

# Vegetation of the Barry M. Goldwater Range West, Marine Corps Air Station – Yuma, Arizona

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## Summary

The purpose of this Cooperative Agreement was to develop a comprehensive vegetation map for the Barry M. Goldwater Range West (BMGR West) under management by the Marine Corps Air Station Yuma (MCAS Yuma), Yuma, Arizona. The vegetation map will allow effective management of the vegetation communities on the BMGR West and also provide a baseline for ecosystem management. The vegetation survey and mapping effort was conducted in support of the Integrated Natural Resources Management Plan (INRMP) dated March 2007 prepared by MCAS Yuma under the Sikes Act Improvement Amendments of 1997.

Items delivered:

- Paper maps, ArcGIS file geodatabase (BMGRW\_Veg.gdb), shapefile, and layer files of the existing vegetation of Barry M. Goldwater Range West, at three levels: alliance, association, and subassociation.
- Access database of 656 relevés (field samples).
- 656 digital photos, one for each relevé.
- GPX file of routes taken by the authors
- Final report

Nearly 700,000 acres were mapped over a period of five years, of lands ranging from mountain summits to dune fields, from over 3000 feet to less than 200 feet above sea level. The minimum mapping unit was one hectare, or 2.4 acres. Each vegetation type is described and quantified via plotless samples called “relevés.” A total of 656 relevés were taken. The resulting database holds quantitative and qualitative data – site description, ground cover, prominence, and height – for almost 300 species across the BMGR West. All mapped units (vegetation types) were named following the conventions of the National Vegetation Classification (NVC).

The majority of the BMGR West is part of Mojave-Sonoran Semi-Desert Scrub Macrogroup, which covers most of the Mojave and Sonoran deserts in the southwestern United States. Within this macrogroup there are six alliances: creosote, bursage, saltbush, brittlebush, watercourse, and blue paloverde. Within these alliances are 23 associations, such as creosote – teddy bear cholla. Finally, within these associations are 40 subassociations, the most detailed mapping unit, and often with reference to a particular landform, such as creosote-white bursage/ocotillo on ridges.

The remainder of the BMGR West falls under the Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup. This vegetation is characterized by shrubs like Mormon tea (*Ephedra*), and is restricted to the north slopes of the higher mountains. Within this Macrogroup there is one alliance, two associations, and two subassociations on the BMGR West.

The final report provides descriptions and illustrations of all mapped units, as well as a summary of notable landforms and previous vegetation maps of the BMGR West.

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## Introduction

The Barry M. Goldwater Range (BMGR) encompasses about 1.113 million hectares (2.8 million acres) of southwestern Arizona, including the restricted airspace above the Cabeza Prieta National Wildlife Refuge (CPNWR). Because public access is restricted, the BMGR is relatively undisturbed, and an important element of our nation's biodiversity. These lands support charismatic species like badger, lion, bighorn, Sonoran pronghorn, mule deer, desert tortoise, and flat-tailed horned lizard, and literally countless others vertebrates and invertebrates. A complete inventory of the biological resources is impossible – the area is too vast – yet the last decade has seen much progress in mapping the basis of wildlife on the BMGR: the vegetation.

There is also an aesthetic value to vegetation, which is one reason we fret over the human-introduced species like Sahara mustard (*Brassica tournefortii*): we wish to preserve the beauty and diversity of a pre-industrial world, and our military bases offer some of our best opportunities. With good maps, our military bases can serve our troops with top-notch training, as well as place on-the-ground training in the proper areas – say, a creosote flat instead of area of moving sands that might harbor rare plants whose importance we don't know – and are pretty, too.

Following the protocol of Warren et al. (1981) in mapping the vegetation of Organ Pipe Cactus National Monument, virtually all of the BMGR has been mapped: The eastern half of the CPNWR, as well as the BLM lands in the Ajo Block (Malusa 2003a, b); the North and South Tactical Ranges (McLaughlin et al, 2007); the East Tactical Range and Area B (Osmer et al., 2009); the western San Cristobal Valley (Shepherd, 2011); and the eastern San Cristobal Valley, Aguila Mountains, and Sentinel Plain (Whitbeck, 2013). Mapping continues in the Crater Range and Black Gap (Jaron Weston and Jeff Fehmi, University of Arizona, in progress), and the western portion of the CPNWR (Malusa, in progress). When the CPNWR is completed in 2019, all of southwestern Arizona will be mapped using a common methodology and mapping units.

The western portion of the Goldwater (BMGR West), nearly 700,000 acres managed by the Marine Corps Air Station (MCAS) Yuma, is the subject of this report. Fieldwork for the vegetation mapping of the BMGR West began in 2009, and was completed in 2014. The resulting vegetation map is presented here at the alliance, association, and the subassociation levels, reflecting the hierarchical structure of the Federal Geographic Data Committee's standards for the National Vegetation Classification (2008). Alliance is the broadest level, while subassociation is the finest level of vegetation mapping.

## The Study Area

The BMGR West is situated in the desert of the southwestern corner of Arizona, between Interstate 8 and the international frontier with Mexico (Fig. 1). The BMGR West is roughly 90 km (56 miles) from east to west and 48 km (30 miles) north to south, at least when measured at its 'tallest' and 'widest' points. Elevations span from 56 meters (185 feet) at the southwest corner of the range, to 962 meters (3156 feet) at Sheep Mountain, summit of the Gila Mountains. There are no long-term climate data on the range proper, but a fair indication of the climate can be seen in the 85 year record from the nearby Yuma Citrus Station: an average high of 41.2° C (106.1°F) in July to an average low of 3.9° C (39.1°F) in January, and an average annual precipitation of 87 m (3.4 in) (<http://www.wrcc.dri.edu/>; Yuma Citrus Station). These data are from 58 meters (190 feet), so we can expect cooler temperatures and more precipitation at the higher elevations within the range.

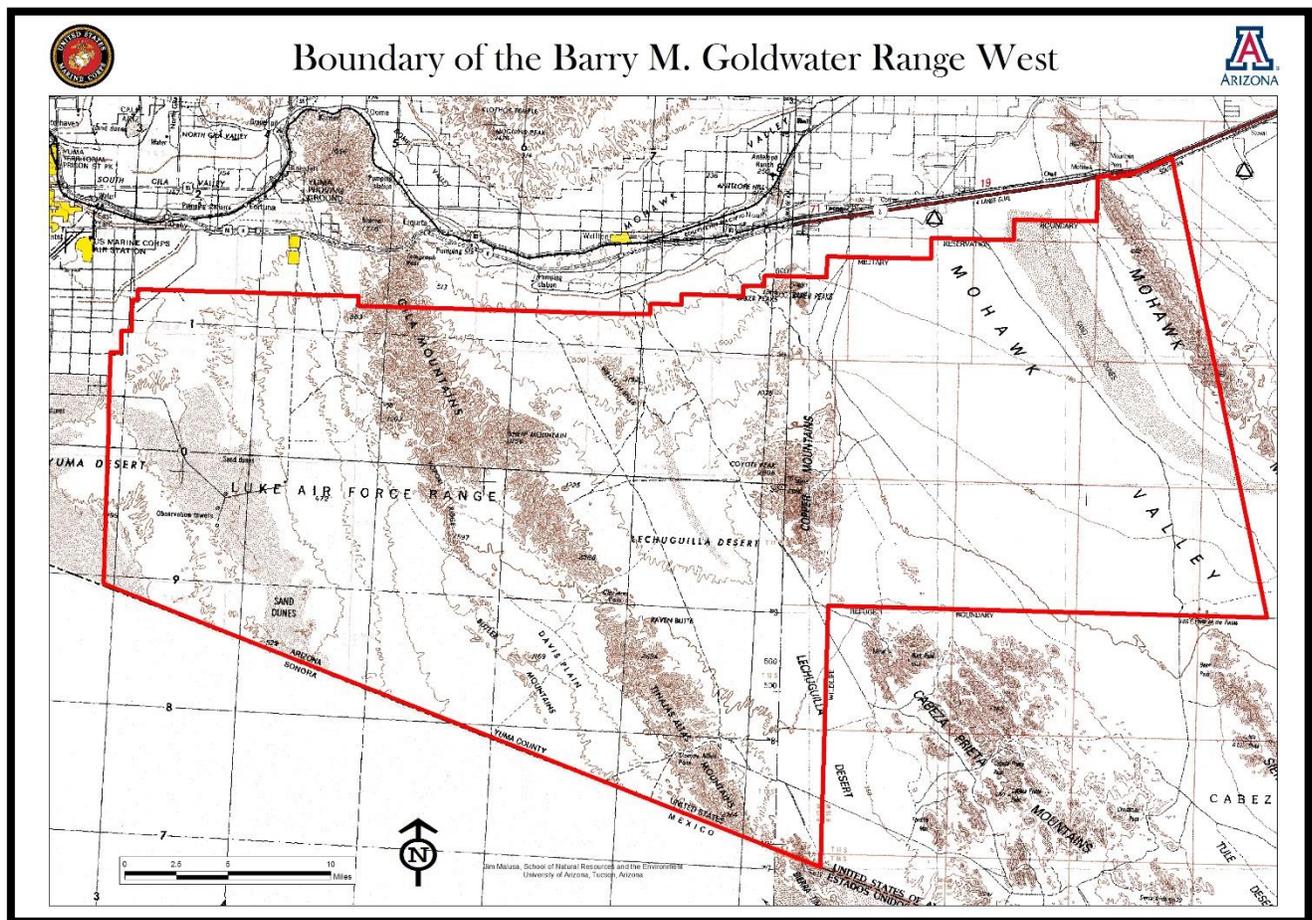


Figure 1. The boundary of the BMGR – West, in southwestern Arizona. Until 1986, BMGR East and West was collectively known as the Luke Air Force Range.

## Geology

This is basin and range country, with three “ranges” running northwest to southeast: the Mohawk Mountains, the Copper Mountains, and the Gila Mountains/Tinajas Altas Mountains. As in most of southwestern Arizona, the ranges are block-faulted and separated by broad alluvial valleys or plains; more plainly put, each range and valley is a piece of the earth’s crust that’s cracked along a fault, then tilted so one end is high – the mountain - and the other is low, buried under valley alluvium, often as deep or deeper as the mountain is high.

The present topography began to form about 15 – 20 million years ago. The last five million years have seen the formation of Gulf of California/Salton Sea trough, with subsequent rerouting of the Colorado and Gila Rivers. The plainest evidence of this faulting and vagrant rivers can be found by driving south on Foothill Boulevard across the tremendous desert pavements along the west side of the Gila Mountains. Here you can see that the stones making up the pavements are polished river gravels and cobbles, several hundred feet above their presumed source in the Gila and/or Colorado River.

The rocks themselves are typically much older than the faulting that lifted them. The oldest is Precambrian metamorphic rocks, mostly commonly schist, found in the Mohawk, Copper, and Gila Mountains. Such rock is over a billion years old; it’s shown as an olive color in Fig. 2. Precambrian granite is found in the northern Gila Mountains, and shown as a dark brown in Fig 2. The most widespread rock is Tertiary age granite in the Tinajas Altas and Copper Mountains, dating from the Eocene (34-56 million years ago). It is shown as red in figure 2. Younger sedimentary rocks from the Miocene and Oligocene, 15-25 million years ago, make up a broad pediment north of the Copper Mountains, as well as the Baker Peaks; these are shown as a burnt orange in Figure 2. The youngest rock is a basaltic lava only 10 to 16 million years old that tops Raven Butte (Jenney and Reynolds 1989, Kresan 2007, Shafiqullah et al. 1980).

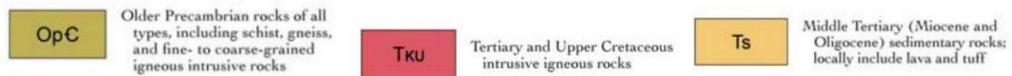
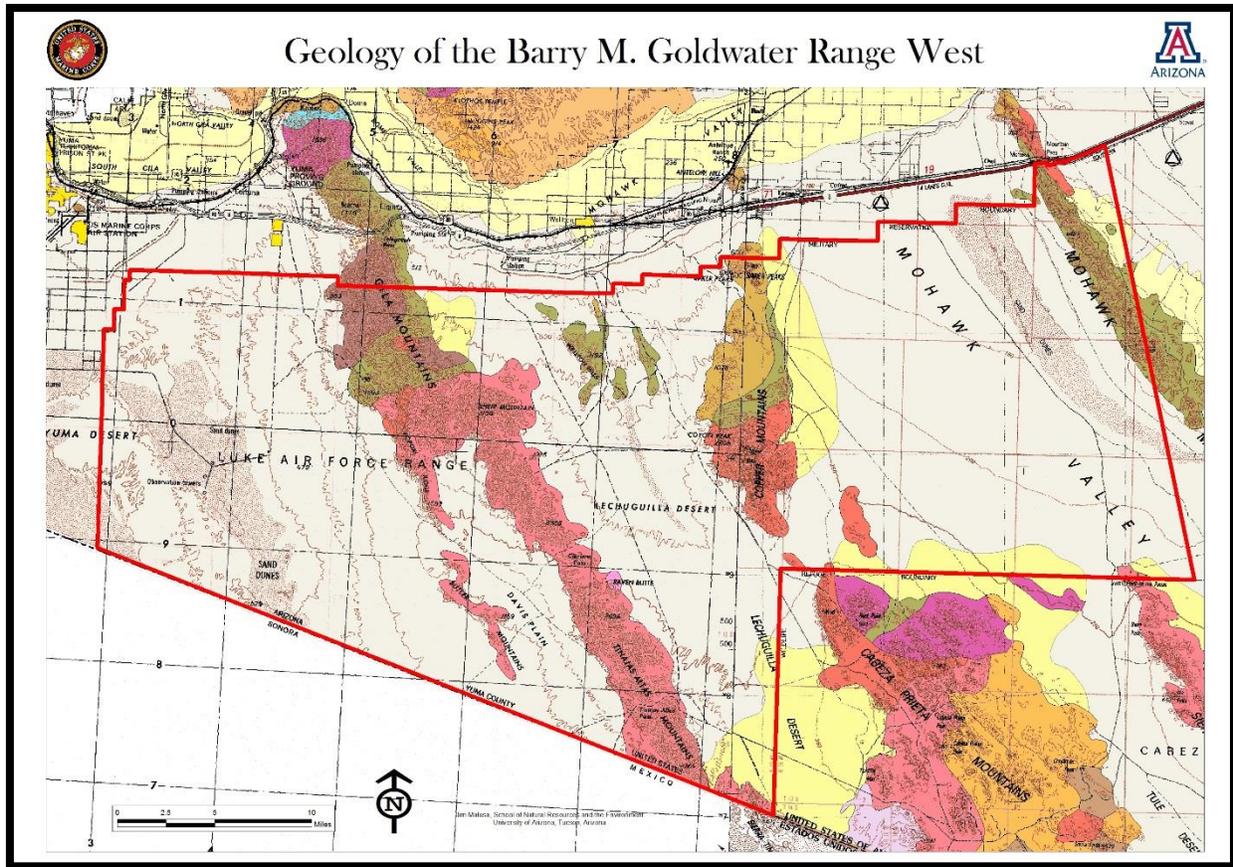


Figure 2. The geology of the BMGR – West, in southwestern Arizona. (Arizona Geologic Survey, 2015)

## Notable Landforms

### Mohawk Mountains

Steep on the east side, and steeper on the west, the Mohawks are a long and narrow range that reach 846 meters (2775 feet) at an unnamed summit. North of the interstate highway they are granite, but within the BMGR West they are mainly built of schist, a metamorphic rock which bears “a strong field resemblance to the schists of the Gila Mountains. Most of their exposures consist of coarsely laminated, medium to fine-grained aggregates of quartz, feldspar, hornblende, and biotite with locally sericitic phases and appear to be, in large part, of sedimentary origin.” (Wilson, 1933)

Schist is a dark rock, capturing heat, and the Mohawks hold few places that might be considered oases. They are a hot range, with only a few ephemeral waterholes (tinajas) on the BMGR West. The westernmost fringe of the range is mostly treeless. The rest of the range holds a mix of yellow paloverde with brittlebush and white bursage (*Ambrosia dumosa*), with a supporting cast of cholla. There are no prickly pear, but there are several canyons with elephant tree (*Bursera microphylla*). This frost-sensitive species is usually found on south-facing slopes, but in the Mohawk Mountains it is apparently drought limited, and found on north slopes in a few deep canyons. Hike around and you’ll find rocky clefts that collect rains and can hold happy surprises like Arizona live-forever (*Dudleya arizonica*) and Mohave sage (*Salvia mohavensis*); elsewhere, you’ll find platoons of cholla (*Cylindropuntia bigelovii*) (Figs. 3 - 4).



Figure 3. The summit ridgeline of the Mohawk Mountains is thick with teddy bear cholla (*Cylindropuntia bigelovii*).



Figure 4. Arizona live-forever (*Dudleya arizonica*), growing near the summit of the Mohawk Mts. This species withstands drought by withering until it looks like Fritos corn chips, then springs back with the rains.

## Mohawk Dunes

The dunes cover about 7,700 hectares (19,000 acres) in an area about 32 km (20 miles) long and 3.2 km wide, along the west side of the Mohawk Mountains, with a valley between dune and mountain. The dunes are a mosaic of sand ridges and the depressions between, a pattern best described as crest and swale. As seen from a plane, the dunes resemble the scales of giant reptile. The dunes are mostly vegetated, not nude, and not particularly impressive as seen from the west. However, the steeper east side offers numerous crests up to fifty feet above the swales between.

The flora of sand dunes are unusual because so many species are annuals, popping up only when the time is right. Of the 120 plant species reported by Felger et al (2003) from the Mohawk Dunes, 67 are annuals, making up 55% of the flora. Some of these, like dune primrose and sand verbena, can produce spring blooms (Fig. 5). The rest of the year the dune crests are characterized by tawny hummocks of big galleta grass and silver-green mounds of white bursage (*Ambrosia dumosa*). At the highest crests are half-buried clumps of Mormon tea (*Ephedra trifurca*), apparently very old.

In contrast, the swales in the Mohawk Dunes are often barren, holding only creosote and exposed layers of calcium carbonate ('caliche'), with the latter indicating that the dune field is quite old. The sands are probably not from the Colorado River delta (like the Yuma Dunes), but may have their origin in the Gila River (Felger et al., 2003). Some swales are actually small playas, closed drainages that fill with exceptional rains.



Figure 5. The view east from the Mohawk Dunes, to the Mohawk Mountains. Sand verbena (*Abronia villosa*) is in spring bloom in this photo from March 12, 2010. The grass is big galleta (*Pleuraphis rigida*), and the silver green shrub is white bursage (*Ambrosia dumosa*).

## Mohawk Valley

One of the most important species in the Arizona upland of the Sonoran Desert, the triangle-leaf bursage, finds its geographic limit on the east side of the Mohawk Valley, between the Copper Mountains and Mohawk Dunes (Fig. 6). This bursage, *Ambrosia deltoidea*, is a common plant along the Papago Well Road paralleling the dunes, but it doesn't extend west of the valley center. Turner et al. (1995) notes: "...*A. deltoidea* depends on bi-seasonal rainfall. Its western limit does not extend beyond the area of dependable summer rain."



Figure 6. Pete Sundt amid an unusually dense stand of triangle-leaf bursage in the creosote floodplain habitat of the Mohawk Valley.

## Copper Mountains, Baker Peaks, and Baker Tanks

As defined by Wilson (1933), the “Copper Mountains extend southward ... from Baker Tanks to the alluvial gap at the northwestern end of the Cabeza Prieta Mountains.” The southern half of the Copper Mountains are mostly built of pale granite, and rise to 880 meters (2888 feet) at an unnamed summit about 1.6 km (1 mile) south of Coyote Peak, and can be reached from Betty Lee Canyon. The north side of the peak is only place on the BMGR West with a population of scallopleaf sage, also known as Vasey’s sage, *Salvia vaseyi*. The population was discovered during this project, and along with a population in the nearby Sierra Pinta, comprises the entire Arizona population of this sturdy and fragrant shrub (Cain et al., 2010).

The cooler aspects of the southern half of the Copper Mountains are home to a shrub community of Mormon tea (*Ephedra aspera*), flattop buckwheat (*Eriogonum fasciculatum*), and goldeneye (*Viguiera parishii*) (Fig. 7). The hotter slopes hold elephant tree (*Bursera microphylla*), yellow paloverde, brittlebush (*Encelia farinosa*) and white bursage (*Ambrosia dumosa*) (Fig. 8).

