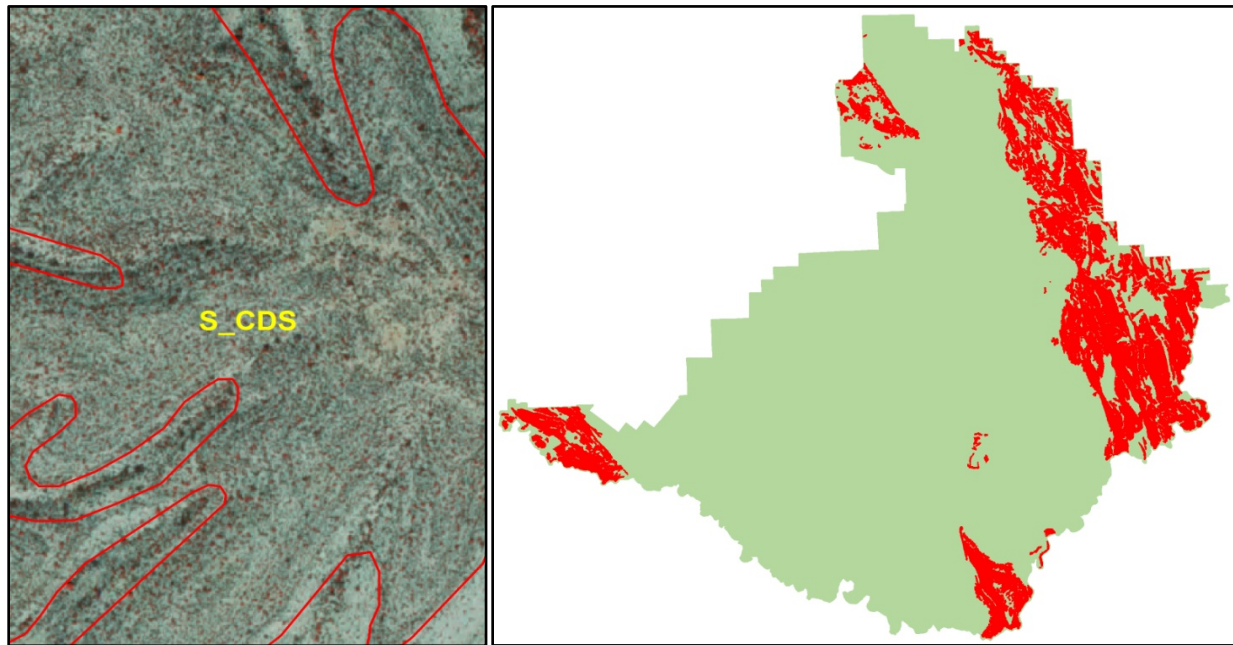
**Physiognomy:** S\_CDS contained sparse to moderate vegetation on dry rock, soil and other stable substrates and were comprised of short desert evergreen shrubs (mainly cacti and succulents) with scattered grasses and forbs.



**Condition:** Good. The S\_CDS is a limestone type that is widespread at BIBE. Drought, climate change, and prolonged freezing events may alter the composition of this type.

**CIR Signature:** Polygons of S\_CDS exhibited various colors and textures including swirls and bands. Bare ground colors ranged from gray to tan and white. The vegetation appeared as small red and brown spots and understory grasses (if present) were tan in color.

**Mapping Notes:** The S\_CDS map unit contained similar vegetation found in the S\_CTAL and S\_YUC map units. S\_CDS was used to map large, limestone areas containing sparse and short vegetation. The various SP\_LDES and S\_CB map units were used in similar, non-limestone areas.



Example photo signature (left) and range and distribution map (right).



**Map Code      Calcareous Chaparral**  
**S\_CHAP**

---

Common Species

- Oaks (*Quercus* spp.)
- Littleleaf ash (*Fraxinus greggii*)
- Evergreen sumac (*Rhus virens*)
- Torrey's yucca (*Yucca torreyi*)
- Thompson's yucca (*Yucca thompsoniana*)
- Green sotol (*Dasyllirion leiophyllum*)
- Spiny greasebush (*Glossopetalon spinescens*)
- Gregg's catclaw (*Senegalia greggii*)
- Desert olive (*Forestiera angustifolia*)

rUSNVC Association

– *Quercus* (*pungens*, *mohriana*) – *Fraxinus greggii* – *Rhus virens* – (*Yucca faxoniana*) Shrubland (NPSBIBE009) [Provisional]



Representative Ground Photo.

### Description

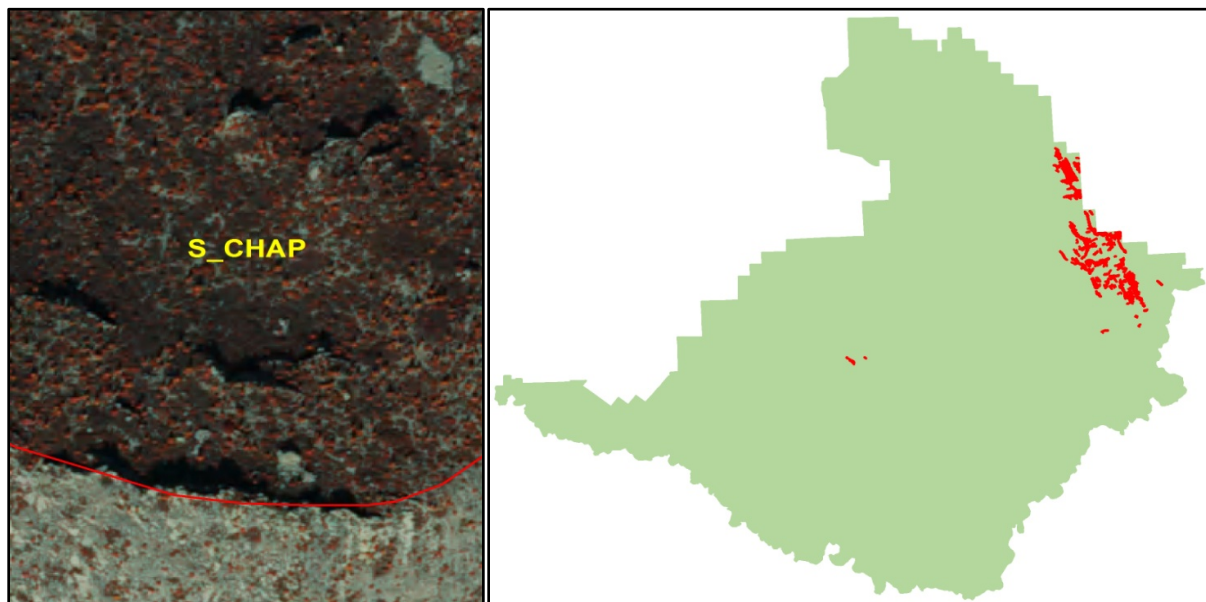
**Frequency:** Calcareous chaparral shrublands and short woodlands were restricted to mesic north and northeast facing slopes on limestone formations. They were found primarily at mid to high elevations in the northeast portion of the park. A few isolated patches were found in the Chisos Mountains.

**Physiognomy:** S\_CHAP contained moderate to dense vegetation on dry rock, soil, and other stable substrates and were comprised of short deciduous trees and tall evergreen shrubs, yuccas, short evergreen shrubs. Short shrubs, grasses, and forbs were prominent in the understory.

**Condition:** Good. The S\_CHAP is a mesic limestone type. Drought, climate change, and prolonged freezing events may alter the composition of this type.

**CIR Signature:** Polygons of S\_CHAP exhibited an obvious pattern of tall shrub and short trees that appeared as evenly spaced orange spots. Canopy openings contained various colors and textures including dark reds (shrubs) and gray rocks.

**Mapping Notes:** S\_CHAP was used to map limited, mesic limestone areas containing dense vegetation. The S\_CHAP map unit contained similar vegetation found in the S\_YUC and S\_YWASH map units. The S\_YUC type was used to map nearby sparse vegetated areas and the S\_YWASH map unit was used to map similar areas in drainages.



Example photo signature (left) and range and distribution map (right).

**Map Code     Alkaline Clay Flat Shrubland**  
**S\_CLAY**

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Common Species

- Desert seepweed (*Suaeda suffrutescens*)
- Madagascar dropseed (*Sporobolus pyramidatus*)
- False Rhodes grass (*Trichloris crinita*)
- Tubercled saltbush (*Atriplex acanthocarpa*)
- Christmas cactus (*Cylindropuntia leptocaulis*)
- Sixweeks grama (*Bouteloua barbata*)
- Honey mesquite (*Prosopis glandulosa*)
- Desert horsepurslane (*Trianthema portulacastrum*)
- Creosotebush (*Larrea tridentata*)

rUSNVC Association

– *Suaeda suffrutescens* / *Sporobolus pyramidatus* Shrubland (NPSBIBE027) [Provisional]



Representative Ground Photos.

Description

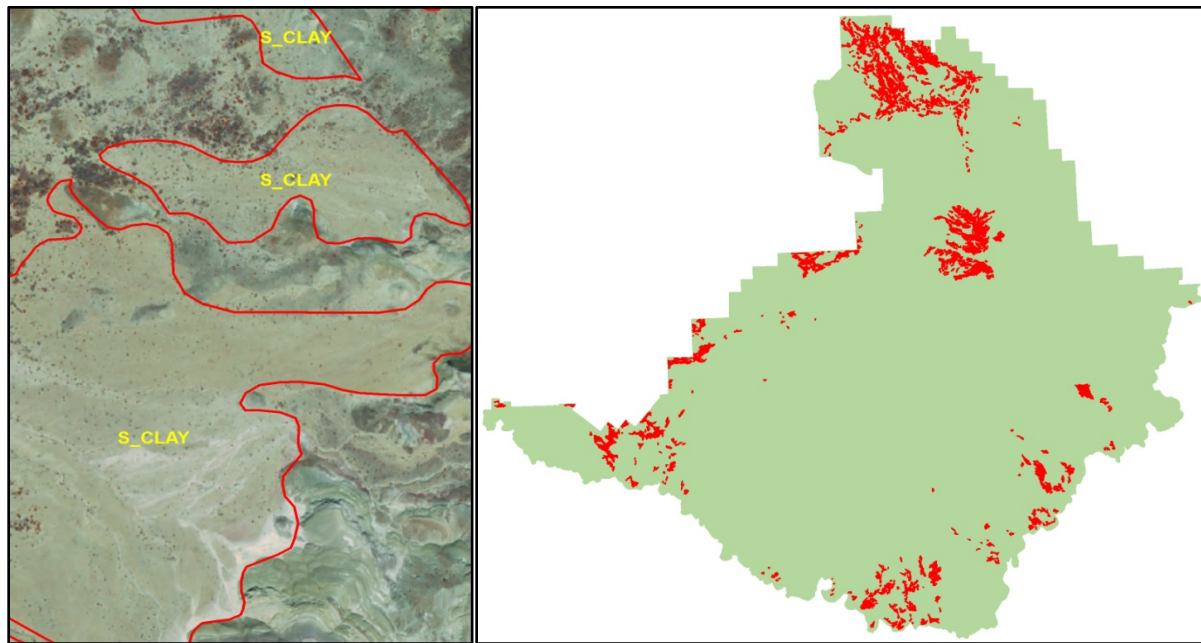
**Frequency:** Clay flats were common throughout the low elevation areas at BIBE and were often associated with badland formations. Gypseous flats were rare and only found on the upper floodplains of the Rio Grande River.

**Physiognomy:** S\_CLAY polygons were mostly bare and devoid of vegetation. Some isolated patches of bunch grasses, low growing evergreen shrubs, and early successional weedy species were locally abundant. Gypseous flats supported some unique, but sparse evergreen short shrubs and perennial grasses.

**Condition:** Fair. The S\_CLAY map unit was mostly devoid of vegetation and the nature of the substrate makes it unlikely that extensive vegetation will ever occur in these areas. S\_CLAY should be monitored for the presence of weedy species that may invade nearby vegetation communities.

**CIR Signature:** This map unit appeared as large smooth white and gray flat areas. If present, shrubs were red and brown dots and grasses appeared as orange and brown smudges.

**Mapping Notes:** S\_CLAY map unit was used to map all of the large flat areas that mostly lacked vegetation. Future mapping and ground-truthing efforts could help split the gypseous from non-gypseous flats.



Example photo signature (left) and range and distribution map (right).



**Map Code      *Calcareous Talus Mixed Shrubland***  
**S\_CTAL**

---

Common Species

- Thompson's yucca (*Yucca thompsoniana*)
- Green sotol (*Dasylirion leiophyllum*)
- Torrey's yucca (*Yucca torreyi*)
- Lechuguilla (*Agave lechuguilla*)
- Candelilla (*Euphorbia antisyphilitica*)
- Rough jointfir (*Ephedra aspera*)
- Chino grama (*Bouteloua ramosa*)
- Blind pricklypear (*Opuntia rufida*)
- Texas rainbow cactus (*Echinocereus dasyacanthus*)

rUSNVC Association

– *Agave lechuguilla* – *Euphorbia antisyphilitica* – *Ephedra aspera* / *Bouteloua ramosa* Shrubland  
(NPSBIBE010 – Park Special) [Provisional]



Representative Ground Photo.

Description

**Frequency:** S\_CTAL polygons were common on limestone formations at mid to high elevations throughout BIBE on eroding mountain and hill slope formations.

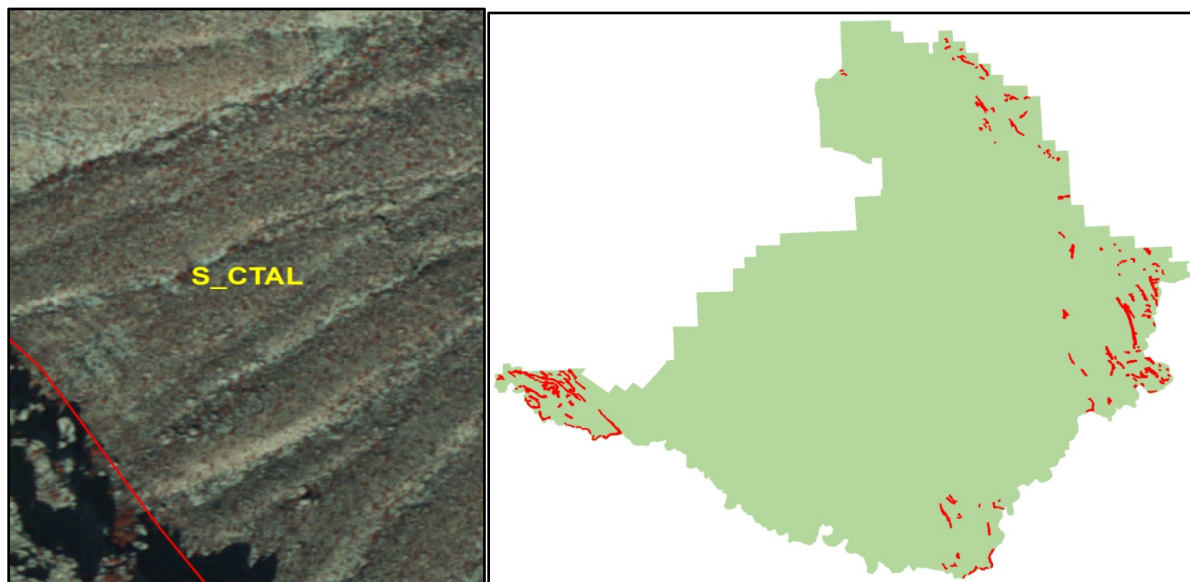


**Physiognomy:** S\_CTAL contained sparse to moderate vegetation on a talus substrate consisting of short to medium sized evergreen shrubs (mainly yuccas, cacti, and succulents) with a scattered grass understory component.

**Condition:** Good. The S\_CTAL is a limestone talus, boulder, and scree formation that is widespread at BIBE. Drought, climate change, and prolonged freezing events may alter the composition of this type (especially the grasses and succulent components).

**CIR Signature:** Polygons of S\_CTAL exhibited various colors and textures depending on the geologic parent material. Colors ranged from gray to tan and white. Textures were coarse for large cobbles and boulders and smooth for scree and talus. The vegetation appeared as small red spots and understory grasses were tan in color.

**Mapping Notes:** The S\_CTAL type was similar in species composition to the S\_CDS and S\_YUC map units and may represent a transitional area. S\_CTAL was used to map large areas containing talus/scree material occurring directly below eroding limestone outcrops. The splitting of S\_CTAL from S\_CDS was done to help provide more information on the dynamic nature of the vegetation growing on limestone formations in BIBE.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Thurber's Willow Spring Shrubland**  
**S\_CWIL**        ***Salix thurberi* Spring Shrubland**

---

Common Species

- Thurber's willow (*Salix thurberi*)
- Coyote (Narrowleaf) willow (*Salix exigua*)
- Rooseveltweed (*Baccharis neglecta*)
- Seepwillow (Mule-fat) (*Baccharis salicifolia*)
- Black willow (*Salix nigra*)
- Gregg's catchlaw (*Senegalia greggii*)
- Texas persimmon (*Diospyros texana*)
- Desert olive (*Forestiera angustifolia*)
- Texas lignum-vitae (*Guaiaacum angustifolium*)
- Honey mesquite (*Prosopis glandulosa*)

rUSNVC Associations

– *Salix thurberi* – *Baccharis salicifolia* Shrubland (CEGL005980)



Representative Ground Photos.

### Description

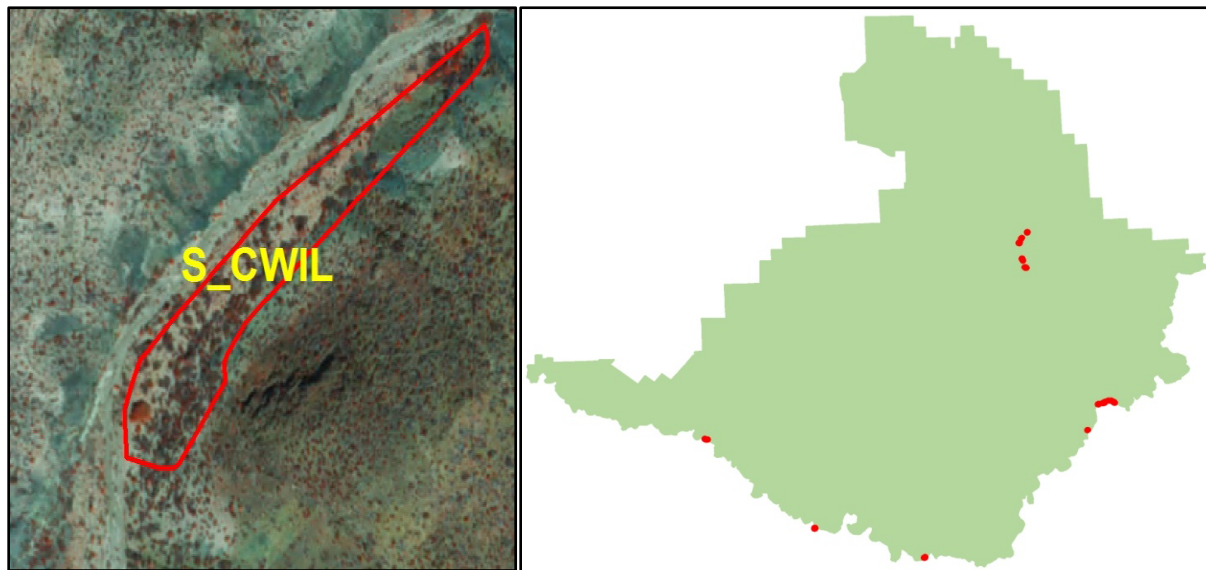
**Frequency:** Thurber's willow shrublands were scattered throughout BIBE occurring in a few mesic upland sites and in the riparian corridors of the Rio Grande River and its major tributaries.

**Physiognomy:** S\_CWIL polygons contained stands of deciduous tall shrubs and short trees of various sizes. The understory and sub-canopy layers, if present, had a mix of tall grasses, deciduous shrubs, and some weedy or early successional herbaceous vegetation.

**Condition:** Poor. Willow shrublands are an important riparian and wetland habitat and are potentially threatened by prolonged flooding and drought. Willow regeneration was observed in some areas. Pressure from non-native species, especially tamarisk and giant cane was documented in many of the riparian stands that were sampled.

**CIR Signature:** On the imagery, canopies of S\_CWIL were small dark red dots. If present, giant cane understories were bright pink, tamarisk red, and mesquite trees were brown. Polygons of S\_CWIL were often located by linear streams, dry washes, or in depressions. Bare ground and stream bank material appeared blue and white.

**Mapping Notes:** The S\_CWIL map unit included stands with mainly willow shrubs and tall sapling trees. The S\_RWIL map unit was used to map taller, mixed willow tree stands and the W\_GWIL was used to map upland sites containing mature Goodding willow trees.



Example photo signature (left) and range and distribution map (right).

**Map Code      Foothills Wash Channel Shrubland**  
**S\_FWASH**

---

Common Species

- Desert willow (*Chilopsis linearis*)
- Gregg's catclaw (*Senegalia greggii*)
- Roemer's catclaw acacia (*Senegalia roemeriana*)
- Trans-Pecos poreleaf (*Porophyllum scoparium*)
- Singlewhorl burrobrush (*Hymenoclea monogyra*)
- Seepwillow (Mule-fat) (*Baccharis salicifolia*)

rUSNVC Association

– *Chilopsis linearis* – *Yucca torreyi* – (*Brickellia laciniata*) Shrubland (NPSBIBE042) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Foothill washes and drainages were common in the upper high desert and foothill regions of BIBE.

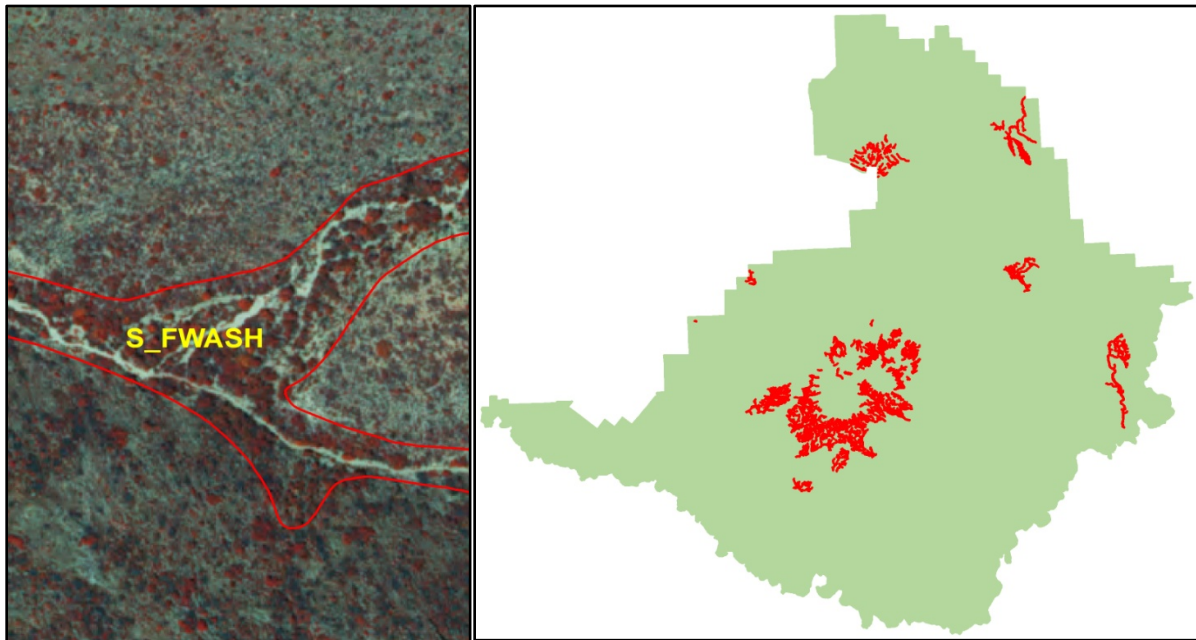
**Physiognomy:** Polygons of S\_FWASH were dominated by a mix of medium and tall deciduous and evergreen shrubs growing along prominent washes and drainages.

**Condition:** Good. All washes are prone to flash flooding events. Overall, this type is potentially threatened by invasion from non-native grasses, localized erosion, and other disturbances.

**CIR Signature:** Polygons of S\_FWASH had a characteristic linear pattern with obvious thin drainage channels. Tall shrubs appeared as bright red and brown spots. Smaller dots represented understory species. Grasses, if present, were a smooth brown color.



**Mapping Notes:** The S\_FWASH map unit was used to map very complex washes and drainages extending from the base of mountains into higher elevations. The presence of thick and tall shrubs and short trees directed the mapping of this type Other mid-elevation shrub species (such as acacias and honey mesquite) often occurred in the same drainages and may have caused some confusion during the mapping. S\_WASH and S\_TMIX were used to map similar areas at BIBE at lower elevations.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **High Chisos Gray Oak – Mountain Mahogany Chaparral**  
**S\_GOAK**      **High Chisos *Quercus grisea* – *Cercocarpus montanus* Chaparral**

---

Common Species

- Gray oak (*Quercus grisea*)
- Weeping juniper (*Juniperus flaccida*)
- Mexican pinyon (*Pinus cembroides*)
- Graves' (Chisos red) oak (*Quercus gravesii*)
- Alligator juniper (*Juniperus deppeana*)
- Alderleaf mountain mahogany (*Cercocarpus montanus*)
- Foothill beargrass (*Nolina crumpens*)
- Pinyon ricegrass (*Piptochaetium fimbriatum*)

rUSNVC Association

– *Quercus grisea* – *Cercocarpus montanus* Shrubland (NPSBIBE022) [Provisional]



Representative Ground Photo.

Description

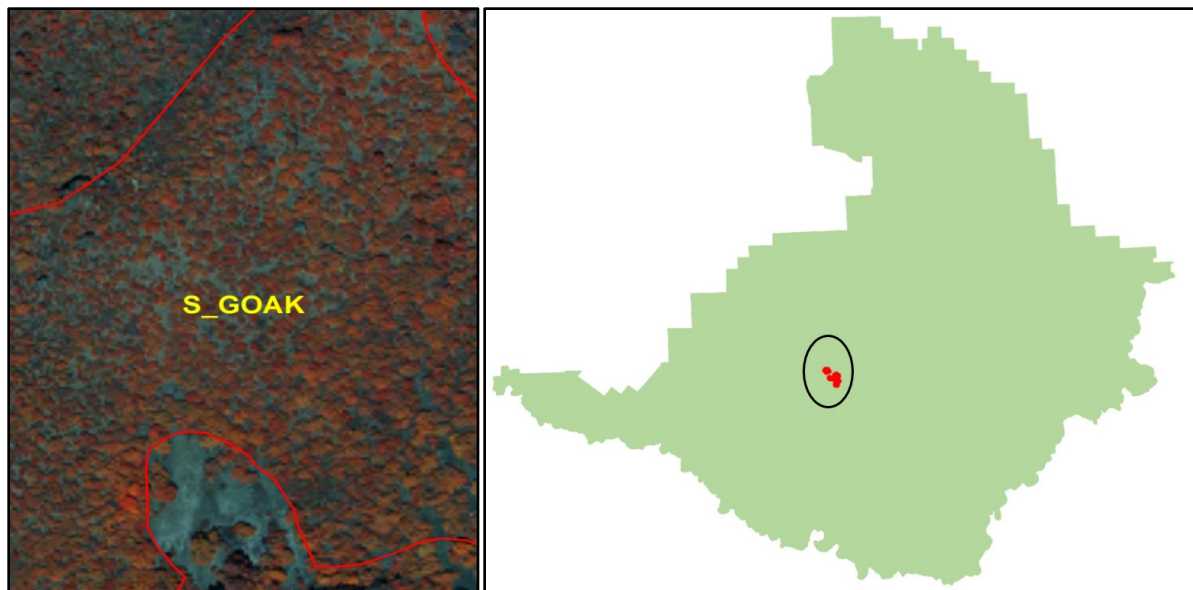
**Frequency:** Sites dominated by gray oak shrubs and trees only occurred on a few rocky slopes in the high Chisos Mountain region of BIBE.

**Physiognomy:** Stands of S\_GOAK were dominated by short to medium-sized, broad-leaved deciduous trees and tall shrubs. The understory for this type was thick with grasses and forbs and often contained other shrub and short tree species.

**Condition:** Good-Fair. Gray oak is a common species in the Chisos Mountains but it usually occurred with other species of oaks and pinyon pine and juniper trees. When it did occur as the dominant species, these sites were often small and may be prone to threats from wildfires, drought, insect infestations, and wildlife disturbance.

**CIR Signature:** The S\_GOAK map unit had a highly recognizable signature consisting of overlapping dark red and orange splotches. The gray oak trees appeared smaller than the other oak types. A blue or gray background color was present caused by the reflectance from the soil and rock substrate.

**Mapping Notes:** Gray oak stands were only found in a few locations that overlapped with similar oak types, especially W\_HOAK. Many species in this map unit were also common across multiple map units. More ground-truthing of the Chisos Mountain types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Low Montane Mixed Shrub / Sideoats Grama Shrubland**  
**S\_LMIX**        **Low Montane Mixed Shrub / *Bouteloua curtipendula* Shrubland**

---

Common Species

- Sideoats grama (*Bouteloua curtipendula*)
- Foothill beargrass (*Nolina erumpens*)
- Whitebrush (*Aloysia gratissima*)
- Whitethorn acacia (*Vachellia constricta*)
- Pinchot's juniper (*Juniperus pinchotii*)
- Skunkbush sumac (*Rhus trilobata* var. *pilosissima*)
- Mexican pinyon (*Pinus cembroides*)
- Engelmann's prickly pear (cactus apple) (*Opuntia engelmannii* var. *engelmannii*)
- Mimosa (*Mimosa* spp.)

rUSNVC Association

– *Juniperus (coahuilensis, pinchotii) / Dasyllirion leiophyllum / Nolina erumpens* – *Bouteloua curtipendula* Shrubland (NPSBIBE021-Park Special) [Provisional]



Representative Ground Photo.

Description

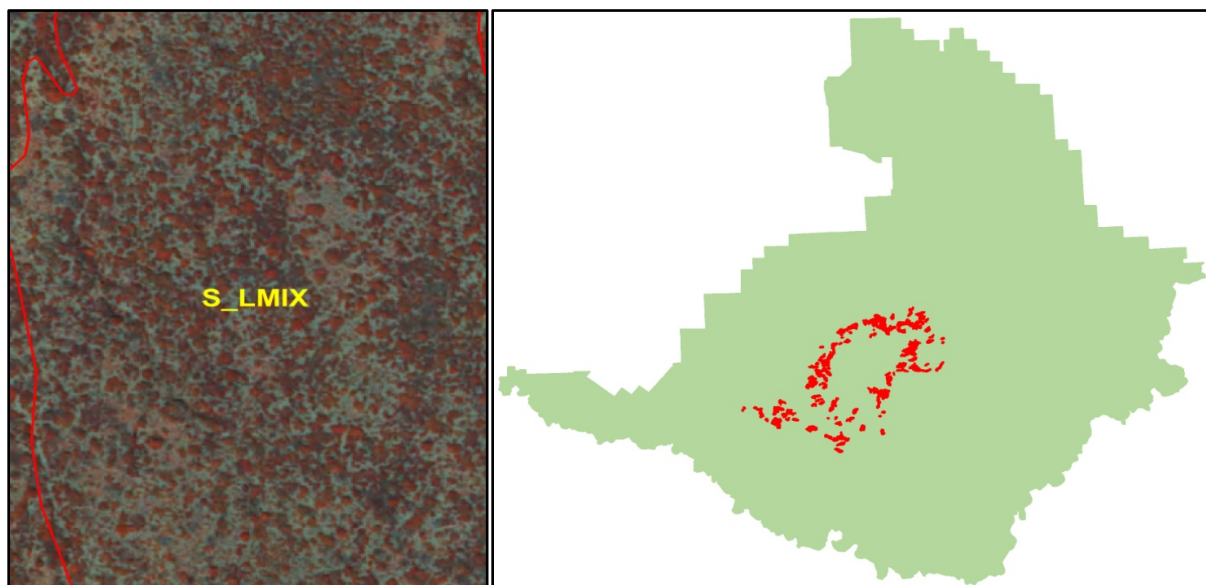
**Frequency:** The S\_LMIX type was common throughout the upper foothills and lower slopes of the Chisos Mountains at BIBE.

**Physiognomy:** S\_LMIX polygons were dominated by medium-sized evergreen and deciduous shrubs with thick understories consisting of mainly native grasses and other deciduous short and dwarf-shrubs.

**Condition:** Good. The S\_LMIX type appears stable and healthy at this time. The suppression of wildfires may allow for some encroachment of oaks and juniper trees into this type. Wildfires, invasive grasses, and wildlife pressure are potential threats to this type.

**CIR Signature:** Polygons of S\_LMIX had a mottled red (shrubs) and gray (bare ground) texture. Smaller shrubs were apparent on the imagery as smaller dark red dots and grasses appeared as pink and brown smudges.

**Mapping Notes:** The S\_LMIX likely represents a transitional type between the sparser chino grass and sotol high desert types and the wooded uplands of the Chisos Mountains. Juniper and oak trees overlap with this type and may have caused some confusion in the mapping. More ground-truthing of the Chisos Mountain types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Mesquite – Creosotebush Desert Scrub**  
**S\_MEQ**        ***Prosopis glandulosa* – *Larrea tridentata* Desert Scrub**

---

Common Species

- Honey mesquite (*Prosopis glandulosa*)
- Creosotebush (*Larrea tridentata*)
- Mariola (*Parthenium incanum*)
- American tarwort (*Flourensia cernua*)
- Warty caltrop (*Kallstroemia parviflora*)
- Littleleaf ratany (*Krameria erecta*)
- Syrian mesquite (*Prosopis farcta*)
- Fourwing saltbush (*Atriplex canescens*)
- Sixweeks grama (*Bouteloua barbata*)
- Tanglehead (*Heteropogon contortus*)

rUSNVC Association

– *Prosopis glandulosa* – *Larrea tridentata* – (*Flourensia cernua*, *Parthenium incanum*) Shrubland  
(NPSBIBE025) [Provisional]



Representative Ground Photos.

Description

**Frequency:** S\_MEQ polygons were common on dry upland flats and desert areas throughout the middle portions of BIBE.

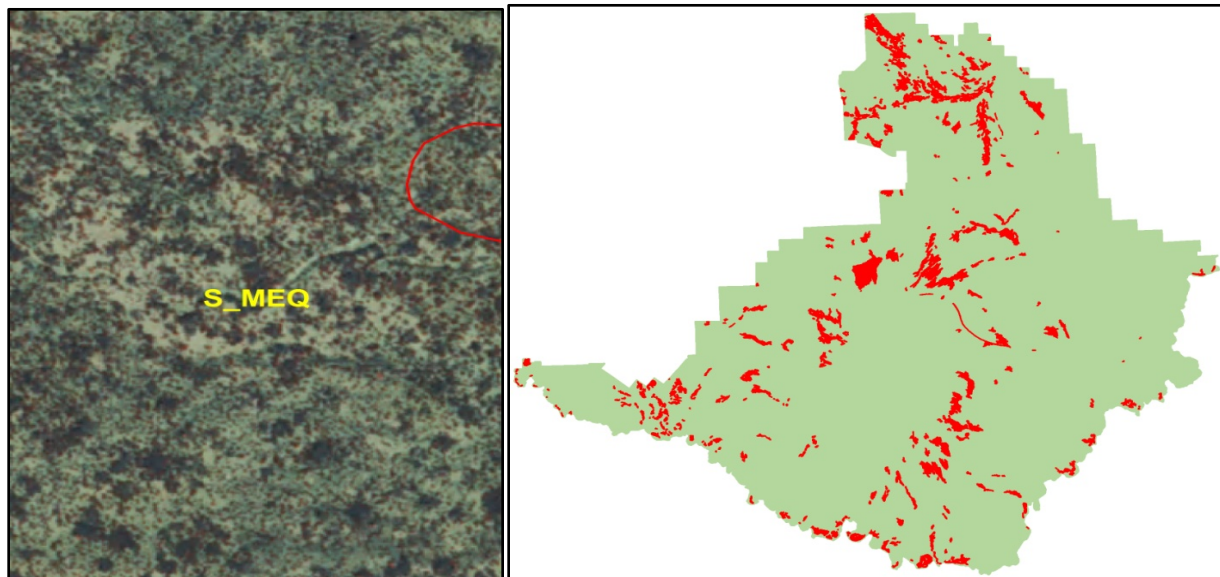


**Physiognomy:** S\_MEQ sites were dominated by short to medium-sized evergreen shrubs with sparse understories consisting of sparse cacti, grasses, forbs, and other minor short shrubs.

**Condition:** Fair. S\_MEQ polygons may indicate past disturbed areas. Some sites contained dead or dormant shrubs. Non-native species, fire, and animal/human pressure are potential threats.

**CIR Signature:** Polygons of S\_MEQ consisted of large dark brown to black color splotches with some grey and tan spots (dormant grasses and bare ground) in the canopy openings. Individual honey mesquite shrubs may be large and robust appearing as large circles.

**Mapping Notes:** The S\_MEQ map unit was created to address upland stands of of honey mesquite as opposed to the more mesic and tall riparian stands (S\_MRIP). Some confusion likely occurred between the two honey mesquite map units and more ground-truthing may allow for further refinement and increased accuracy. The S\_MEQ map unit may have inclusions of S\_CBO, S\_CB, H\_GRS, and H\_TOB. The heavy presence of honey mesquite shrubs helped to define this map unit.



Example photo signature (left) and range and distribution map (right).

**Map Code      Montane Mixed Chaparral**  
**S\_MMIX**

---

Common Species

- Evergreen sumac (*Rhus virens*)
- Oaks (*Quercus* spp.)
- Skeletonleaf goldeneye (*Viguiera stenoloba*)
- Foothill beargrass (*Nolina erumpens*)
- Littleleaf ash (*Fraxinus greggii*)
- Alderleaf mountain mahogany (*Cercocarpus montanus*)
- Skunkbush sumac (*Rhus trilobata* var. *pilosissima*)
- Mexican buckeye (*Ungnadia speciosa*)
- Wright's beebrush (*Aloysia wrightii*)

rUSNVC Association

– *Rhus virens* – *Quercus* spp. / *Viguiera stenoloba* – *Nolina erumpens* Shrubland (NPSBIBE005)  
[Provisional]



Representative Ground Photo.

Description

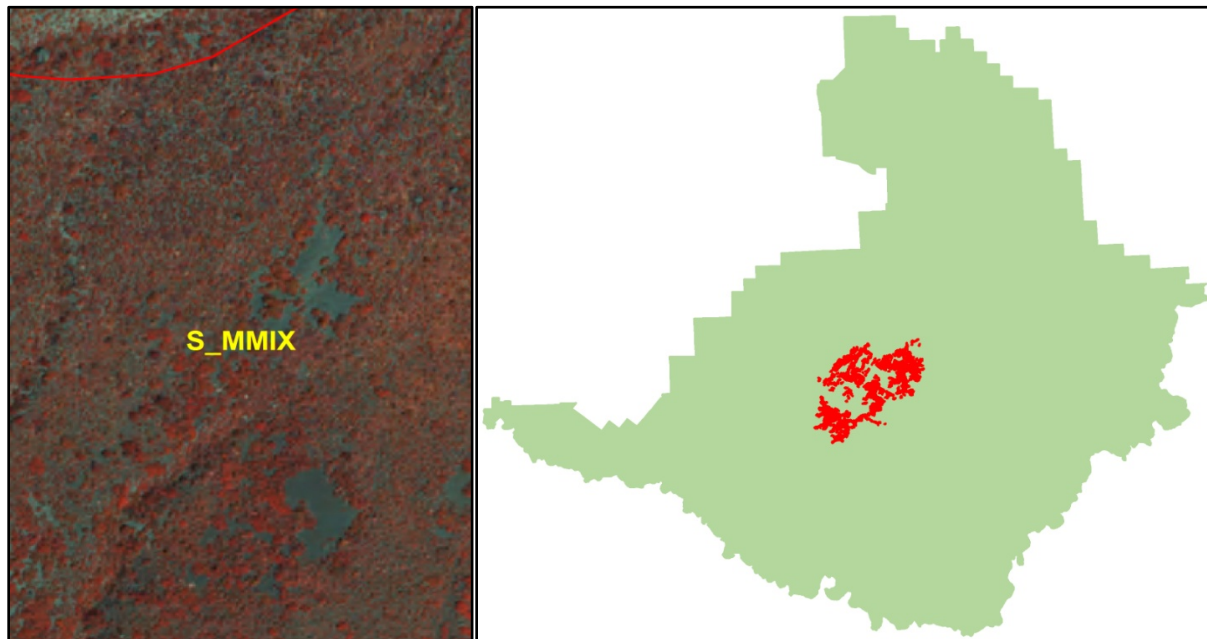
**Frequency:** Polygons with thick, high elevation chaparral containing tall shrubs were found throughout the Chisos Mountains of BIBE.

**Physiognomy:** S\_MMIX polygons contain a mix of deciduous and evergreen shrubs and thick understories of grasses and other shorter shrubs and forbs.

**Condition:** Good. Areas with S\_MMIX are relatively remote and less likely to be invaded by non-native species. The suppression of wildfires may allow for some encroachment of trees into this type. Wildfires, drought, and insect infestations are potential threats to this type.

**CIR Signature:** The S\_MMIX map unit had an unique signature consisting of a closely aligned mix of orange and red dots. Small patches of gray rock and talus were usually present. Trees, if present, were larger and darker red in appearance.

**Mapping Notes:** The S\_MMIX was the dominant shrubland type in the Chisos Mountains. Pinyon pine, juniper and oak trees overlap with this type and may have caused some confusion in the mapping. More ground-truthing of all the Chisos Mountain types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Rio Grande Mesquite Riparian Bosque**  
**S\_MRIP**      **Rio Grande *Prosopis glandulosa* Riparian Bosque**

---

Common Species

- Honey mesquite (*Prosopis glandulosa*)
- Creosote bush (*Larrea tridentata*)
- Huisache (Sweet acacia) (*Vachellia farnesiana*)
- Giant reed (*Arundo donax*)
- Fourwing saltbush (*Atriplex canescens*)
- Coyote (Narrowleaf) willow (*Salix exigua*)
- Common reed (*Phragmites australis*)
- Tamarisk (Saltcedar) (*Tamarix ramosissima*)

rUSNVC Association

– *Prosopis glandulosa* Wet Scrub Association (CEGL004934)



Representative Ground Photos.

Description

**Frequency:** Riparian stands of S\_MRIP were common along the Rio Grande River and its major tributaries.

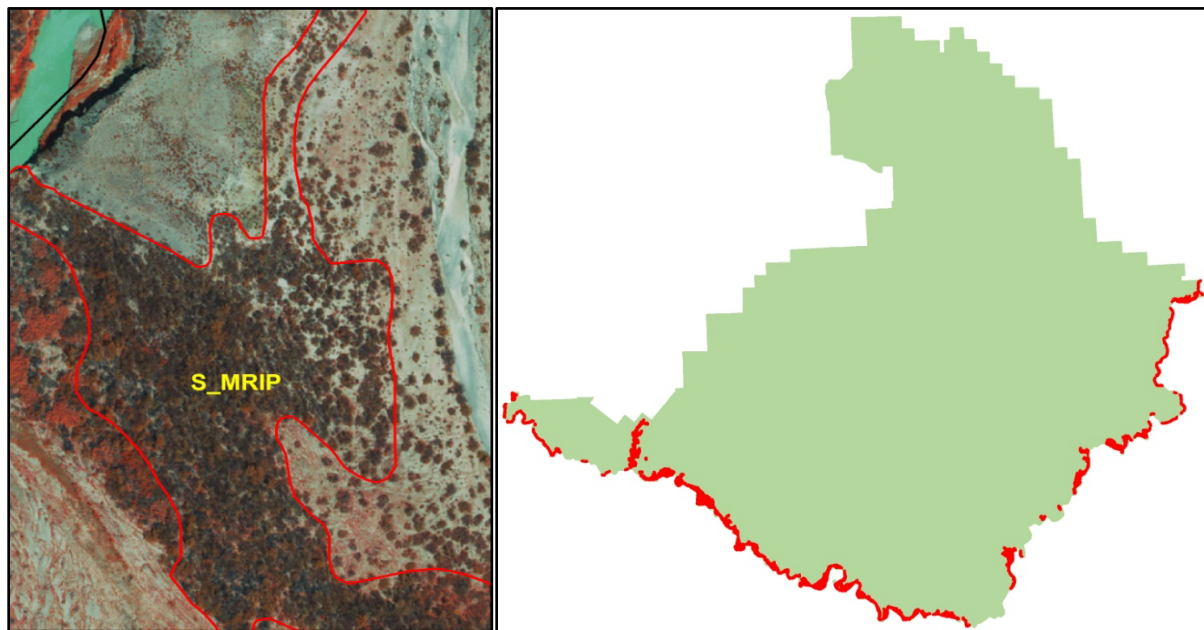


**Physiognomy:** S\_MRIP polygons contained moderate to very dense stands of short-medium sized evergreen shrubs/trees. Understories varied by location, with most having some mixed shrubs and grasses or were sparse.

**Condition:** Good-Fair. Honey mesquite trees (shrubs) at BIBE were widespread. Fuel loading of dead woody material may present a fire hazard and most sites are prone to flooding. Non-native plant invasion (giant cane and tamarisk), extended flooding, drought, animal pressure, and human disturbance are potential threats to this type.

**CIR Signature:** On the imagery, canopies of S\_MRIP had a very characteristic mix of light brown (living trees) and grey (dead or dying tree) colors. When present, the understory was often a mottled light gray/white color (bare ground) or a mix of light brown and red spots (shrubs and non-native grasses).

**Mapping Notes:** The S\_MRIP map unit was created to address the unique Rio Grande Riparian Mesquite Bosque type. Shorter upland honey mesquite stands were mapped as the S\_MUP type. Although not widespread, huisache trees were included in this map unit.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Persimmon – Littleleaf Ash Foothills Shrubland**  
**S\_PERS**        ***Diospyros texana* – *Fraxinus greggii* Foothills Shrubland**

---

Common Species

- Texas persimmon (*Diospyros texana*)
- Littleleaf ash (*Fraxinus greggii*)
- Weeping juniper (*Juniperus flaccida*)
- Whitethorn acacia (*Vachellia constricta*)
- Apache plume (*Fallugia paradoxa*)
- Tree cholla (*Cylindropuntia imbricata*)
- Spiny hackberry (*Celtis ehrenbergiana*)
- Engelmann's prickly pear (cactus apple) (*Opuntia engelmannii* var. *engelmannii*)
- Sideoats grama (*Bouteloua curtipendula*)

rUSNVC Association

– *Fraxinus greggii* – *Diospyros texana* – *Rhus virens* – *Senegalia* spp. Shrubland (NPSBIBE013)  
[Provisional]



Representative Ground Photo.

Description

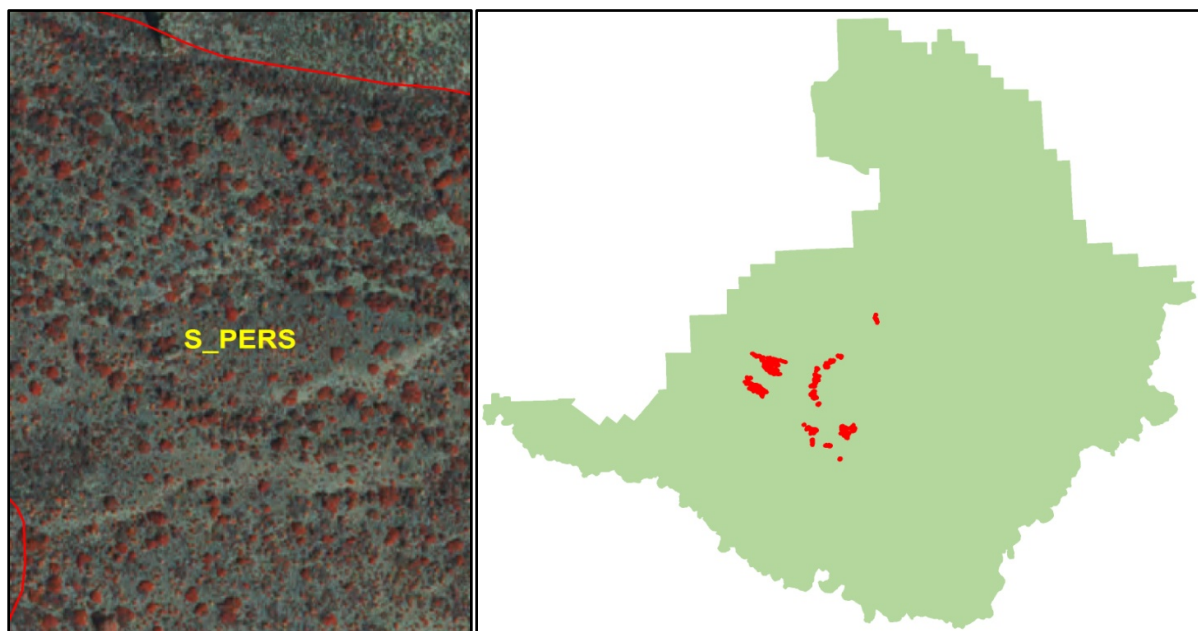
**Frequency:** Persimmon and ash shrublands were found in limited quantities in the Chisos Mountain foothills and in some mesic high desert locations.

**Physiognomy:** S\_PERS polygons were dominated by medium-sized deciduous shrubs with a moderate to thick understory consisting of mainly native grasses and other deciduous short and dwarf-shrubs.

*Condition:* Fair. S\_PERS shrublands were limited in distribution and might represent either a declining association at BIBE or one that is unique to a small environmental niche. Wildfires, invasive grasses, and wildlife pressure are potential threats to this type.

*CIR Signature:* Polygons of S\_PERS had a mottled red appearance indicating tall shrubs. Spaces between the tall shrubs were large and contained gray and brown spots related to grasses and short shrubs.

*Mapping Notes:* The S\_PERS map unit maybe a tranisistional type similar to the S\_LMIX type. Sotol and Chino grama grass were common in this type and may indicate some overlap with map units. More ground-truthing of all the Chisos Mountain foothill types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Redberry Juniper – Sotol Shrubland**  
**S\_RJUN**        ***Juniperus (coahuilensis, pinchotii)* – *Dasyllirion leiophyllum* Shrubland**

Common Species

- Pinchot (Redberry) juniper (*Juniperus pinchotii*)
- Green sotol (*Dasyllirion leiophyllum*)
- Gray oak (*Quercus grisea*)
- Evergreen sumac (*Rhus virens*)
- Mexican pinyon pine (*Pinus cembroides*)
- Arizona threeawn (*Aristida arizonica*)
- Side-oats grama (*Bouteloua curtipendula*)
- Blue grama (*Bouteloua gracilis*)

rUSNVC Association

– *Juniperus (coahuilensis, pinchotii)* / *Dasyllirion leiophyllum* – *Nolina erumpens* – *Bouteloua curtipendula* Shrubland (NPSBIBE021) [Provisional]



Representative Ground Photo.

Description

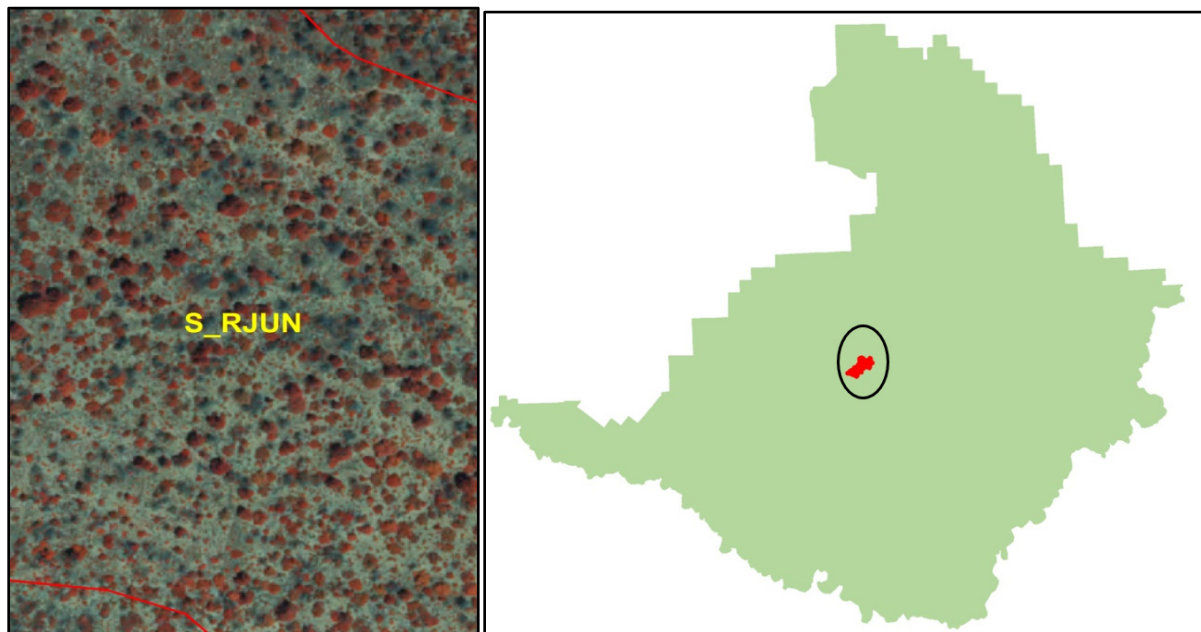
**Frequency:** Sites dominated by short juniper trees only occurred on a few lower slopes in the Chisos Mountain basin and areas around the visitor center at this site.

**Physiognomy:** Stands of S\_RJUN were dominated by low to medium-sized, broad-leaved evergreen trees, and tall shrubs. The understory was thick with grasses and forbs and often contained other shrub and short tree species.

**Condition:** Good-Fair. Juniper trees were common the Chisos Mountain Basin. Mostly they occurred with other species of oaks, pinyon pine, and other juniper trees. When they did occur as the dominant species, these sites were often small and may be prone to threats from wildfires, insect infestations, and wildlife disturbance.

**CIR Signature:** The S\_RJUN map unit has a recognizable signature consisting of spaced out dark brown spots. The juniper trees appeared smaller and darker than the light brown and orange colored pinyon pine trees and oaks. A blue or gray background color was present caused by the reflectance from the soil and rock substrate. Understory grasses and shrubs appeared as small gray and pink dots.

**Mapping Notes:** Low-growing juniper stands were only found in a few locations that closely overlapped with the S\_LMIX, W\_EOAK, and W\_PJ map units. More ground-truthing of the Chisos Mountain types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).



Common Species

- Goodding willow (*Salix gooddingii*)
- Thurber's willow (*Salix thurberi*)
- Tamarisk (Saltcedar) (*Tamarix ramosissima*)
- Yellow rabbitbrush (*Chrysothamnus viscidiflorus*)
- Giant reed (*Arundo donax*)
- Bermuda grass (*Cynodon dactylon*)
- Common reed (*Phragmites australis*)
- Tree tobacco (*Nicotiana glauca*)

rUSNVC Association

– *Salix (gooddingii, thurberi)* Rio Grande Shrubland (NPSBIBE019) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Willow shrublands were found primarily in riparian corridors along the Rio Grande River at BIBE.

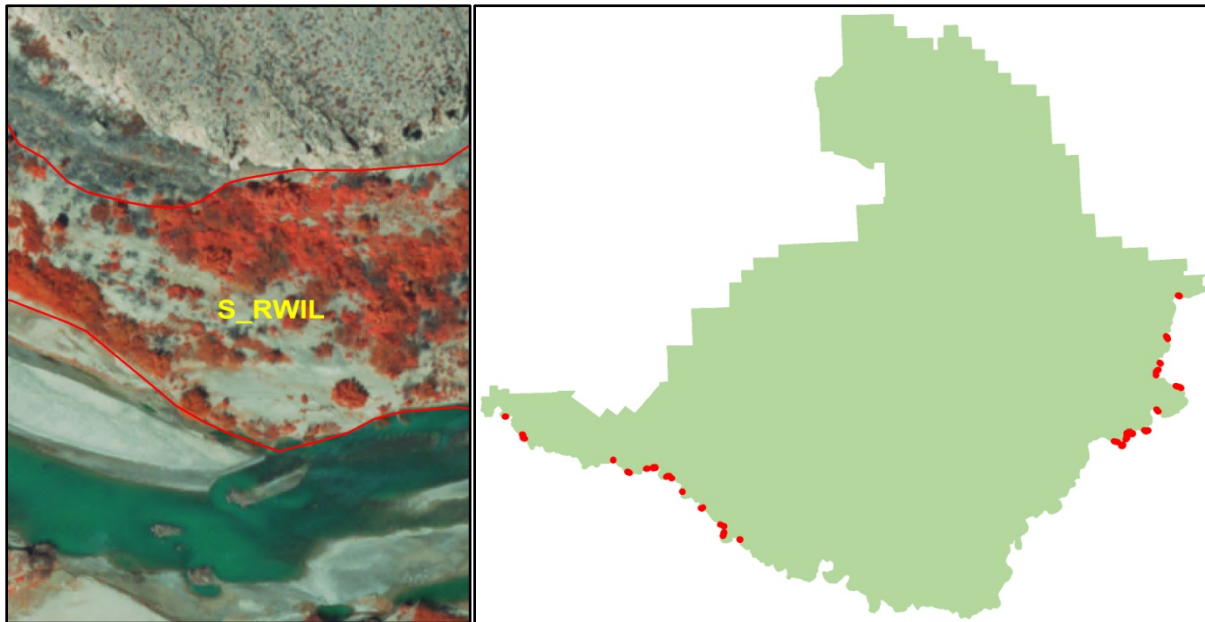
**Physiognomy:** S\_RWIL polygons contained stands of deciduous shrubs and short trees of various sizes. The understory and sub-canopy layers, if present, had a mix of tall grasses, other non-native tree species, and some weedy or early successional herbaceous vegetation.

**Condition:** Poor. Willow shrublands are an important riparian habitat and are potentially threatened by prolonged flooding and drought. Willow regeneration was observed in some areas. Pressure from non-native species, especially tamarisk and giant cane was documented in many of the stands that were sampled.



**CIR Signature:** On the imagery, canopies of S\_RWIL had a feathery, pink and orange color. If present, giant cane understories were bright pink, tamarisk dark red, and mesquite trees were brown. Polygons of S\_RWIL were often located by linear streams and contained patches of gray looking bare ground and stream bank material.