The northern half of the Copper Mountains (Fig. 9) are low rolling ridges and hills made of a conglomerate that “appears to be of local origin, consists mainly of granite and gneiss pebbles or boulders embedded in a minor amount of weakly cemented sand.” (Wilson, 1933) This bedrock pediment extends north to the Baker Tanks (Fig. 10). Further north rise the Baker Peaks, which are sandstone that is more resistant to the action of wind and rain than the conglomerate (Fig. 11). Sandstone and conglomerate are nowhere else on the BMGR West (save for a sliver of pediment in the northern Wellton Hills). They are not associated with any unusual species, but erosion of this formation has led to abundant sands on the bajadas to the northwest of the Copper Mountains, which in turn supports unusual stands of big galleta grass (Fig. 12).



Figure 7. The north slope of the summit of the Copper Mountains holds a population of scallop-leaf sage (*Salvia vaseyi*), shown here in the foreground just below the large agave.



Figure 8. A typical south-facing slope in the Copper Mountains near Betty Lee Canyon. The dark-leaved many-trunked trees are elephant trees (*Bursera microphylla*), and the foreground shrubs are brittlebush.



Figure 9. The low rolling hills of the northern Copper Mountains, as seen here looking north to the Baker Peaks. The trees are mostly yellow paloverde – there are no elephant trees (*Bursera microphylla*) in this region.



Figure 10. Conglomerate bedrock is plain to see at the Baker Tanks.



Figure 11. The view south to the Copper Mountains from the summit of the Baker Peaks, at 431 meters (1415 feet). In contrast to the crumbling granites of the southern Copper Mountains, the Baker Peaks are a monolithic sandstone, and without paloverde, ironwood, or elephant tree (*Bursera microphylla*). They are treeless.



Figure 12. The Copper Mountains in the background, as seen looking southeast from near the Military Drag Road. Note the abundance of big galleta grass, possibly due to the erosion of the conglomerate pediment just upslope.

## Lechuguilla Valley and Coyote Wash

The Mohawk, Growler and San Cristobal Valleys are among the largest in extreme southwestern Arizona, which is defined here as south of Interstate 8, east of the Colorado River, and west of Gila Bend. Each valley has very large arroyo that runs along its axis, and each arroyo vanishes in a maze of progressively smaller distributaries – inland deltas, actually. They drain north but never reach the Gila as a coherent channel.

But Coyote Wash curiously sticks together as a single large arroyo, albeit with islands of floodplain, running nearly the entire 50 km (31 miles) of the Lechuguilla Valley. Coyote Wash begins near the Sierra de Lechuguilla, a range that straddles the US/Mexico Border, at an elevation of 320 meters (1050 feet) on the valley floor. Coyote Wash historically joined the Gila River at the town of Wellton, but nowadays ends at the huge berm that protects the Wellton Mohawk Canal. Still, as a conduit for both xeroriparian plant species as well as wildlife, the uninterrupted run from Wellton-to-Mexico is outstanding.

Coyote Wash's upper reaches (Fig. 13) are typically dominated by mesquite (*Prosopis sp.*) while its lower end is mainly ironwood (*Olneya tesota*) (Fig. 14). But any given stretch of the arroyo can be dominated by several species, including catclaw, blue paloverde, and cheesebush (*Hymenoclea salsola*). Large floodplains can be infested with the invasive Sahara mustard (*Brassica tournefortii*) (Fig. 15).



Figure 13. The view north down Coyote Wash near Coyote Water, an intermittent seep 4 km (2.5 miles) north of the Camino. Here, at 960 feet (293 meters), the vegetation is dominated by mesquite, catclaw, and wolfberry (*Lycium sp.*).



Figure 14. The view north up Coyote Wash at the southern end of the Wellton Hills, near the old Double Eagle Mine. This fine example of an ironwood (*Olneya tesota*) is about 12.2 meters (40 feet) tall, and is likely several hundred years old. At this elevation, 170 meters (560 feet), Coyote Wash vegetation is typically ironwood and cheesebush (*Hymenoclea salsola*).



Figure 15. The view northeast to the Copper Mountains from the floodplain of Coyote Wash, at the center of the Lechuguilla Valley, about 8 km (5 miles) east of Raven Butte. Note the abundant dried flower stalks of the invasive Sahara mustard (*Brassica tournefortii*).

## Gila Mountains/Tinajas Altas Mountains

The Gila/Tinajas Altas chain runs for 67 kilometers (42 miles), from the Gila River clear into Mexico. There are only two passes crossable by regular vehicles, Tinajas Altas Pass and Cipriano Pass. They are also the highest mountains on the BMGR West, with the summit of Sheep Mountain in the Gila Mountains reaching 962 meters (3,156 feet). Three kilometers (1.8 miles) to the southwest is another peak, unnamed but near the Black Butte Mine, over 900 meters tall. The Tinajas Altas top out at 842 meters (2764 feet), near the Mexico border, and there at least a half dozen other peaks over 800 meters between Interstate 8 and Mexico.

As seen from Interstate 8, the Gila Mountains look particularly cruel, where much of the northern end of the range is either darkly metamorphosed schist or Precambrian granite, more than a billion years old. The schist is unfriendly to plants, but the granite supports occasional swaths of Kearny's sumac (*Rhus kearnyi*) and desert beargrass (*Nolina bigelovii*) as far north the 823 meter (2700 foot) peak just west of the Golden Dream Mine (accessible from the old trail out of Fortuna Canyon). Healthy stands of elephant tree (*Bursera microphylla*) are also common in the granite, but not the schist.

South of Sheep Mountain, the Gila/Tinajas Altas are built of much younger granite, of Eocene age, 34 to 56 million years ago. The north slope of Sheep Mountain is dominated by Kearny's sumac, desert beargrass, arrowleaf and Mormon Tea to a degree not seen elsewhere on the BMGR West (Fig. 16). South slopes are dominated by white bursage (*Ambrosia dumosa*), brittlebush (*Encelia farinosa*), and elephant tree (*Bursera microphylla*). (Fig. 17).



Figure 16. The north slope of Sheep Mountain, at about 800 meters (2625 feet) elevation. Kearny's sumac is the bright leafy bush on the right. Desert beargrass, at center and left, looks like a big yucca or small palm. There are no elephant trees, paloverdes, or saguaros on this relatively cool exposure.

The younger granite persists for the next 35 kilometers (22 miles) to Frontera Canyon on the Mexico border. So does the vegetation, with much elephant tree (*Bursera microphylla*) on the hot slopes, and a mix of Mormon tea, Kearny's sumac and desert beargrass on the cooler slopes, especially above 500-600 meters (1700-2000 feet) and along canyon bottoms (Fig. 18). Nowhere else in the United States is do these species occur together in such abundance, making a strange and lovely garden of rock and bizarre plants. The presence is likely due to a lack of frost and the moist influence of the Gulf of California, which is only 65 km (40 miles) from the southern end of the range.



Figure 17. Mara McKinnon examines an elephant tree (*Bursera microphylla*), a common species on granite bedrock in the Gila and Tinajas Altas Mountains.



Figure 18. The two-headed plant on the right is desert beargrass (*Nolina bigelovii*), 5 meters tall (16 feet). This species (which typically does not split into two) is found on the BMGR West only in the Gila and Tinajas Altas Mountains. This scene is from Skull Canyon, whose mouth is 1.3 miles (2.1 km) north of Cipriano Pass, on the east side of the Gila Mountains.

Raven Butte is a natural standout, 700 feet of black basalt, flat-topped and set against the jagged peaks of granite that make up the Tinajas Altas. Although it's easy to imagine that the entire butte is a heap of basalt, the black boulders are just a veneer dating from about 11 million years ago (Shafiqullah et al., 1980), overlaying granite that appears as white patches where the basalt boulders have rolled away. Oddly, you won't find any black boulders more than 10 meters from the toe of the butte, which is presumably because basalt is much denser than granite. Geologist Dan Lynch (pers. comm.) believes that those boulders that make it to the desert floor slowly but ultimately sink beneath the sands.

The slopes of Raven Butte are dominated by brittlebush, especially the south side (Fig. 19). The summit platform tops out at 540 meters (1773 feet) and is treeless, with a simple community of creosote, white bursage (*Ambrosia dumosa*), and fagonia.



Figure 19. The view west to the south slope of Raven Butte, with the Tinajas Altas behind. The brittlebush, in spring flower, streaks the basalt with yellow blooms, and lines the arroyo at its base.

Raven Butte is near Cipriano Pass, which can be regarded as the divide between the Gila Mountains (to the north) and the Tinajas Altas Mountains (south). The paloverdes on the east side of Cipriano Pass are hybrids between the yellow paloverde and the blue paloverde. Drive or walk west through Cipriano Pass and you'll find no such hybrids on the west side – only blue paloverde.

Our studies show that the yellow paloverde, usually ubiquitous, does not live on the west side of the Tinajas Altas Mountains range, only the east, and sparingly at that. Apparently the crest of the

Tinajas Altas creates enough of a summer rain shadow that this classic 'Arizona Upland' species cannot persist, just as the triangle-leaf bursage quit at the Mohawk Valley (Turner et al., 1995). Northward, in the Gila Mountains, the yellow paloverde is absent on both east and west sides, until reaching the northern boundary of the BMGR West, where it somewhat mysteriously reappears on relatively young geologic formations that allow the passage of Interstate 8 through Telegraph Pass.

The High Tanks, the "Tinajas Altas" for which the mountains are named, are a series of nine plunge pools of special beauty and cultural significance (Fig. 20). A recent book by Broyles et al. (2012) covers the all the bases, from geology to anthropology, while Felger et al. (2012) focuses on the botanical record over the last 40,000 years, using packrat middens for a view back to the ice age flora. Biggs et al. (2002) provide geologic explanations for the formation of the high tanks, as well as the origin of 'tafoni', the numerous cavities in the granite that range from fist-sized to small caves several meters deep.

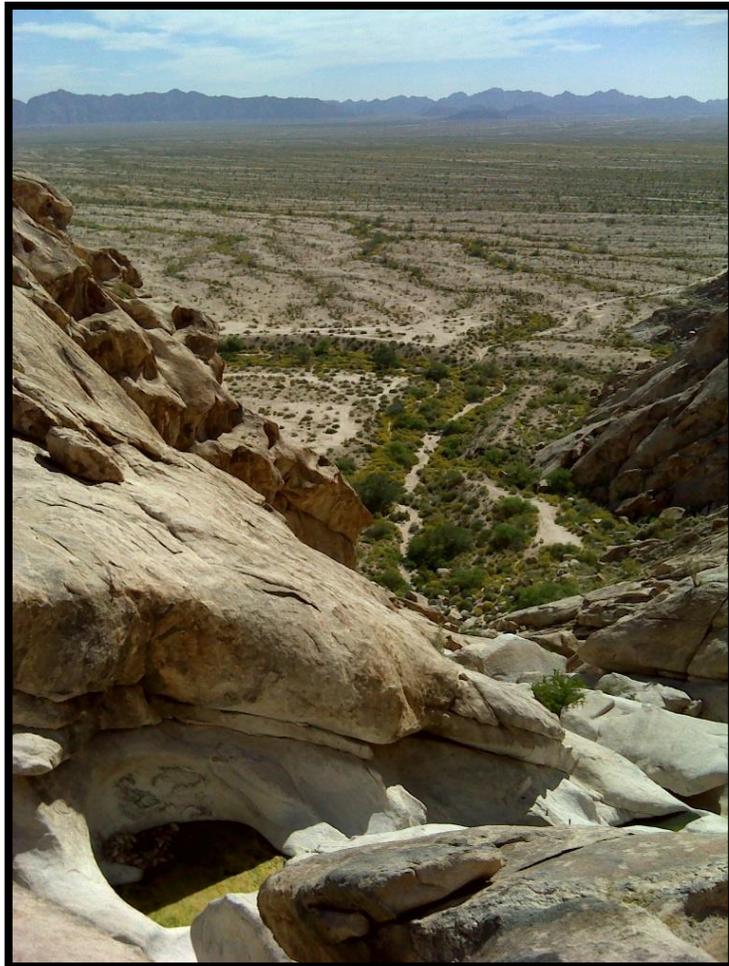


Figure 20. The view east from the highest of the *Tinajas Altas*, or high tanks. The track of the Camino del Diablo can be seen approaching from the back right. Water is in the top tank, half-shaded by the granite wall.

## Wellton Hills

The Wellton Hills are mostly gneiss (metamorphosed granite) and schist. Wilson (1933) wrote of the mineral deposits: “Certain veins of the Wellton Hills are spectacularly marked with copper stain which extends for a short distance into the wall rock. In places, this copper-stained gneiss carries visible specks of free gold.”

Not surprisingly, miners were intrigued, and the Wellton Hills had nine mines/prospects in 1933, the largest of which was the Double Eagle, at the south end of the hills. Even the Double Eagle is a small mine, with a main shaft reported to be 100 feet deep. A 1909 ‘test shipment’ weighing 23 tons netted “\$1364 of gold, 23 ounces of silver, and 133 pounds of copper.” (Wilson, 1933).

But that was about it for the mineral wealth, and the vegetation is not much richer. The Wellton Hills are just 363 meters (1192 feet) high at the summit, too low to bring enough rain to support much more than creosote, brittlebush, white bursage (*Ambrosia dumosa*), and fagonia (Fig. 21). Like the Baker Peaks, there are no trees, with the exception of the extreme northwest spur of the hills. The rock on this spur is less metamorphosed, and looks to be simply old granite. The vegetation is striking: there are numerous blue palo verde on the slopes. The blue palo verde, at least in Arizona, typically lives in arroyos, and perhaps the slopes of this spur are actually similar to an arroyo, as the trees are rooted between boulders in the decomposed granite similar to sand.

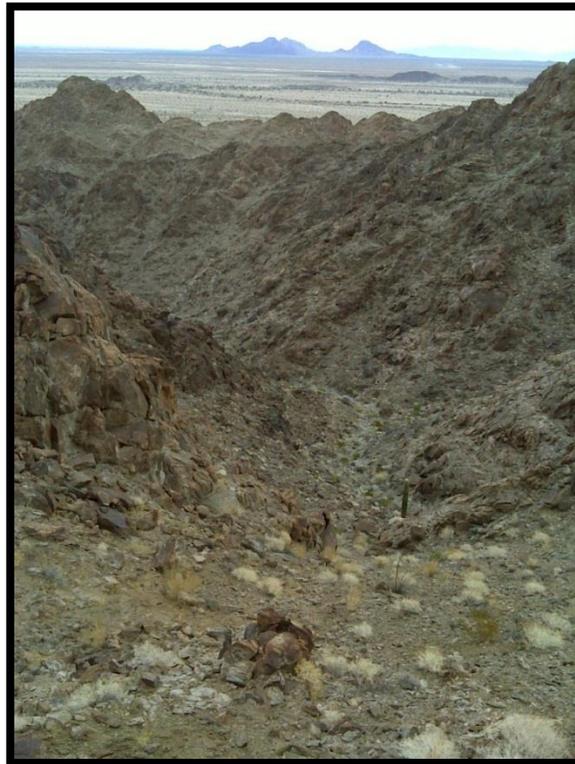


Figure 21. Near the arid summit of the Wellton Hills, the view east to the Baker Peaks.

## Davis Plain – Spook Canyon, Ocotillo Plain, and Saltbush Badlands

Between Vopoki Ridge and the main spine of the Gila Mountains is a great sand sheet called the Davis Plain. On most maps, the area further southeast, between the Butler Mountains and Tinajas Altas Mountains, is also considered part of the Davis Plain, but this area isn't very distinctive. In contrast, the area near Vopoki Ridge is notable for its lack of watercourses – or rather, the land is covered with very small watercourses that fail to join into something over a meter wide. Consequently it is mostly treeless. Creosote (*Larrea tridentata*) shares dominance with Ocotillo (*Fouquieria splendens*) and white bursage (*Ambrosia dumosa*) in a very regular pattern.

At the head of the plain a large arroyo system gathers runoff from about 25,000 hectares (62,000 acres) from the Gila Mountains, including Sheep Mountain, at 962 meter (3,156 feet). The arroyo's logical course is south, down the gradually sloping Davis Plain. Remarkably, the arroyo instead turns west for Vopoki Ridge, which rises well above the plain. The arroyo twists through an entrenched meander called Spook Canyon that cuts clean through Vopoki Ridge (Fig. 22).

Oddly eroded hills that are best described as badlands are heaped above the entrance to Spook Canyon, at the head of the Davis Plain. Composed of poorly sorted decomposed granite, they support the only population of hollyleaf saltbush (*Atriplex hymenelytra*) on the BMGR West, and 60 hectares (147 acres) are thusly mapped as subassociation 710 (Fig. 23). This tenacious species is more typical of the Mohave Desert, all the way up to Death Valley, California.

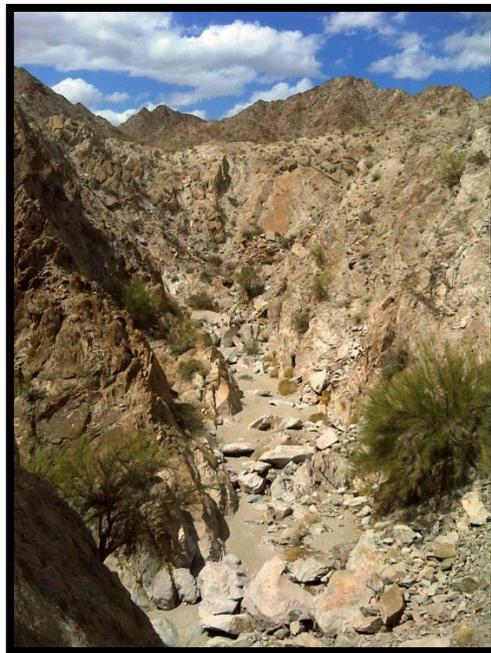


Figure 22. Between Vopoki Ridge and the Gila Mountains is Spook Canyon, which drops about 65 meters (200 feet) in its short (0.9 km, 0.5 mile) and unlikely route through Vopoki Ridge. The large trees are elephant trees (*Bursera microphylla*). On the west end of the canyon, on the south-facing wall, is the largest elephant tree recorded (so far) in the United States, measuring 16 feet tall and 22 feet across, with a trunk 40 inches in circumference.



Figure 23. The saltbush badlands at the head of the Davis Plain and Spook Canyon.

## Butler Mountains

The Butler Mountains are perfectly in line with Vopoki Ridge, and it's not hard to recognize that the two are actually a single geologic feature, with the broad pass between the Butlers and Vopoki Ridge currently occupied by the sands of the Davis Plain. The Butlers are a small, isolated range of granite ridges running about 11 kilometers (7 miles), rising only a few hundred feet above the plain, with a summit of 356 meters (1169 feet). There are perhaps a dozen individual ridges, all running northwest to southeast and separated by sandy passes or sometimes by a single arroyo (one of which originates in Cipriano Pass and runs clear to the Mexico border). It's a lonely little mountain range, and according to Wilson (1933), "This range was not shown on any published maps until 1930 when it was named for Dean G. M. Butler, of the University of Arizona."

Despite the favorable granite bedrock, there are no elephant trees (*Bursera microphylla*), presumably because it's too arid. In general, there are no trees at all on the slopes, but there are numerous ironwood (*Olneya tesota*) gathered at the toe of most of the ridges, benefitting from the runoff. Most ridges have on their east side what appears to be a low sand dune but is actually an ancient, petrified dune, with cross-bedding and an argillic (clay) horizon beneath a veneer of sand (Fig. 24). The vegetation reflects this underlying soil, and instead of typical dune plants like primrose, these 'paleo-dunes' support only creosote, white bursage (*Ambrosia dumosa*) and ocotillo (*Fouquieria splendens*).

There are, however, 9 hectares (22 acres) of ‘true’ active dunes in the Butler Mountains, accessible from the A-10 intersection of the Camino del Diablo and Cipriano Pass roads. These moving sands, in which rains penetrate quickly and deeply, hold typical dune species like *Ephedra trifurca* and *Psoralea emoryi*.



Figure 24. Pete Sundt takes in the view southeast from the Butler Mountains towards the Tinajas Altas. In the middle background is one of many ‘paleo’ dunes that surround the Butler Mountains. They appear to be sand dunes, but no longer hold enough sand to support dune vegetation.