**Mapping Notes:** The S\_RWIL map unit included stands with willow trees, saplings, and seedlings. Polygons often contained varying amounts of giant cane, mesquite, and tamarisk. The W\_GWIL map unit was used to map upland willow stands and the S\_CWIL type was used to map larger, more mature willow tree stands.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Coahuila Scrub Oak Chaparral**  
**S\_SOAK**      ***Quercus intricata* Chaparral**

---

Common Species

- Coahuila (Dwarf) oak (*Quercus intricata*)
- Elbowbush (Stretchberry) (*Forestiera pubescens*)
- Green sotol (*Dasyilirion leiophyllum*)
- Alligator juniper (*Juniperus deppeana*)
- Little bluestem (*Schizachyrium scoparium*)
- Foothill beargrass (*Nolina erumpens*)

rUSNVC Association

– *Quercus intricata* – *Dasyilirion leiophyllum* Shrubland (CEGL004530)



Representative Ground Photo.

Description

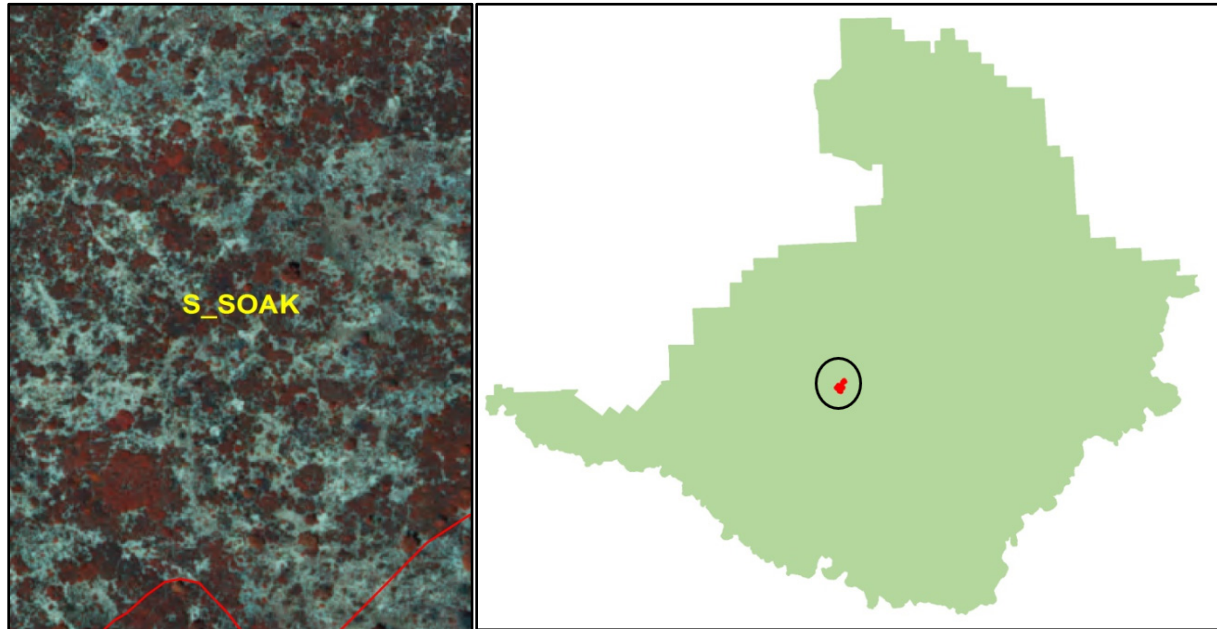
**Frequency:** Sites dominated by coahuila scrub oak shrubs only occurred on a few rocky slopes in the high Chisos Mountain region of BIBE.

**Physiognomy:** Stands of S\_SOAK were dominated by low to medium-sized, broad-leaved deciduous short trees, and tall shrubs. The understory for this type was thick with grasses and forbs and often contains other shrub and short tree species.

**Condition:** Good-Fair. Coahuila oak is a common species in the Chisos Mountains but it usually occurred with other species of oaks and pinyon pine and juniper trees. When it did occur as the dominant species, these sites were often small and may be especially prone to threats from wildfires, insect infestations, and wildlife disturbances.

**CIR Signature:** The S\_SOAK map unit had a highly recognizable signature consisting of very spread out brown and dark red splotches. A prominent blue or gray background color was present caused by the reflectance from the soil and rock substrate.

**Mapping Notes:** Coahuila scrub oak stands were only found in a few locations that overlapped with similar pinyon-juniper types (W\_PJ and W\_MPJ). Species found in this type were also common across multiple map units. More ground-truthing of the Chisos Mountain types may allow for further refinement and increased accuracy.



Example photo signature (left) and range and distribution map (right).

<b>Map Code</b>	<b>Sotol – Lechuguilla Foothills Shrub Grassland</b>
<b>S_SOT</b>	<b><i>Dasyilirion leiophyllum</i> – <i>Agave lechuguilla</i> Foothills Shrub Grassland</b>

---

#### Common Species

- Green sotol (*Dasyilirion leiophyllum*)
- Lechuguilla (*Agave lechuguilla*)
- Sideoats grama (*Bouteloua curtipendula*)
- Tanglehead (*Heteropogon contortus*)
- Mariola (*Parthenium incanum*)
- Chino grama (*Bouteloua ramosa*)
- Sideoats grama (*Bouteloua curtipendula*)
- Whitethorn acacia (*Vachellia constricta*)
- Black grama (*Bouteloua eriopoda*)
- Engelmann’s prickly pear (cactus apple) (*Opuntia engelmannii* var. *engelmannii*)

#### rUSNVC Association

– *Dasyilirion leiophyllum* – *Agave lechuguilla* / *Bouteloua curtipendula* – *Heteropogon contortus*  
Shrub Grassland (NPSBIBE030) [Provisional]



Representative Ground Photo.

#### Description

**Frequency:** Sotol shrublands with high levels of chino grama grass and lechuguilla were common throughout the mid elevation and high desert portions of BIBE. A band of this type was found to occur around the entire Chisos Mountain range.

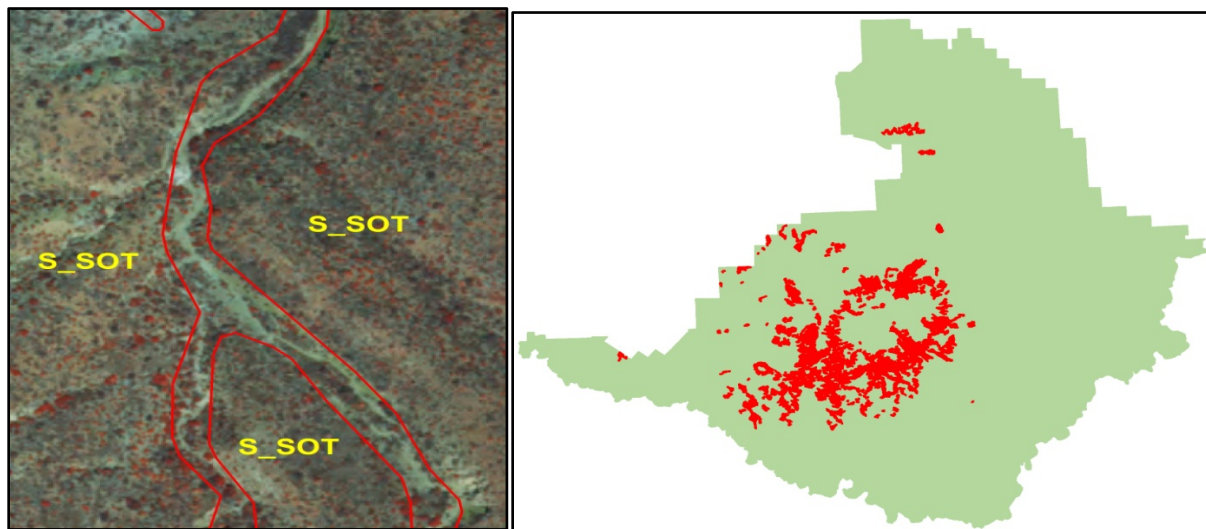
**Physiognomy:** Polygons of S\_SOT were dominated by short evergreen sotol, yuccas and some other associated evergreen shrub species. Understories were thick and contained high cover of grasses, cacti, and succulents.



**Condition:** Good. This type is extensive and appears healthy, with exception of some lechuguilla and grass die-off due to freezing. Potential threats include wildlife grazing, invasive graminoids, climate change, and wildfires.

**CIR Signature:** Polygons of S\_SOT appeared as widely spaced patches of red dots (yucca) against a brown or pick background (grasses). The texture of S\_SOT was smooth when compared to similar shrub and chaparral types.

**Mapping Notes:** The presence and concentration of sotol shrubs was used to separate this type from the similar Chino grama map unit (H\_GRAM). Some confusion likely occurred between these similar types since they contain many of the same species. Mariola shrublands were included in this map unit since they were small, isolated, and hard to distinguish from the sotol on the imagery.



Example photo signature (left) and range and distribution map (right).



**Map Code**      ***Tamarisk – (Tree Tobacco) Riparian Shrubland***  
**S\_TAM**        ***Tamarix* spp. – (*Nicotiana glauca*) Riparian Shrubland**

---

Common Species

- Tamarisk (Salt cedar) (*Tamarix ramosissima*)
- Athel tamarisk (*Tamarix aphylla*)
- Tree tobacco (*Nicotiana glauca*)
- Honey mesquite (*Prosopis glandulosa*)
- Willows (*Salix* spp.)
- Giant Cane (*Arundo donax*)
- Seepwillow (Mule-fat) (*Baccharis salicifolia*)

rUSNVC Association

– *Tamarix* spp. Temporarily Flooded Semi-natural Shrubland (CEGL003114)



Representative Ground Photos.

Description

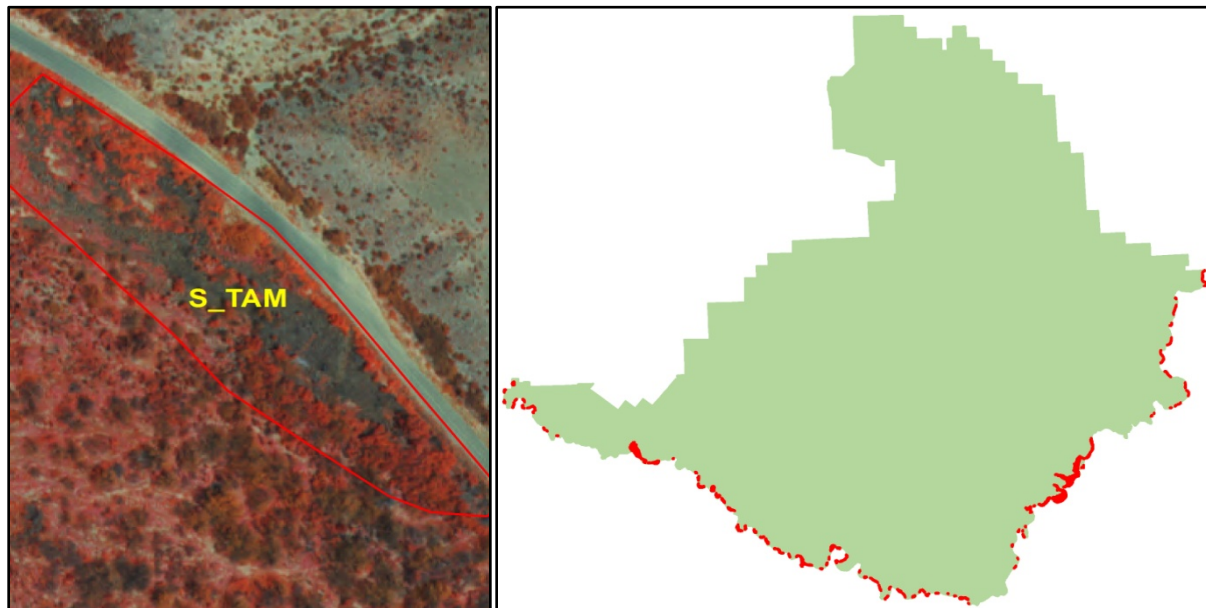
**Frequency:** Tamarisk (salt cedar) was a common species along the Rio Grande River in BIBE.

**Physiognomy:** S\_TAM varied from thick, monotypic stands of evergreen tall shrub/short trees to sparse pockets of low growing seedlings. Barren understories were common in thick stands, whereas high levels of Bermuda grass, annual grasses, and weedy forbs were common when tamarisk was sparse.

**Condition:** Poor. S\_TAM is a non-native species that can displace native shrubs and trees. Prolonged flooding may help to control or kill established tamarisk stands, but upstream locations may act as potential seed sources.

**CIR Signature:** On the imagery, S\_TAM varied from solid, dark-red bands and clumps to open red splotches on grey and white backgrounds (bare soil/rock). Open and sparse polygons often had a red/pink/orange (Bermuda grass) undertone. Treatment areas had a dark gray color relating to the dead or burned tamarisk trees/shrubs.

**Mapping Notes:** The S\_TAM map unit represented areas clearly dominated by tamarisk or where recently treated. Tamarisk may be more widespread at BIBE than indicated since it likely occurs at reduced levels in some of the H\_RIO, SP\_RIO, S\_RWIL, and S\_MRIP polygons. Due to similarities in density and height, S\_TAM may have been confused with the H\_CANE and S\_RWIL types during the mapping. Low floodplain areas delineated as S\_TAM are probably more dynamic and subject to rapid change.



Example photo signature (left) and range and distribution map (right).

**Map Code      *Mixed Tall Shrubs Wash Shrubland***  
**S\_TMIX**

---

Common Species

- Texas persimmon (*Diospyros texana*)
- Honey mesquite (*Prosopis glandulosa*)
- Desert olive (*Forestiera angustifolia*)
- Roemer's catclaw (*Senegalia roemeriana*)
- Gregg's catclaw (*Senegalia greggii*)
- Desert willow (*Chilopsis linearis*)
- Singlewhorl burrobrush (*Hymenoclea monogyra*)
- Trans-Pecos poreleaf (*Porophyllum scoparium*)

rUSNVC Association

– *Diospyros texana* – *Forestiera angustifolia* – *Prosopis glandulosa* – (*Rhus microphylla*) Shrubland (NPSBIBE29) [Provisional]



Representative Ground Photo.

Description

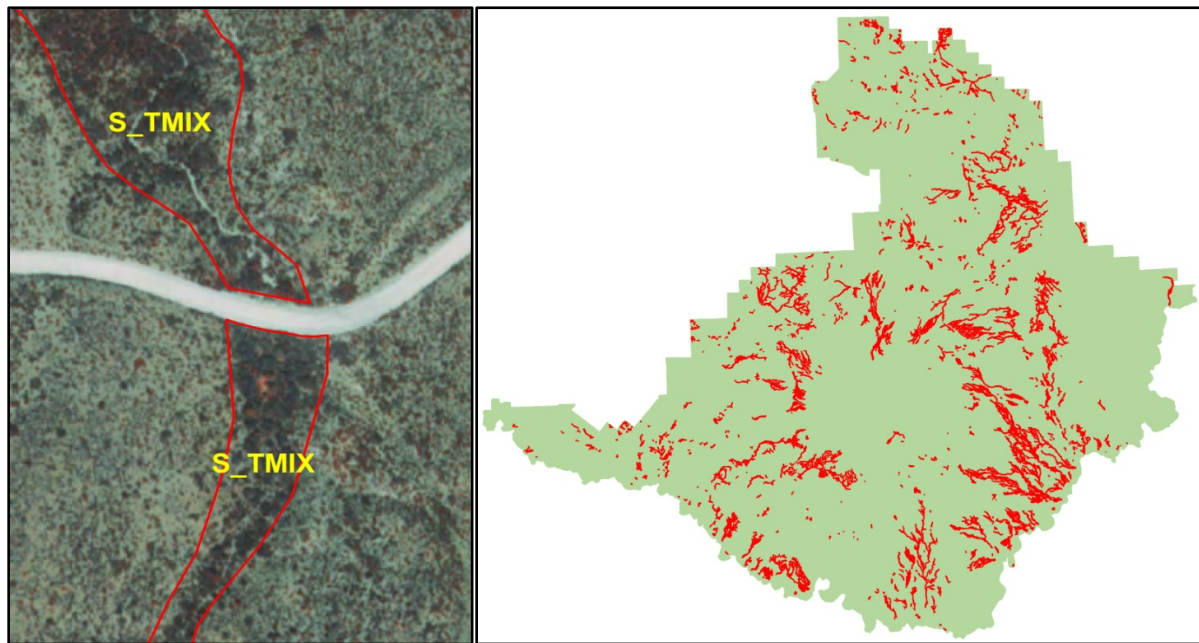
**Frequency:** Mesic tall shrubs were common along dry streams and drainages throughout the low and high desert regions of BIBE.

**Physiognomy:** Polygons of S\_TMIX contained tall (>2 meters) mixes of deciduous and evergreen shrubs. The understory often contained low-growing evergreen shrubs, cacti, succulents, and sparse grasses.

**Condition:** Good–Fair. Stands of S\_TMIX are widespread and appear to be stable. In general, the localized shade and forage provided by this type may make it prone to over-use by wildlife. Flash floods, erosion, and non-native grasses are potential threats to this type.

**CIR Signature:** Polygons of S\_TMIX had either a bunched or a linear pattern with some obvious thin drainage channels. Taller evergreen shrubs appeared as dark brown splotches and deciduous shrubs were red. Smaller dots represented understory species. Grasses, if present, were a smooth brown or orange color.

**Mapping Notes:** The S\_TMIX map unit was used to map low elevation mesic sites containing tall shrubs. Common desert species, especially mesquite and acacias, often occurred and caused some confusion during the mapping of this type when compared to the S\_ACAMEQ, S\_MEQ, and S\_WASH map units.



Example photo signature (left) and range and distribution map (right).



**Map Code      *Big Bend Lowlands Wash Channel Shrubland***  
**S\_WASH**

---

Common Species

- Desert willow (*Chilopsis linearis*)
- Singlewhorl burrobrush (*Hymenoclea monogyra*)
- Trans-Pecos poreleaf (*Porophyllum scoparium*)
- Seepwillow (Mule-fat) (*Baccharis salicifolia*)
- Roemer's catclaw (*Senegalia roemeriana*)
- Spiny hackberry (*Celtis ehrenbergiana*)
- Creosote bush (*Larrea tridentata*)
- Mariola (*Parthenium incanum*)
- Apache plume (*Fallugia paradoxa*)

rUSNVC Association

– *Hymenoclea monogyra* – *Chilopsis linearis* – *Porophyllum scoparium* Shrubland (NPSBIBE014)  
[Provisional]



Representative Ground Photo.

Signature Description

**Frequency:** Desert washes and drainages were very common throughout the lower portions of BIBE.

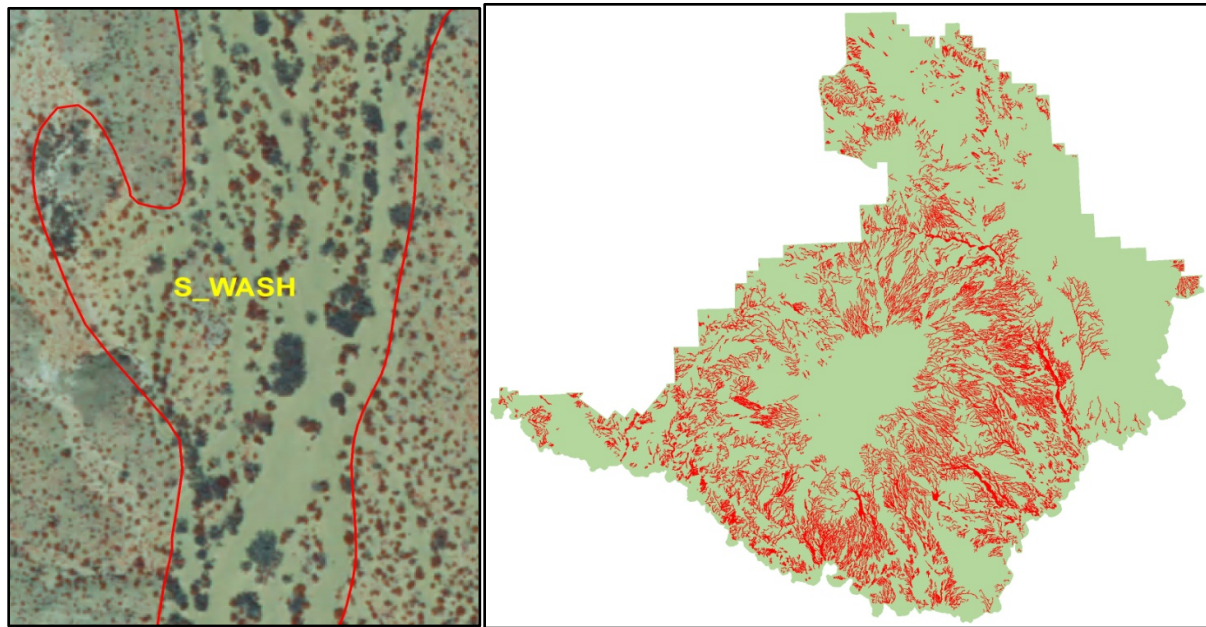
**Physiognomy:** Polygons of S\_WASH were dominated by short to medium sized evergreen and some deciduous shrubs. The understory often contained low-growing evergreen shrubs, cacti, succulents, and sparse grasses.

**Condition:** Good. All desert washes are prone to flash flooding events. Overall, this type is potentially threatened by invasion from non-native grasses, localized erosion, and other disturbances.



**CIR Signature:** Polygons of S\_WASH had a characteristic linear pattern with obvious thin drainage channels. Taller shrubs appeared as dark red and brown spots. Smaller dots represented understory species. Grasses, if present, were a smooth brown color.

**Mapping Notes:** The S\_WASH map unit was used to map all of the very complex, low elevation desert washes and drainages. The importance of hydrology and drainage patterns influenced the mapping of this type down to about 2–3 meters in width. Common desert species, especially creosotebush and mesquite, often occurred in the drainages and caused some confusion during the mapping of this type. S\_WASH may overlap the S\_FWASH and S\_TMX map units in some of the high desert regions of BIBE.



Example photo signature (left) and range and distribution map (right).

**Map Code**      ***Yucca – Sotol Calcareous Shrub Grassland***  
**S\_YUC**        ***Yucca* spp. – *Dasyilirion leiophyllum* Calcareous Shrub Grassland**

---

Common Species

- Eve's needle (giant dagger) (*Yucca faxoniana*)
- Thompson's yucca (*Yucca thompsoniana*)
- Green sotol (*Dasyilirion leiophyllum*)
- Torrey's yucca (*Yucca torreyi*)
- Spiny greasebush (*Glossopetalon spinescens*)
- Gregg's catclaw (*Senegalia greggii*)
- Desert olive (*Forestiera angustifolia*)
- Skeletonleaf goldeneye (*Viguiera stenoloba*)
- Sideoats grama (*Bouteloua curtipendula*)

rUSNVC Association

– *Yucca faxoniana* – *Yucca thompsoniana* – *Dasyilirion leiophyllum* / *Nolina erumpens* – *Bouteloua curtipendula* Shrub Grassland (NPSBIBE040) [Provisional]



Representative Ground Photo.

Description

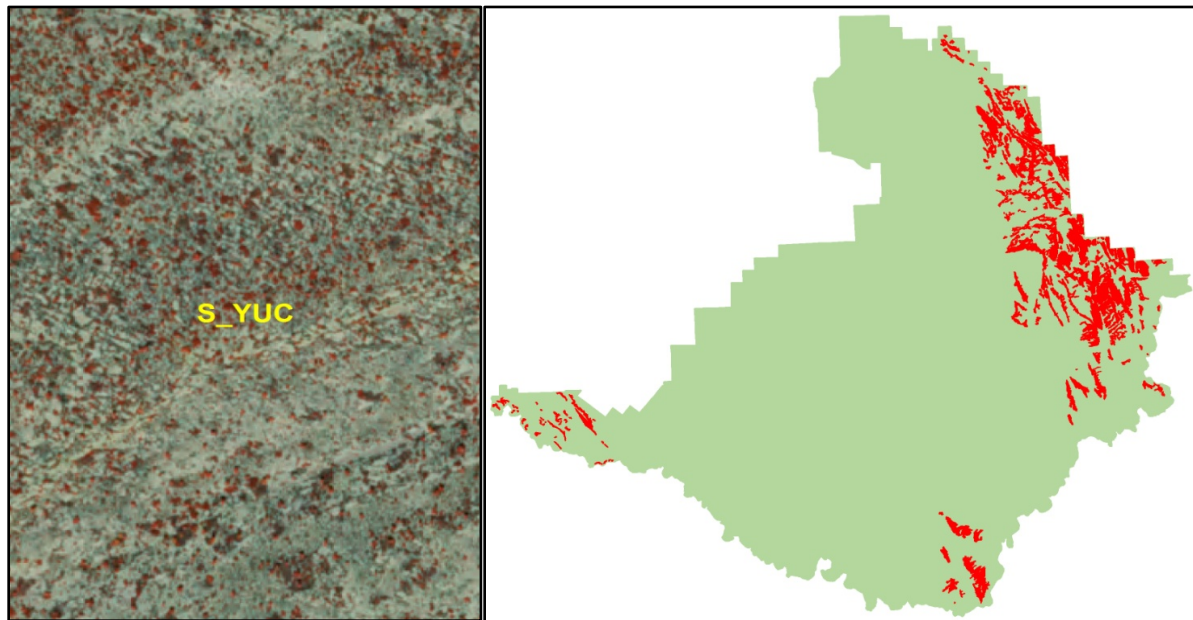
**Frequency:** Mixed yucca and sotol shrublands were common throughout BIBE occurring on limestone formations.

**Physiognomy:** The S\_YUC map unit contained a characteristic mix of evergreen shrub, cacti, and succulents with a moderate to thick understory of grasses and herbaceous vegetation.

**Condition:** Good. Areas with S\_YUC are likely influenced by the water retained from surrounding rock formations and may represent a transition from desert scrub to chaparral. Prolonged drought and cold weather may affect this type and cause the yuccas, grasses, and succulents to decline.

**CIR Signature:** On the imagery, the S\_YUC had a typical white, gray, and blue background color. Taller yucca shrubs were dark red and were larger than the small brown and red dots associated with the understory shrub species. Grasses and herbaceous vegetation (if present) were brown in color.

**Mapping Notes:** The S\_YUC map unit contains similar vegetation found in the S\_CDS, S\_CTAL, and S\_CHAP map units. The S\_YUC map unit was used to map obvious yucca locations that did not have other large shrubs.



Example photo signature (left) and range and distribution map (right).

**Map Code**     ***Yucca Calcareous Wash Channel Shrubland***  
**S\_YWASH**    ***Yucca* spp. Calcareous Wash Channel Shrubland**

---

Common Species

- Soaptree yucca (*Yucca elata*)
- Eve's needle (giant dagger) (*Yucca faxoniana*)
- Thompson's yucca (*Yucca thompsoniana*)
- Green sotol (*Dasyllirion leiophyllum*)
- Torrey's yucca (*Yucca torreyi*)
- Spiny greasebush (*Glossopetalon spinescens*)
- Gregg's catclaw (*Senegalia greggii*)
- Desert olive (*Forestiera angustifolia*)

rUSNVC Association

– *Yucca faxoniana* – *Yucca thompsoniana* – *Dasyllirion leiophyllum* / *Nolina erumpens* – *Bouteloua curtipendula* Shrub Grassland (NPSBIBE040 – Park Special) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Mixed yucca drainages were common throughout BIBE occurring within limestone formations.

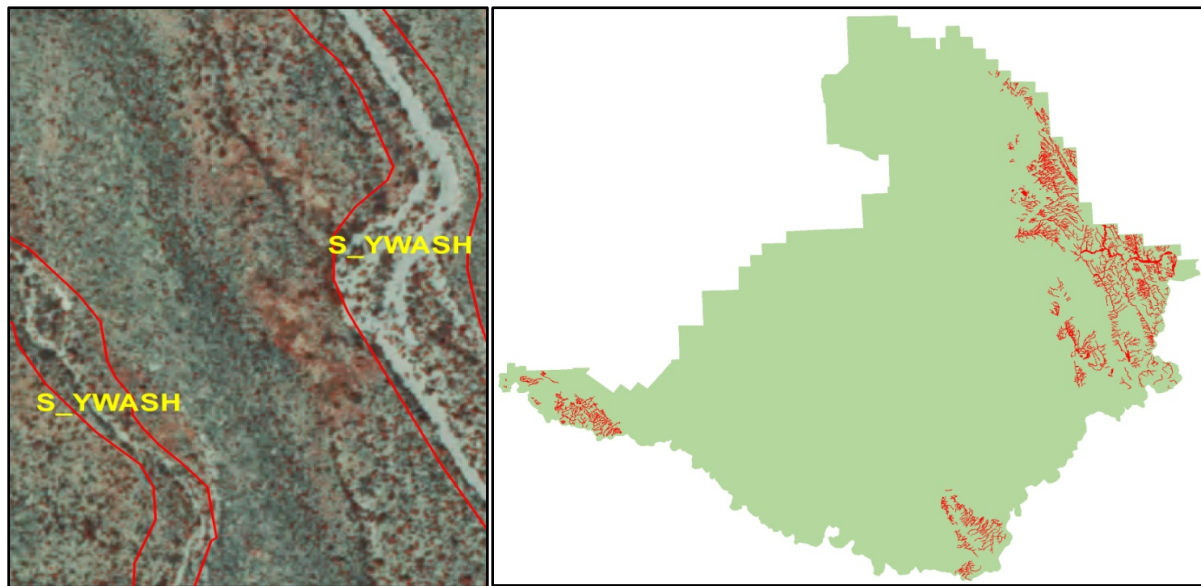
**Physiognomy:** The S\_YWASH map unit contained a characteristic mix of evergreen shrub, cacti, and succulents with a sparse understory of grasses and herbaceous vegetation found growing in and around desert washes.

**Condition:** Good. Areas with S\_YWASH are likely influenced by periodic flooding and relatively mesic conditions. Prolonged drought and cold weather may affect this type and cause the yuccas, grasses, and succulents to decline.



**CIR Signature:** On the imagery, the S\_YWASH had a linear wash pattern with bare white and gray drainage channels. Taller yucca shrubs were dark red and were larger than the small brown and red dots associated with the understory shrub species. Grasses and herbaceous vegetation (if present) were brown in color.

**Mapping Notes:** The S\_YWASH was similar in species composition to the S\_YUC map unit. The splitting of S\_YWASH from S\_YUC was done to help provide more information on the vegetation growing on limestone formations in BIBE. Some similarity may exist between this type and the other wash map units.



Example photo signature (left) and range and distribution map (right).



## Herbaceous Vegetation

**Map Code**      **Alkali Sacaton Riparian Grassland**

**H\_ASAC**      ***Sporobolus airoides* Riparian Grassland**

---

### Common Species

- Alkali sacaton (*Sporobolus airoides*)
- Fourwing saltbush (*Atriplex canescens*)
- Desert seepweed (*Suaeda suffrutescens*)
- Lotebush (*Ziziphus obtusifolia*)
- Tree tobacco (*Nicotiana glauca*)

### rUSNVC Association

– *Atriplex canescens* – *Suaeda suffrutescens* / *Sporobolus airoides* Shrub Herbaceous Vegetation (NPSBIBE026) [Provisional]



Representative Ground Photo.

### Description

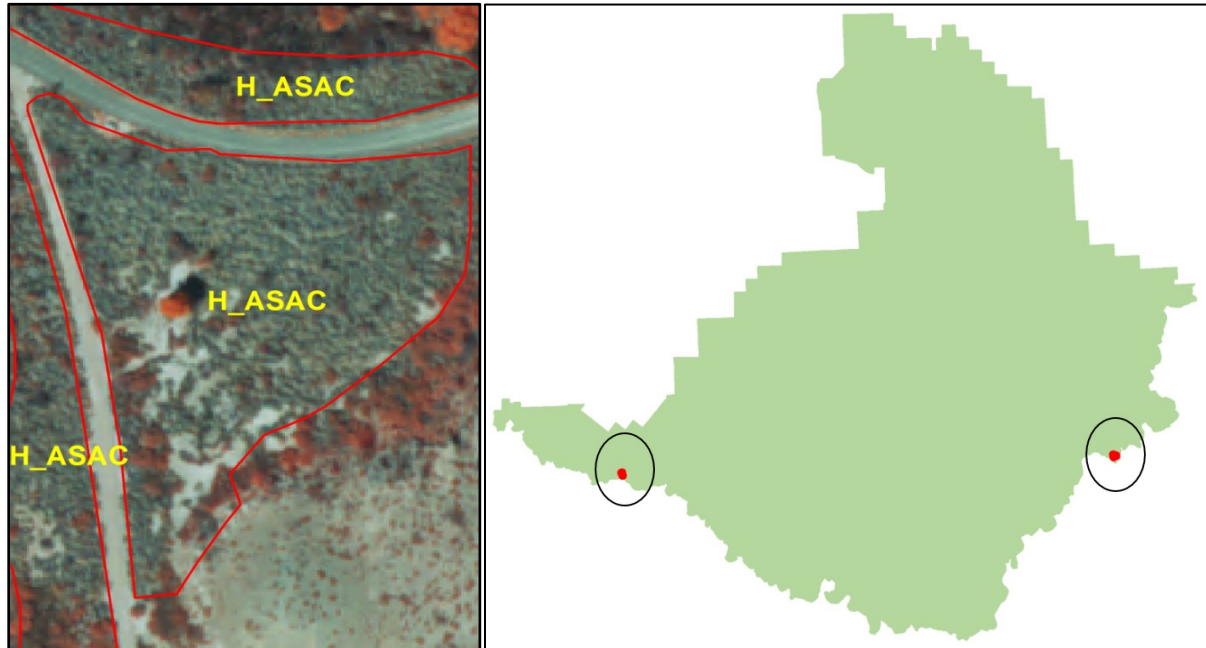
**Frequency:** Only a few polygons of H\_ASAC occurred at BIBE. One site was near the Rio Grande Village and the other near Castolon. The presence of this type may be related to past disturbance events.

**Physiognomy:** H\_ASAC polygons contained high cover of perennial grasses with some minor non-native shrub, native shrub, forb and other grass components. Most areas with this type were mesic.

**Condition:** Poor. This map unit is restricted to few locations and may occur only after past disturbance events. Invasion and overgrowth from shrubs and trees may occur.

**CIR Signature:** On the imagery, the H\_ASAC map unit had a characteristic coarse gray signature with white areas representing bare soil. The gray color is likely from the grass being dormant, when actively growing it would likely exhibit a pink or orange color. Red and brown spots indicate shrubs and short trees.

**Mapping Notes:** This map unit was primarily used to map alkali sacaton in areas where it was known to occur and that were large enough to map. Further ground-truthing, would help refine and improve the distribution of this mapping unit.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Bermuda Grass Herbaceous Vegetation**  
**H\_BERM**      ***Cynodon dactylon* Herbaceous Vegetation**

---

Common Species

- Bermuda grass (*Cynodon dactylon*)
- Tamarisk (Salt cedar) (*Tamarix ramosissima*)
- Tanglehead (*Heteropogon contortus*)
- Creosotebush (*Larrea tridentata*)
- Honey mesquite (*Prosopis glandulosa*)
- Johnson grass (*Sorghum halepense*)
- Buffelgrass (*Pennisetum ciliare*)

rUSNVC Association

– *Cynodon dactylon* Arid Southwest Herbaceous Vegetation (NPSBIBE017) [Provisional]



Representative Ground Photo.

Description

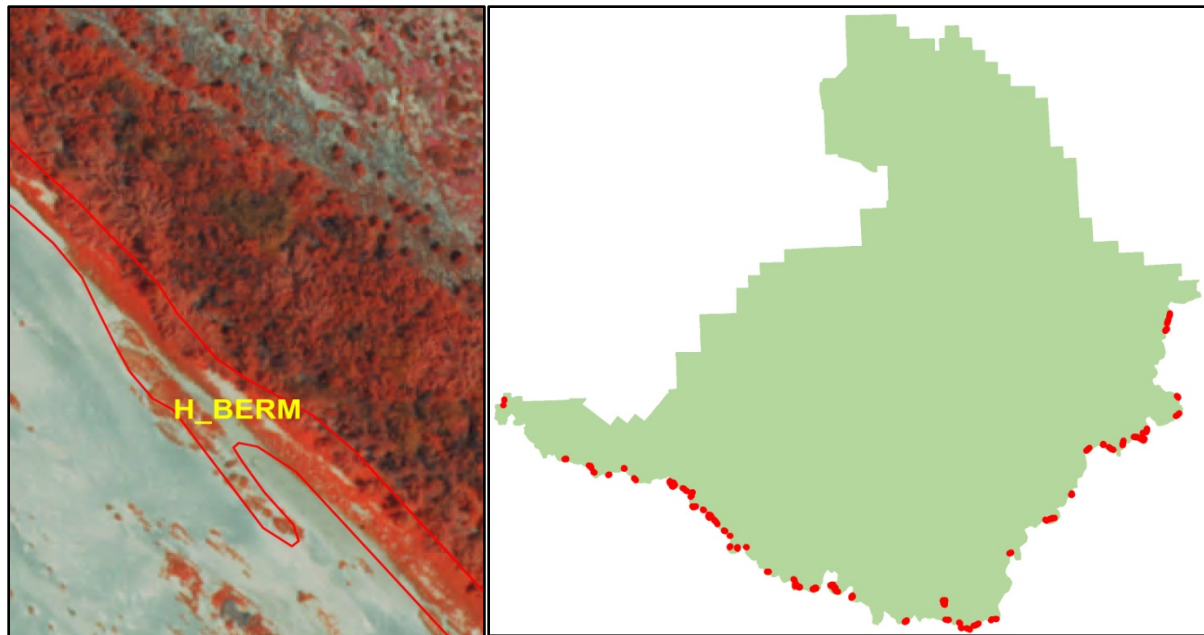
**Frequency:** Bermuda grass was found primarily around the Rio Grande River where it occurred on floodplains, shorelines, and other recently flooded or inundated areas. Bermuda grass was also found in the campgrounds and facilities where it was maintained.

**Physiognomy:** H\_BERM polygons contain high cover of perennial grasses with some weedy forbs and short early successional shrubs and trees.

**Condition:** Poor. H\_BERM is an early successional type and its presence likely points to areas that were recently flooded or disturbed. Bermuda grasslands may be vectors for other invasive species like giant cane and tamarisk.

**CIR Signature:** On the imagery, the H\_BERM map unit had a characteristic smooth, bright pink and red color. Gray patches likely indicate dead or dormant stands. Pink and red spots were small shrubs, tree/shrub seedlings, and/or weedy forbs.

**Mapping Notes:** The H\_BERM type will likely change in cover and abundance with seasonal flooding. Sites may also become overgrown with shrubs and trees when dry for extended periods. Areas maintained as lawns were also mapped using this type.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Giant Cane Riverbank Herbaceous Vegetation**  
**H\_CANE**      ***Arundo donax* Riverbank Herbaceous Vegetation**

---

Common Species

- Giant cane (*Arundo donax*)
- Bermuda grass (*Cynodon dactylon*)
- Tree tobacco (*Nicotiana glauca*)
- Mealy goosefoot (*Chenopodium incanum*)
- Tamarisk (Salt cedar) (*Tamarix ramosissima*)

rUSNVC Association

– *Arundo donax* Riverbank Herbaceous Vegetation (CEGL004101)



Representative Ground Photo.

Description

**Frequency:** Tall, thick stands of giant cane were common along the Rio Grande River at BIBE.

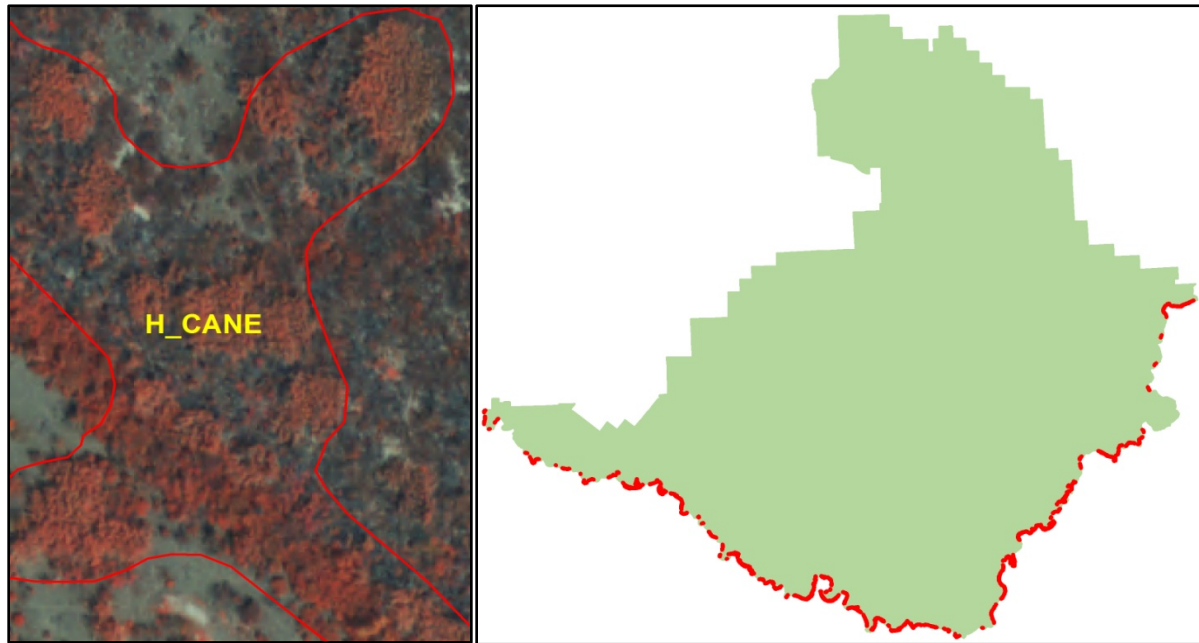
**Physiognomy:** Polygons of H\_CANE contained linear bands and thick clumps of tall (> 1 meter), perennial grasses. Other associated species were mostly absent due the density of the giant cane stands.

**Condition:** Poor. Giant cane is considered an invasive species that invades riparian corridors and floodplains. The thick and tall growth of this type displaces native species and prevents them from re-establishing. Monitoring and suppression of this type through fire and removal may be needed.

**CIR Signature:** On the imagery, the H\_CANE type exhibited a very bright pink color that was taller than the other herbaceous riparian types but shorter than the nearby willow and tamarisk woodlands. Polygons of this type were often bunched or linear in shape and were next to open water. Treatment areas had a dark gray color relating to the dead or burned giant cane grasses.



**Mapping Notes:** Mixing of the giant cane with tamarisk and willow trees presented some confusion during the mapping and more ground-truthing may help to improve the accuracy of this type.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Finestem Needlegrass Montane Grassland**  
**H\_FINE**        ***Nassella tenuissima* Montane Grassland**

---

Common Species

- Finestem needlegrass (*Nassella tenuissima*)
- Tarragon (*Artemisia dracunculus*)
- Blue grama (*Bouteloua gracilis*)
- Hairy grama (*Juniperus communis*)
- Pine dropseed (*Blepharoneuron tricholepis*)
- Chisos Mountain pricklypear (*Opuntia chisosensis*)

rUSNVC Association

– *Nassella tenuissima* Herbaceous Vegetation (NPSBIBE003) [Provisional]



Representative Ground Photo.

Description

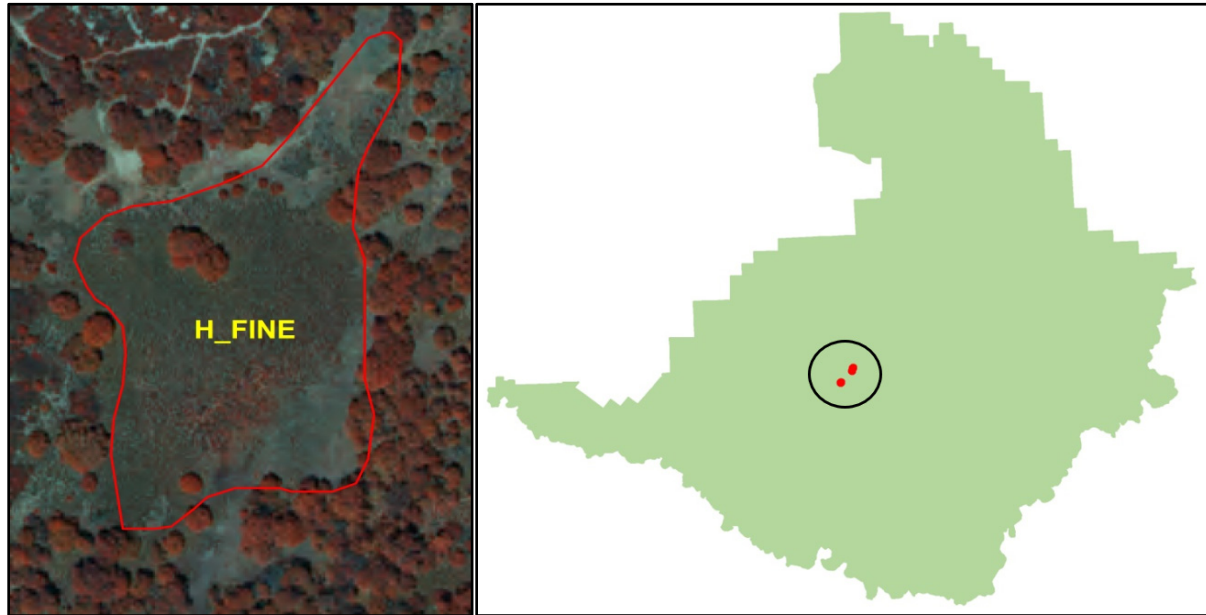
**Frequency:** Finestem needlegrass polygons were found in limited quantities in the High Chisos Mountains.

**Physiognomy:** Polygons of H\_FINE contained perennial herbaceous vegetation consisting of localized patches of grasses with occasional forbs and isolated shrubs and trees.

**Condition:** Fair. H\_FINE grasslands were rare in the High Chisos Mountains. This type likely represents a transitional state occurring under a dead or dying tree canopy. Some sites on very rocky substrates may be viable and stable for long times. Tree encroachment, rockslides, wildfires, invasive species, and drought may all affect this type.

**CIR Signature:** On the imagery, the H\_FINE type exhibited a smooth gray signature that likely changes to red or pink when the grasses are actively growing. Polygons of this type often contained one or two red clumps of trees and pink dots (forbs and shrubs). Coarse gray patches were sometimes present representing bare rocks and talus.

**Mapping Notes:** The H\_FINE map unit was only used when no evidence of trees or shrubs were observed. Finestem needlegrass was likely a dominant understory species in the High Chisos shrub and tree map units.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Chino Grama Shrub Grassland**  
**H\_GRAM**      ***Bouteloua ramosa* Shrub Grassland**

---

Common Species

- Chino grama (*Bouteloua ramosa*)
- Lechuguilla (*Agave lechuguilla*)
- Sideoats grama (*Bouteloua curtipendula*)
- Blind pricklypear (*Opuntia rufida*)
- Dwarf stickpea (*Calliandra humilis*)
- Green sotol (*Dasyllirion leiophyllum*)
- Texas lignum-vitae (*Guaiaicum angustifolium*)
- Mariola (*Parthenium incanum*)

rUSNVC Association

– *Dasyllirion leiophyllum* – *Viguiera stenoloba* – *Agave lechuguilla* / *Bouteloua ramosa* Shrubland (CEGL004604)



Representative Ground Photos.

Description

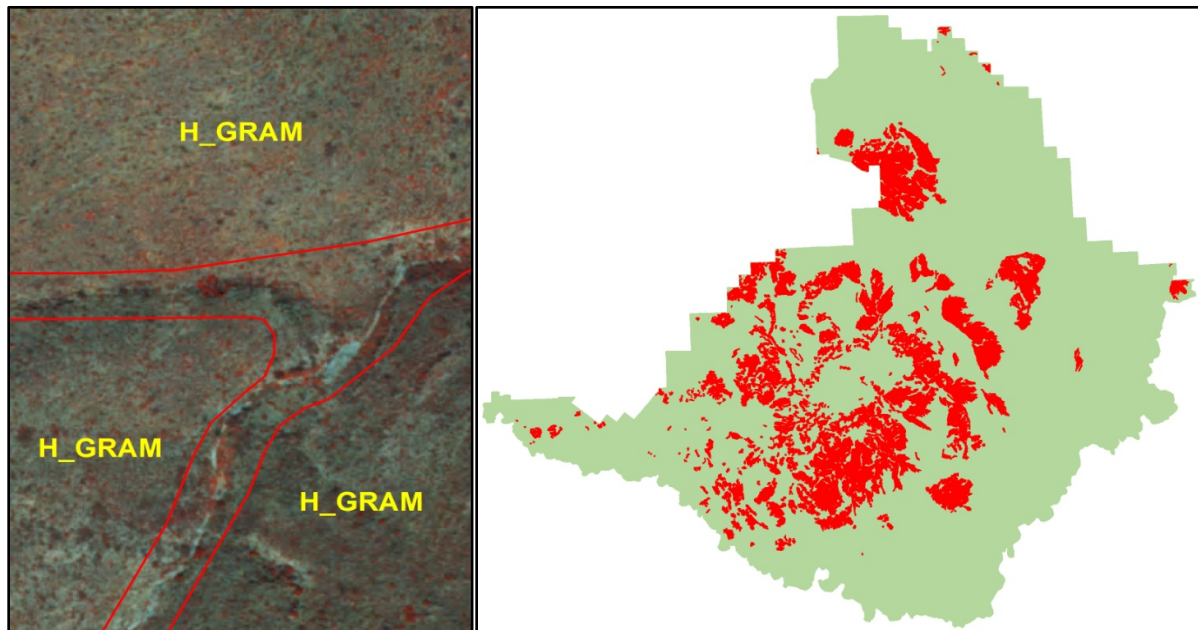
**Frequency:** Chino grass dominated sites were common throughout the high desert portions of BIBE.

**Physiognomy:** Polygons of H\_GRAM contained moderate cover of perennial herbaceous vegetation with some associated short shrubs, yuccas, and cacti.

**Condition:** Good-Fair. Chino grama grass is prevalent throughout BIBE and occurs both as common grassland type and as an understory species in sotol and yucca shrublands. Cold weather and freezing appeared to have severely reduced the abundance of Chino grama and this type may be prone to changes in climate and drought.

**CIR Signature:** On the imagery, the H\_GRAM type exhibited a varied smooth signature ranging from red and pink swaths (healthy) to gray and brown patches (dead or dormant). Shrubs, if present, were sparse and appeared as small red and brown dots. Polygons of this type often contained gray rocks, boulders, and small talus fields.

**Mapping Notes:** The H\_GRAM map unit was very similar in appearance and occurred in the same locations as the S\_SOT type. Some confusion between these similar map units likely occurred.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Johnson Grass – Russian Thistle Desert Grassland**  
**H\_GRS**        ***Sorghum halepense* – *Salsola tragus* Desert Grassland**

---

Common Species

- Johnson grass (*Sorghum halepense*)
- Tobosa grass (*Pleuraphis mutica*)
- Russian thistle (*Salsola tragus*)
- Honey mesquite (*Prosopis glandulosa*)
- Creosotebush (*Larrea tridentata*)
- Whitebrush (*Aloysia gratissima*)
- Berlandier's wolfberry (*Lycium berlandieri*)
- Silverleaf nightshade (*Solanum elaeagnifolium*)

rUSNVC Association

– *Sorghum halepense* Chihuahuan Desert Herbaceous Vegetation (NPSBIBE018) [Provisional]



Representative Ground Photo.

Description

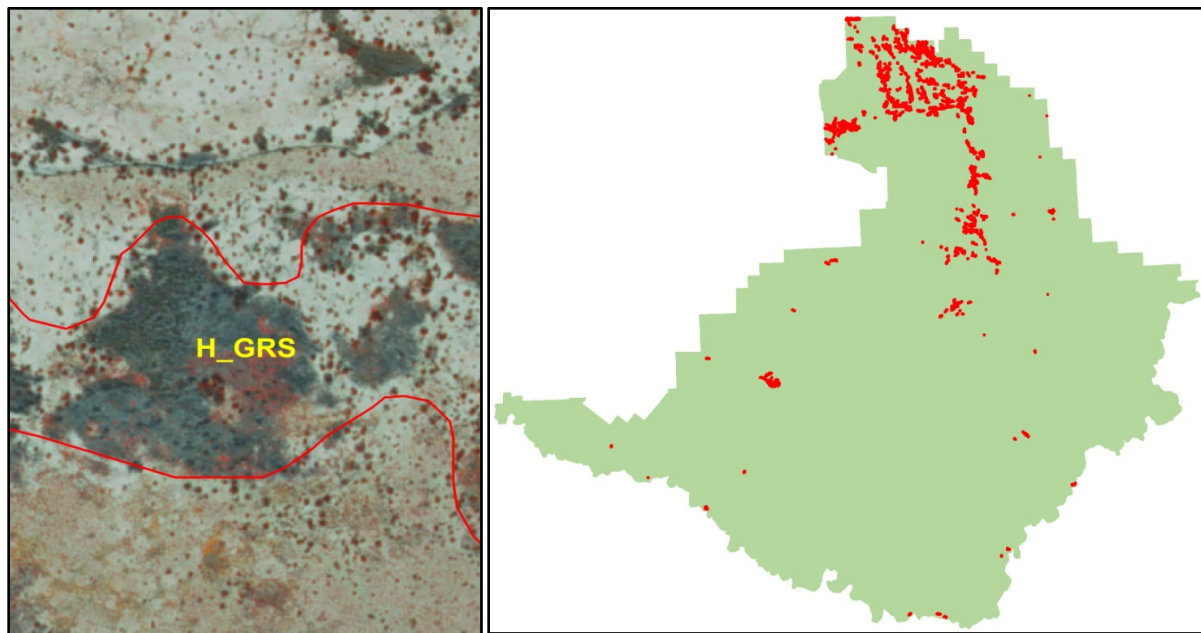
**Frequency:** Johnson grass was a common grass species throughout BIBE and was mainly concentrated in larger areas in the north and along the main park road from Persimmon Gap to Panther Junction.

**Physiognomy:** H\_GRS polygons contain mainly perennial non-native grasses with some minor native shrub components.

**Condition:** Poor. This map unit is an early successional type found on disturbed desert sites, areas that were reclaimed through water diversions, and former agricultural fields. Johnson grass may invade other native types.

**CIR Signature:** On the imagery, the H\_GRS map unit had a characteristic mottled appearance and was often orange or pink (healthy) or gray and dark (dead grass). Pockets of Johnson grass often contained small shrubs that appeared as brown or red dots. Usually this type occurred in more mesic depressions and along washes and drainages.

**Mapping Notes:** This map unit was primarily used to map disturbed sites in BIBE. Other pockets of H\_GRS likely occurred but were mapped as part of the S\_CLAY, S\_MEQ, or S\_CB map units. Tobosa grass (H\_TOB), another non-native species, was common in areas with Johnson grass and some confusion between these two very similar grassland types likely occurred. Further ground-truthing, especially in disturbed areas would help refine and improve the accuracy of H\_GRS.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Bull Muhly Montane Grassland**  
**H\_MUHL**      ***Muhlenbergia emersleyi* Montane Grassland**

---

Common Species

- Bull muhly grass (*Muhlenbergia emersleyi*)
- Desert muhly grass (*Muhlenbergia glauca*)
- Purple muhly grass (*Muhlenbergia rigida*)
- Copper fern (*Bommeria hispida*)
- Golden lipfern (*Cheilanthes bonariensis*)
- Lechuguilla (*Agave lechuguilla*)
- Pine dropseed (*Blepharoneuron tricholepis*)
- Foothill beargrass (*Nolina erumpens*)
- Chisos Mountain pricklypear (*Opuntia chisosensis*)
- Havard's century plant (*Agave havardiana*)
- Arizona wheatgrass (*Elymus arizonicus*)

rUSNVC Association

– *Muhlenbergia emersleyi* – *Bommeria hispida* – *Cheilanthes bonariensis* Herbaceous Vegetation (NPSBIBE008) [Provisional]



Representative Ground Photo.

Description

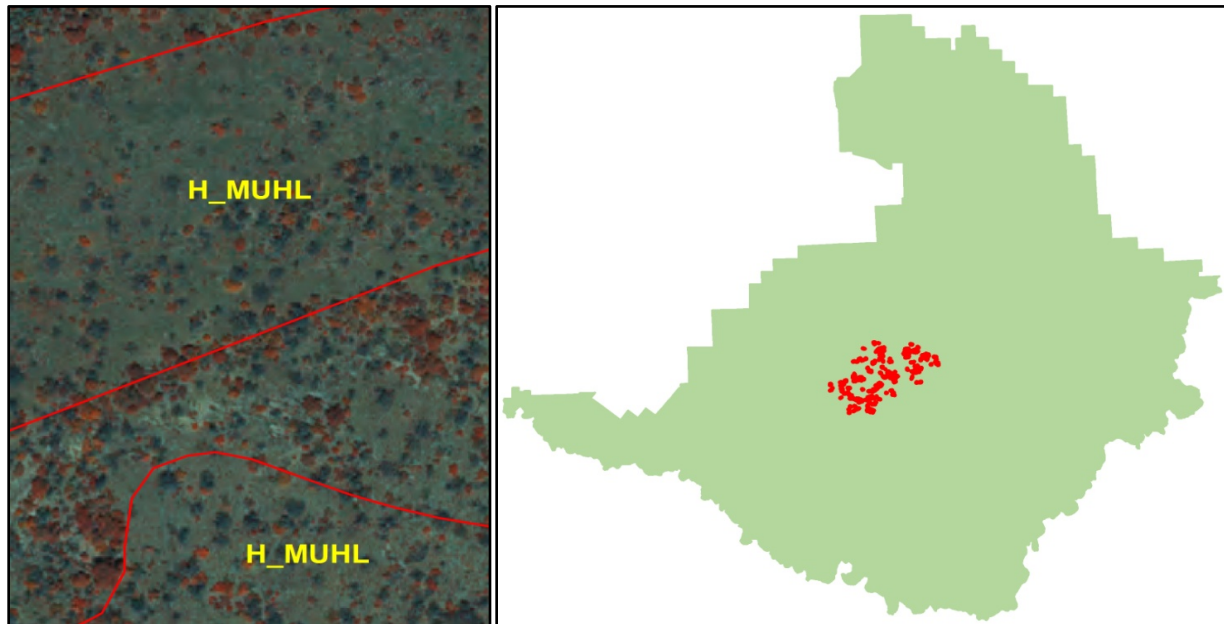
**Frequency:** Muhly grasslands were common throughout the Chisos Mountains. Muhly grasslands were often small and their presence may be related to sites where the trees have died or are dying.

**Physiognomy:** Polygons of H\_FINE contained a mix of perennial grasses with some localized patches of short shrubs, yuccas, and succulents. Sparse trees and evergreen shrubs may also be present.