## Yuma Dunes

West from the Butler Mountains there is no bedrock until beyond the Colorado River, into California and Mexico. This reach of the BMGR West, roughly 70,000 hectares (173,000 acres), is the least visited (and least impacted by visitors) because of the presence of several Hazard Areas for training. The Border Patrol maintains a constant presence along the border wall, but their tire tracks fade quickly to the north, in part due to the Hazard Areas, as well as the wind that is continually rearranging the sands.

This region of BMGR West is sculpted by the predominantly south-southwest winds delivering sands from the Colorado River delta (Landcaster, 1995; Muhs et. al., 2003), a process that has created the landforms and soils, which in turn shape the vegetation. The wind has the power to

heap sand in various forms – linear dunes, for instance – and to excavate the spaces between, in a process called ‘deflation’. Deflation has blown away much of soil and created many a creosote flat on the BMGR West, and between the Butler Mountains and the Yuma Dunes are the largest pure creosote flats on the range. The biggest is 6635 hectares (13,395 acres) or 25 square miles of nothing but creosote. While traveling the border road you’ll see these flats interrupted by sand ridges. During dry times these sand ridges are little more than creosote, but after favorable winter rains they are festooned with Spanish needles, primrose, verbena, and Ajo lilies. They lack the characteristic species of deeper sands, such as white bursage (*Ambrosia dumosa*), big galleta grass, and Mormon tea. They are not mapped as dunes (subassociation 260), but instead as subassociation 117, “Creosote- Spanish needles-white bursage on sands”.

Traveling west, the creosote flats and sand ridges end abruptly at the foot of the Yuma Dunes (Fig. 25). The largest part of the dune field, 2600 hectares (6425 acres, or 10 square miles) is south of the blacktop (‘hardball’) access road to the Hazard Areas. Seven smaller dune fields, totally 750 hectares (1853 acres), are north of the hardball and south of County 17<sup>th</sup> Wash. Finally there are numerous small dunes of 1 to 4 hectares just east of Highway 195 (ASH), south of the P-111 facility on County 14<sup>th</sup>. Altogether, there are about 3400 hectares (8402 acres) of dunes in the western BMGR West, compared to 6857 hectares (16,944 acres) in the Mohawk Dunes.

Unlike the Mohawk Dunes, the flora of the Yuma Dunes is closely related to the Gran Desierto of Sonora, which is hardly surprising since they are separated only by the border wall (Felger 1980, 2000). Species found nowhere else on the BMGR West include dune buckwheat, showy sunflower, dune spurge, and dune croton. Near the dune field, and associated with moving sands, we recently discovered the first US population of giant sandbur (*Cenchrus palmeri*) (Malusa et al. 2013) (Fig. 27).

Perhaps because of limited off-road travel, the Yuma Dunes system is mostly free of Sahara mustard – except for the virtually continuous infestation that now parallels the border wall (Fig. 26). Of 10 relevés (samples) within the dune field, zero held evidence of Sahara mustard. In contrast, 6 of the 14 relevés from the Mohawk Dunes held Sahara mustard. Instead they hold several rare species only found in this corner of the range, including *Helianthus niveus*, *Euphorbia platysperma*, and *Eriogonum deserticola* (Figures 28-30).

In the extreme southwestern corner of the BMGR West, west of the Yuma Dunes, there are long narrow ridges of active sands separated by equally narrow creosote flats. The pattern, like waves in a sea, is scarcely evident on the ground, but is evident from the air, and from the vegetation map.



Figure 25. The view west across the Yuma Dunes, 1 km(0.6 mile) west of Foothill Blvd, about 2.5 kilometers (1.5 miles) north of the Mexico border.



Figure 26. The view southeast from Border Butte, with a blooming brittlebush. The border wall, visible in the right background, runs southeast for 35 km (22 miles) to the distant Tinajas Altas Mountains; it runs the same distance to the northwest, to San Luis on the Colorado River.



Figure 27. Giant sandbur (*Cenchrus palmeri*), west of Foothill Blvd, about 2.5 kilometers (1.5 miles) north of the Mexico border. There is an additional population 10.2 km (6.3 miles) north of the border. This species, restricted to the Sonoran Desert and typically found along dunes bordering the Gulf of California, was first discovered in the United States during this study.



Figure 28. Showy Sunflower (*Helianthus niveus*), along the international frontier near the terminus of Foothills Blvd. This is a close relative of the endangered Algodones sunflower, *Helianthus niveus* subsp. *tephrodes*.



Figure 29. Dune spurge (*Euphorbia platysperma*), along the international frontier, between Foothills Blvd and the road to the Butler Mountains.



Figure 30. Dune buckwheat (*Eriogonum deserticola*) in the Yuma Dunes just west of Foothills Blvd, about 3 kilometers (1.8 miles) north of the international border, with Abigail Rosenberg holding a 1.2 meter stick. Note the plants upslope, nearly buried in the moving sands.

## Yuma Mesa and Upper Mesa

According to Pearthree (2011), the far northwestern corner of the BMGR West can be seen as two mesas, Yuma Mesa and Upper Mesa. Most of Yuma's productive farm land is on the western side, Yuma Mesa, which is a very flat terrace left by the Colorado River during the last 100,000 years (late Pleistocene). The only pieces of BMGR West on the Yuma mesa is the Air Station/Yuma

International Airport, and the so-called orphan parcels which have been isolated by Highway 195 (ASH). Both areas have been heavily modified by human use (Fig. 31).

The eastern mesa, or Upper Mesa, is also built of Colorado River deposits, but these are up to 3.6 to 5.3 million years old (Pliocene). Similar river deposits, holding petrified wood, can be found on the Yuma Proving Grounds just to the north. On the far northwestern corner BMGR-West, there are exposures of the old river cobbles, beautifully polished, at the old quarry between the ASH and P-111 (Fig. 32).

The Upper Mesa is cut in two by the Algodones fault zone, which has conveniently provided the gap for County 19<sup>th</sup> to enter the BMGR West, at the rifle range. To the south of this point, the vegetation on the Upper Mesa is almost exclusively creosote and white bursage (*Ambrosia dumosa*). To the north the mesa is a bit higher, more dissected, and rearranged by floods coming down County 17<sup>th</sup> Wash. Consequently, there is considerably more vegetative diversity, including impressive swaths of big galleta grass. On the east side of the ASH, there are also several large crucifixion thorn (*Castela emoryi*) (Fig. 33). This species, while widespread in the Sonoran Desert, is uncommon on the BMGR West, only occurring here and along the Mohawk Dunes.



Figure 31. The view southeast from an 'orphan parcel' near Country 15th, a part of the BMGR West that has been cut off by the ASH, Highway 195. These areas were previously disturbed, making them prime territory for the invasive Sahara Mustard, which pretty much covers the parcel in this photo from the spring of 2013.



Figure 32. Exposures of the Upper Mesa at the old quarry along Highway 195 (ASH) reveals Colorado River cobbles and gravels (left), which sometimes wear a cap of sandstone (right).



Figure 33. Mara McKinnon contemplates the Crucifixion thorn (*Castela emoryi*) on the east side of Highway 195 (ASH).

## PREVIOUS VEGETATION MAPS OF BMGR WEST

It's no surprise that early vegetation maps of North America show all of the BMGR West as desert, as can be seen below in the 1907 map by J. Bartholomew (Fig. 34).

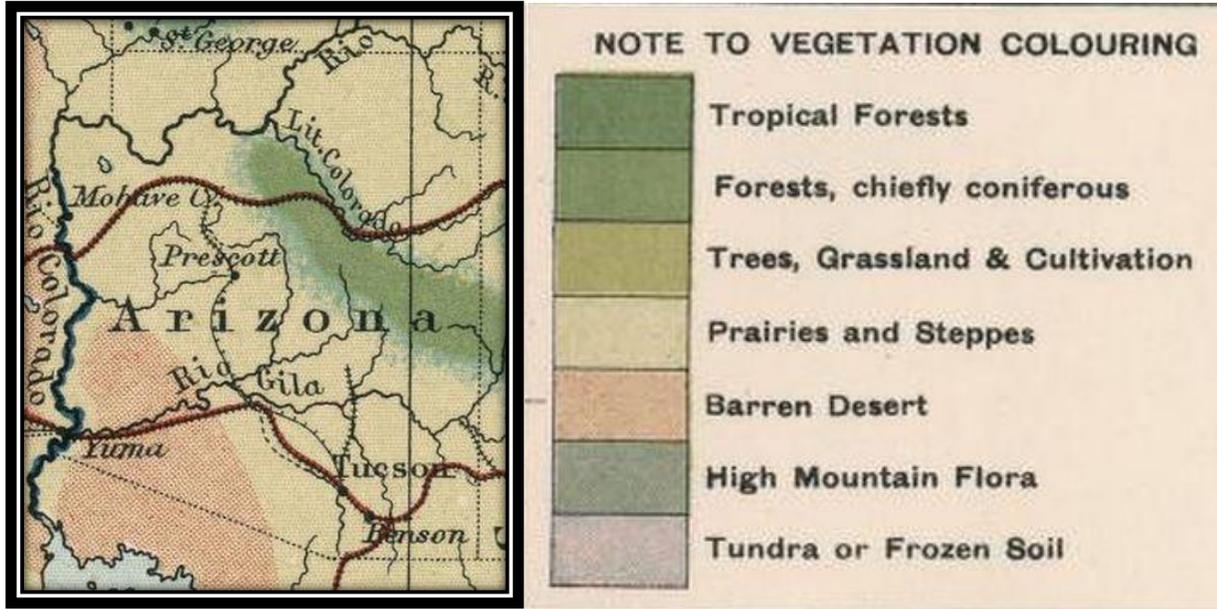


Figure 34. A portion of a 1907 map of North American vegetation, by J. Bartholomew. The BMGR West is, naturally, "Barren Desert."

But even a casual observer can see that the mountains are not like the valleys. This distinction between mountain and valley on BMGR West was captured on another early vegetation map, produced by Nichol (1937), who classified the mountains as "Palo Verde – Cacti, and Burr Sage" and the valleys as "Creosote Bush + Salt Brush" (Fig. 35).

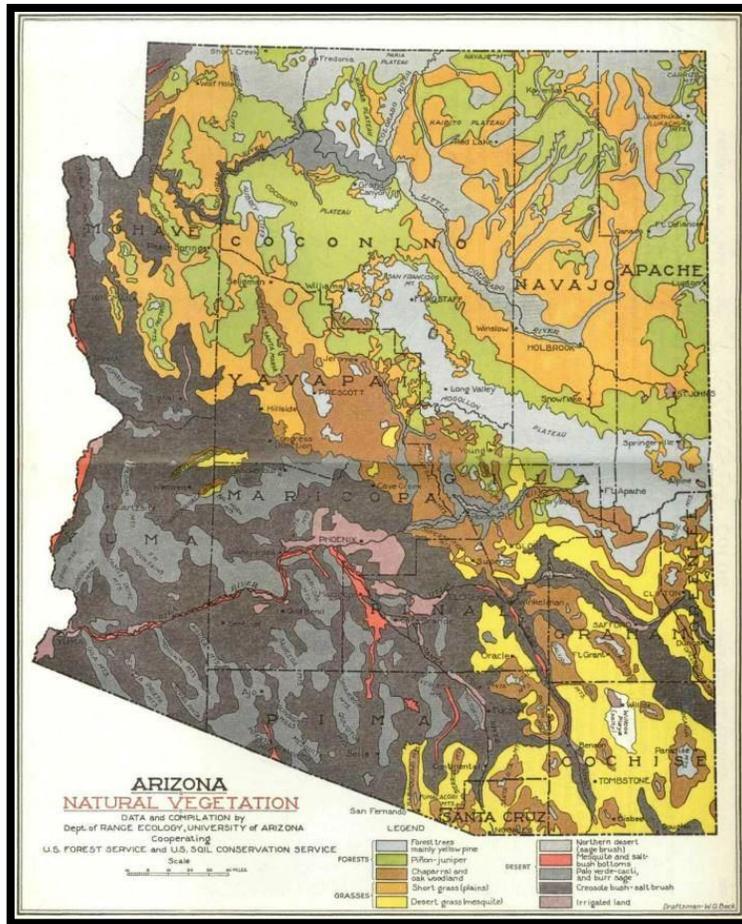


Figure 35. Nichol’s 1937 map of Arizona’s natural vegetation.

Nichol’s map was followed by the excellent article “Vegetation and soil relations in the lower Colorado Desert,” by John Brady Marks (1950). Marks observed that the vegetation from one valley to the next was different, and he sought to explain why. Lacking the sort of aerial imagery that is commonplace nowadays, he makes no attempt to define the precise borders between plant associations on the BMRG West, but instead reveals the relationship of soil and plants in southwestern Arizona and southeastern California. It is a nice piece of work, and required reading for a student of desert vegetation.

The most often cited vegetation map for the southwestern United States and northwestern Mexico is Brown and Lowe’s “Biotic Communities of the American Southwest-United States and Mexico” (1982). This encyclopedic work built upon their earlier effort to create a hierarchical classification of vegetation (Brown et al., 1979; Brown and Lowe, 1974). The resulting map covers such a vast area that there is no distinction between vegetation types on the BMRG West – it’s all one color on their map, representing the “Lower Colorado River subdivision” of Sonoran desert scrub. The importance of their contribution was not the map, but the classification.

Tunncliff et al. (1986) created the first vegetation map tailored specifically for the BMGR, which at that time was called the Luke Air Force Range. This map was subsequently revived by the Nature Conservancy for their 2001 report, “Conservation Elements of and a Biodiversity Management Framework for the Barry M. Goldwater Range, Arizona” (Hall et al. 2001) (Fig. 36). The map improves upon Nichol (1937) and Brown and Lowe (1982), but not much. More notable is the use, for the first time on the BMGR, of Brown and Lowe’s hierarchical vegetation classification, following the example of Warren et al. (1981) and their vegetation map of Organ Pipe Cactus National Monument. A hierarchical vegetation classification is like the United States Marine Corps who funded this research: just as there are several Staff Sergeants for every Sergeant Major, there are several creosote and bursage vegetation associations in what we call the Sonoran Desert.

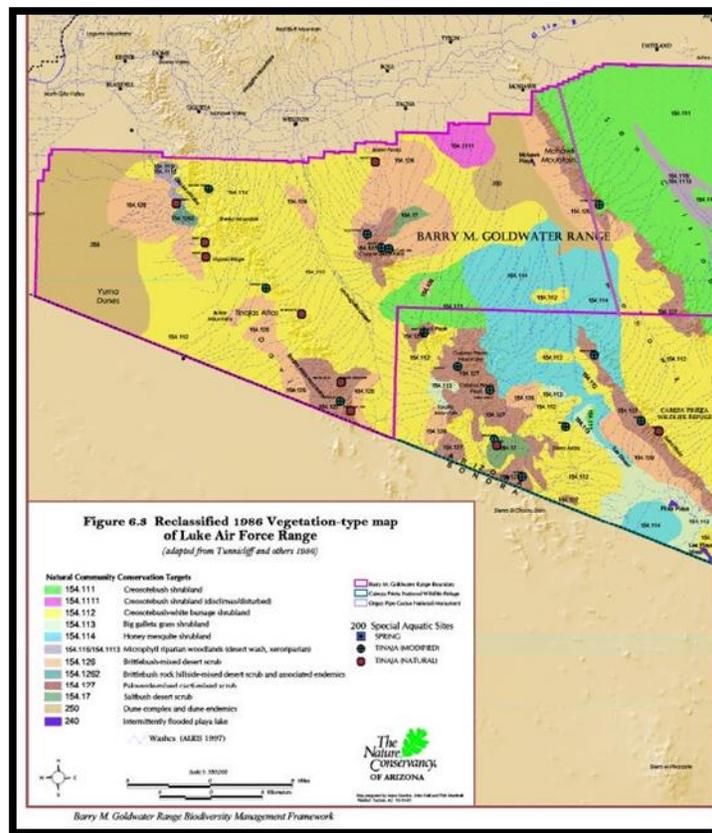


Figure 36. Map of the ‘Natural Communities’ of the Luke Air Force Range (Tunncliff et al 1986), clipped here to show the BMGR West.

Trouble is, despite efforts to standardize the process, it’s difficult to try and get everyone to agree on the names of vegetation types, and where they belong in the hierarchy; in fact, there is scarce agreement on what to call some of the levels in the hierarchy. Note that the vegetation units of the Nature Conservancy/Tunncliff et al. map are “Natural Communities”. This is roughly equivalent to an “Ecological System”, as well as to a “Series” and even perhaps a “Group”.

This confusion has diminished somewhat over the past decade with the advent of the National Vegetation Classification (FGDC, 2008). At the same time remote sensing has improved. Landsat ETM+ imagery was used to create the GAP vegetation map of Arizona (as well as Colorado, Nevada, New Mexico and Utah; Lowry et al, 2005). Produced by the USGS, this ambitious map was good at distinguishing “Paloverde-Mixed Cacti Desert Scrub,” but not much else. The valleys are mapped as either “Warm Desert Active and Stabilized Dune” or “Creosotebush-White Bursage Desert Scrub”, but doesn’t place them correctly, missing the Yuma Dunes and instead making the entire Mohawk Valley a dune field (Fig. 37).

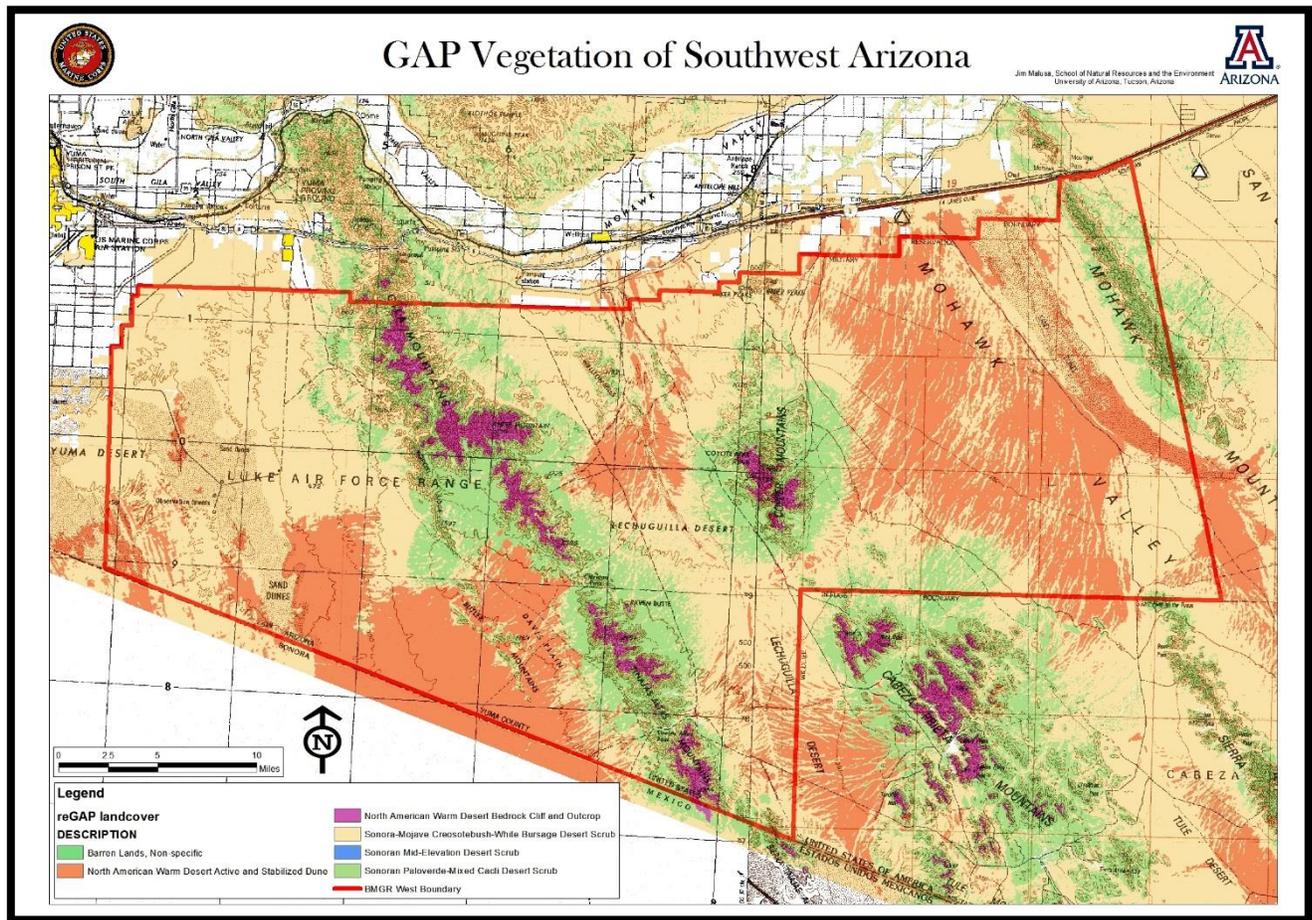


Figure 37. The GAP vegetation map, showing ‘landcover’ on the BMGR West.