**Condition:** Fair. Muhly grasslands by their location and condition maybe relics of past woodlands where the trees have died. They are likely susceptible to new tree and shrub colonization. Fire, drought, and climate change are potential threats.

**CIR Signature:** On the imagery, the H\_FINE exhibited a smooth gray signature that contained dark gray circles (dead trees) and some small orange and red spots (healthy shrubs and trees). Dead tree canopies and trunks were usually visible.

**Mapping Notes:** The H\_FINE map unit was only used in areas with dead or dying trees and shrubs. Natural pockets of this type may have occurred but were too small to map.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Common Reed Riparian Herbaceous Vegetation**  
**H\_REED**      ***Phragmites australis* Riparian Herbaceous Vegetation**

---

Common Species

- Common reed (*Phragmites australis*)
- Giant cane (*Arundo donax*)
- Bermuda grass (*Cynodon dactylon*)
- Tamarisk (Salt cedar) (*Tamarix ramosissima*)
- Seepwillow (Mule-fat) (*Baccharis salicifolia*)
- Rough cocklebur (*Xanthium strumarium*)

rUSNVC Association

– *Phragmites australis* Chihuahuan Desert Riparian Herbaceous Vegetation (NPSBIBE023)  
[Provisional]



Representative Ground Photo.

Description

**Frequency:** Common reed sites were only found in along the Rio Grande River at BIBE.

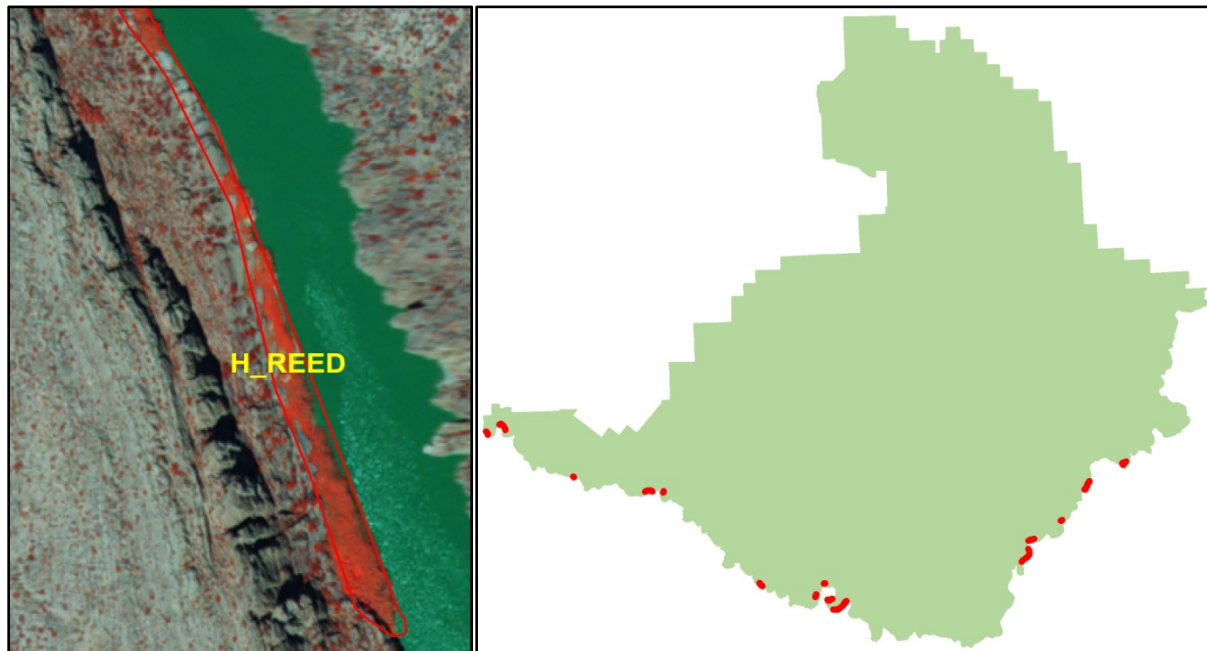
**Physiognomy:** This type includes mostly perennial herbaceous vegetation consisting of various riparian grasses, sedges and other herbaceous species.

**Condition:** Good – Fair. Localized patches are likely prone to flooding and low water levels. Non-native species such as tamarisk and giant cane may invade these areas.

**CIR Signature:** Polygons of H\_REED appeared as linear bands and clumps of low-growing orange and red colored grasses. Open water and rocks were usually present.



**Mapping Notes:** H\_REED was used to map riparian areas dominated by common reed. Other common species such as giant cane, tamarisk, and willows were sometimes present. Other polygons of H\_CANE, H\_RIO, and S\_TAM map units likely contain some common reed but in lower abundance.



Example photo signature (left) and range and distribution map (right).

**Map Code     *Rio Grande Alluvial Herbaceous Vegetation***  
**H\_RIO**

---

Common Species

- Seepwillow (Mule-fat) (*Baccharis salicifolia*)
- Pretty sneezeweed (*Helenium elegans*)
- Salt heliotrope (*Heliotropium curassavicum*)
- Curly dock (*Rumex crispus*)
- Giant cane (*Arundo donax*)
- Bermuda grass (*Cynodon dactylon*)
- Russian thistle (*Salsola tragus*)
- Tamarisk (Saltcedar) (*Tamarix ramosissima*)

rUSNVC Associations

- *Baccharis salicifolia* / (*Phragmites australis*) Chihuahuan Riparian (NPSBIBE047) [Provisional]
- *Schoenoplectus californicus* Chihuahuan-Tamaulipan Riparian Herbaceous Vegetation (NPSBIBE050) [Provisional]
- *Schoenoplectus pungens* Herbaceous Vegetation (CEGL001587)



Representative Ground Photo.

Description

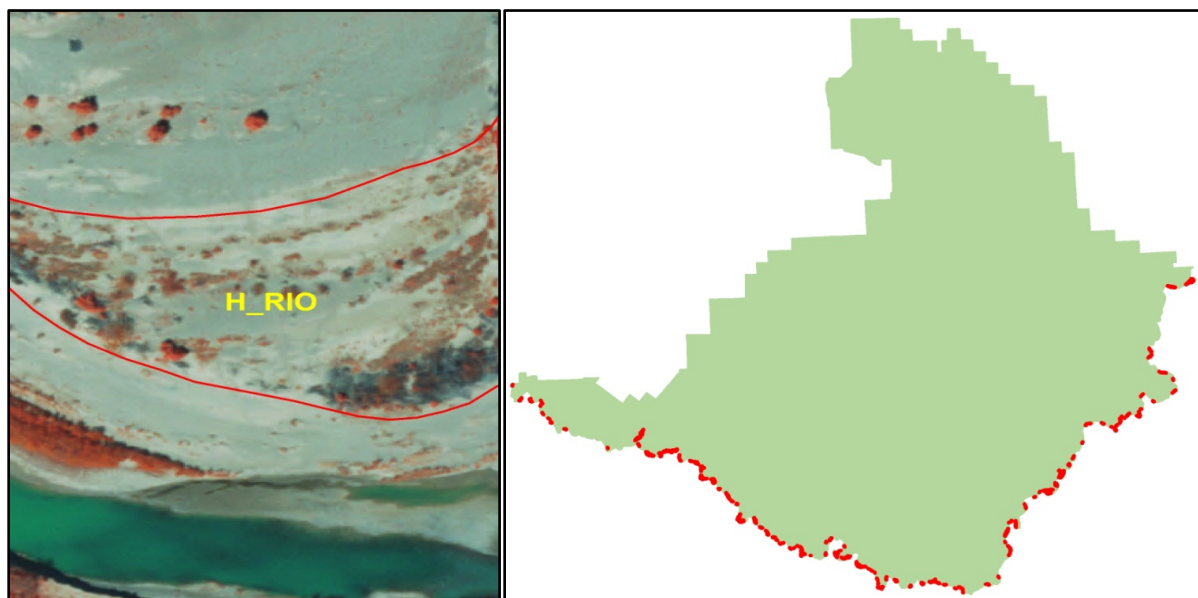
**Frequency:** Polygons of H\_RIO were restricted to the active Rio Grande River channel, floodplain, and portions of the larger tributaries that flow into it.

**Physiognomy:** The H\_RIO type contained sparse to moderate amounts of mixed annual grasses, forbs, and early successional weedy shrubs.

**Condition:** Poor. H\_RIO is an early successional type found on disturbed, previously inundated shorelines, drainages, and floodplains. The presence of this type likely indicates recent flooding, inundation, and disturbance.

**CIR Signature:** On the imagery, the H\_RIO map unit had a strong soil and rock reflectance (usually white or gray) with associated red, pink, and orange patches indicating short and actively growing vegetation.

**Mapping Notes:** H\_RIO polygons are dynamic and may be wiped out with flooding and reappear in different locations (especially on SP\_RIO sites). With less flooding these sites may evolve into other more established riparian shrubland and woodland types. The SP\_RIO type was used to map similar areas that contained little cover of herbaceous vegetation.



Example photo signature (left) and range and distribution map (right).

**Map Code**      ***Lechuguilla – Spikemoss Rocky Shrub Herbaceous Vegetation***  
**H\_SPIK**        ***Agave lechuguilla – Selaginella* spp. Rocky Shrub Herbaceous Vegetation**

---

Common Species

- (Peruvian) Spikemoss (*Selaginella peruviana*)
- Lechuguilla (*Agave lechuguilla*)
- Chisos Mountain pricklypear (*Opuntia chisosensis*)
- Copper fern (*Bommeria hispida*)
- Bull muhly grass (*Muhlenbergia emersleyi*)
- Ocotillo (*Fouquieria splendens*)
- Wright's beebrush (*Aloysia wrightii*)
- Lipfern (*Cheilanthes* spp.)
- Foothill beargrass (*Nolina erumpens*)
- Sideoats grama (*Bouteloua curtipendula*)

rUSNVC Association

– *Agave lechuguilla* – *Viguiera stenoloba* / *Selaginella peruviana* – *Bommeria hispida* – *Muhlenbergia emersleyi* Shrub Herbaceous Vegetation (NPSBIBE006) [Provisional]



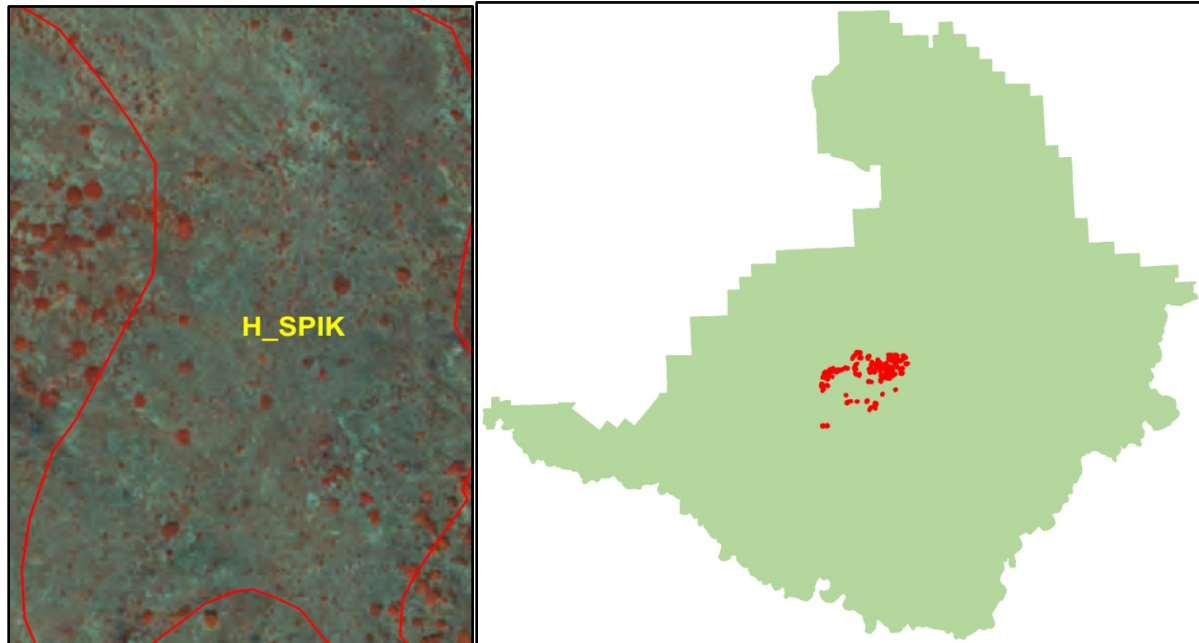
Representative Ground Photo.

Description

**Frequency:** Polygons of H\_SPIK were rare and restricted to mesic rocky slopes and rock outcrops in the Chisos Mountain portion of BIBE.

**Physiognomy:** This map unit contained short mats of spikemoss with some scattered cacti, succulents, and perennial grasses.

**Condition:** GOOD. The rugged and rocky nature of this type helps guard it against most fire events and possible invasion from non-native species. Localized rockslides, avalanches, and climate change may be potential threats. **Signature:** The H\_SPIK type appeared as a smooth blue and brown color. Most polygons contained some scattered shrubs and tree (red circles) and bare rock (gray) formations were usually present.



Example photo signature (left) and range and distribution map (right).



<b>Map Code</b>	<b>Seepwillow – Bushy Bluestem Spring Vegetation</b>
<b>H_SWIL</b>	<b><i>Baccharis salicifolia</i> – <i>Andropogon glomeratus</i> Spring Vegetation</b>

---

Common Species

- Seepwillow (Mule-fat) (*Baccharis salicifolia*)
- Bushy bluestem (*Andropogon glomeratus*)
- Bermuda grass (*Cynodon dactylon*)
- Southern cattail (*Typha domingensis*)
- Southern goldenbush (*Isocoma pluriflora*)
- Common maidenhair (*Adiantum capillus-veneris*)

rUSNVC Association

– *Baccharis salicifolia* / *Andropogon glomeratus* Shrub Herbaceous Vegetation (NPSBIBE016)  
[Provisional]



Representative Ground Photo.

Description

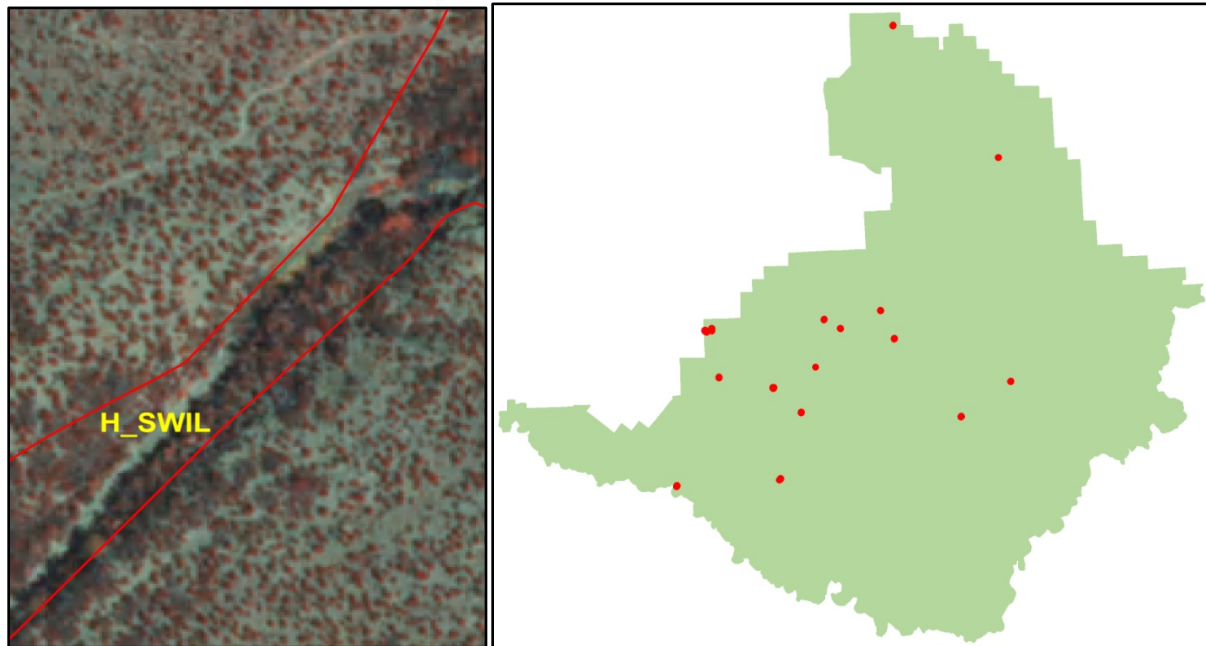
**Frequency:** The H\_SWIL map unit was a rare riparian/wetland type found on mesic sites in the high desert portions of BIBE.

**Physiognomy:** This type includes low to medium sized clumps and patches of perennial herbaceous vegetation consisting mainly of seepwillows, cattails, and tall grasses.

**Condition:** Fair. Localized patches are likely prone to flash floods and wildlife pressure.

**CIR Signature:** Polygons of H\_SWIL appeared as red spots often associated with drainage channels. Some occurred more as patches next to seeps and springs. Common nearby shrubs often encroached on this type and were visible as dark red and brown spots.

**Mapping Notes:** The H\_SWIL type was generously mapped where it was known to occur. Other areas may be dominated by similar riparian and wetland species, such as cattails and grasses. Seepwillows were also found along the Rio Grande River but were either too small to map or where incorporated into the larger SP\_RIO or H\_RIO map units.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Tobosa Grass Desert Grassland**  
**H\_TOB**        ***Pleuraphis mutica* Desert Grassland**

---

Common Species

- Tobosa grass (*Pleuraphis mutica*)
- Johnson grass (*Sorghum halepense*)
- Honey mesquite (*Prosopis glandulosa*)
- Purple threeawn (*Aristida purpurea*)
- Buffelgrass (*Pennisetum ciliare*)
- Creosotebush (*Larrea tridentata*)

rUSNVC Association

– *Pleuraphis mutica* Monotype Herbaceous Vegetation (CEGL001637)



Representative Ground Photo.

Description

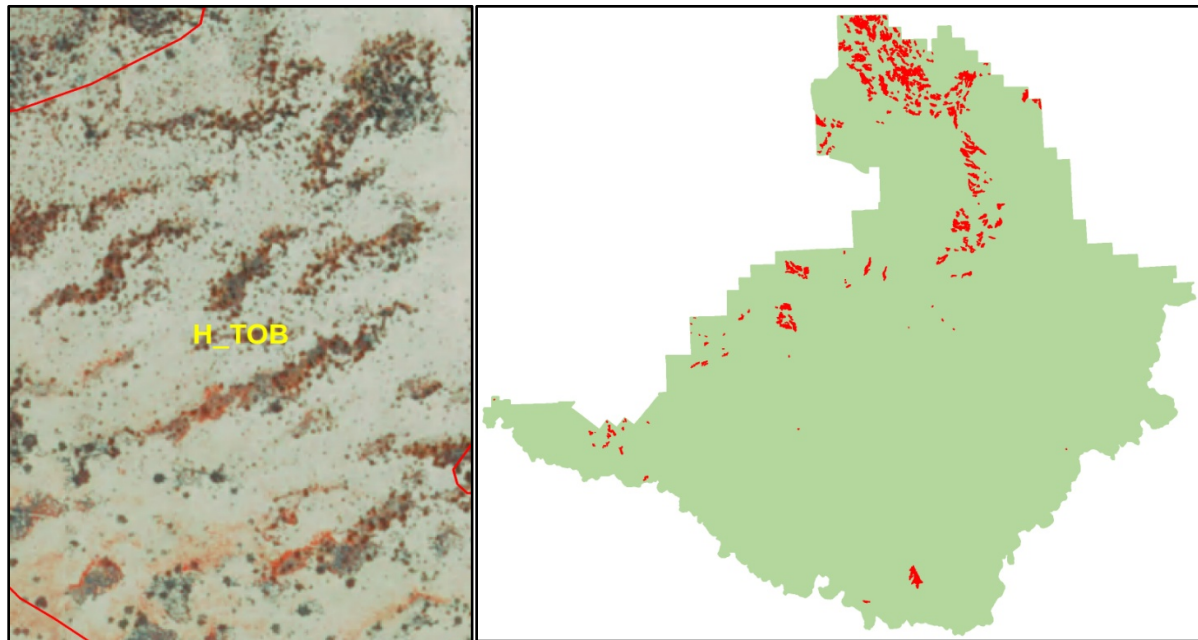
**Frequency:** Tobosa grasslands were prevalent in the northern portions of BIBE and within newly acquired lands near the Rosillos Mountains. In these locations, H\_TOB was more prevalent likely due to past disturbance events and former ranching and farming activities.

**Physiognomy:** H\_TOB polygons contain perennial non-native grasses with some minor native shrub grass components.

**Condition:** Poor. This map unit is an early successional type found on disturbed desert sites, areas that were reclaimed through water diversions, and former agricultural fields. Tobosa grass may invade other native types.

**CIR Signature:** On the imagery, the H\_TOB map unit had a characteristic bunched appearance and was often orange or pink (healthy) or gray and dark (dead grass). Pockets of tobosa grass often contained small shrubs that appeared as brown or red dots. Usually this type occurred on clay flats and the white and gray soil background color is evident.

**Mapping Notes:** This map unit was primarily used to map disturbed sites in BIBE. Other pockets of H\_TOB likely occurred but were mapped as part of the S\_CLAY, S\_MEQ, or S\_CB map units. Johnson grass (H\_GRS), another non-native species, was common in areas with tobosa grass and some confusion between these two very similar grassland types likely occurred. Further ground-truthing, especially in disturbed areas would help refine and improve the accuracy of H\_TOB.



Example photo signature (left) and range and distribution map (right).



**Map Code     Upland Ruderal Herbaceous Vegetation**  
**H\_UPG**

---

Common Species

- Russian thistle (*Salsola tragus*)
- Buffelgrass (*Pennisetum ciliare*)
- Tanglehead (*Heteropogon contortus*)
- Canadian horseweed (*Conyza canadensis*)

rUSNVC Association

– (*Heteropogon contortus*, *Pennisetum ciliare*, *Eragrostis lehmanniana*) – Mixed Forbs Chihuahuan Ruderal Herbaceous Vegetation (NPSBIBE046) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Upland ruderal mixed grasslands were only found in one location at BIBE on a recently disturbed site. Other locations containing mixed planted grasses, exotic grasses, and weedy forbs likely exist but were too small to map or were a minor component of other map units.

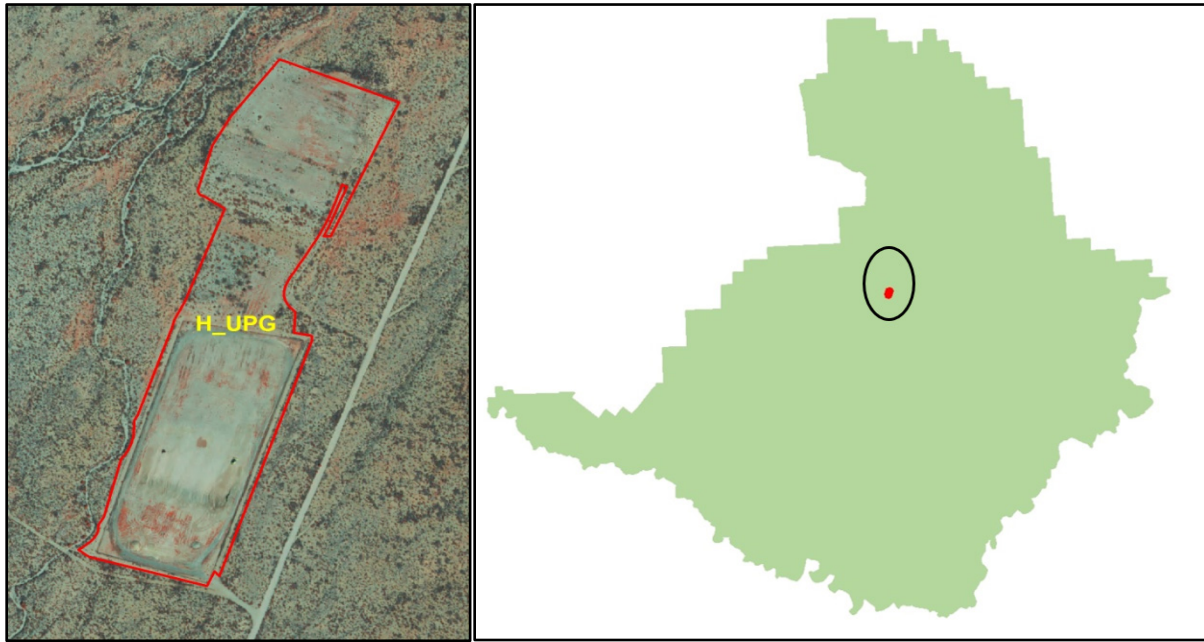
**Physiognomy:** Polygons of this type contained perennial grasses and forbs.

**Condition:** Poor. H\_UPG represents mostly weedy herbaceous sites and other disturbed areas. Left alone or restored these areas may revert back to more natural types like S\_CBO or S\_MEQ.

**CIR Signature:** On the imagery, polygons of H\_UPG exhibited a range of smooth colors from orange and pink for growing vegetation to gray and blue for dead and bare areas.



**Mapping Notes:** The H\_UPG map class was used to map transitional upland grasslands. The H\_TOB and H\_GRS map units were similar to the H\_UPG map unit but were more monotypic in nature. Other non-native and invasive grasses were found in the arid portions of BIBE, especially California cottontop (*Digitaria californica*) and Lehman's Lovegrass (*Eragrostis lehmanniana*). These grasses were never the dominant species however, and were always associated as an understory species in various desert shrub associations. The presence of non-native and invasive grasses was also noted in the BIBE vegetation map layer as a separate attribute.



Example photo signature (left) and range and distribution map (right).

## Sparse Vegetation

**Map Code**     **Badlands Sparse Vegetation**

**SP\_BAD**

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### Common Species

- Honey mesquite (*Prosopis glandulosa*)
- Creosotebush (*Larrea tridentata*)
- False grama (*Cathastecum erectum*)
- Big Bend dog cholla (*Grusonia aggeria*)
- Mound saltbush (*Atriplex obovata*)
- Littleleaf leadtree (*Leucaena retusa*)
- Fluffgrass (*Dasyochloa pulchella*)

### rUSNVC Association

– *Atriplex obovata* / *Tidestromia carnosa* Dwarf-shrubland (CEGL004575)



Representative Ground Photos.

### Description

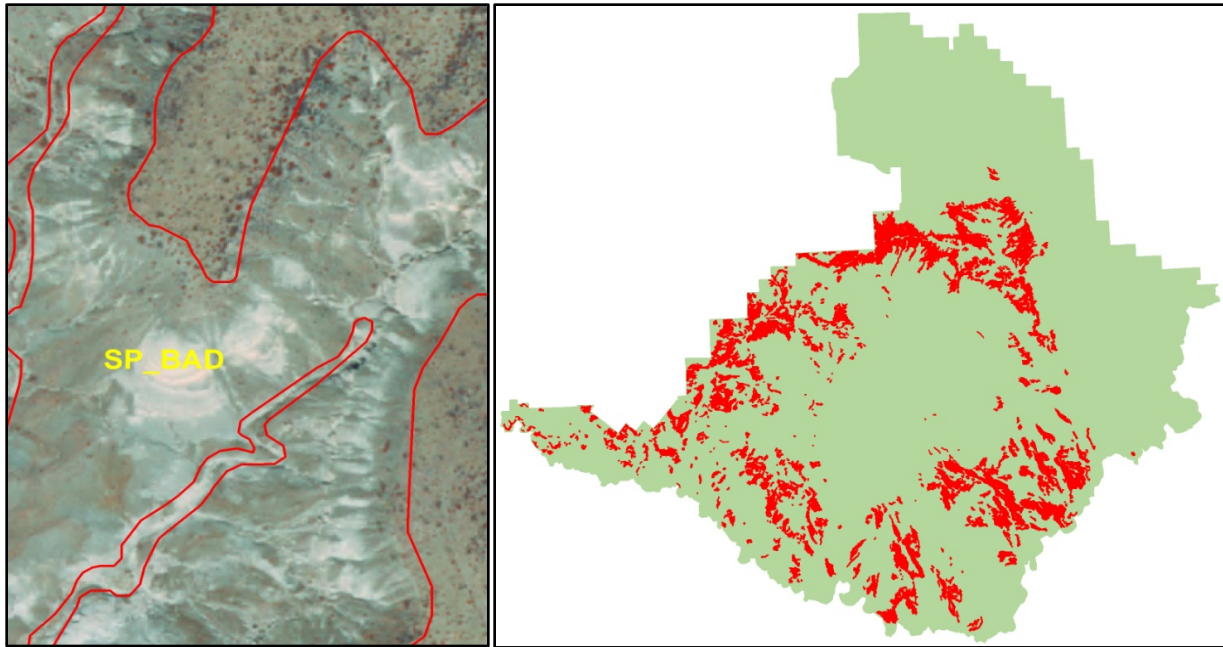
**Frequency:** Polygons of SP\_BAD were common throughout the mid and lower elevations at BIBE.

**Physiognomy:** The SP\_BAD map unit consisted of primarily very sparse, low-growing mixed desert shrubs and perennial herbaceous vegetation. Plant species composition varied by location.

**Condition:** Good – Fair. The SP\_BAD type was widespread throughout BIBE. The alkaline soil types and active erosion from water and wind likely makes plant establishment difficult in these locations.

**CIR Signature:** On the imagery, the various soil and geology colors were prevalent and variable. Common colors included swirls of white, gray, brown, and light pinks. Vegetation was mostly absent or appeared as small dots.

**Mapping Notes:** The SP\_BAD map unit was used to delineate almost barren badland formations. The SP\_LDES2 map unit was similar but vegetation was apparent and consistent on the imagery for this type.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Calcareous Outcrop Lichen and Sparse Vegetation**  
**SP\_CAL**

---

Common Species

- Creosotebush (*Larrea tridentata*)
- Lechuguilla (*Agave lechuguilla*)
- Eagle-claw cactus (*Echinocactus horizonthalonius*)
- Texas false agave (*Hechtia texensis*)
- Ocotillo (*Fouquieria splendens*)
- Whitethorn acacia (*Vachellia constricta*)
- Chino grama (*Bouteloua ramosa*)
- Fluffgrass (*Dasyochloa pulchella*)
- Resurrection plant (*Selaginella lepidophylla*)

rUSNVC Association

– Chihuahuan Desert Calcareous Outcrop Lichen Vegetation (NPSBIBE039) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Barren and sparsely vegetated polygons of SP\_CAL were common in the high limestone regions of the Dead Horse Mountains and on other high elevation limestone formations.

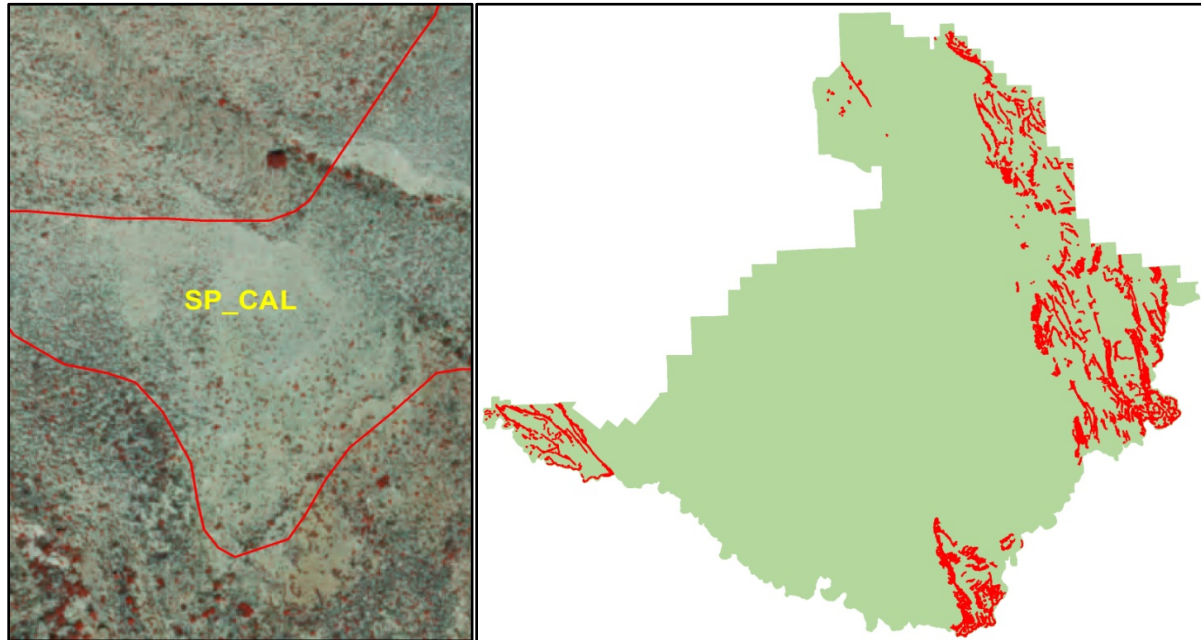
**Physiognomy:** SP\_CAL sites contained sparse evergreen shrubs, succulents, and grasses.

**Condition:** Good. SP\_CAL polygons represent mostly barren rock outcrops that may never support extensive stands of vegetation. Drought, freezing, and climate change may alter and affect this type.



**CIR Signature:** Polygons of SP\_CAL had the characteristic limestone white and blue colors and dark shadows were usually present. Sites with large rocks were coarse in texture and bedrock appeared smooth. Shrubs appeared as small red and brown dots.

**Mapping Notes:** High elevation limestone formations were common and were split from the nearby S\_CDS, S\_CHAP, and S\_YUC map units. Vegetated limestone talus was mapped with the S\_CTAL map unit. Similar sites on igneous rock were mapped with SP\_IGN. Rock outcrops at lower elevations were mapped with either SP\_CAL (limestone) or SP\_NCAL.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Montane Igneous Outcrop Lichen Vegetation**  
**SP\_IGN**

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Common Species

- (Peruvian) Spikemoss (*Selaginella peruviana*)
- Skeletonleaf goldeneye (*Viguiera stenoloba*)
- Copper fern (*Bommeria hispida*)
- Bull muhly grass (*Muhlenbergia emersleyi*)
- Wright's beebrush (*Aloysia wrightii*)
- Lipfern (*Cheilanthes* spp.)
- Foothill beargrass (*Nolina erumpens*)
- Sideoats grama (*Bouteloua curtipendula*)

rUSNVC Association

– Madrean Igneous Outcrop Lichen Vegetation (NPSBIBE037)



Representative Ground Photo.

Description

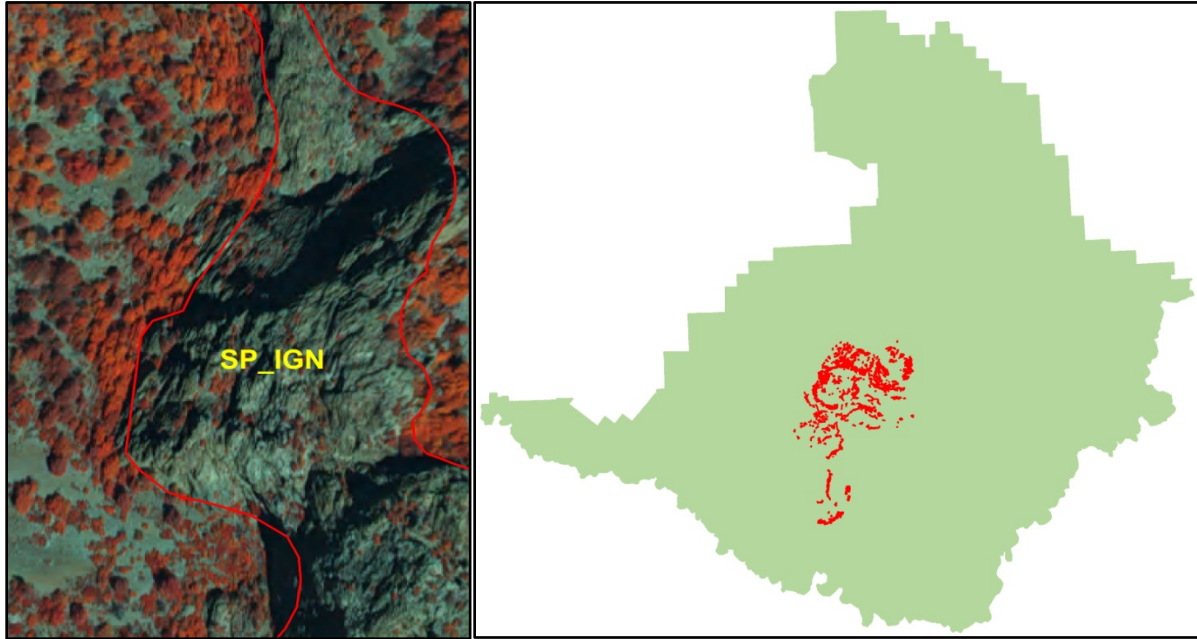
**Frequency:** Barren and sparsely vegetated polygons of SP\_IGN were common in the Chisos Mountains.

**Physiognomy:** SP\_IGN sites contained sparse deciduous shrubs and grasses along with some scattered low growing oak, pinyon pine and juniper trees.

**Condition:** Good. SP\_IGN polygons represent barren rock outcrops that may never support stands of vegetation.

**CIR Signature:** Polygons of SP\_IGN exhibited various colors and textures depending on the geologic parent material. Colors ranged from white to gray. Dark shadows were usually present. Sites with large rocks were coarse in texture and bedrock appeared smooth.

**Mapping Notes:** High elevation igneous rock formations were common in the Chisos Mountains. Sparse and unvegetated talus was mapped with a separate map unit (SP\_MTAL). Some SP\_IGN areas may contain small patches of S\_MMIX, W\_HOAK, or W\_PJ. Similar sites on limestone were mapped as SP\_CAL. Rock outcrops at lower elevations were mapped with either the SP\_NCAL (limestone) or SP\_NCAL map units.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Boquillas Basin Calcareous Creosotebush Desert Scrub**  
**SP\_LCAL**      **Boquillas Basin Calcareous *Larrea tridentata* Desert Scrub**

---

Common Species

- Creosote bush (*Larrea tridentata*)
- Lechuguilla (*Agave lechuguilla*)
- Eagle-claw cactus (*Echinocactus horizonthalonius*)
- Texas false agave (*Hechtia texensis*)
- Ocotillo (*Fouquieria splendens*)
- Whitethorn acacia (*Vachellia constricta*)
- Chino grama (*Bouteloua ramosa*)
- Fluffgrass (*Dasyochloa pulchella*)
- Resurrection plant (*Selaginella lepidophylla*)

rUSNVC Association

– *Larrea tridentata* – *Agave lechuguilla* – *Hechtia texensis* – *Echinocactus horizonthalonius*  
Shrubland (NPSBIBE011)



Representative Ground Photo.

Description

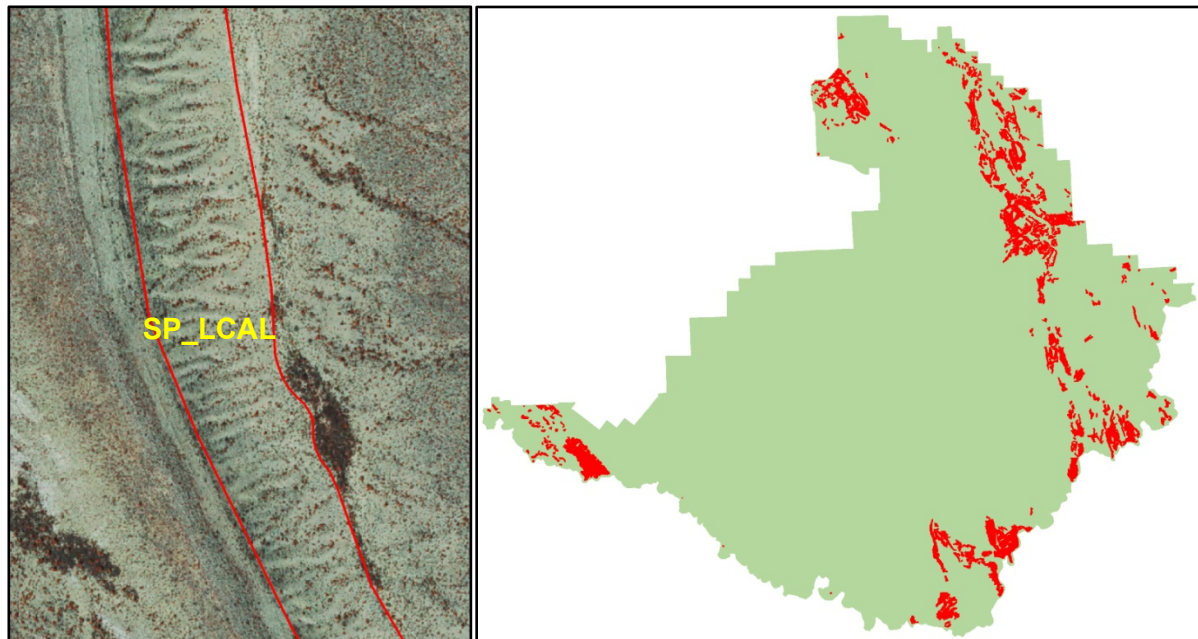
**Frequency:** Sparsely vegetated polygons of SP\_LCAL were common on limestone formations at low elevations.

**Physiognomy:** SP\_LCAL sites contained sparse evergreen shrubs, succulents, and grasses. Species composition and density may vary based on location.

**Condition:** Fair. SP\_LCAL polygons represent scrubby desert sites on limestone bedrock that are impacted by dry conditions. Drought, freezing, and climate change may alter and affect this type.

**CIR Signature:** Polygons of SP\_LCAL had the characteristic white and blue colors of the limestone substrate. Bands and drainage patterns were often apparent. The vegetation was mostly sparse and scattered with red and brown dots representing shrubs and small pink dots grasses and succulents.

**Mapping Notes:** Low elevation limestone formations were common and were split from the nearby S\_CDS map unit. Vegetated limestone talus was mapped with the S\_CTAL map unit. Similar sites on igneous rock were mapped with SP\_NCAL. Rock outcrops at higher elevations were mapped with either SP\_CAL (limestone) or SP\_IGN.



Example photo signature (left) and range and distribution map (right).



**Map Code      *Big Bend Lowlands (Flats, Benches, and Plateaus)***  
**SP\_LDES1**

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Common Species

- Creosote bush (*Larrea tridentata*)
- False grama (*Cathetecum erectum*)
- Chino grama (*Bouteloua ramosa*)
- Lechuguilla (*Agave lechuguilla*)
- Mound saltbush (*Atriplex obovata*)
- Christmas cactus (*Cylindropuntia leptocaulis*)
- Littleleaf leadtree (*Leucaena retusa*)
- Fluffgrass (*Dasyochloa pulchella*)
- Big Bend dog cholla (*Grusonia aggeria*)

rUSNVC Association

– *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathetecum erectum*  
Shrubland (NPSBIBE031-Park Special) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Sparsely vegetated polygons of SP\_LDES1 were common on flats, benches, low plateaus, and other non-limestone formations at low elevations in BIBE.

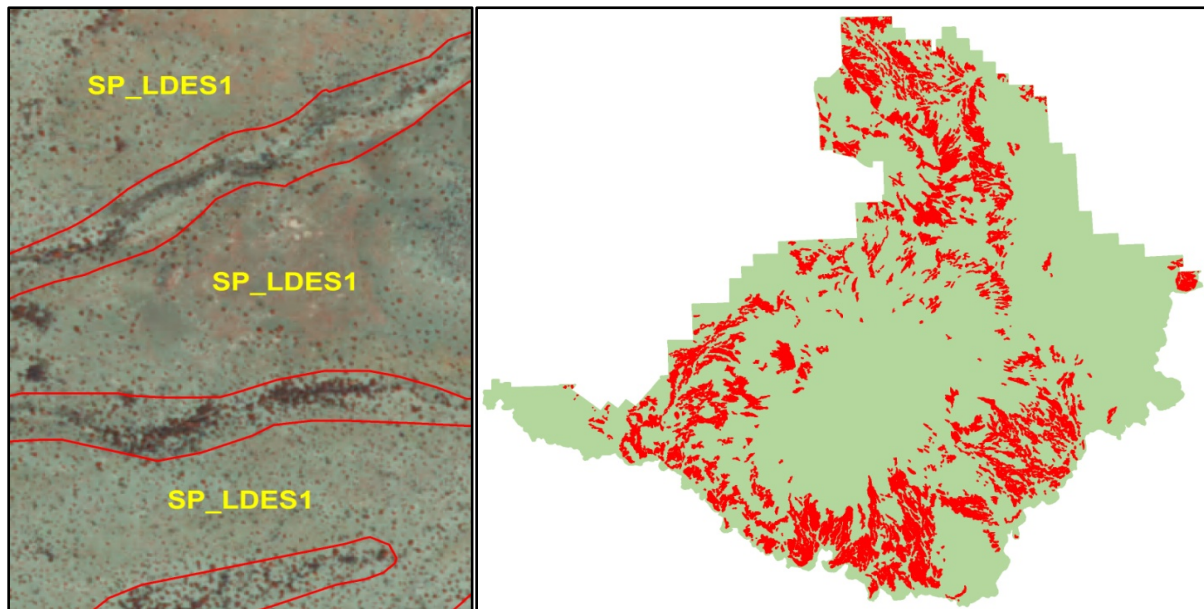
**Physiognomy:** SP\_LDES1 sites contained sparse evergreen shrubs, succulents, and grasses. Species composition and density varied based on location.

**Condition:** Fair. SP\_LDES1 polygons represent scrubby desert sites on various bedrock formations not including limestone. All areas are dry and receive little moisture. Drought, freezing, and climate change may affect this type.



**CIR Signature:** Polygons of SP\_LDES1 had various colors reflecting the different substrates. The vegetation was sparse and scattered with red and brown dots representing shrubs and pink dots grasses and succulents.

**Mapping Notes:** Low elevation scrub sites were common and were split into those types occurring on basalt (SP\_LDES3), and those on eroding slopes and hillsides (SP\_LDES2). S\_CB differed from this type due to the higher cover of creosotebush. The S\_CLAY map unit was also similar to this type but was restricted to flat clay and gypseous basins that were almost completely devoid of all vegetation.



Example photo signature (left) and range and distribution map (right).

**Map Code      *Big Bend Lowlands (Eroding Slopes, Hillsides, and Badlands)***  
**SP\_LDES2**

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Common Species

- False grama (*Cathastecum erectum*)
- Chino grama (*Bouteloua ramosa*)
- Lechuguilla (*Agave lechuguilla*)
- Mound saltbush (*Atriplex obovata*)
- Creosote bush (*Larrea tridentata*)
- Christmas cactus (*Cylindropuntia leptocaulis*)
- Littleleaf leadtree (*Leucaena retusa*)
- Fluffgrass (*Dasyochloa pulchella*)
- Big Bend dog cholla (*Grusonia aggeria*)

rUSNVC Association

– *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathastecum erectum*  
Shrubland (NPSBIBE031-Park Special) [Provisional]



Representative Ground Photos.

Description

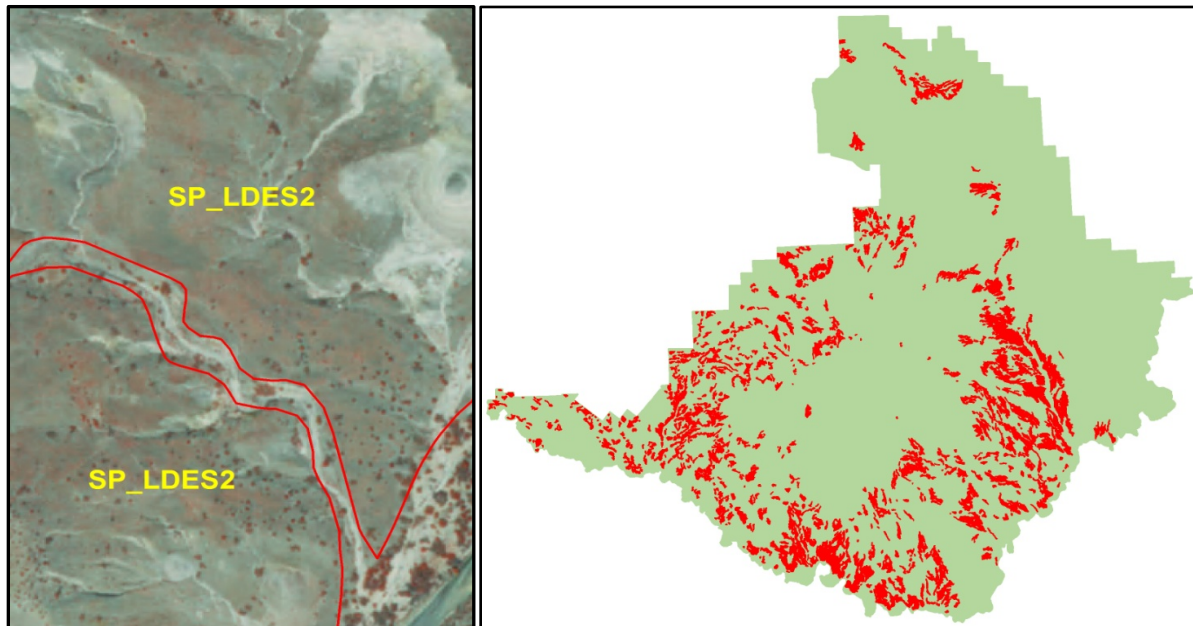
**Frequency:** Sparsely vegetated polygons of SP\_LDES2 were common on eroding slopes, hillsides, and other areas, some similar to badland formations at low elevations in BIBE.

**Physiognomy:** SP\_LDES2 sites contained sparse evergreen shrubs, succulents, and grasses. Species composition and density varied based on location.

**Condition:** Fair. SP\_LDES2 polygons represent scrubby desert sites on various eroding bedrock formations not including limestone. All areas are dry and receive little moisture. Drought, freezing, erosion, and climate change may affect this type.

**CIR Signature:** Polygons of SP\_LDES2 had various colors reflecting the different substrates. The vegetation was sparse and scattered with red and brown dots representing shrubs and pink dots grasses and succulents.

**Mapping Notes:** Low elevation scrub sites were common and were split into those types occurring on flatter areas (SP\_LDES1) and those occurring on basalt (SP\_LDES3). The SP\_BAD map unit differed from this type since it had little if any cover of vegetation.



Example photo signature (left) and range and distribution map (right).

**Map Code      *Big Bend Lowlands (Basalt, Lava, and Volcanic Rocks)***  
**SP\_LDES3**

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Common Species

- Rough jointfir (*Ephedra aspera*)
- Featherplume (*Dalea formosa*)
- Christmas cactus (*Cylindropuntia leptocaulis*)
- Fluffgrass (*Dasyochloa pulchella*)
- Creosote bush (*Larrea tridentata*)
- Big Bend dog cholla (*Grusonia aggeria*)
- Bastardsage (*Eriogonum wrightii*)

rUSNVC Association

– *Larrea tridentata* – *Cylindropuntia leptocaulis* / *Dasyochloa pulchella* – *Cathastecum erectum*  
Shrubland (NPSBIBE031-Park Special) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Sparsely vegetated polygons of SP\_LDES3 were common on basalt, lava and other volcanic formations at low elevations in BIBE.

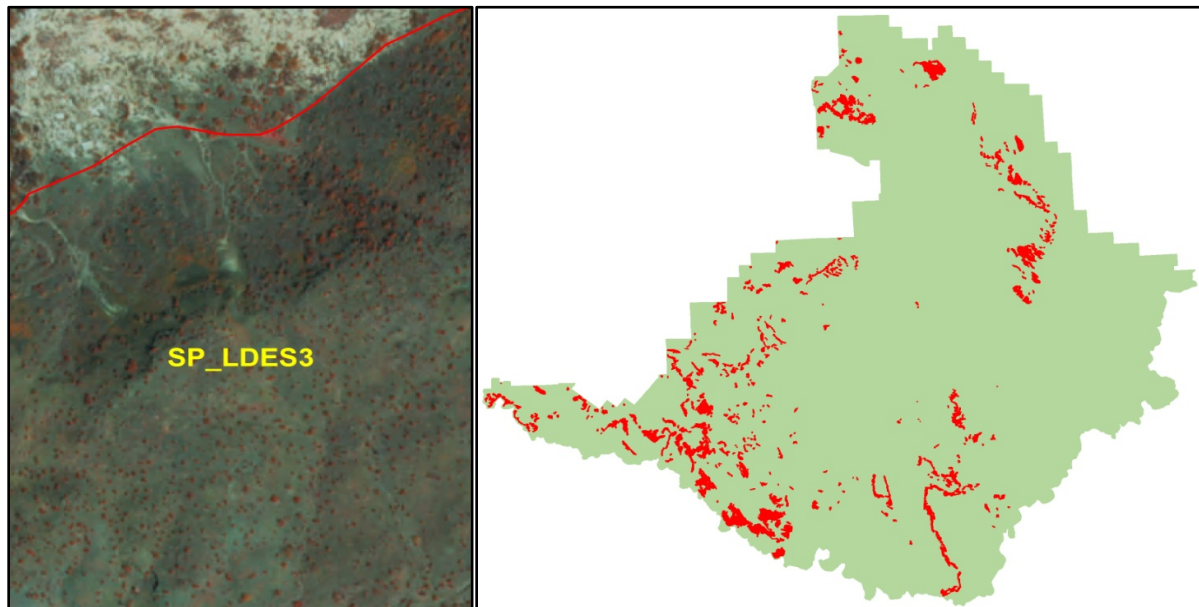
**Physiognomy:** SP\_LDES3 sites contained sparse evergreen shrubs, succulents, and grasses. Species composition and density varied based on location.

**Condition:** Fair. SP\_LDES3 polygons represent scrubby desert sites on various basalt and volcanic formations. All areas are dry and receive little moisture. Drought, freezing, erosion, and climate change may affect this type.



**CIR Signature:** Polygons of SP\_LDES3 had mostly a black or dark color reflecting the basalt substrate. The vegetation was sparse and scattered with red and brown dots representing shrubs and pink dots grasses and succulents.

**Mapping Notes:** Low elevation scrub sites were common and were split into those types occurring on flatter areas (SP\_LDES1) and those occurring on erosional hillsides and slopes (SP\_LDES2). The SP\_LDES3 map unit was mapped primarily based on the color and type of substrate. Small pockets of S\_CBO, S\_CB, and S\_MEQ likely occur within some polygons of this type.



Example photo signature (left) and range and distribution map (right).



**Map Code**      **Montane Talus and Cliff Rocky Sparse Shrubland**  
**SP\_MTAL**

---

Common Species

- Evergreen sumac (*Rhus virens*)
- Star cloak fern (*Notholaena standleyi*)
- Littleleaf ash (*Fraxinus greggii*)
- Cloakfern (*Astrolepis* spp.)
- Goldman's silktassel (*Garrya ovata* ssp. *goldmanii*)
- Skeletonleaf goldeneye (*Viguiera stenoloba*)
- Mexican buckeye (*Ungnadia speciosa*)
- Lipferns (*Cheilanthes*)

rUSNVC Association

– *Fouquieria splendens* – *Dasyllirion leiophyllum* / *Bouteloua curtipendula* – *Notholaena standleyi*  
Rocky Sparse Shrubland (NPSBIBE020) [Provisional]



Representative Ground Photo.

Description

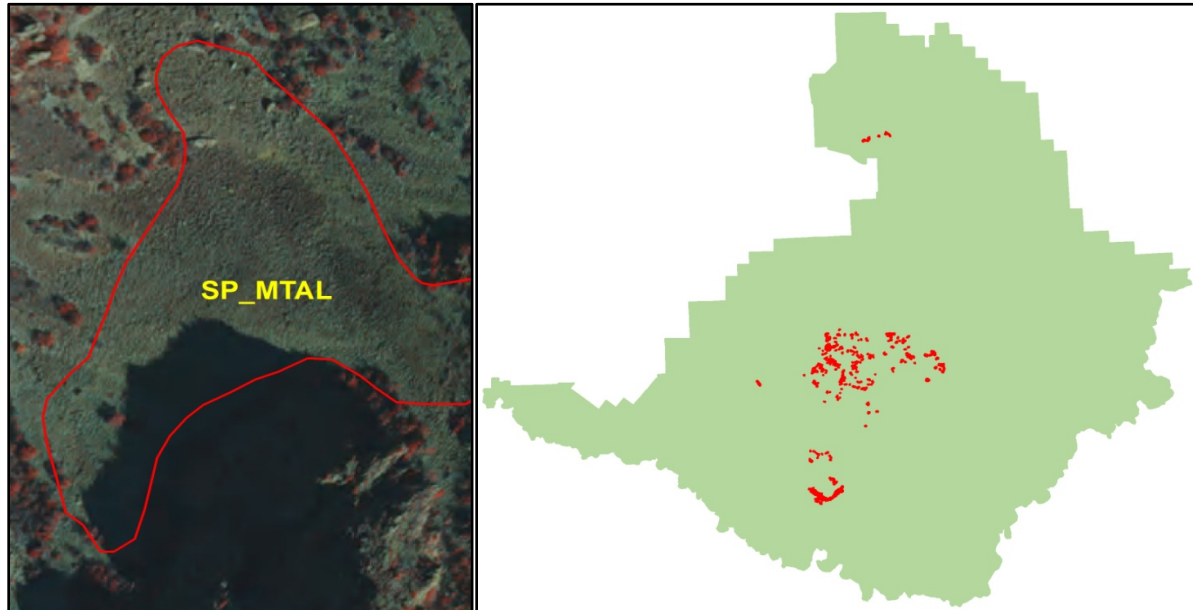
**Frequency:** SP\_MTAL was common at higher elevations throughout BIBE on eroding mountain slope formations.

**Physiognomy:** Polygons of SP\_MTAL often contained sparse vegetation consisting of short to medium size deciduous shrubs with a scattered grass and mesic forb/fern understory component.

**Condition:** Fair. SP\_MTAL is mostly a bare rock formation that contains some sparse vegetation. Local communities likely vary in composition and may be prone to small avalanches, erosion, and drought.

**CIR Signature:** Polygons of SP\_MTAL exhibited various colors and textures depending on the geologic parent material. Colors ranged from black to gray to tan and white. Textures were coarse for large cobbles and boulders and smooth for scree and talus.

**Mapping Notes:** Montane talus slopes with little (< 10% cover) or no vegetation cover were mapped with this map unit. Polygons of S\_MMIX, W\_PJ, W\_HOAK, and other montane types were often close by. The SP\_TAL map unit was used to map similar areas in the low desert and mid-elevation portions of BIBE. The S\_CTAL map unit was used to map similar sites on limestone formations.



Example photo signature (left) and range and distribution map (right).