Recognizing a need, Arizona Game and Fish stepped up with a more accurate map in the early 2000’s (unpublished), which covers the lands south of Interstate 8, between Yuma and Gila Bend. The BMGR West is mapped as 12 ‘communities’, all of which are part of the either the Arizona Upland or the Lower Colorado River Valley, which in turn are part of the Sonoran Desert. The map was a major advance, but because it was apparently intended for internal use there is little supporting documentation (seven pages) and no data, only descriptions (Fig. 38).

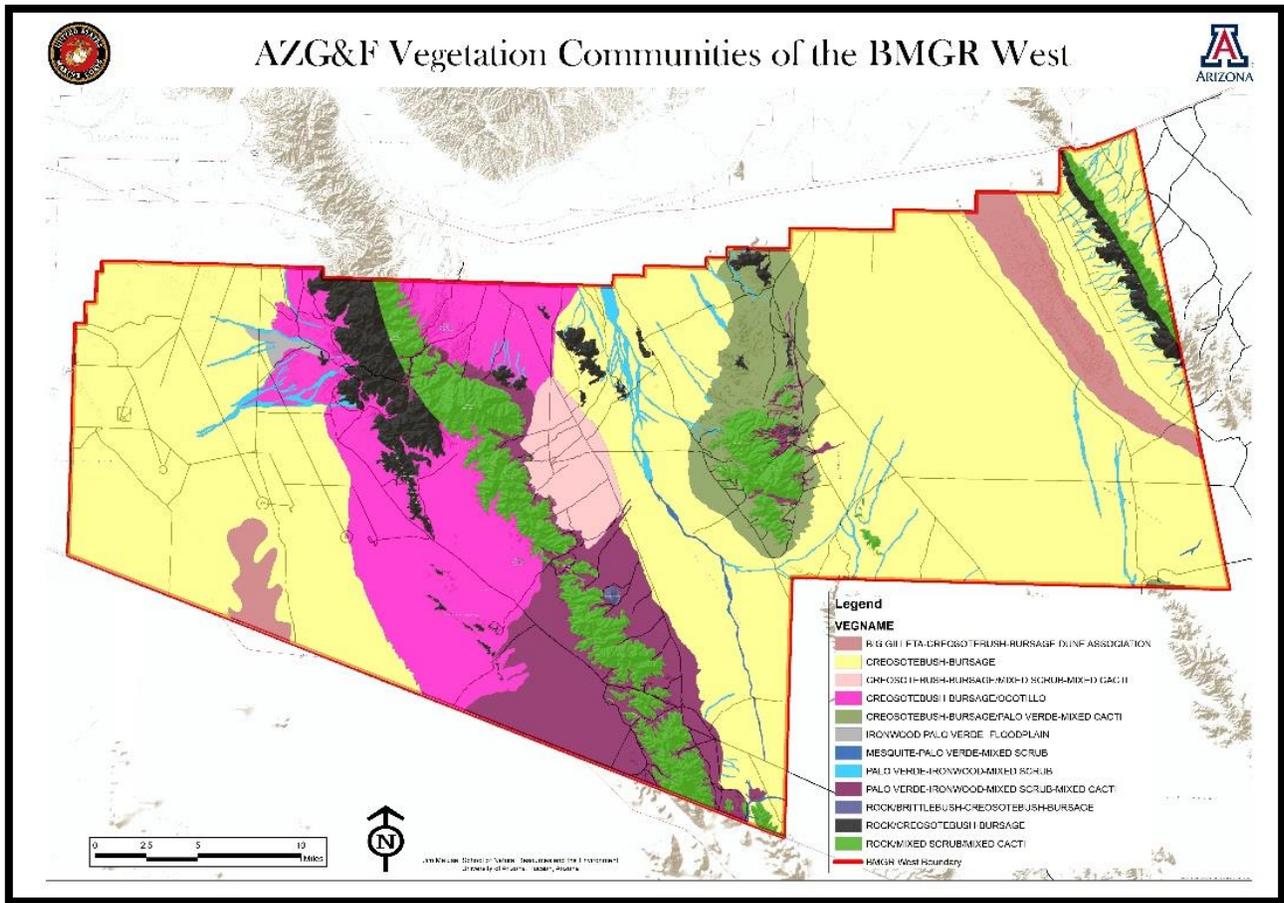


Figure 38. The western portion of the Arizona Game and Fish map of vegetation communities of southwest Arizona. There are a dozen communities on the BMGR West.

## METHODS

### The Basics

Vegetation field sampling and mapping followed the protocol established for lands on the Cabeza Prieta National Wildlife Refuge ([CPNWR] Malusa, 2003a, b) and the BMGR East (McLaughlin et al, 2007; Osmer, 2009; Shepherd, 2011; Whitbeck, 2013). This basic method is to become familiar with both the land and aerial images of the land – so familiar, in fact, that you can interpret an aerial image to determine to which vegetation type it belongs. Once proficient at the task, you can then draw the boundary of the vegetation (creating a “polygon”) directly on the image displayed on a computer monitor while using a program called ArcGIS (Fig. 39).



Figure 39. A view of an area about 400 meters across (1/4 mile) on the northeast side of the Gila Mountains, illustrating how the vegetation map was made. The two crooked black lines are the boundaries between three vegetation types in this example. In this particular example, it’s easy to make the distinction between the desert pavement and the large arroyo in the middle. More difficult is placing the line between the arroyo and the vegetation to the far right, especially near the top right of the image, where the arroyo splits into many channels.

Mapping of the BMGR West began in 2009, when the best available imagery was Digital Ortho Quarter Quad (DOQQ) images from the National Agricultural Inventory Program (NAIP). The DOQQs have a resolution of 1 meter, which renders vegetation and landscape as patterns: stippled creosote flats, wavy drifts of dunes, linear arroyos, teardrops of desert pavements, and more. These were the basis for drawing the boundaries of all the vegetation associations in the eastern

BMGR West – such as the Mohawk Mountains – but as the project moved west, Google Earth and Bing imagery was also used. By 2014 this online imagery was often good enough to make out individual ocotillos. Unfortunately, it is not suitable for use with ArcGIS, so two computer monitors were used side by side, one with the DOQQ on ArcGIS, and the other with Google Earth or Bing.

This sounds easy enough – and sometimes it is easy, especially when they are associated with particular landforms, such as desert pavements.

More often it is not easy. No matter what level of detail you are mapping, you must have a rule for when one vegetation becomes another. These rules are often left unsaid, as they are with all previous vegetation maps of southwestern Arizona discussed above. To use the example of the GAP map and its two large mapping units, “Paloverde-Mixed Cacti Desert Scrub” and “Creosotebush-White Bursage Desert Scrub” – how is the line between them determined? There is no such line in nature, that instead there are fewer and fewer paloverde (and ironwood, *Olneya tesota*) as we move away from the mountain front and into the valley. The line on the map is a threshold created by the vegetation mapper. We strive to make rule sets by which we try to abide, e.g., if creosote is the dominant species, and big galleta grass is common and more than 1% cover, then it is association 16 (*Larrea tridentata/Pleuraphis rigida*).

Equally important to remember is this: the line between this association and its neighbors is merely the 1 percent cover cutoff for big galleta grass. You can expect two places to either side of this line, but very close to the line, to be very similar, *despite living in different vegetation associations*. They know nothing of the line, which is drawn by the mapmaker, and based on field trips and imagery.

## In the Field

Fieldwork is necessary not only to figure out what we’re looking at on the aerial imagery and help draw the bounds of each vegetation type, but also to give a statistical picture of the diversity and structure of the vegetation – how common is a species, what is its canopy cover, and how tall is it? To this end, each vegetation type was sampled with numerous “relevés”, a ten-dollar word for a one buck idea: describe what lies within the vegetation you are describing.

Relevé is a French word for summary, or list. Its use in vegetation ecology can be attributed to a Josias Braun-Blanquet, who developed relevés as a standard method of sampling in the early 1900’s. The important thing about relevés: they are not random. They are not the best way to “discover” vegetation types, but a way to describe them. In other words, the field biologists in this study – Malusa and Sundt – recognize different vegetation and seek to describe it in a way that is useful to other biologists. For instance, if you are interested in the bird known as Le Conte’s thrasher, the relevé method and the resulting vegetation map are ideal, because you’ll have a good idea of the species composition, the canopy cover, and height in every mapping unit.

Let's say we are sampling creosote/big galleta grass (*Larrea tridentata*/*Pleuraphis rigida*), which ideally looks something like Figure 40:



Figure 40. A photogenic swath of creosote/big galleta grass vegetation, looking southeast to the Copper Mountains. The big galleta grass is especially common in this region along the Military Drag Road, between the Baker Peaks and the Wellton Hills.

Let's also assume we're working as a team, Malusa and Sundt. I (Malusa) place myself squarely within a place that is, so far as possible, where (a) creosote is dominant or co-dominant, and (b) big galleta grass has at least one percent cover. I pick a point on the horizon, then toss my walking stick over my shoulder; wherever it lands is the random starting point. From this point I first name the relevé with the first letters of the name of the 7.5 minute quad sheet, sequentially numbered, e.g., the first sample from the Mohawk quad is M-1. Sundt records the location with a GPS and take a geo-tagged photo oriented along the path to be taken. The photo is later given the same name as the relevé. A brief environmental description is recorded: slope (a variety of inclinometers were used, from a simple protractor to an iPhone app; and in areas of less than 3% slope, we just guessed), aspect, geomorphology, lithology, and dominant surface texture.

Then I begin walking toward the point on the horizon chosen earlier, keeping track of the number of paces with a hand clicker. An average step was 0.7 meters (2.3 feet). Each time the tip of my boot falls atop or under a plant canopy (including branches that may/may not be alive), that species is noted on the data sheet. More than one species can occupy the space above the point, especially in the case of a palo verde or ironwood, which often sheltered other species.

A list of all perennial species in the relevé is gathered as I walk, whether it receives a 'hit' or not. The precise width of the relevé depends on the sort of vegetation and the species observed – a lone saguaro cactus, for instance, can be spotted a mile away, while a pincushion cactus is a different story. The BMGR West is relatively open vegetation, and in most instances, such as relevé among creosote and bursage, it was possible to scan everything within ten meters to either side while 'walking the line". In the case of a typical 500 step relevé, this works out to 7000 square meters, or 0.7 hectares, or 1.7 acres.

I keep walking until no new perennial species are being added to the list. Transects ranged from 200 to 1000 points (about 200 to 700 meters), depending on the terrain and plant cover, with a lower number of points on steep slopes with higher cover, and a higher number of points on, say, a creosote flat with few species.

Concluding the relevé, I'll tally up the number of 'hits' to figure out (1) the canopy cover and (2) the prominence of each perennial species. If a species got 20 hits in 500 paces, that's 4% canopy cover. The species with the highest cover value is the **dominant** species for that relevé. If the cover values of two or more species are close – say, with 1 or 2 % - they are considered **co-dominant**. If they are neither dominant nor co-dominant, yet plain to see, they are **common**. (Expressed as a cover value, this is greater than 0.4% cover). **Uncommon** species have lower cover values, and you have to search for them unless they are very tall and obvious. In other words, a relevé with 5 saguaros over 300 meters would rank them as uncommon, though it was no trouble at all to find them. Finally, **rare** species are those with only one or two individuals discovered in the relevé. Keep in mind that doesn't mean one or two that received 'hits' from the point transect, but instead only one or two seen anywhere in the relevé.

Both canopy cover and prominence values are entered as a code (Table 1) on the data sheet (Fig. 41).

I then measure the mean height (n=10) from each perennial species that ranks as common, co-dominant, or dominant. Individuals were chosen haphazardly, which means that if there are a lot of juveniles in the population the mean height is skewed. To limit this effect in populations with many young recruits, I didn't measure individuals that were less than 1/10 the estimated height of adult plants, which in itself is merely an estimate. For instance, if a typical palo verde looked to be 3 meters tall, I didn't count juveniles 30 cm or less.

Height was estimated to the nearest 10cm, with the exception of trees and ocotillos, whose height was estimated to the nearest 0.5 m. Abundant annuals were noted in the relevé data and included in the association descriptions, although they may or may not be characteristic of a particular association – the seed banks of annuals can 'migrate' as conditions change. Regardless of their cover values, annuals were not assigned prominence values higher than 'common', and not as dominant or co-dominant, because the National Vegetation Classification is built on the relative abundance of only perennial species.

**Table 1. Canopy cover and prominence codes entered on data sheet.**

<u>Cover Class Code</u>	<u>Percent Cover</u>
0	unknown
1	<1%
2	1-4%
3	5-9%
4	10-14%
5	15-25%
6	26-40%
7	41-60%
8	61-80%
9	81-100%

<b>Prominence Codes</b>
5 = dominant
4 = co-dominant
3 = common
2 = uncommon
1 = rare



Note: early in this study, I used a modified nearest-neighbor method of estimating cover (Catana, 1953) because that was the method used in early studies near Organ Pipe Cactus NM (see Malusa 2003a, b). However, it performed poorly as the vegetation cover decreased while moving into more arid lands on the BMGR West. The point-transect method described above was adopted (Elzinga et al, 1998), which also has its faults for very low cover values, but at least took less time than the nearest neighbor method. Further, the species list generated for each relevé includes all perennial species within view – the so-called ocular method – and thus circumvents a common lament for using the point-transect in areas of very low cover, mainly that it is too easy to miss a rare species (Godinez-Alvarez et al, 2009).

Watercourses and desert pavements had special protocols for relevés. Care was taken on desert pavements to walk perpendicular to the many small watercourses; otherwise, you can easily end up paralleling either the pavement or the watercourse, each of which differs dramatically from the other.

Watercourses were sampled along a single bank for 100 paces (about 70 meters). While walking in the watercourse, I paused with each step and made an imaginary line with my walking stick extending 2 meters back from the bank. Every species that fell along, above, or below that line was included as a 'hit'. This method was chosen because it was very difficult to run a point transect anywhere near the bank, which was a dense tangle of wolfberry and catclaw. Consequently, and unfortunately, the cover values generated from the watercourse relevés cannot be compared to those from other vegetation types. Instead, these cover values were solely to establish which species are dominant/co-dominant within the relevé, and to provide a picture for the reader of what the typical vegetation resembled.

As mentioned above, ultimately the boundaries between vegetation types were drawn on a computer directly from imagery, but there were plenty of lines drawn in the field, too. For each of the approximately 50 "quarter quadrangles" (1/4 of a standard 7.5 minute topo sheet) within the BMGR West, a field map was created by printing out the DOQQ image at 1:10,000. At this scale, each millimeter on the map equals ten meters on the ground. When equipped with a GPS and ruler, it was then possible to place yourself within ten meters anywhere on the range, where notes could be appended directly to the map (Fig. 42).

Finally, binoculars and a spotting scope were especially useful in the mountains, where certain species, like Kearny's sumac (*Rhus kearnyi*) or desert beargrass (*Nolina bigelovii*), could be seen from up to a mile away. Naturally, we nonetheless attempted to visit every corner of the BMGR West, and each trip was recorded by our Garmin 550t GPS units as a GPX file that is included with the delivered data.



Figure 42. A heavily annotated field map of the northern Copper Mountains. Note the red grid, with each square covering 500 meters square.

## In the Lab

### The Database

All data were entered into a Microsoft Access database initiated by Malusa (2003a). When combined with data from the Cabeza Prieta NWR and the surrounding BLM lands (Malusa 2003a, b), there are now well over a thousand relevés in southwestern Arizona. The database is regularly updated, and the user should email the lead author, [Malusa@email.arizona.edu](mailto:Malusa@email.arizona.edu), to check if they have the most recent iteration to ensure the correct vegetation type is attributed.

### Drawing the Map

The final GIS platform was ArcMap 10.2. All digitization was by Jim Malusa, with technical support from Mickey Reed, Craig Wissler, and Andy Honaman of the ART Lab, School of Natural Resources and the Environment, University of Arizona. Every possible data source was used for the imagery, from NAIP to Google Earth to a SID image of Yuma County from 2010 provided by Marine Corps Air Station Yuma (MCAS Yuma), who also provided a shapefile of the BMGR West boundary, and the road system ("Gold Standard") for the entire BMGR.

The section of the map covering the so-called 'orphan parcels', west of the ASH (Highway 195), were mapped by the consulting firm Cardno under a separate contract. Cardno contacted Malusa directly and asked for descriptions of the vegetation mapping units, so their map would match. Cardno completed the mapping in 2013 and supplied the resulting shapefile to Malusa, who adopted it for the vegetation map presented in this study. However, Cardno did the field work before subassociation 117 was recognized. When merging their data with this study's, some of the Cardno polygons were reattributed as 117.

GIS data were kept in a file geodatabase (MCAS UA.gdb). All features were drawn as polygons with the exception of narrow washes. The minimum mapping unit was 1.0 hectare. Stands less than 1.0 hectares, if deemed important, were mapped as point or linear features. Watercourses with an open bed between 1 and 5 meters wide (3.3 – 16 feet) were mapped as either (a) polygons, if they supported a broad band of vegetation, which made it easy to draw; or as (b) linear features in a separate feature class called arroyos, if narrowly banded by vegetation. These linear features were later incorporated as polygons, by creating a 4 meters (15.1 feet) wide buffer along each line, then creating polygons from the output. These polygons were used like a cookie-cutter to place them within the pre-existing polygonal vegetation layer.

Earlier mapping efforts, including the CPNWR (Malusa 2003a, b), the North and South Tactical Ranges (McLaughlin et al, 2007) were motivated by the Sonoran pronghorn (*Antilocapra americana sonoriensis*), which typically does not venture into the mountains. Consequently, these earlier maps show the mountains simply as a landform with slopes greater than 20%, not as vegetation associations. In contrast, the present study samples heavily from the mountains, and maps their vegetation in a dozen different types, ranging from Mormon tea shrub-lands dotted with sumac and beargrass (on north slopes above 700 meters [2000 feet]), to barren rocky slopes holding only creosote and fagonia (such as the Wellton Hills). A 10 meter digital elevation model (DEM) was used to make the cutoff between slopes greater and less than 20%. Difficult terrain, with rock spires and overhangs, can confuse the algorithm and misplace the "20% line"; in these cases, the line was fixed manually, using a digital raster graphic topographic map (DRG).

Care was taken to map disturbed areas, because they are areas of erosion as well as vectors for invasive species (Brooks and Berry, 2006). Roads that are still in use are not mapped as 'disturbed', but rather recognized as roads in the 'Gold Standard' road layer provided by the Marines. However, abandoned roads in and around the former laser range on the east side of the Gila Mountains (north of Cipriano Pass) were mapped as disturbed. So were large 'turn-arounds' created by the Border Patrol for their tire-drags, and lands disturbed by range infrastructure such as threat emitters and the shooting range. However, ironwoods cut by miners in the last century were not mapped. Such trees, or rather stumps, are especially common in the arroyos along the Gila Mountains.

## Problems

(a) There remains a lack of simple crosswalk to mapping units in California. As the study progressed, it became clear that the National Vegetation Classification (NVC) rules for alliance and association can be broadly interpreted. The NVC rules (FGDC, 2008) state that an “alliance consists of one or a group of diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation layer...” while an “association is characterized by diagnostic species that occur in all strata (overstory and understory) of the vegetation.” Perhaps in regions with multiple strata – like a forest – this distinction is helpful. In the Sonoran Desert, where the distinction between overstory and understory is usually moot, the result is that many of association in this study would be considered alliances in California, simply because of different interpretations.

For instance, in this study the dominant/co-dominant species defined the alliance level. If creosote (*Larrea tridentata*) was the dominant/co-dominant species, the mapping unit fell under the creosote alliance. Likewise, if white bursage (*Ambrosia dumosa*) were the dominant/co-dominant species, it was part of that alliance. The most common **association** on the BMGR West is characterized by creosote as the dominant/co-dominant with 5-9% cover, and with white bursage (*Ambrosia dumosa*) as a common species with 1-4% cover. It is also part of the creosote **alliance**.