**Map Code**      **Low Elevation Non-Calcareous Outcrop Lichen and Sparse Vegetation**  
**SP\_NCAL**

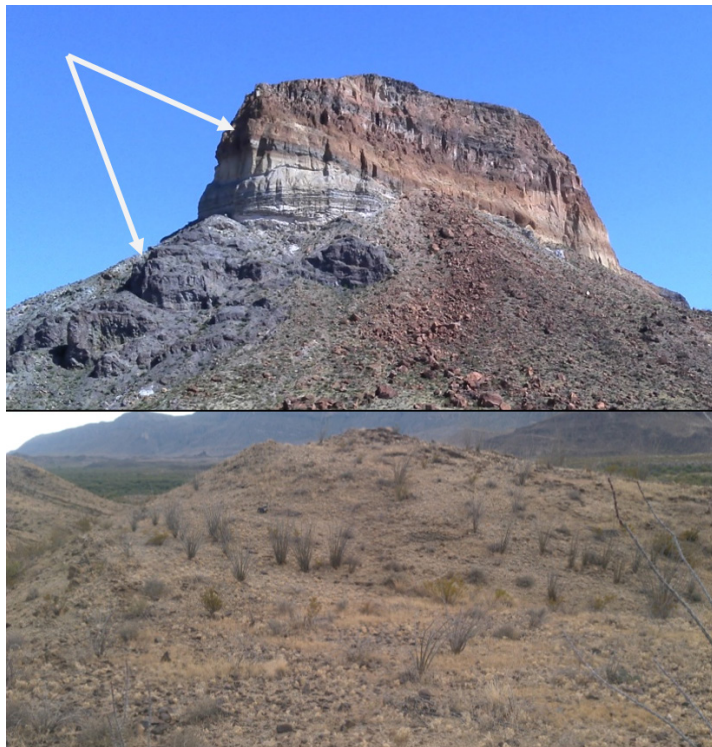
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Common Species

- Creosotebush (*Larrea tridentata*)
- Fluffgrass (*Dasyochloa pulchella*)
- Chino grama (*Bouteloua ramosa*)
- False grama (*Cathestecum erectum*)
- Lechuguilla (*Agave lechuguilla*)
- Big Bend dog cholla (*Grusonia aggeria*)

rUSNVC Association

– Chihuahuan Desert Non-calcareous Outcrop Lichen Vegetation (NPSBIBE038) [Provisional]



Representative Ground Photos.

Description

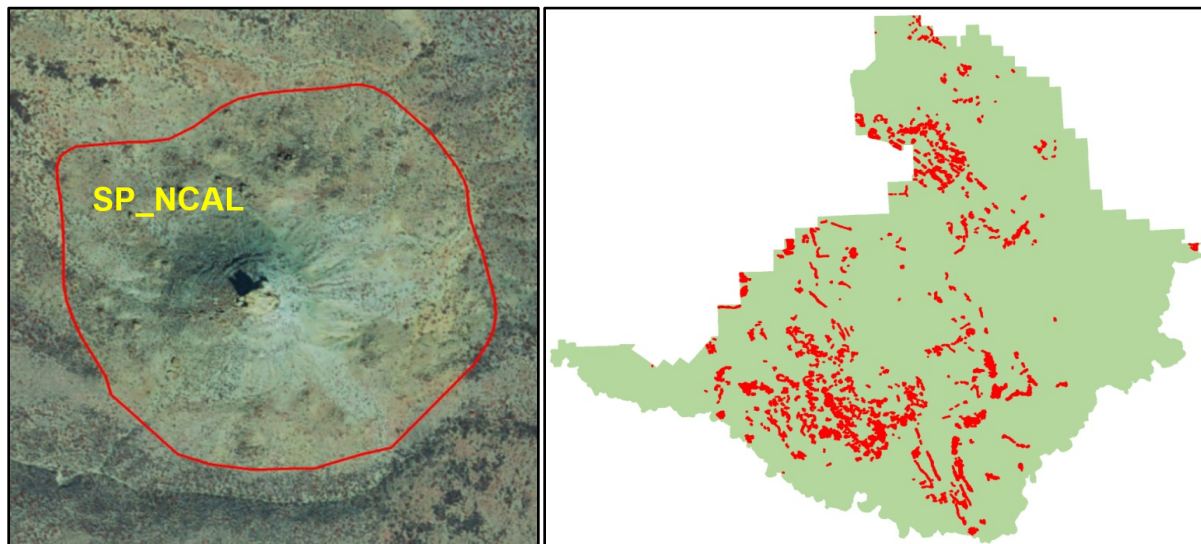
**Frequency:** Barren and sparsely vegetated polygons of SP\_NCAL were common throughout the low elevation portions of BIBE.

**Physiognomy:** SP\_NCAL sites contained sparse grasses and some low growing evergreen shrubs. Some areas (bottom picture) may have shrubs and grasses that have died or are dormant.

**Condition:** Good – Fair. SP\_NCAL polygons represent both barren rock outcrops that may never support vegetation and other areas with declining vegetation that has recently reverted to the rock substrate.

**CIR Signature:** Polygons of SP\_NCAL exhibited various colors and textures depending on the geologic parent material. Colors for this map unit ranged from gray to tan to white. Sites with large rocks were coarse in texture and bedrock appeared smooth.

**Mapping Notes:** Low elevation barren rock formations were mapped with the SP\_NCAL map unit. Sparse and unvegetated talus sites were mapped with a separate map unit. Some areas may have sparse or small vegetation patches of the H\_GRAM, S\_SOT, or S\_CBO map units. Similar sites in limestone were mapped with SP\_LCAL. Rock outcrops at higher elevations were mapped with either SP\_CAL (limestone) or SP\_IGN.



Example photo signature (left) and range and distribution map (right).



**Map Code**     **Rio Grande Alluvial Sparse Vegetation**  
**SP\_RIO**

---

Common Species

- Pretty sneezeweed (*Helenium elegans*)
- Salt heliotrope (*Heliotropium curassavicum*)
- Curly dock (*Rumex crispus*)
- Russian thistle (*Salsola tragus*)
- Tamarisk (Saltcedar) (*Tamarix ramosissima*)

rUSNVC Association

– Arid West Alluvial Bar Shrub Herbaceous Vegetation (NPSBIBE024) [Provisional]



Representative Ground Photo.

Description

**Frequency:** Polygons of SP\_RIO were restricted to the active Rio Grande River channel, recent floodplains, and portions of the larger tributaries that flow into it.

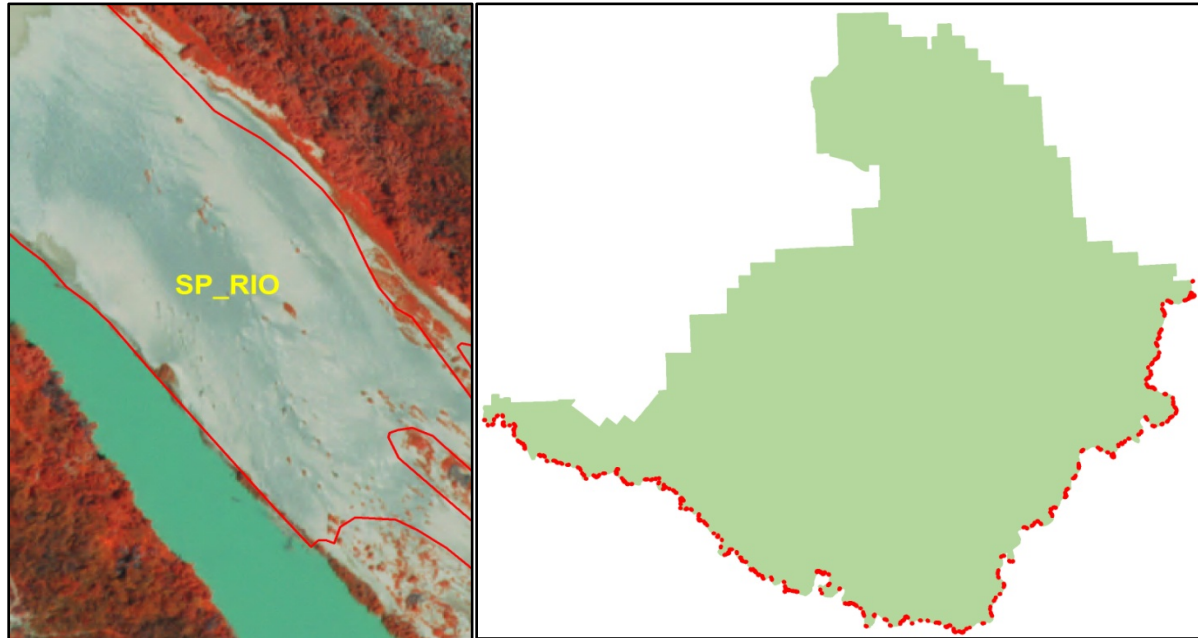
**Physiognomy:** The SP\_RIO type contained very sparse mixes of annual grasses, forbs, and early successional weedy shrubs.

**Condition:** Poor. SP\_RIO is an early successional type found on disturbed and previously inundated shorelines, drainages, and floodplains. The presence of this type likely indicates recent flooding, inundation, and disturbance.

**CIR Signature:** On the imagery, the SP\_RIO map unit had a strong soil and rock reflectance (usually white or gray) with scattered red, pink, and orange patches indicating low-growing vegetation.



**Mapping Notes:** SP\_RIO polygons are dynamic and may be wiped out with flooding and reappear in different locations. With less flooding these sites may evolve into other more established riparian types. The H\_RIO type was used to map similar areas that contained more cover of herbaceous vegetation.



Example photo signature (left) and range and distribution map (right).

**Map Code**     **Low Elevation Talus and Dune Sparse Vegetation**  
**SP\_TAL**

---

Common Species

- Leatherstem (*Jatropha dioica*)
- Blind pricklypear (*Opuntia rufida*)
- Lechuguilla (*Agave lechuguilla*)
- Ocotillo (*Fouquieria splendens*)
- Green sotol (*Dasylirion leiophyllum*)
- Sideoats grama (*Bouteloua curtipendula*)
- Buffelgrass (*Pennisetum ciliare*)
- False grama (*Cathastecum erectum*)

rUSNVC Associations

– *Jatropha dioica* – *Opuntia rufida* Talus Sparse Vegetation (NPSBIBE036) [Provisional]



Representative Ground Photo.

Description

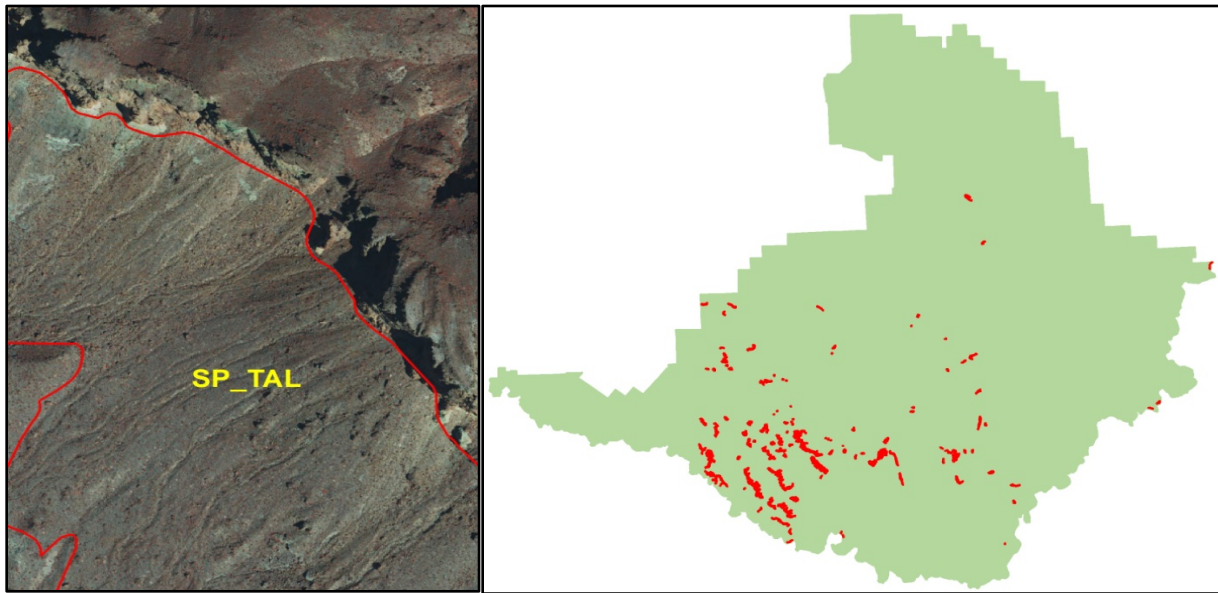
**Frequency:** SP\_TAL was common throughout BIBE on eroding hills and small mountain formations.

**Physiognomy:** Polygons of SP\_TAL often contained sparse vegetation consisting of short evergreen shrubs with a scattered grass understory component.

**Condition:** Fair. SP\_TAL is mostly a bare rock formation that contains some sparse vegetation. Local communities likely vary in composition and may be prone to small avalanches, erosion, and drought.

**CIR Signature:** Polygons of SP\_TAL exhibited various colors and textures depending on the geologic parent material. Colors ranged from gray to tan to white. Textures were coarse for large cobbles and boulders and smooth for scree and talus.

**Mapping Notes:** Talus slopes with little (< 5% cover) or no vegetation cover were mapped with this map unit. Two associations are within this type. The leatherstem-blind prickly pear association represents lower elevation sites and the ocotillo type occurs higher in elevation—more towards the middle of BIBE. The SP\_MTAL map unit was used to map similar areas in the Chisos and other higher mountain ranges. The S\_CTAL map unit was used to map similar sites on limestone formations.



Example photo signature (left) and range and distribution map (right).

**Map Code      *Big Bend Lowlands Sparsely Vegetated Wash Channel***  
**SP\_WASH**

---

Common Species

- Creosotebush (*Larrea tridentata*)
- Singlewhorl burrobrush (*Hymenoclea monogyra*)
- Trans-Pecos poreleaf (*Porophyllum scoparium*)
- Desert willow (*Chilopsis linearis*)
- False grama (*Cathestecum erectum*)
- Fluffgrass (*Dasyochloa pulchella*)
- Russian thistle (*Salsola tragus*)
- Whitethorn acacia (*Vachellia constricta*)
- Roemer's catclaw (*Senegalia roemeriana*)

rUSNVC Association

– *Hymenoclea monogyra* – *Chilopsis linearis* – *Porophyllum scoparium* Shrubland (NPSBIBE014)  
[Provisional]



Representative Ground Photo.

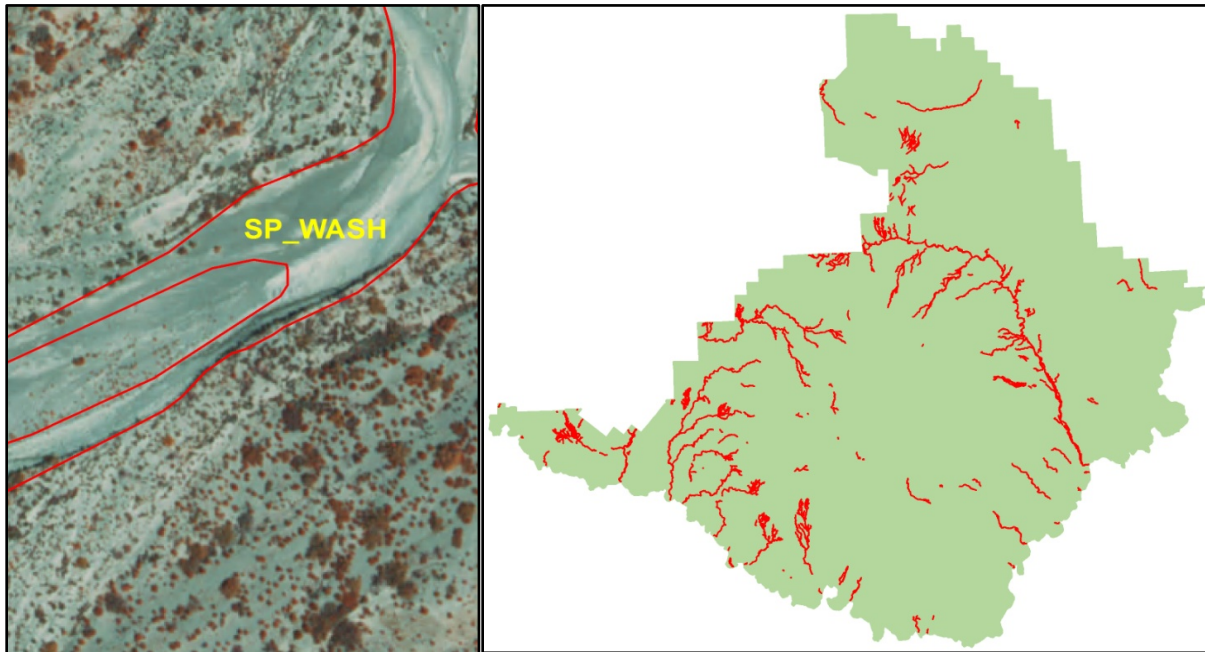
Description

**Frequency:** Sparse and barren washes and drainages were very common throughout the lower portions of BIBE.

**Physiognomy:** Polygons of SP\_WASH were mostly absent of vegetation. Some small isolated patches of short evergreen shrubs, bunch grasses, and other early successional species may be present.

**Condition:** FAIR. All desert washes are prone to flash flooding and erosion. Some SP\_WASH areas may become S\_WASH or S\_TMIX sites in the future.

**CIR Signature:** Polygons of SP\_WASH had a characteristic smooth, linear pattern with obvious drainage channels. **Mapping Notes:** The SP\_WASH is a variant of the S\_WASH type. The SP\_WASH map unit was used to map the very complex, low elevation desert washes and drainages that were mostly devoid of vegetation. The importance of hydrology and drainage patterns at BIBE influenced the mapping of this type.

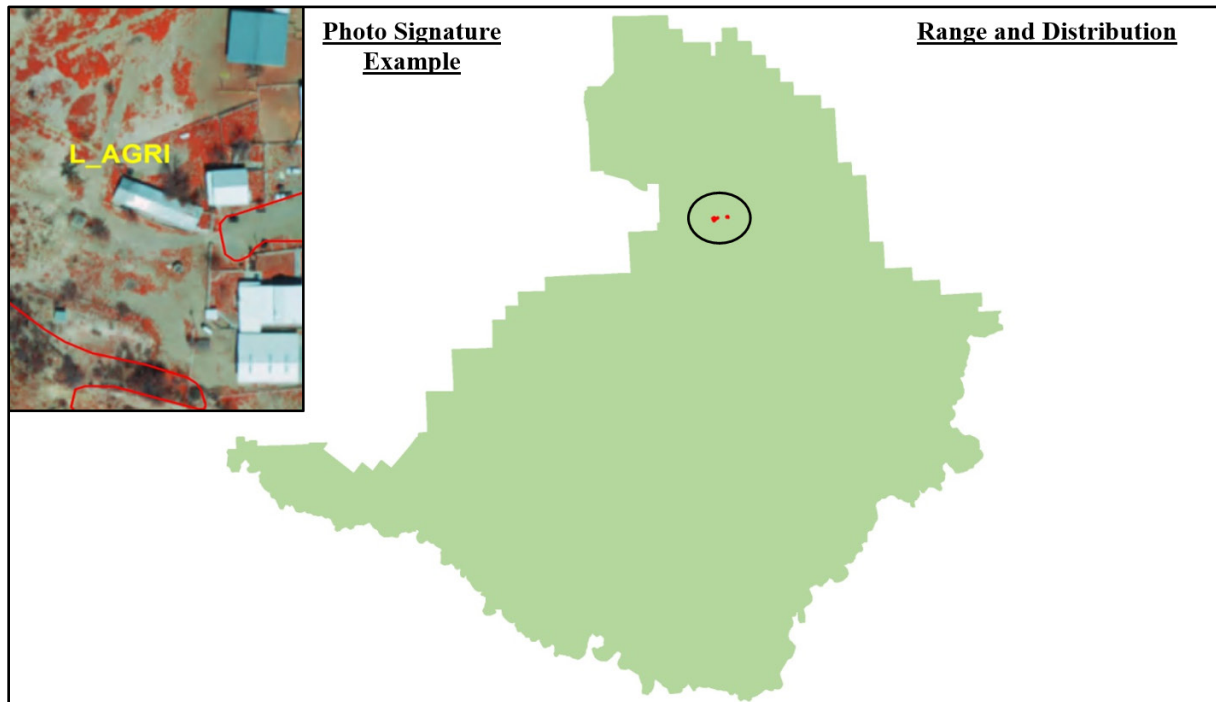


Example photo signature (left) and range and distribution map (right).



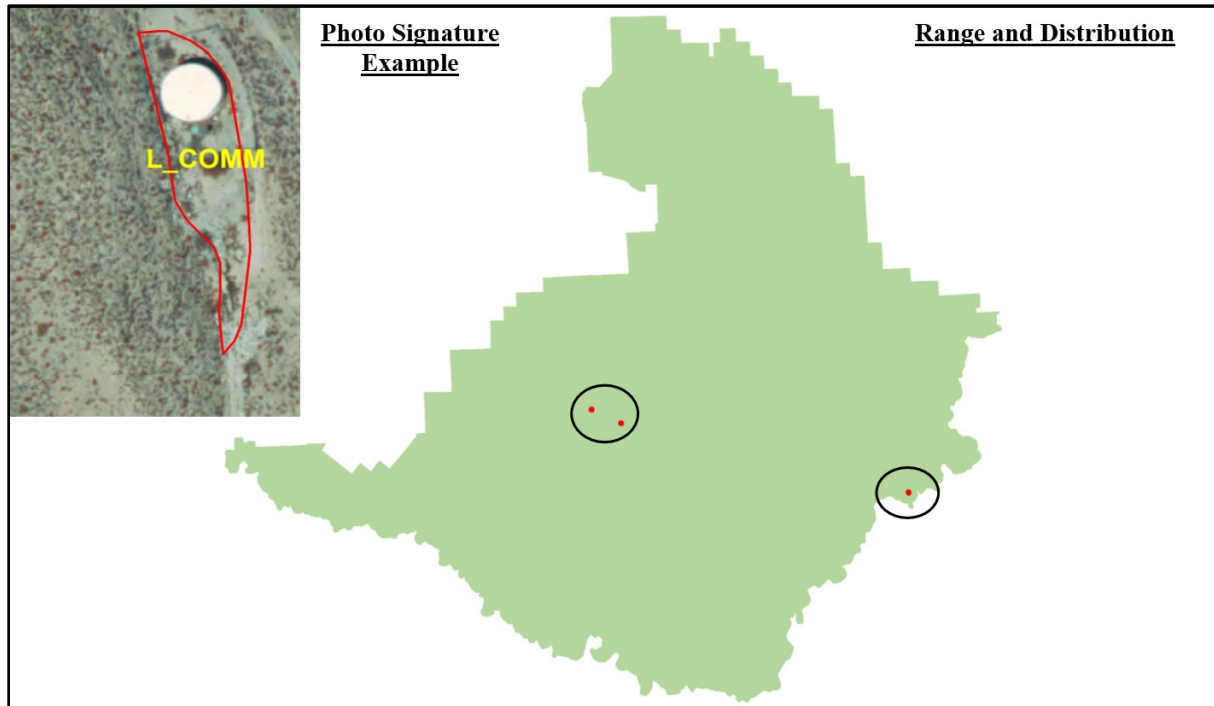
## LAND USE – LAND COVER

**L\_AGRI**      *Agricultural Business / Ranches*



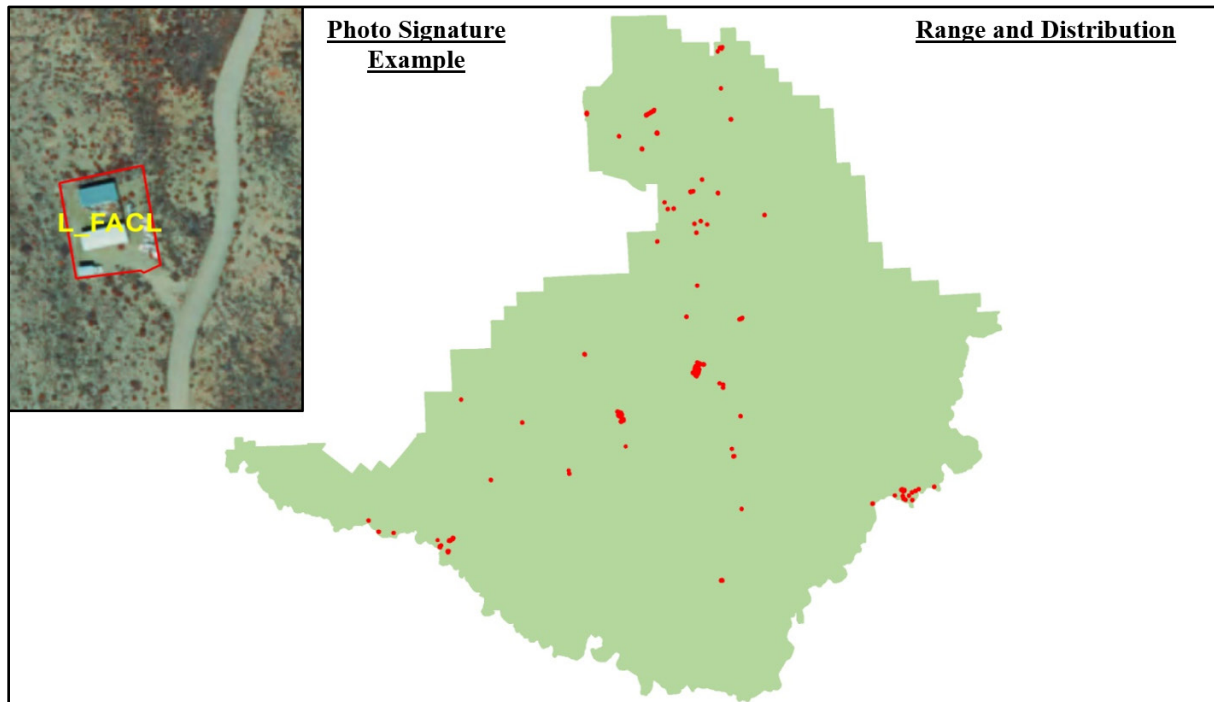
Example photo signature (left) and distribution map (right) for Agricultural Business / Ranches.

***L\_COMM      Communications and Utilities***



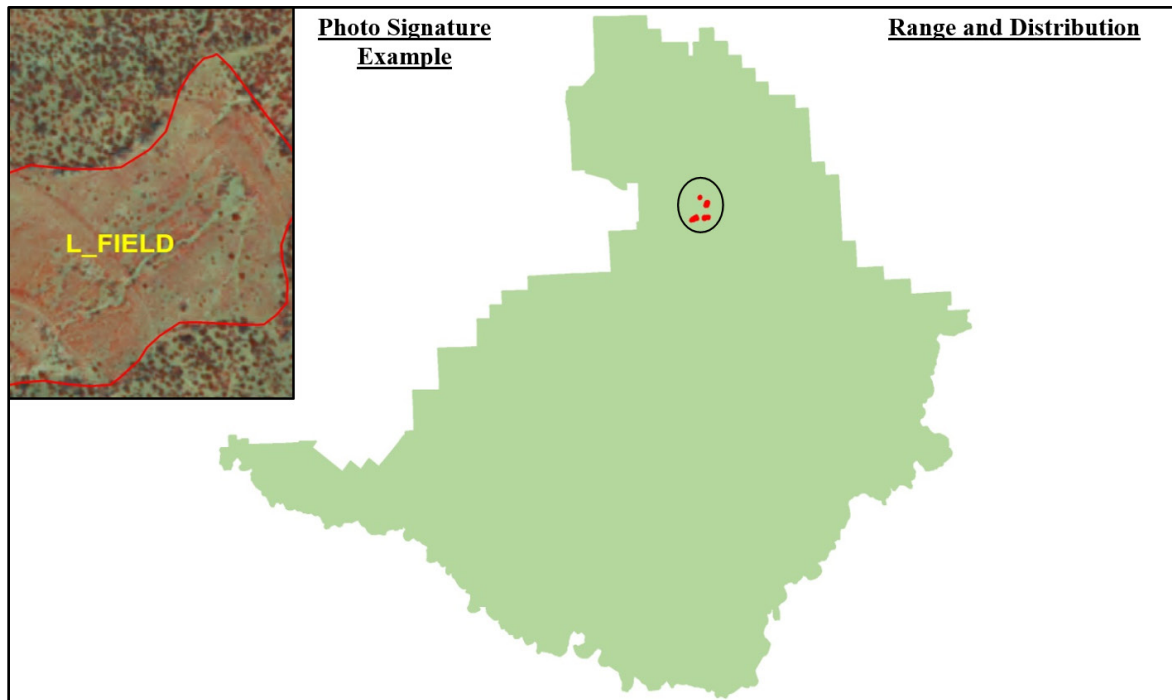
Example photo signature (left) and distribution map (right) for Communications and Utilities.

***L\_FACL      NPS and Other Facilities***



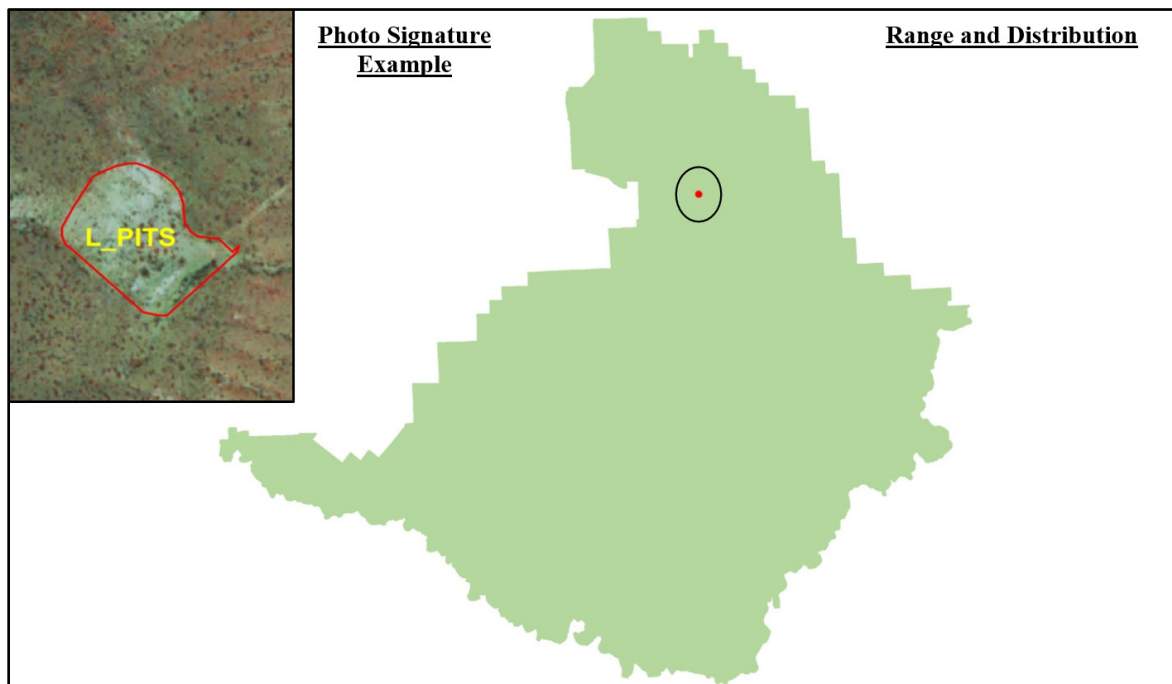
Example photo signature (left) and distribution map (right) for NPS and Other Facilities.

***L\_FIELD***      ***Planted / Cultivated / Fallow Fields and Pastures***



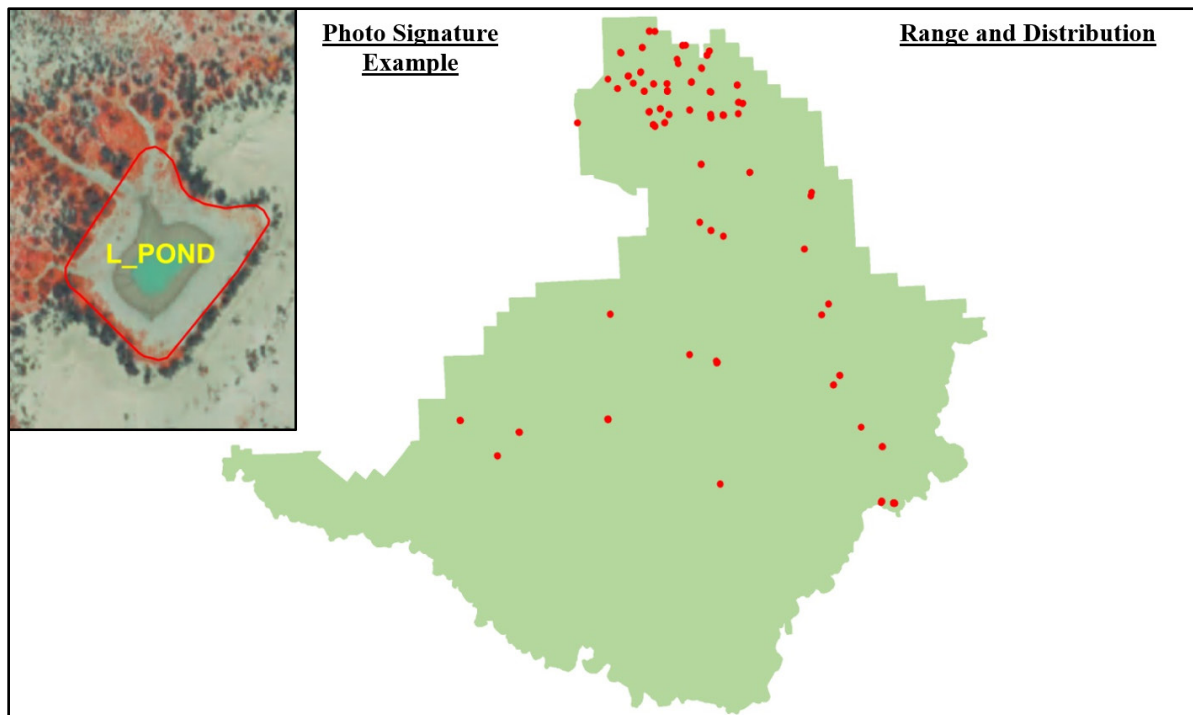
Example photo signature (left) and distribution map (right) for Planted / Cultivated / Fallow Fields and Pastures.

***L\_PITS***      ***Quarries / Strip Mines / Gravel Pits***



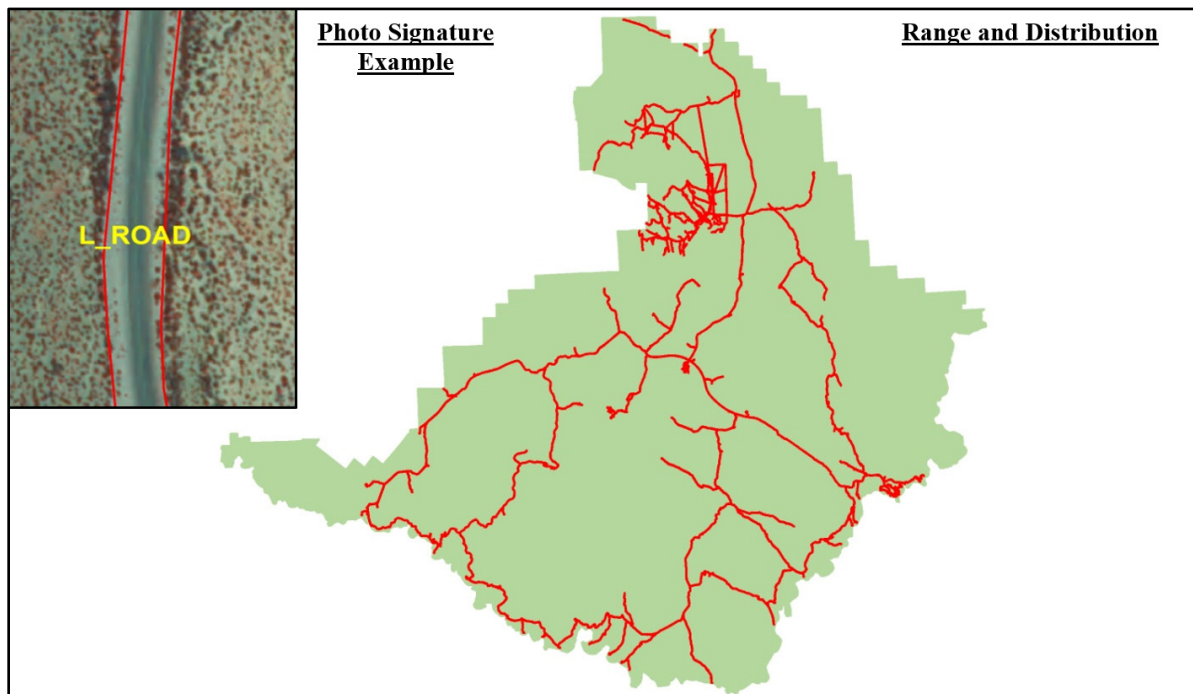
Example photo signature (left) and distribution map (right) for Quarries / Strip Mines / Gravel Pits.

***L\_POND      Small Lake / Pond / Watering Catchments***



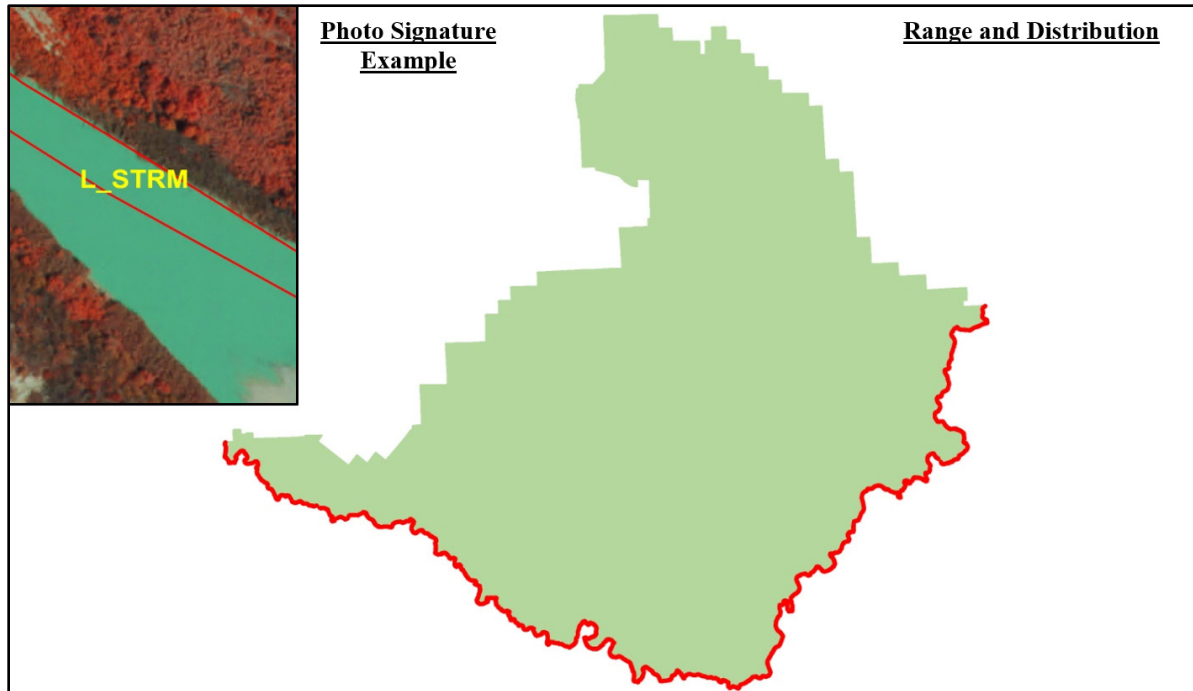
Example photo signature (left) and distribution map (right) for Small Lake / Pond / Watering Catchments.

***L\_ROAD      Main Roads and Transportation Structures***



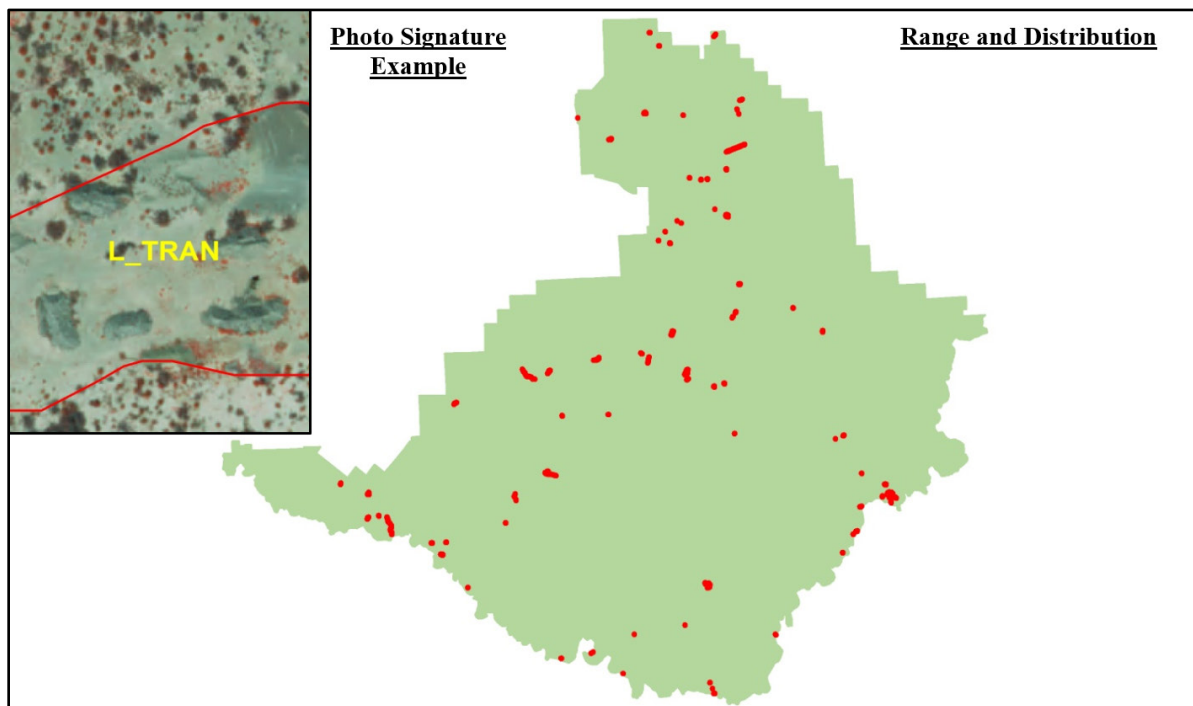
Example photo signature (left) and distribution map (right) for Main Roads and Transportation Structures.

***L\_STRM***      ***Stream / River***



Example photo signature (left) and distribution map (right) for Stream / River.

***L\_TRAN***      ***Transitional Area***

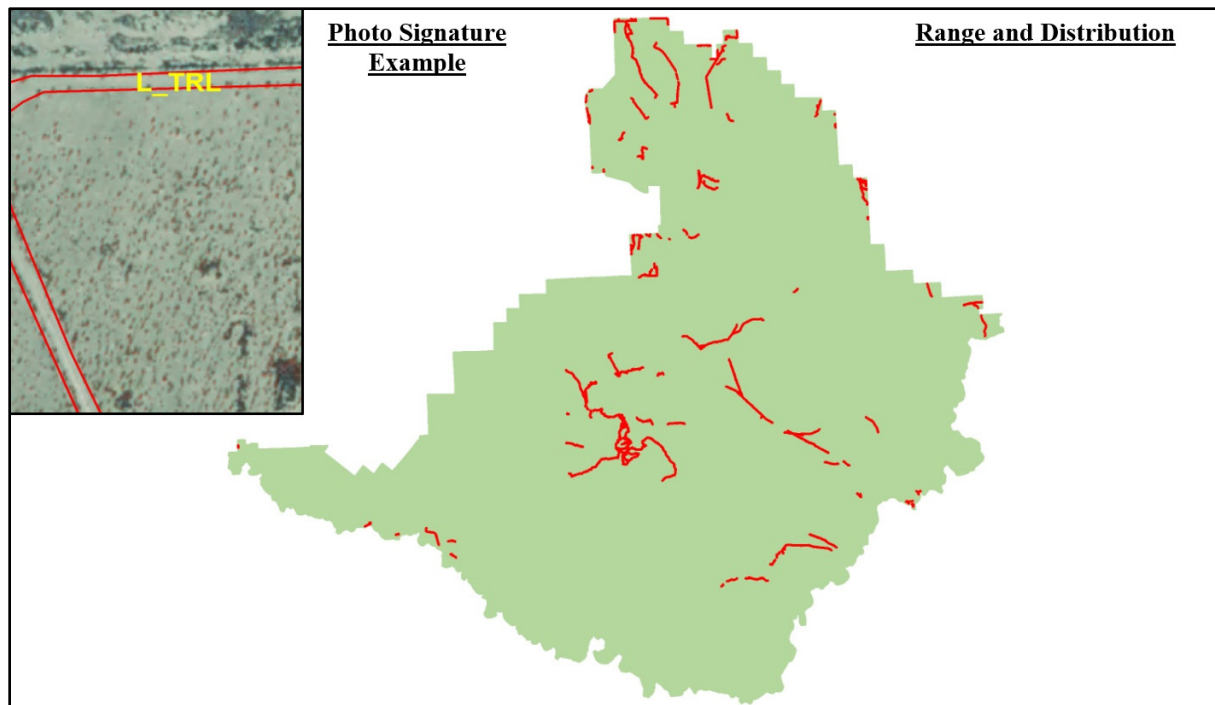


Example photo signature (left) and distribution map (right) for Transitional Area.



***L\_TRL***

***Trails and Two-Track Roads***



Example photo signature (left) and distribution map (right) Trails and Two-Track Roads.

## Appendix F: BIBE Vegetation Maps

The following pages contain the fine scale vegetation map legend (Figure F-1), fine scale vegetation map (Figure F-2), and coarse scale vegetation map for the Big Bend National Park Vegetation Inventory Project (Figure F-3).



**Figure F-1a.** Legend for the Big Bend National Park Vegetation Map.



**Vegetation Inventory Project**

**Fine Scale Vegetation Map Legend (continued)**

**Chihuahuan Non-Calcareous Desert Scrub**

- Big Bend Lowlands (Basalt, Lava, and Volcanic Rocks)
- Big Bend Lowlands (Eroding Slopes, Hillsides, and Badlands)
- Big Bend Lowlands (Flats, Benches, and Plateaus)
- Creosotebush - Ocotillo - Lechuguilla Mixed Desert Scrub
- Creosotebush Desert Scrub
- Mesquite - Creosotebush Desert Scrub

**Chihuahuan Non-Calcareous High Desert Shrub and Grassland**

- Chino Grama Shrub Grassland
- Sotol - Lechuguilla Foothills Shrub Grassland

**Non-Calcareous Chaparral**

- Coahuila Scrub Oak Chaparral
- High Chisos Gray Oak - Mountain Mahogany Chaparral
- Low Montane Mixed Shrub - Sideoats Grama Shrubland
- Montane Mixed Chaparral
- Redberry Juniper - Sotol Shrubland

**Foothills Riparian Wash Scrub**

- Foothills Wash Channel Shrubland
- Persimmon - Littleleaf Ash Foothills Shrubland

**Montane Cliff, Scree, and Rock Vegetation**

- Lechuguilla - Spikemoss Rocky Shrub H. V.
- Montane Igneous Outcrop Lichen Vegetation
- Montane Talus and Cliff Rocky Sparse Shrubland

**Low Montane and Foothills Wood and Grass land**

- Alligator Juniper - Pinyon Pine - Gray Oak Woodland
- Bull Muhly Montane Grassland
- Dry - Mesic Pinyon Pine - Oak - Juniper Woodland
- Dry Pinyon Pine Woodland
- Emory Oak Woodland
- Finestem Needlegrass Montane Grassland
- Lacey's Oak Woodland
- Lechuguilla - Spikemoss Rocky Shrub H.V.

**High Montane Forest and Woodland**

- Arizona Cypress - Graves' Oak - Pinyon Pine Forest
- Arizona Pine - Graves' Oak Forest
- Graves' Oak - Bigtooth Maple Forest
- Graves' Oak - Emory Oak Canyon Forest
- High Chisos Oak - Pine Forest

**Land-use and Land-cover**

- Agricultural Business / Ranches
- Communications and Utilities
- Main Roads and Transportation Structures
- NPS and Other Facilities
- Planted / Cultivated / Fallow Fields and Pastures
- Quarries / Strip Mines / Gravel Pits
- Small Lake / Pond / Watering Catchments
- Stream / River
- Trails and 2-Track Roads
- Transitional Area

**Figure F-1b.** Legend for the Big Bend National Park Vegetation Map.





## Vegetation Inventory Project

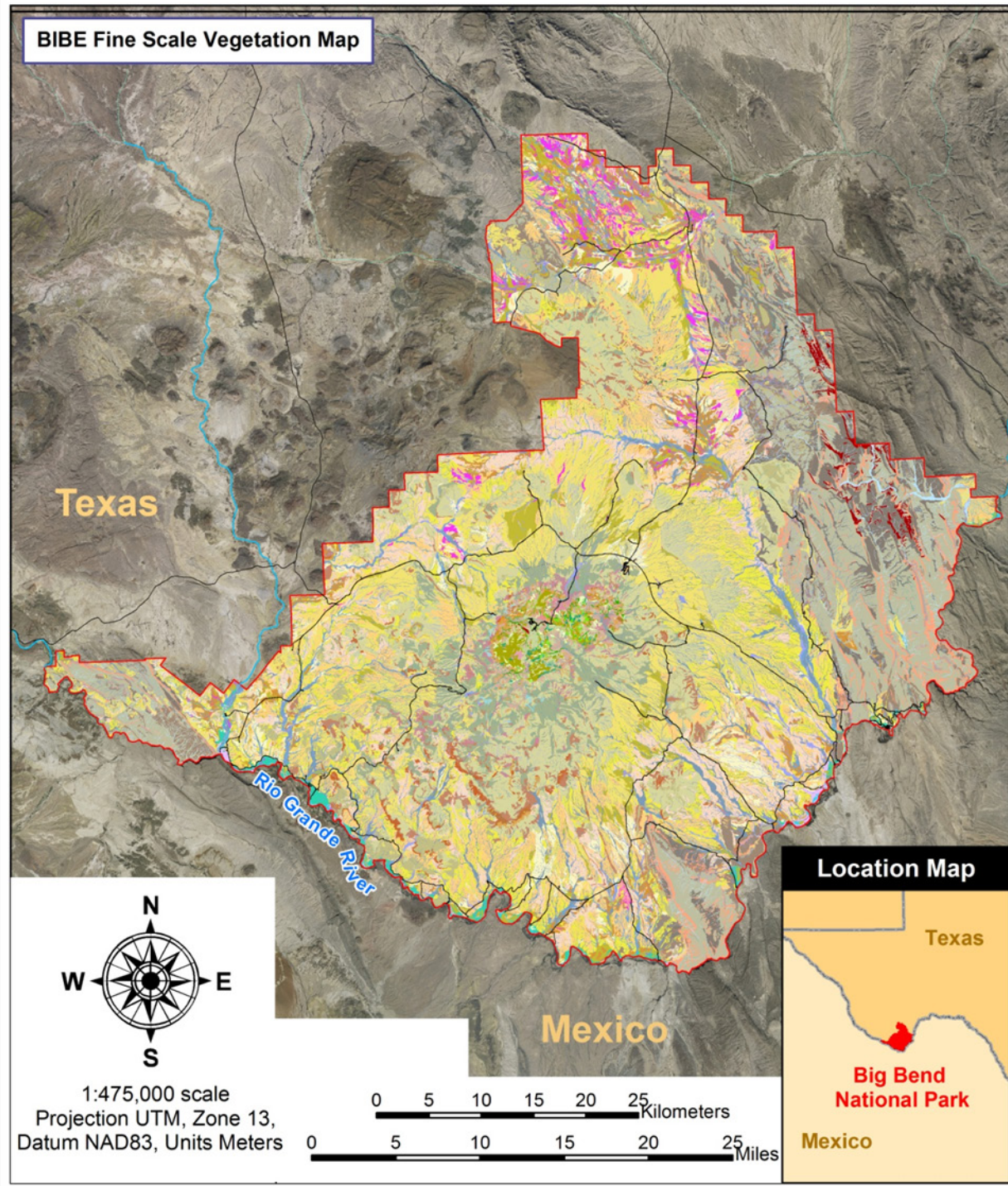


Figure F-2. Fine Scale Vegetation Map for Big Bend National Park.

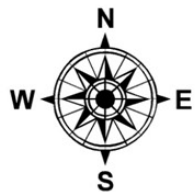




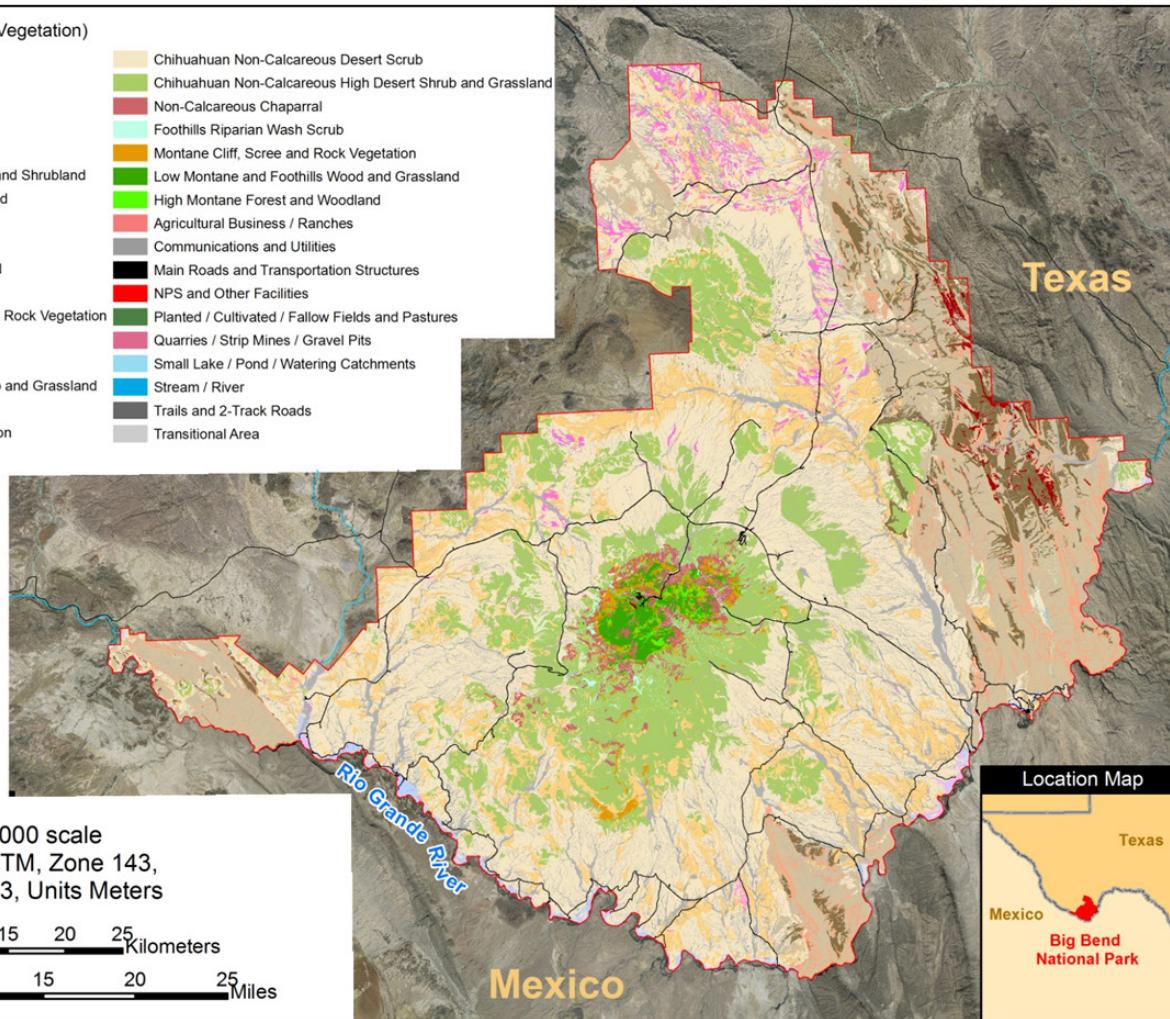
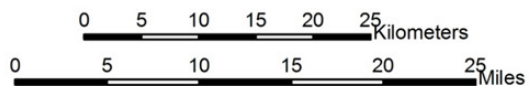
## Vegetation Inventory Project

### Overview Map Legend (Coarse Scale Vegetation)

- |  |   |
|--|---|
| Major Roads  | Chihuahuan Non-Calcareous Desert Scrub                    |
| Rivers and Streams   | Chihuahuan Non-Calcareous High Desert Shrub and Grassland |
| Intermittent Streams                                       | Non-Calcareous Chaparral                                  |
| Perennial Rivers and Streams                               | Foothills Riparian Wash Scrub                             |
| BIBE and Project Boundary                                  | Montane Cliff, Scree and Rock Vegetation                  |
| Lowland Freshwater Marsh, Wet Meadow and Shrubland         | Low Montane and Foothills Wood and Grassland              |
| Ruderal Marsh, Wet Meadow and Shrubland                    | High Montane Forest and Woodland                          |
| Warm and Cool Desert Riparian Forest                       | Agricultural Business / Ranches                           |
| Ruderal Flooded Forest and Shrubland                       | Communications and Utilities                              |
| Warm Desert Ruderal Scrub and Grassland                    | Main Roads and Transportation Structures                  |
| Tree Developed Vegetation                                  | NPS and Other Facilities                                  |
| Low Elevation Semi-Desert Cliff, Scree and Rock Vegetation | Planted / Cultivated / Fallow Fields and Pastures         |
| Warm Desert Riparian Wash Scrub                            | Quarries / Strip Mines / Gravel Pits                      |
| Chihuahuan Calcareous Desert Scrub                         | Small Lake / Pond / Watering Catchments                   |
| Chihuahuan Calcareous High Desert Shrub and Grassland      | Stream / River  |
| Calcareous Chaparral                                       | Trails and 2-Track Roads                                  |
| Calcareous Cliff, Scree, and Rock Vegetation               | Transitional Area   |



1:500,000 scale  
Projection UTM, Zone 143,  
Datum NAD83, Units Meters



**Figure F-3.** Coarse Scale Vegetation Map for Big Bend National Park.





The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 155/176675, July 2021

National Park Service  
U.S. Department of the Interior



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**[Natural Resource Stewardship and Science](#)**

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