However, in the Terrestrial Vegetation of California (Barbour et al., 2007), the same vegetation is excluded from the creosote alliance, with the following rule: “*Ambrosia dumosa* or *Encelia farinosa* absent or < 1% cover”. Instead, this vegetation is placed within a *Larrea tridentata*/*Ambrosia dumosa* Shrubland Alliance with the following rule: “Both *Larrea tridentata* and *Ambrosia dumosa* ≥ 1% absolute cover in the shrub canopy; both species exceeding 2 × the cover of other shrub species.”

The upshot is that the mapping units from this study cannot be directly carried over to California’s deserts. Fortunately, the rules are clearly stated in both this study and in the California manual of vegetation, so an alert land manager will recognize the differences. A GIS technician would need extra care in matching the map boundaries.

(b) Defining arroyos based on the width of the open bed isn’t a good system, but was nonetheless carried over from earlier studies. It made sense 15 years ago, when imagery wasn’t good enough to distinguish species, but the upshot is a very complicated vegetation mapping unit. For example, there were 11 species that could be dominant/co-dominant in the narrow arroyos (812) mapping unit. Faced with this diversity, this study created a watercourse ‘alliance,’ which, strictly speaking, is against the rules. Alliances are supposed to be based on floristics, meaning particular species. But having an alliance name with 11 species was unwieldy. One final complication: we could not distinguish between various species of wolfberry (*Lycium*), so all ‘hits’ when estimating cover were simply attributed to *Lycium*.

(c) An accuracy assessment was neither budgeted nor performed.

(d) The soil surface description on the data sheet provided only the most basic information on soils, which are key to understanding the vegetation (e.g., McAuliffe, 1999). There is no soil map for the BMGR West, a situation which is currently being remedied by a study funded by Range Management.

(e) Certain alliances in the study have names that aren't entirely satisfactory. For instance, watercourses in the mountains are clearly dominated by desert lavender (*Hyptis emoryi*). This vegetation is previously described in the NVC, yet in this study is simply included as part of the 'watercourse' alliance.

This is for two reasons. One is to provide the primary users of this map – the range managers of the BMGR West – with a clear way to utilize the vegetation map for range management, and there was no better way than providing a common name and GIS code for “watercourses.”

Second, and more complicated, there was no room in the hierarchy (as built in this study) for an additional alliance. This map has its roots with Brown and Lowe (1982), Warren et al. (1981), and Malusa (2003 a, b). We strived to keep the classification scheme as uniform as possible. In particular, we ultimately wanted a map that used the same mapping units from Organ Pipe Cactus NM to Yuma, so land managers would know what was meant by, for example, “creosote/white bursage association.”

All of these previous studies in turn relied on the Brown and Lowe (1974) classification, “A digitized computer-compatible classification...” It's a base ten hierarchy, and there is no way to put more than ten associations, say, into a single alliance. Further, for the final two years of the present study, there was no way to determine to which 'group' (the next level up in the hierarchy) the alliances belonged, because they were under review by the NVC. Once the NVC review of the alliances is complete, there are bound to be some changes in the names/GIS codes assigned in this study.

(f) Certain species could be difficult to identify when not flowering. Consequently, all three species of pincushion cactus (*Mammillaria*) that could be on the range were simply identified at the genus level. Likewise, wolfberry (*Lycium*), of which there are at least six species on the range, were lumped as simply *Lycium*. Finally, two species of Dalea were recognized at the study's onset, *Dalea mollissima* and *Dalea mollis*. Recent taxonomic work sinks *mollissima* as a subspecies of *mollis*.

(g) Places with plenty of limberbush (*Jatropha cuneata*) were found in the Tinajas Altas and Gila Mountains. In some places it was the dominant species, and likely worthy of recognition as an association, but we lacked the time/money/imagery to distinguish such lands as a separate mapping unit.

## Results

### Data Management

A total of 656 relevés were collected (Fig. 43). A few are outside the boundary of the BMGR West, but were included in the database if they occurred in the mapping units on the BMGR West. Nearly 300 species were encountered during the study. Each was assigned a taxonomic code in the table “Plants”, which also lists the family, genus, species and common name for each species. For a researcher interested in, say, elephant tree (*Bursera microphylla*), its presence/absence at every relevé can be accessed in the database in the table “VegPromSummary.” All fields from the data sheets were entered in their respective tables. For example, the table “Description” has the records for lithology, landform, and soil texture. The table “Relevé” contains most of the information from the data sheet, including the general location (e.g., ‘Summit of Baker Peaks’), the date, elevation, slope, aspect, and the code for the association and subassociation.

Photos from the relevés are renamed to match the relevé. As mentioned above, a relevé name is alpha-numeric. The letters are the first letters of the name of the 7.5 minute quad sheet in which it is found, sequentially numbered, e.g., the first sample from the Mohawk quad is M-1. The fifth relevé from the Point of the Pintas quad would be POTP-5.

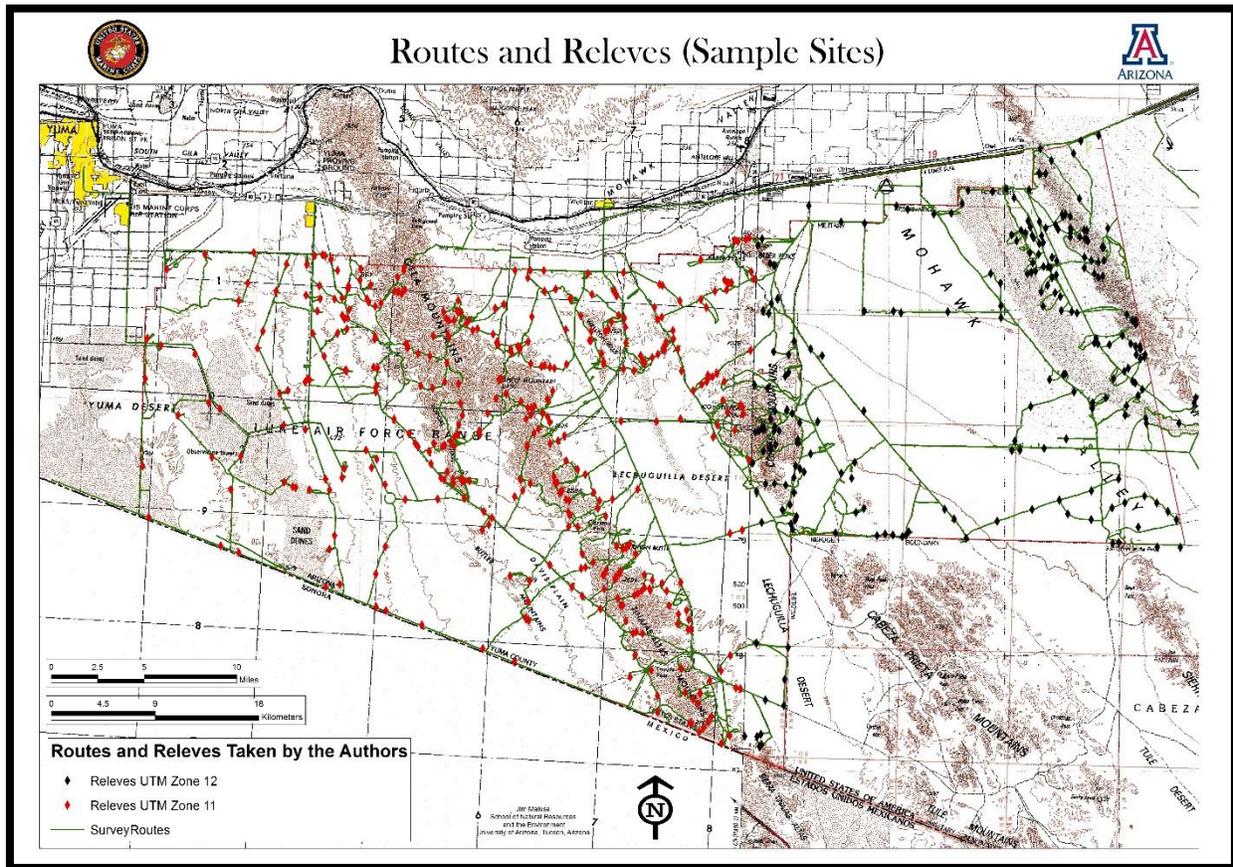


Figure 43 – Locations of the 656 relevés collected during the study.

## Naming an Alliance, Association, or Subassociation

Based on the imagery and relevés, seven vegetation alliances (not counting “barren” and “disturbed” alliances), 25 associations and 42 subassociations were recognized and mapped. The naming conventions used in this study reflect the hierarchical structure of the Federal Geographic Data Committee's standards for the National Vegetation Classification (2008).

### Class

#### Subclass

#### Formation

#### Division

#### Macrogroup

#### Group

#### Alliance

#### Association

According to National Vegetation Classification, “*These eight levels comprise the standard levels of the NVC. Lower level units, such as sub-association or variant, may also be used, if desired.*” (FGDC, 2008). In this study, subassociation was used extensively.

Because the NVC classification essentially covers the entire earth, the highest levels, such as Class, are very broad, and based on macro-climatic criteria and the characteristic growth form. In the case of the BMGR West, the whole range falls into the Class called “Xeromorphic Woodland, Scrub & Herb Vegetation”, which is another way of saying: desert and semi-desert.

Using a real example from the BMGR West, here’s where a creosote flat would be placed in the NVC hierarchy:

Xeromorphic Woodland, Scrub & Herb Vegetation **Class**

Warm Desert and Semi-Desert Woodland, Scrub and Grassland **Subclass**

Warm desert and Semi-Desert scrub and Grassland **Formation**

North American Warm Desert Scrub and Grassland **Division**

*Carnegiea gigantea - Stenocereus thurberi - Ambrosia dumosa* Mojave-Sonoran Semi-Desert Scrub **Macrogroup**

*Larrea tridentata - Ambrosia dumosa - Encelia farinosa* Desert Scrub **Group**

*Larrea tridentata* Shrubland **Alliance**

*Larrea tridentata* monotype Shrubland **Association**

On the north slopes of the higher mountains are two mapping units (400 and 410) that fall under the *Chrysothamnus viscidiflorus - Coleogyne ramosissima / Achnatherum hymenoides* Great Basin & Intermountain Dry Shrubland & Grassland **Macrogroup**. This is part of the Western North American Cool Semi-Desert Scrub and Grassland **Division** – the only part of the BMGR West to

actually have the word “Cool” as part of its official name. These lands cover some 1,943 hectares (4,801 acres) of the BMGR West – a sizable hunk of the range, and rarely visited.

The rest of the BMGR West falls under the *Carnegiea gigantea* - *Stenocereus thurberi* - *Ambrosia dumosa* Mojave-Sonoran Semi-Desert Scrub **Macrogroup**, which covers most of the Mojave and Sonoran deserts in the southwestern United States. Within this Macrogroup, the vegetation of BMGR West fell under three broad Groups.

(1) Elephant-tree – Physic nut - Senita Cactus Desert Scrub Group **Group**. This includes the most frost-sensitive species, and contains elements of the Brown and Lowe (1982) Copal-Torote Series (Central Gulf Coast subdivision) of the Sonoran Desert. (*Copal* is Spanish for Elephant tree.)

(2) Saguaro - Yellow Paloverde - Triangle Bur-ragweed Mixed Cacti Desert Scrub **Group**. Characterized by the big cactus and palo verde, this corresponds to Brown and Lowe (1982) Arizona Upland Subdivision of the Sonoran Desert.

(3) Creosotebush - Burrobush - Brittlebush Desert Scrub **Group**. Corresponds to the Lower Colorado River subdivision of Brown and Lowe (1982).

Within these three groups, each type of BMGR West vegetation (“mapping unit”) was classified into an **Alliance**, **Association**, and **Subassociation**. An Alliance may have only one Association, or many. Likewise, an Association may have one to many Subassociations, the finest level of vegetation mapping.

There are seven vegetation alliances mapped in the BMGR West: creosote, bursage, saltbush, brittlebush, Mormon tea, watercourse, and blue paloverde. Within these alliances are 25 associations; within these associations are 42 subassociations, the most detailed mapping unit, and whose name is often with reference to a particular landform, e.g., creosote-white bursage/ocotillo on ridges. Lands that were denuded or disturbed by humans were coded as Alliance (5) in the GIS attribute table. Lands naturally lacking vegetation were coded as Alliance (0). See table 2 (or the Table of Contents) for a complete list. The maps are shown in miniature in Figs. 44 – 46.

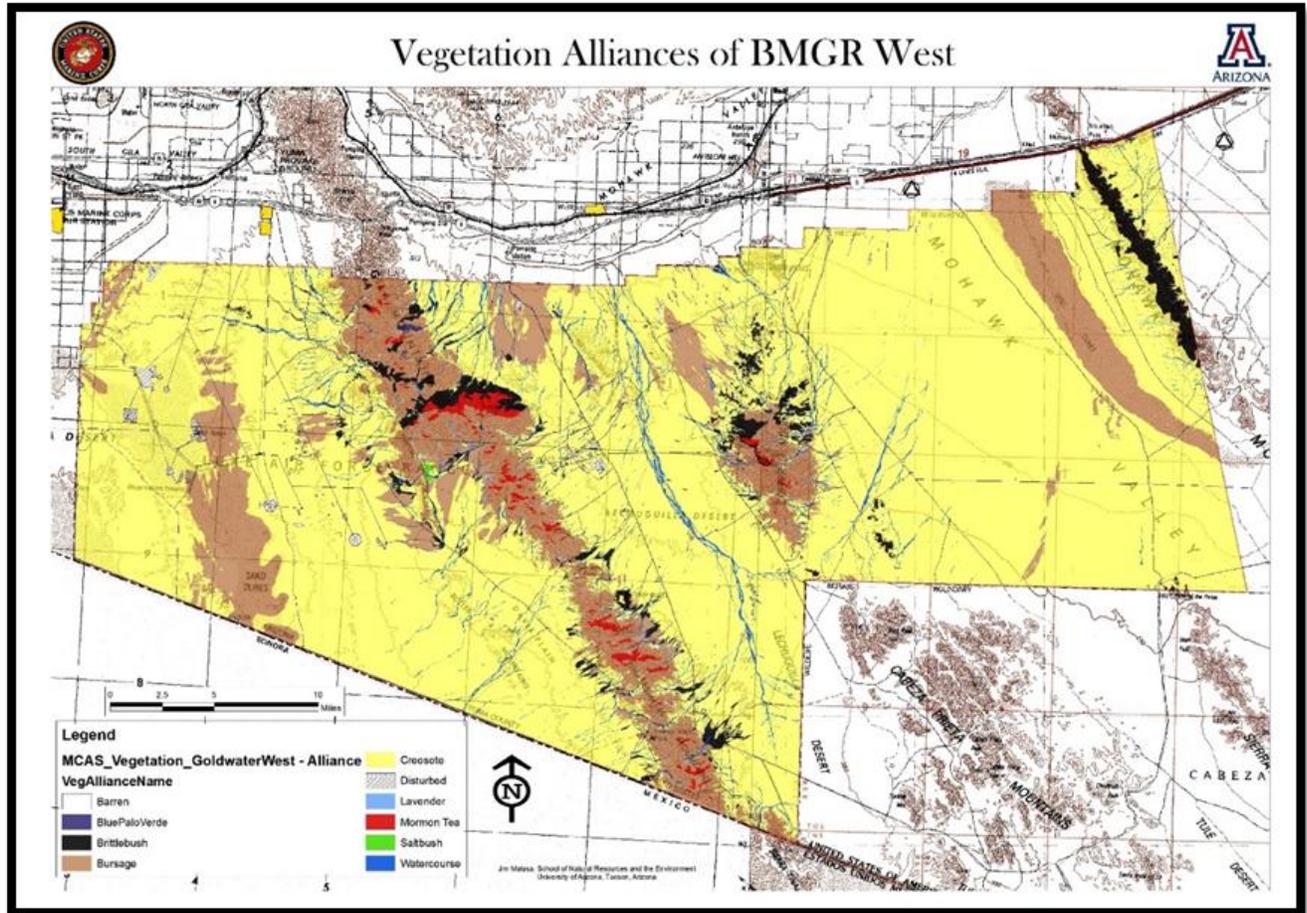


Figure 44. Vegetation alliances on the BMGR West.

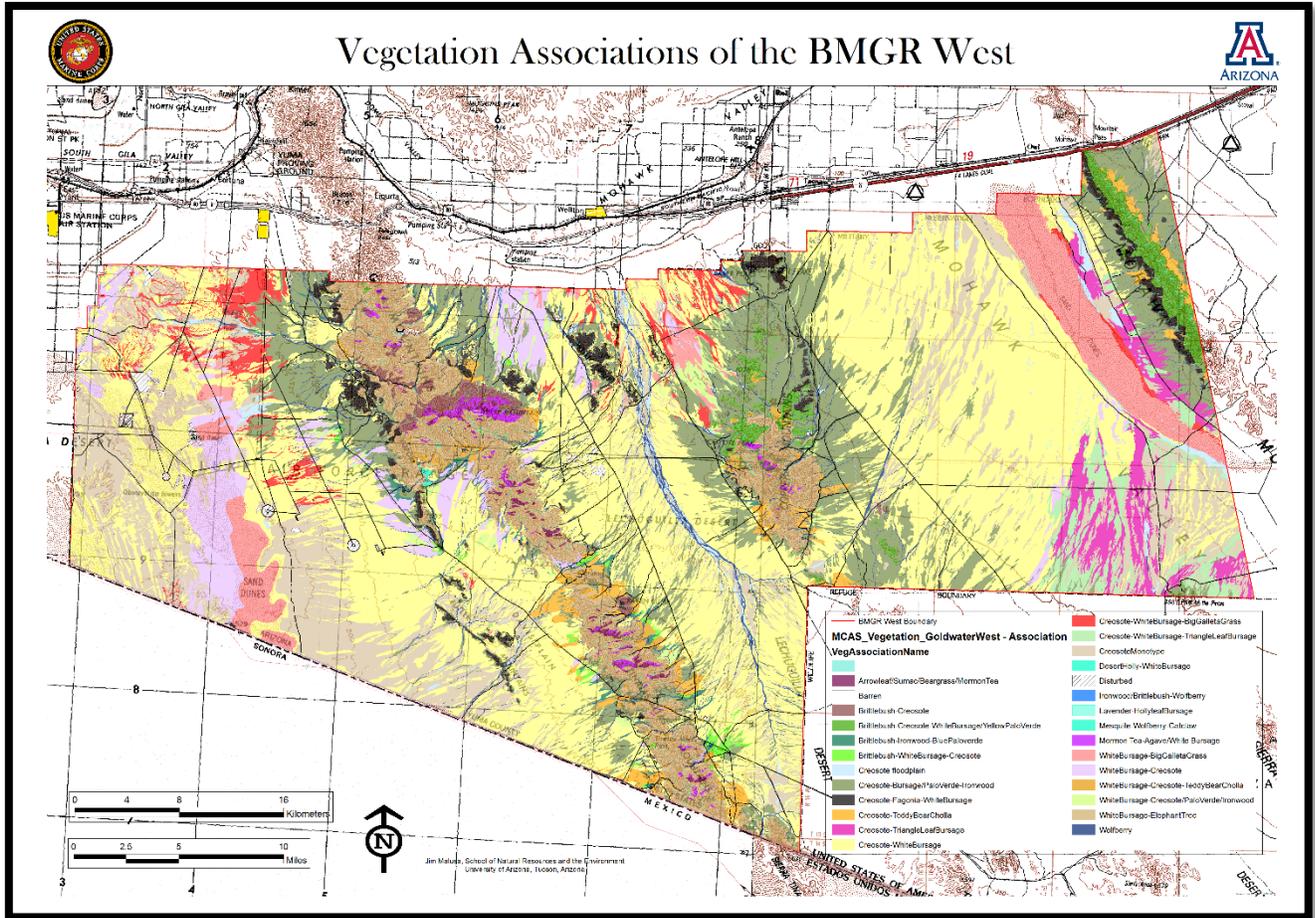


Figure 45. The 25 vegetation associations on the BMGR West.

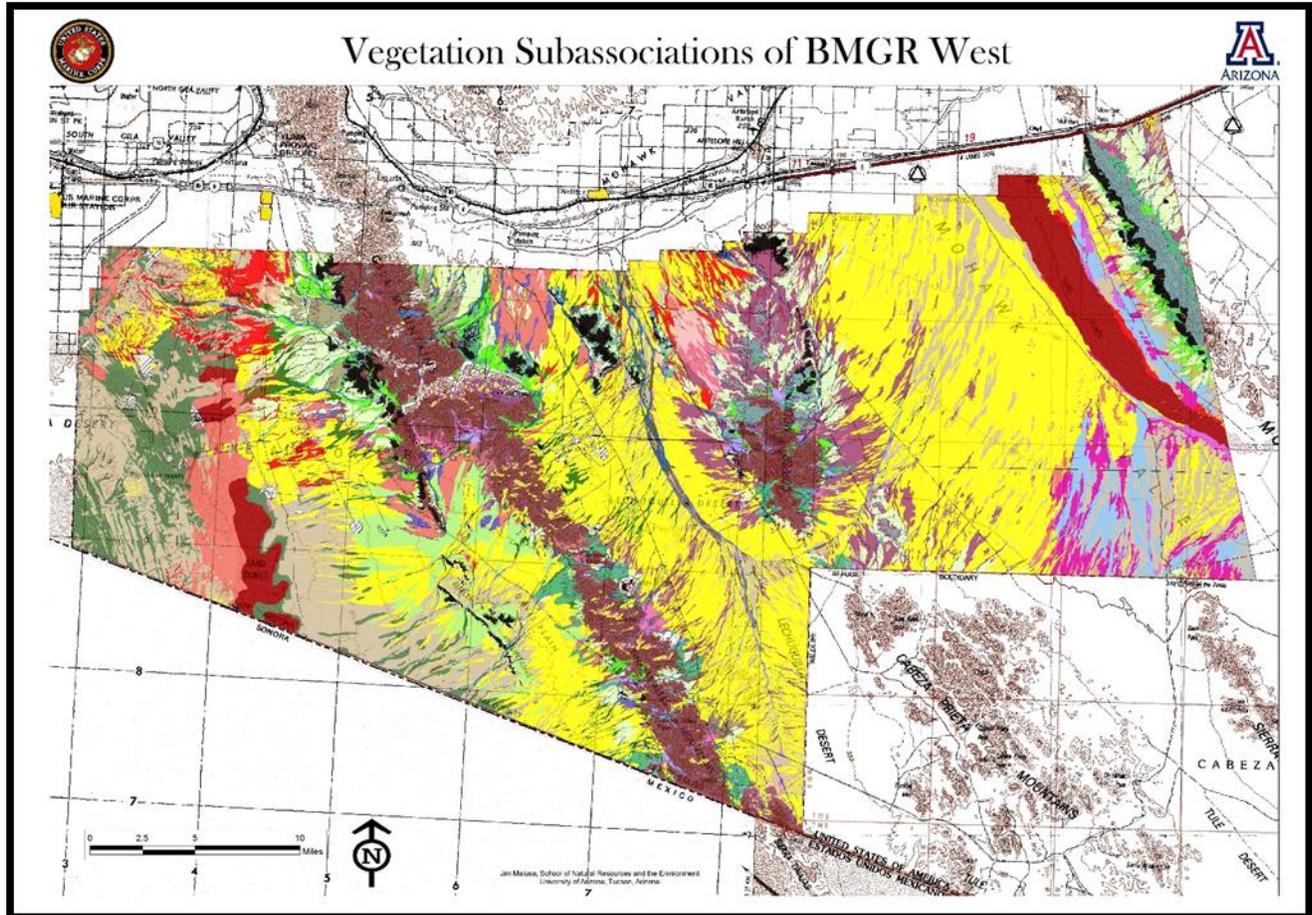


Figure 46. The vegetation subassociations on the BMGR West. No key is shown because it is not possible at this scale to show all 42 mapping units.

Table 2. Alliances, Associations, and Subassociations of the BMGR West. The table is essentially the Table of Contents without the page numbers. The numbers in parentheses (xx) refer to the code in the GIS attribute table. For Latin (scientific) names, see full descriptions of each mapping unit in the text.

## Alliance: Barren (0)

### Alliance: Creosote (1)

**Association:** Creosote monotype (10)

**Subassociation:** Creosote monotype (100)

**Association:** Creosote - white bursage (11)

**Subassociation:** Creosote - white bursage (110)

**Subassociation:** Creosote-fagonia-white bursage on hills (113)

**Subassociation:** Creosote- white bursage-ocotillo on ridges (115)

**Subassociation:** Creosote - ocotillo - white bursage on plains (116)

**Subassociation:** Creosote – Spanish needles - white bursage on sands (117)

**Association:** Creosote – triangle leaf bursage (12)

**Subassociation:** Creosote – triangle leaf bursage (120)

**Association:** Creosote – white bursage -triangle leaf bursage (13)

**Subassociation:** Creosote – white bursage - triangle leaf bursage (130)

**Subassociation:** Creosote-white bursage-triangle leaf bursage, burned (132)

**Association:** Creosote – teddy bear cholla (14)

**Subassociation:** Creosote - white bursage –teddy bear cholla (141)

**Association:** Creosote floodplain (15)

**Subassociation:** Creosote - mesquite – triangle leaf bursage floodplain (150)

**Subassociation:** Creosote – white bursage – blue palo verde floodplain (151)

**Subassociation:** Creosote – white bursage playa/floodplain (152)

**Association:** Creosote – white bursage – big galleta grass (16)

**Subassociation:** Creosote – white bursage – big galleta grass (160)

**Association:** Creosote – bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – triangle-leaf bursage – yellow paloverde/ironwood (170)

**Subassociation:** Creosote – white bursage/paloverde-ironwood pavements (171)

**Subassociation:** Creosote – white bursage/yellow paloverde-ironwood bar/swale (175)

**Subassociation:** Creosote – white bursage/ironwood-blue paloverde (176)

**Subassociation:** Creosote – white bursage/ironwood-yellow paloverde (177)

**Subassociation:** Creosote – white bursage/ironwood-blue paloverde – club cholla (178)

**Association:** Creosote – fagonia– white bursage (19)

**Subassociation:** Creosote – fagonia– white bursage on steep slopes (191)

### Alliance: Bursage (2)

**Association:** White Bursage-Creosote-Teddy Bear Cholla (24)

**Subassociation:** White Bursage-Creosote-Teddy Bear Cholla (241)

**Subassociation:** White Bursage-Creosote-Ironwood-Teddy Bear Cholla (242)

**Association:** White Bursage-Big Galleta Grass (26)

**Subassociation:** White Bursage-Big Galleta Grass on Dunes (260)

**Subassociation:** White Bursage-Big Galleta Grass on Fans (261)

**Association: Bursage/Elephant Tree (27)**

Subassociation: White Bursage/Elephant Tree on alluvium/pediment (275)

Subassociation: White Bursage-Elephant Tree-Brittlebush on mountains (276)

**Association: White Bursage – Creosote (28)**

Subassociation: White Bursage- Creosote – Ocotillo (280)

**Association: White Bursage – Creosote/PaloVerde/Ironwood (29)**

Subassociation: White Bursage- Creosote – Yellow PaloVerde (291)

**Alliance: Mormon Tea (4)**

**Association: Mormon Tea-Agave/White Bursage (40)**

Subassociation: Mormon Tea-Agave/White Bursage (400)

**Association: Arrowleaf/Sumac/Beargrass/MormonTea (41)**

Subassociation: Arrowleaf/Sumac-Beargrass/MormonTea-Lavender (410)

**Alliance: Disturbed (5)**

**Alliance: Brittlebush (6)**

**Association: Brittlebush-Creosote-WhiteBursage/YellowPaloVerde (63)**

Subassociation: Brittlebush-Creosote-WhiteBursage/YellowPaloVerde (631)

**Association: Brittlebush-Creosote (67)**

Subassociation: Brittlebush-Creosote on Dark Rocks (670)

**Association: Brittlebush-Creosote-WhiteBursage (68)**

Subassociation: Brittlebush-WhiteBursage-Creosote on Fans (681)

**Association: Brittlebush/Ironwood-BluePaloverde (69)**

Subassociation: Brittlebush/Ironwood-BluePaloverde on Fans (691)

**Alliance: Saltbush (7)**

**Association: DesertHolly-WhiteBursage (71)**

Subassociation: DesertHolly-WhiteBursage-WandHoldback (710)

**Alliance: Watercourse (8)**

**Association: Mesquite (80)**

Subassociation: Mesquite Bosque (800)

**Association: Wolfberry (81)**

Subassociation: Mesquite/Wolfberry-Catclaw-Cheesebush (810)

Subassociation: Ironwood/Brittlebush-Wolfberry-Cheesebush (811)

Subassociation: Ironwood/Brittlebush-Wolfberry-White Bursage (812)

**Association: Lavender/Hollyleaf bursage (83)**

Subassociation: Lavender/Hollyleaf bursage – Brittlebush (830)

**Alliance: Blue Paloverde (9)**

**Association: Blue PaloVerde/Hollyleaf Bursage (90)**

Subassociation: Blue PaloVerde/Hollyleaf Bursage on mountains (900)

## Relative Abundance of Vegetation Alliances on the BMGR West

A total of 13,215 polygons were drawn to represent the vegetation, with a typical minimum mapping unit of 1 hectare. Alliance is the top level in this classification scheme. Within each alliance are one to ten associations, and within each association may be one to ten subassociations. The polygons are all drawn at the subassociation level, the most detailed. This doesn't mean every polygon is small; the single largest polygon was 35,004 hectares (86,497 acres) of creosote/white bursage in the Mohawk Valley, an area equivalent to 135 square miles! Using the GIS codes in the attribute table, the subassociations can be grouped into associations, which in turn can be grouped into alliances. The respective areas for alliances, associations, and subassociations are in Tables 3 - 7.

The creosote alliance rules southwest Arizona and the BMGR West. Creosote was recorded at 604 of 656 relevés. Within the creosote alliance there are 9 associations and 20 subassociations – all variations for which creosote (*Larrea tridentata*) is a dominant or co-dominant species. Most of these associations and subassociations would be apparent at a glance: for instance, at the toe of many mountains, creosote is associated with teddy-bear cholla, the most aggressive plant on the range. Other creosote associations include creosote/big galleta grass, creosote/palo verde/ironwood, and creosote/white bursage.

Subassociations divide up the associations, often based on landform. For example: the creosote/white bursage association, which is the most common association on the BMGR West. To make the map more useful, especially to wildlife biologists, the vegetation map reveals the following subassociations:

- 113 – Bald hills characterized by the small and spiny *Fagonia*, common across the range.
- 115 – Ocotillo ridges that reach out from the northern Gila Mountains.
- 116 – Ocotillo plains characteristic of the Davis Plain.
- 117 – Moving sands in the western extreme of the range, which is flat-tailed horned lizard habitat (Jones and Lovich, 2009).

In all of the above, creosote is typically dominant, with white bursage (*Ambrosia dumosa*) common. But the landform and associated species are very different. In the case of subassociation 117, the moving sands, the differences might be apparent only when the time is right. Among these low, wind-shaped sand ridges near the Yuma Dunes, creosote still dominates, yet its winter-spring neighbors can be lovely annuals like primrose and sand verbena – if it rains.

The creosote alliance is not almighty. In the big dunes and on mountain slopes, white bursage (*Ambrosia dumosa*) is usually the winner, so there is a white bursage alliance as well, the second largest alliance on the BMRG West. Brittlebush (*Encelia farinosa*), dominant on the dark metamorphic rocks and basalts, is the hallmark species of the third most common alliance; it is also

the most common at the delta-like fans at the terminus of watercourses coming from the Gila and Tinajas Altas Mountains. Watercourses are the fourth most common alliance, and very diverse. Steep watercourses in the mountains are most often rubble chutes typically dominated by desert lavender (*Hyptis emoryi*), while the valley watercourse hold a mix of wolfberry (*Lycium*), ironwood (*Olneya tesota*), blue palo verde (*Parkinsonia florida*), and cheesebush (*Hymenoclea salsola*). At the higher elevations on north slopes, Mormon tea (*Ephedra aspera*) is the characteristic shrub, forming the fifth most common alliance.

The rest of the BMGR West – less than 1 % of the total area – is comprised of disturbed lands, natural barrens without vegetation, an unusual saltbush badlands at the head of the Davis Plain, and blue palo verde mountain slopes. The latter two alliances are more typical of vegetation in southeastern California.

## The Distribution of Certain Species

The attribute table in the GIS database is set up so you can make the map display areas with over 1% cover of:

- Big galleta grass (*Pleuraphis rigida*)
- Ocotillo (*Fouquieria splendens*)
- Teddy bear cholla (*Cylindropuntia bigelovii*)
- Ironwood (*Olneya tesota*) and paloverde (*Parkinsonia* spp) trees

To use this capability, you need basic GIS skills in choosing the ‘symbology’.

To pinpoint the location of other species, you need to use the Access database included with this report. For instance, saguaros are not characteristically common within any alliance, association, or subassociation – though they can be very common at certain spots. Where are they? 34 relevés ranked saguaros as common; seven of these had cover > 1-4%. To find these relevés you use the database that is included with the study, searching the table called “VegPromSummary.”

Table 3. Total acres (top) and hectares (bottom) of vegetation alliances. The only difference is the unit of measurement.

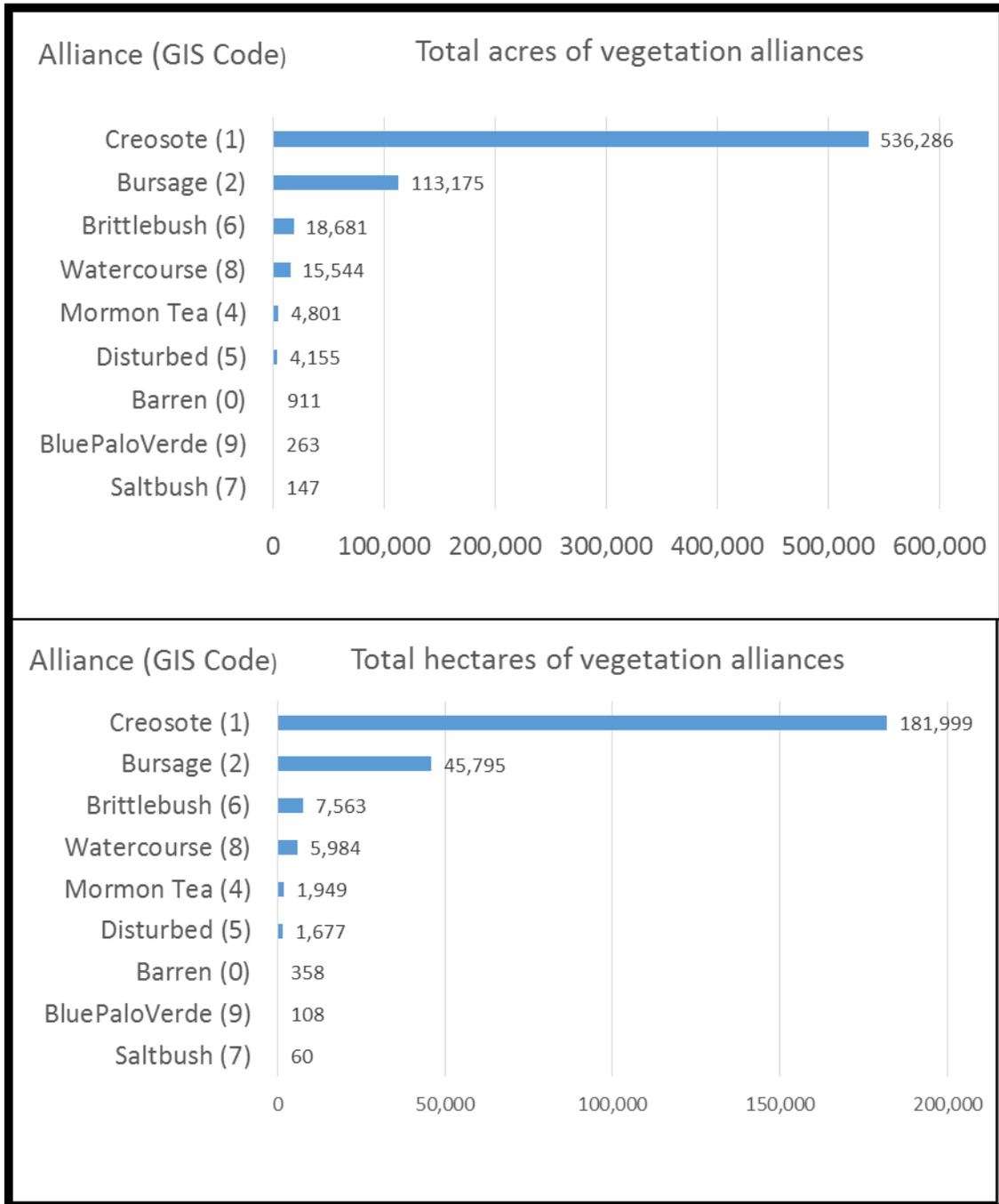


Table 4 – Total hectares mapped of vegetation associations.

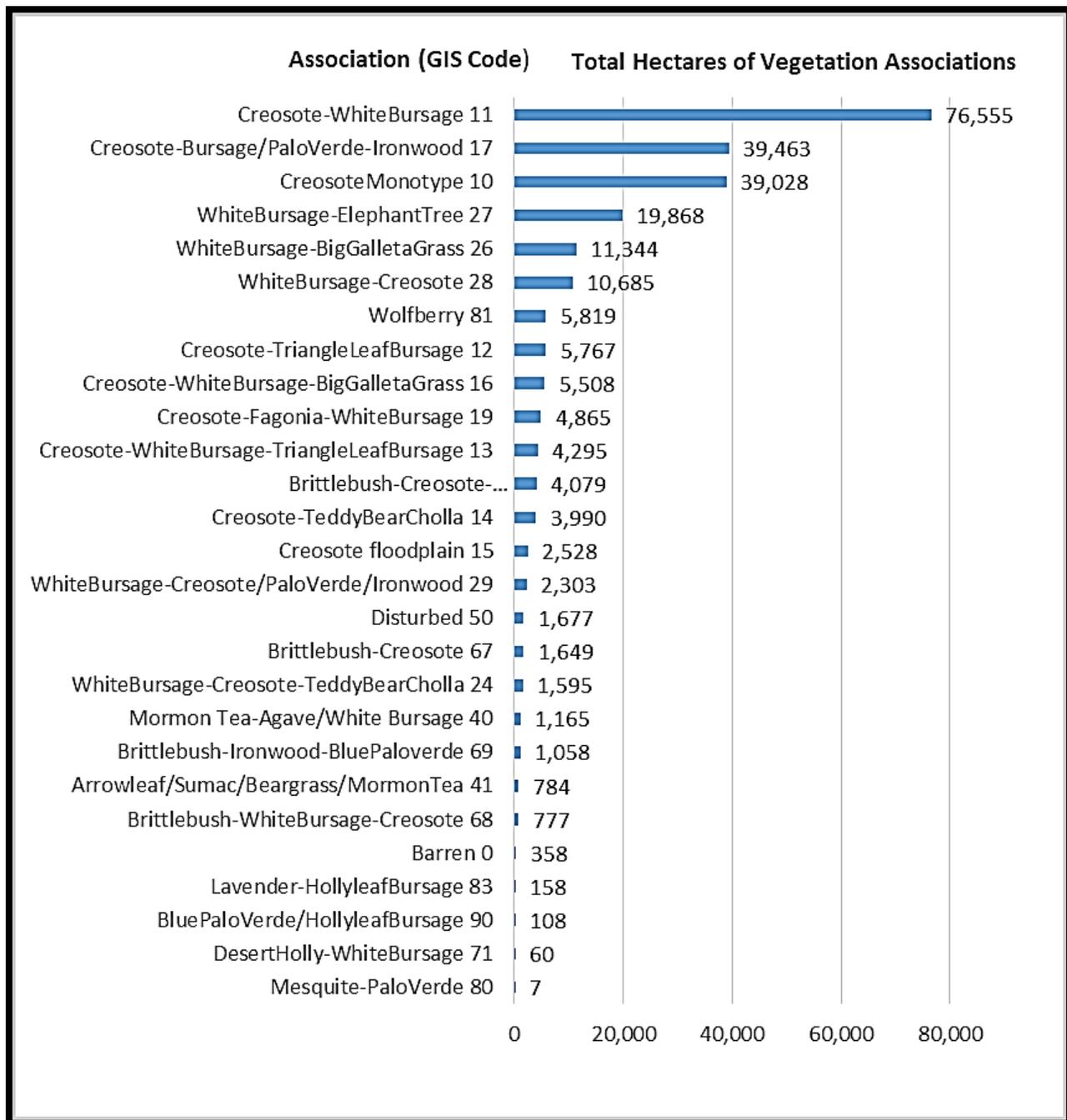


Table 5 – Total acres mapped of vegetation associations.

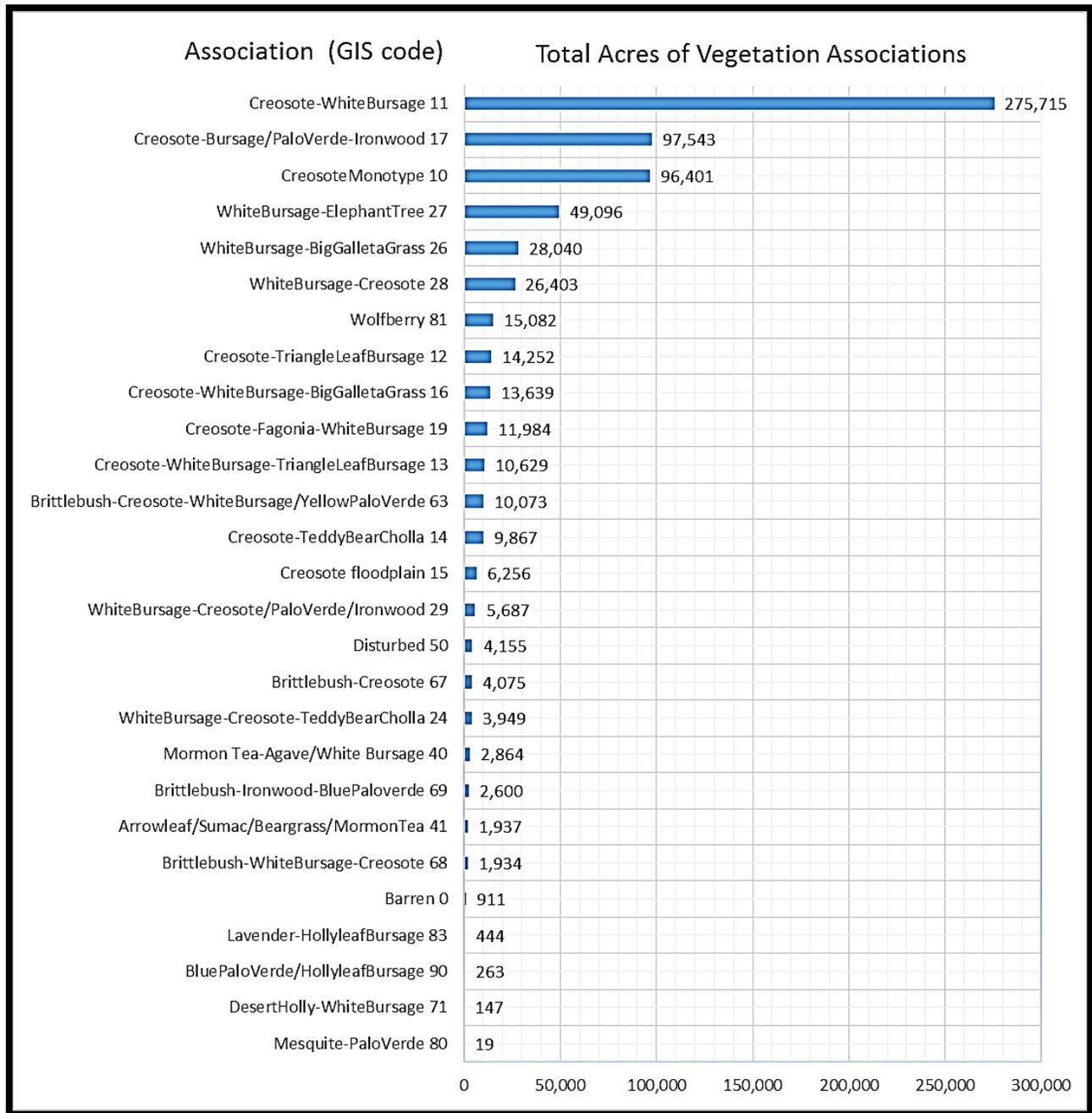


Table 6. Total acres mapped of vegetation subassociations.

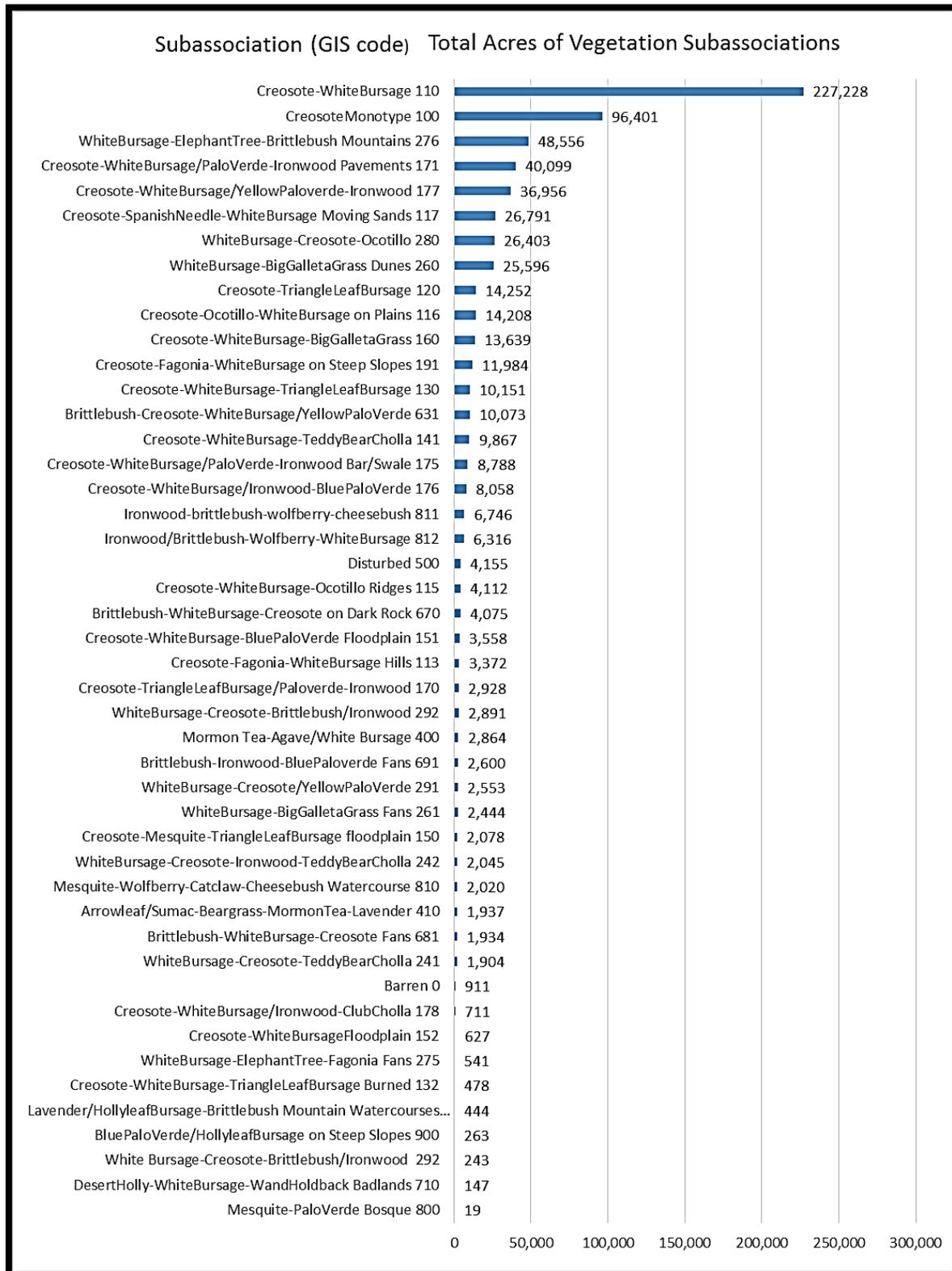
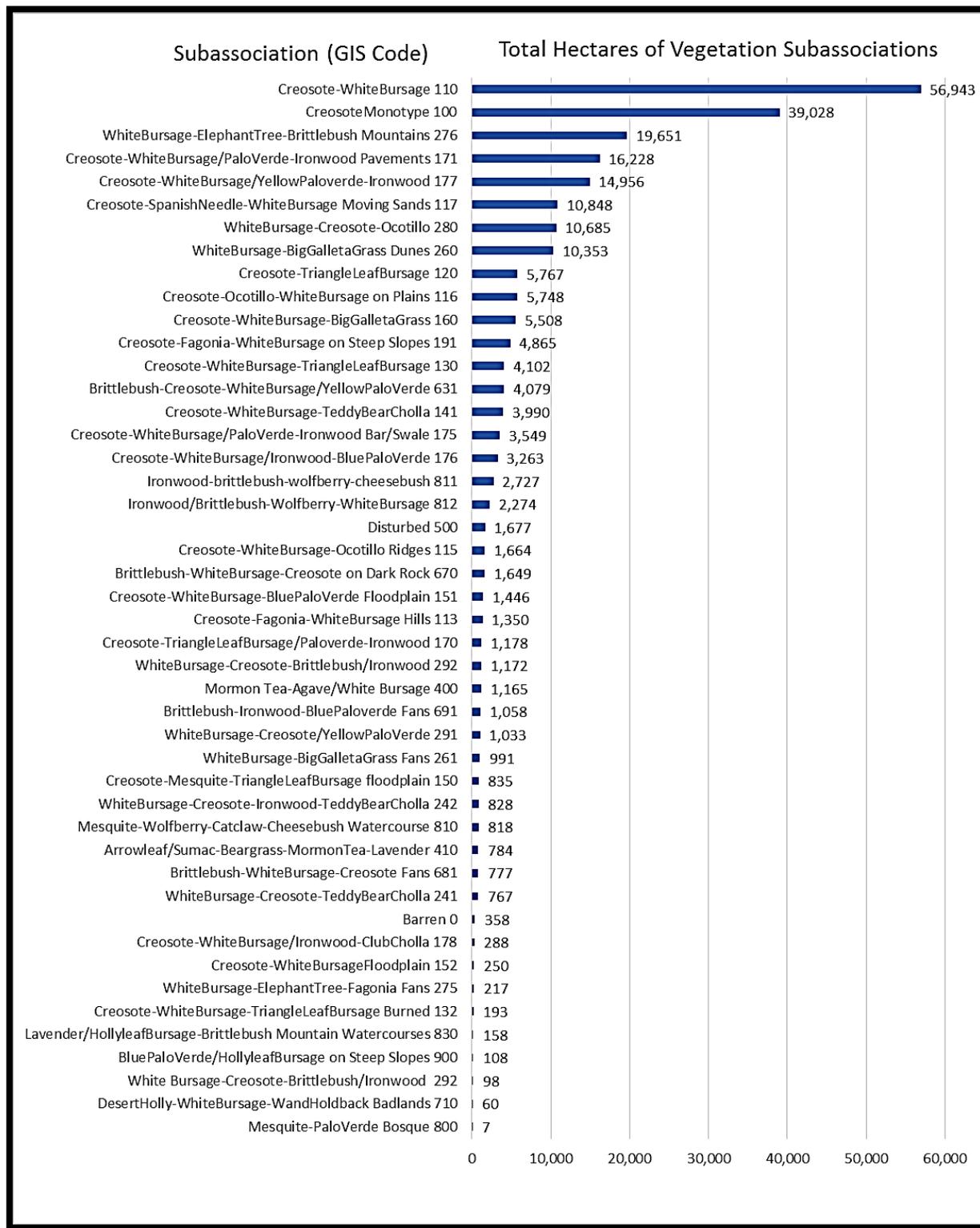


Table 7. Total hectares mapped of each subassociation.



## Vegetation of the BMGR West – Full Descriptions and Data Tables

As mentioned above, alliance is the top level in this classification scheme. Within each alliances are one to ten associations, and within each association may be one to ten subassociations. Below are summary description of each subassociation, the most detailed mapping unit. They are arranged by alliance and association. For instance, the “creosote-white bursage-ocotillo on ridges” subassociation is part of the creosote/white bursage association, which in turn is part of the creosote alliance. Each description also includes a summary data table of the relevés taken during the study, to provide a statistical picture of the vegetation. Real pictures are also provided. For common names of the less-abundant species, please consult the internet or the Access database provided with this study.

There are no summary descriptions for the associations or alliances – you must review the subassociations within, and keep in mind that they may/may not represent the more inclusive and larger groupings of association and alliance.

For example: In the case of the saltbush (*Atriplex spp.*) alliance, there is only subassociation on the entire BMGR West - and it covers only 60 hectares (147 acres) on some unusual badlands at the head of the Davis Plain.

### **Alliance: Saltbush (7)**

**Association:** DesertHolly-WhiteBursage (71)

**Subassociation:** DesertHolly-WhiteBursage-WandHoldback (710)

There is at least one other example from the saltbush alliance on the BMGR East (McLaughlin et al., 2007), featuring a different species (cattle saltbush, or *Atriplex polycarpa*) on a different landform, coppice dunes. There are three saltbush vegetation types from Organ Pipe Cactus National Monument. There is yet another around Tule Well on the Cabeza Prieta National Wildlife Refuge. All are part of the saltbush alliance, but this report only covers the subassociation on the BMGR West.

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote monotype (10)

**Subassociation:** Creosote monotype (100)

**Scientific Name:** *Larrea tridentata* monotype

**NVC Association:** *Larrea tridentata* monotype

**Previous classifications:** Warren et al (1981) use 154.1114 - *Larrea tridentata* with annuals



Figure 47. Relevé TA-2, Lechuguilla Valley, the view southeast to the Cabeza Prieta Mountains.

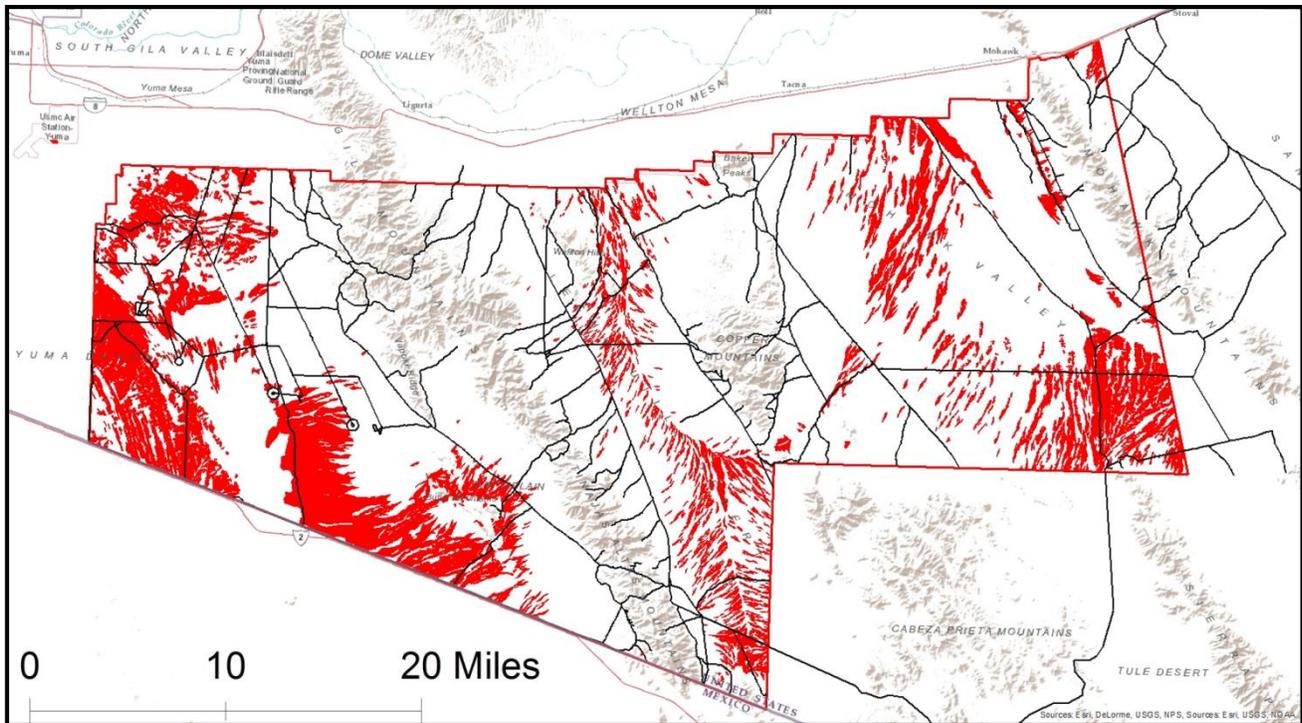


Figure 48. Distribution of Creosote monotype on the BMGR West.

**Description:** Stands of pure or almost pure creosote (*Larrea tridentata*) bush, and commonly called a 'creosote flat.' Scattered big galleta grass (*Pleuraphis rigida*) and/or white bursage (*Ambrosia dumosa*) are uncommon but present in nearly half the relevés. During wet winters, annuals such as *Plantago ovata* can be abundant in the open areas, while *Brassica tournefortii* typically shelters beneath the creosote, or pops up out of abandoned kangaroo rat burrows.

**Location:** On slopes of 0 to 3%, on fan terraces or flood plains. On fans they are often on subtle ridges, raised slightly above the surrounding terrain, and shedding what little rain falls. Creosote monotypes are also common on silty soils alongside large arroyos, and can even form 'islands' within very large braided washes such as Coyote Wash. Finally, in the far western and southwestern corner of the BMGR West, the wind has removed much of the soil/sediment, leaving large areas with hardly anything but creosote.

**Field Identification:** An observer can stand amid the creosote and not see a bursage. There are, in fact, often a few bursage tucked in runnels, but seeing them requires active searching. However, if runnels are common, and so are the bursage within them – say, a dozen bursage every twenty meters – the area was then considered one of the creosote-bursage associations. If there were scattered hummocks of big galleta -- *Pleuraphis rigida* -- it was mapped as creosote flat so long as the big galleta had less than 1% cover, and *Ambrosia* was absent or rare. Likewise, the presence of scattered ironwood or mesquite at less than 1 percent cover did not disqualify the area from being a creosote flat.

**Photo Identification:** Stands of pure creosote were recognized by their habit of each bush being regularly dispersed, with no other vegetation between. This makes a pattern of distinct dots on the photo (Fig. 49).



Figure 49. On this image of the edge of the Mohawk Dunes, there are three associations, from left to right: waves of sand dunes, floodplain speckled with mesquite and wolfberry, and the evenly spaced monotony of the creosote monotype.

**Vegetation:** Creosote (*Larrea tridentata*) monotype

**Alliance/Association/Subassociation codes:** 1 / 10 / 100

**Number of Sample Sites (relevés):** 42

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	42	5 (4-5)	1-4% (1-14%)	1.1
<i>Brassica tournefortii</i> Sahara mustard	26	1.5 (0-3)	<1% (<1-4%)	
<i>Ambrosia dumosa</i> White Bursage	21	0.5 (0-3)	<1% (<1%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	15	0 (0-3)	<1% (<1%)	0.6
<i>Plantago ovata</i> Wooly plantain	13	0 (0-3)	<1% (<1-4%)	
<i>Sphaeralcea coulteri</i> Mallow	6	0 (0-3)	<1% (<1-4%)	0.8
<i>Chorizanthe rigida</i> Spineflower	6	0 (0-3)	<1% (<1%)	
<i>Palafoxia arida</i> Spanish needles	6	0 (0-3)	<1% (<1%)	
<i>Penstemon parryi</i> Parry's penstemon	6	0 (0-3)	<1% (<1%)	
<i>Oenothera deltoidea</i> Dune primrose	6	0 (0-2)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	4	0 (0-3)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	4	0 (0-3)	<1% (<1%)	
<i>Ditaxis serrata</i> Silverbush	4	0 (0-3)	<1% (<1%)	
<i>Camissonia sp.</i>	4	0 (0-2)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	4	0 (0-2)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	4	0 (0-1)	<1% (<1%)	
<i>Tiquilia palmeri</i> Crinkleemat	3	0 (0-4)	<1% (<1-4%)	0.5
<i>Ditaxis neomexicana</i> Silverleaf	3	0 (0-3)	<1% (<1%)	
<i>Tiquilia plicata</i> Crinkleemat	3	0 (0-3)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	3	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Cryptantha angustifolia</i> Pick-me-not	3	0 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	3	0 (0-2)	<1% (<1%)	
<i>Abronia villosa</i> Sand verbena	2	0(0-3)	<1% (<1%)	
<i>Annual grass</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Schismus arabicus</i> Arabian grass	2	0 (0-3)	<1% (<1-4%)	
<i>Dalea mollis</i>	2	0 (0-3)	<1% (<1%)	
<i>Dalea sp.</i>	2	0 (0-3)	<1% (<1%)	
<i>Dimorphocarpa pinnatifida</i>	2	0 (0-3)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	2	0 (0-3)	<1% (<1%)	
<i>Tidestromia lanuginosa</i>	2	0 (0-3)	<1% (<1%)	
<i>Astragalus sabulorum</i>	2	0 (0-2)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	2	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-2)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	2	0 (0-2)	<1% (<1%)	
<i>Mentzelia albicaulis</i>	2	0 (0-2)	<1% (<1%)	
<i>Stillingia linearifolia</i>	2	0 (0-2)	<1% (<1%)	
<i>Boerhavia sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Chaenactis stevioides</i>	1	0 (0-3)	<1% (<1%)	
<i>Cryptantha sp.</i> Pick-me-not	1	0 (0-3)	<1% (<1%)	
<i>Dithyrea californica</i>	1	0 (0-3)	<1% (<1%)	
<i>Grusonia wrightiana</i> Club cholla	1	0 (0-3)	<1% (<1%)	
<i>Lupinus arizonicus</i>	1	0 (0-3)	<1% (<1%)	
<i>Sphaeralcea emoryi</i>	1	0 (0-3)	<1% (<1%)	
<i>Allonia incarnata</i>	1	0 (0-2)	<1% (<1%)	
<i>Bouteloua barbata</i>	1	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Datura discolor</i>	1	0 (0-2)	<1% (<1%)	
<i>Erodium texanum</i>	1	0 (0-2)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	1	0 (0-2)	<1% (<1%)	
<i>Lepidium lasiocarpum</i>	1	0 (0-2)	<1% (<1%)	
<i>Orobanche cooperi</i>	1	0 (0-2)	<1% (<1%)	
<i>Acacia constricta</i>	1	0 (0-1)	<1% (<1%)	
<i>Allonia sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Aristida sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Baileya pleniradiata</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	1	0 (0-1)	<1% (<1%)	
<i>Proboscidea sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Prosopis velutina</i>	1	0 (0-1)	<1% (<1%)	
<i>Stephanomeria schottii</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote - white bursage (11)

**Subassociation:** Creosote - white bursage (110)

**Scientific Name:** *Larrea tridentata* – *Ambrosia dumosa* shrubland

**NVC association:** *Larrea tridentata* – *Ambrosia dumosa* shrubland

**Previous classifications:** In the scheme of Warren et al (1981), this would be part of their 154.1111, which includes either/both *Ambrosia dumosa* and *A. deltoidea*. In light of the scat analysis of Hervert et al. (2000), which suggests *A. deltoidea* is not preferred forage for pronghorn, the Warren et al. association was divided into three associations for this study: *Larrea tridentata/Ambrosia dumosa*, *Larrea tridentata-Ambrosia deltoidea*, and *Larrea tridentata-Ambrosia deltoidea-A. dumosa*.



Figure 50. Relevé CW-1, Lechuguilla Valley, the view northwest to Raven Butte and Tinajas Altas Mountains. The foreground club cholla is *Grusonia wrightiana*.

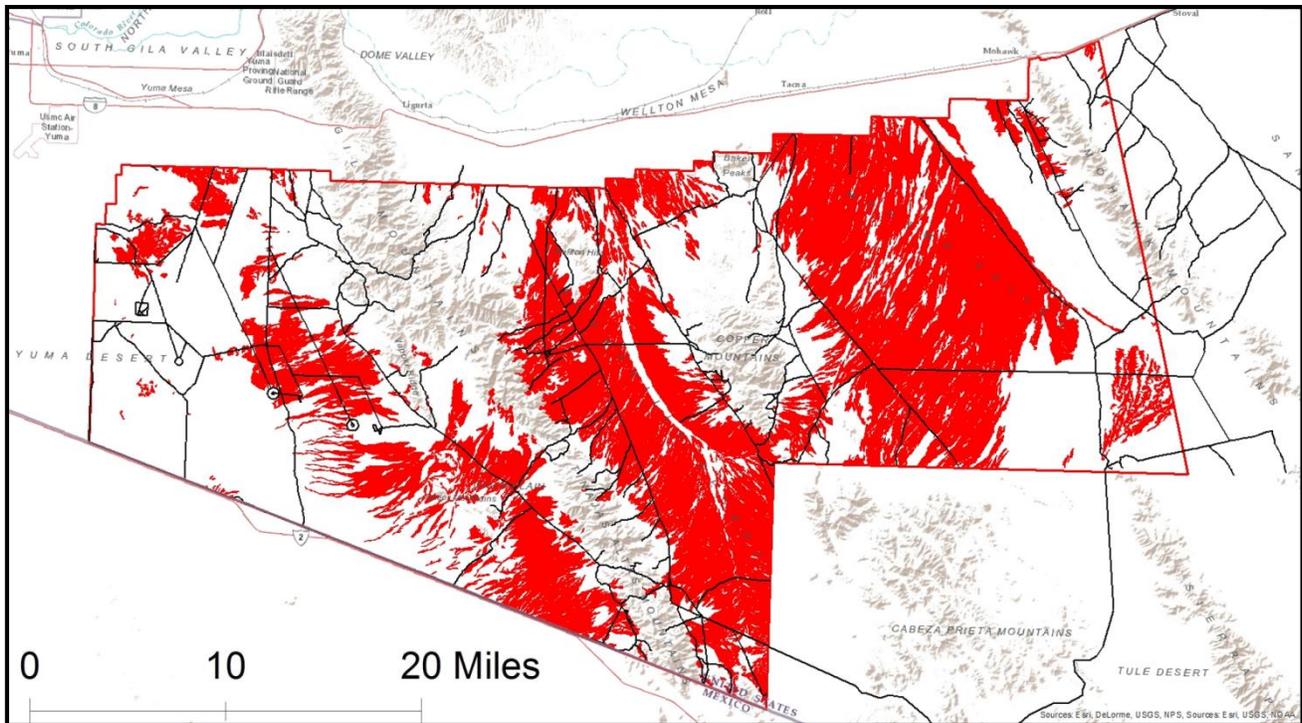


Figure 51. Distribution of creosote - white bursage (110) on the BMGR West.

**Description:** Creosote (*Larrea tridentata*) is dominant or, occasionally, co-dominant with white bursage (*Ambrosia dumosa*). *A. dumosa* is common, with a median canopy cover of 1-4%, compared with 5-9% for *Larrea*. Big galleta grass (*Pleuraphis rigida*) is often present at low cover; it was found at 35 of 51 relevés. Other associates include ratany (*Krameria*), brittlebush, and diamond cholla. The creosote in this association is smaller (1.1 meter) on the BMGR West than those found in the same association on the CPNWR (1.2 meter) and the BLM lands near Ajo (1.4 meter) (Malusa, 2003).

**Location:** By far the most common association on the BMGR West. In general, the creosote/white bursage association is on slopes of 1 to 3%, often on fan terraces, sometimes with gravel/pebbles over much of the surface. Upslope, creosote/white bursage grades into creosote/palo verde-ironwood associations, which includes pavements and bar/swale landforms. Downslope it grades into either creosote monotype flats or creosote floodplain.

**Field Identification:** Creosote/white bursage is associated with the gravelly interfluvies of terraces and, further downslope, "islands" of coarser sediments above the finer soils in floodplains. Ironwood, palo verde, and triangle leaf bursage are uncommon or totally lacking.

**Photo Identification:** Usually this association is on alluvial fans downslope from ironwood and palo verde. It is rarely found in mountains or foothills. The difficulty is in discerning the creosote/white bursage from the white bursage/creosote (swap in dominance). In most cases it is possible by noting the even stippled pattern of the much-larger creosote, which are much less common where white bursage is dominant (see association 281, below). In the southeastern Mohawk Valley, where both species of bursage persist, the

creosote/triangle leaf bursage association is darker on image, mainly because of the higher ground cover of the bursage. The boundary between creosote/white bursage and the creosote/mesquite floodplain is often vague, because of the low relief. If there were no patches of dense vegetation or barrens over 0.5 ha (indicators of floodplain), the area was mapped as creosote/white bursage.



Figure 52. The image above compares subassociation 110 to the similar subassociation 280. The difference is that 110 is creosote dominated (or co-dominant), while 280 has bursage as the dominant (co-dominant). Image is about 500 meters wide, and from the Camino del Diablo Oeste, along the west side of the Gila Mountains, near Spook Canyon.

**Vegetation:** Creosote – white bursage

**Alliance/Association/Subassociation codes:** 1 / 11 / 110

**Number of Sample Sites (relevés):** 51

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	51	5 (4-5)	5-9% (1-14%)	1.1
<i>Ambrosia dumosa</i> White Bursage	51	3 (3-4)	1-4% (<1-9%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	35	2 (0-4)	<1% (<1-4%)	0.8
<i>Krameria grayi</i> Ratany	27	1 (0-3)	<1% (<1-4%)	0.6
<i>Encelia farinosa</i> Brittlebush	22	0 (0-4)	<1% (<1-9%)	0.8
<i>Fouquieria splendens</i> Ocotillo	22	0 (0-3)	<1% (<1-4%)	3.7
<i>Cylindropuntia ramosissima</i> Diamond cholla	21	0 (0-3)	<1% (<1-4%)	0.4
<i>Brassica tournefortii</i> Sahara mustard	21	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	17	0 (0-3)	<1% (<1-4%)	1.1
<i>Carnegiea gigantea</i> Saguaro	16	0 (0-3)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	13	0 (0-3)	<1% (<1%)	2.6
<i>Lycium sp.</i> Wolfberry	10	0 (0-3)	<1% (<1-4%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	10	0 (0-3)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	10	0 (0-1)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	8	0 (0-3)	<1% (<1-14%)	
<i>Parkinsonia florida</i> Blue paloverde	8	0 (0-2)	<1% (<1%)	1.9
<i>Chorizanthe rigida</i> Spineflower	7	0 (0-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	6	0 (0-3)	<1% (<1%)	3.3

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Ditaxis serrata</i> Silverbush	4	0 (0-3)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	3	0 (0-3)	<1% (<1%)	0.3
<i>Grusonia wrightiana</i> Club cholla	4	0 (0-3)	<1% (<1%)	0.4
<i>Aristida adscensionis</i> Six-weeks three-awn	4	0 (0-2)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	4	0 (0-2)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	4	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	4	0 (0-1)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	3	0 (0-3)	<1% (<1-4%)	0.4
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	3	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	3	0 (0-3)	<1% (<1%)	
<i>Stillingia linearifolia</i>	3	0 (0-3)	<1% (<1%)	
<i>Datura discolor</i>	3	0 (0-2)	<1% (<1%)	
<i>Asclepias subulata</i>	3	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	2	0 (0-1)	<1% (<1%)	
<i>Eriogonum trichopes</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Palafoxia arida</i> Spanish needles	2	0 (0-3)	<1% (<1-4%)	
<i>Castela emoryi</i>	2	0 (0-3)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-3)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	2	0 (0-3)	<1% (<1%)	
<i>Lepidium lassiocarpa</i>	2	0 (0-3)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	2	0 (0-2)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	2	0 (0-2)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	2	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Tidestromia lanuginosa</i>	2	0 (0-2)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	2	0 (0-1)	<1% (<1%)	
<i>Tiquilia palmeri</i> Crinkleemat	1	0 (0-3)	<1% (<1-4%)	
<i>Amsinckia sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Dithyrea californica</i>	1	0 (0-3)	<1% (<1%)	
<i>Lesquerella tenella</i>	1	0 (0-3)	<1% (<1%)	
<i>Nama demissum</i>	1	0 (0-3)	<1% (<1%)	
<i>Schismus arabicus</i> Arabian grass	1	0 (0-3)	<1% (<1%)	
<i>Sphaeralcea emoryi</i>	1	0 (0-3)	<1% (<1%)	
<i>Abronia villosa</i> Sand verbena	1	0 (0-2)	<1% (<1%)	
<i>Allonia incarnata</i>	1	0 (0-2)	<1% (<1%)	
<i>Camissonia sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Chaenactis carphoclinia</i>	1	0 (0-2)	<1% (<1%)	
<i>Chorizanthe corrugata</i>	1	0 (0-2)	<1% (<1%)	
<i>Erodium texanum</i>	1	0 (0-2)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	1	0 (0-2)	<1% (<1%)	
<i>Lupinus arizonicus</i>	1	0 (0-2)	<1% (<1%)	
<i>Prosopis velutina</i>	1	0 (0-2)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-2)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	0 (0-1)	<1% (<1%)	
<i>Annual grass</i>	1	0 (0-1)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	1	0 (0-1)	<1% (<1%)	
<i>Bouteloua barbata</i>	1	0 (0-1)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Dimorphocarpa pinnatifida</i>	1	0 (0-1)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Ditaxis sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Oenothera deltoides</i>	1	0 (0-1)	<1% (<1%)	
<i>Orobanche cooperi</i>	1	0 (0-1)	<1% (<1%)	
<i>Peniocereus greggii</i>	1	0 (0-1)	<1% (<1%)	
<i>Penstemon parryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Porophyllum gracile</i>	1	0 (0-1)	<1% (<1%)	
<i>Psilostrophe cooperi</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote - white bursage (11)

**Subassociation:** Creosote-fagonia-white bursage on hills (113)

**Scientific Name:** *Larrea tridentata* - *Fagonia californica* (= *F. laevis*) - *Ambrosia dumosa* shrubland on hills

**NVC association:** *Larrea tridentata* shrubland

**Previous classifications:** None



Figure 53. Relevé WSE-28, at the south end of the Wellton Hills.

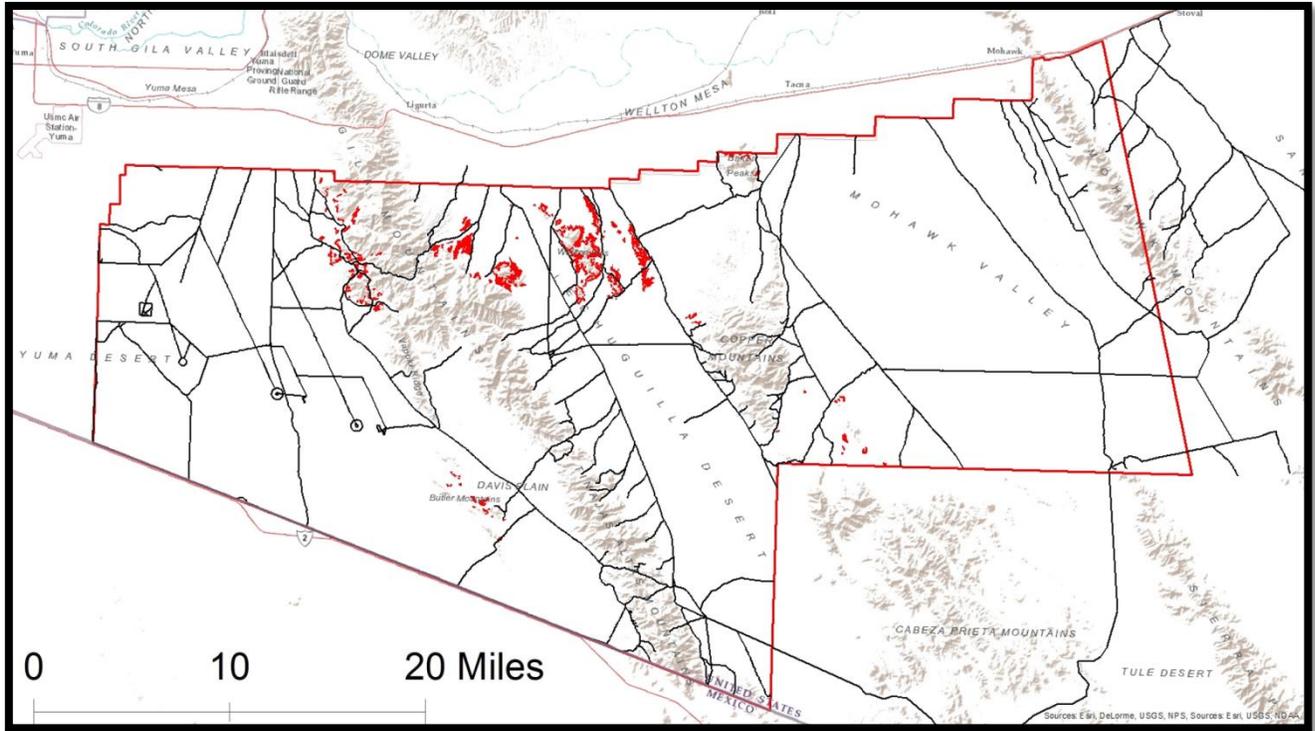


Figure 54. Distribution of creosote-fagonia subassociation (113) on the BMGR West.



Figure 55. Above, *Fagonia californica* (= *F. laevis*) in spring flower. This shrub, typically only 0.2 m tall (six inches), is more often without leaves and flowers, and looks like a large scouring pad, with congested stems and sharp stipules at the nodes.

**Description:** Stony hills with little vegetation, and typically without any trees. Classified as a subassociation of creosote (*Larrea tridentata*) - white bursage (*Ambrosia dumosa*) association because creosote and white bursage are commonly dominant or co-dominant, but always in the company of *Fagonia californica* (= *F. laevis*), a low-growing, spinescent perennial. After winter rains, the *Fagonia* is surprisingly leafy, with dime-sized purple flowers.

**Location:** Foothills of mountains, especially the Wellton Hills, the northern Gila Mountains, and the Butler Mountains. Also as isolated remnants of former buttes and mountains, now eroded to heaps of stones.

**Field Identification:** The lack of trees makes identification possible from a distance, with binoculars. This subassociation is very similar to subassociation 192, which hold many of the same species but is on steep mountains, exceeding 20% slope.

**Photo Identification:** Imagery is good enough to detect the lack of trees in places that are clearly not flat.



Figure 56. Example of subassociation 113 at the south end of the Wellton Hills. Note the lack of trees on gray rock. Image area is 0.66 miles across.

**Vegetation:** Creosote – Fagonia – White bursage on hills

**Alliance/Association/Subassociation codes:** 1 / 11 / 113

**Number of Sample Sites (relevés):** 5

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	5	5 (4-5)	1-4% (1-4%)	0.9
<i>Fagonia californica</i> Fagonia	5	3 (3-4)	<1% (<1-4%)	0.3
<i>Ambrosia dumosa</i> White bursage	5	2 (2-4)	<1% (<1-4%)	0.4
<i>Brassica tournefortii</i> Sahara mustard	4	2 (0-3)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	4	2 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	4	1 (0-2)	<1% (<1%)	
<i>Mentzelia albicaulis</i>	4	1 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	3	2 (0-3)	<1% (<1-4%)	0.6
<i>Pleuraphis rigida</i> Big galleta grass	3	2 (0-2)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	3	1 (0-1)	<1% (<1%)	
<i>Stillingia linearifolia</i>	2	0 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	2	0 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	2	0 (0-2)	<1% (<1%)	1.4
<i>Mammillaria sp.</i> Pincushion cactus	2	0 (0-1)	<1% (<1%)	
<i>Annual grass</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	1	0 (0-1)	<1% (<1%)	
<i>Dalea mollis</i>	1	0 (0-1)	<1% (<1%)	

<b><i>Taxon</i></b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Ditaxis lanceolata</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-1)	<1% (<1%)	1.5

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote - white bursage (11)

**Subassociation:** Creosote- white bursage-ocotillo on ridges (115)

**Scientific Name:** *Larrea tridentata* – *Ambrosia dumosa*- *Fouquieria splendens* on ridges

**NVC Association:** Most similar to *Larrea tridentata* – *Ambrosia dumosa*- *Fouquieria splendens* shrubland, described from Grand Canyon National Park.

**Previous classifications:** Similar to Warren et al (1981) "154.1113", which is *Larrea tridentata* – *Ambrosia deltoidea*- *Fouquieria splendens*. The difference is that there is no *Ambrosia deltoidea* in the BMGR West version of this association, only *Ambrosia dumosa*.



Figure 57. Relevé FSW-3, west side of Gila Mountains, about 1.5 miles east of Foothills Boulevard.

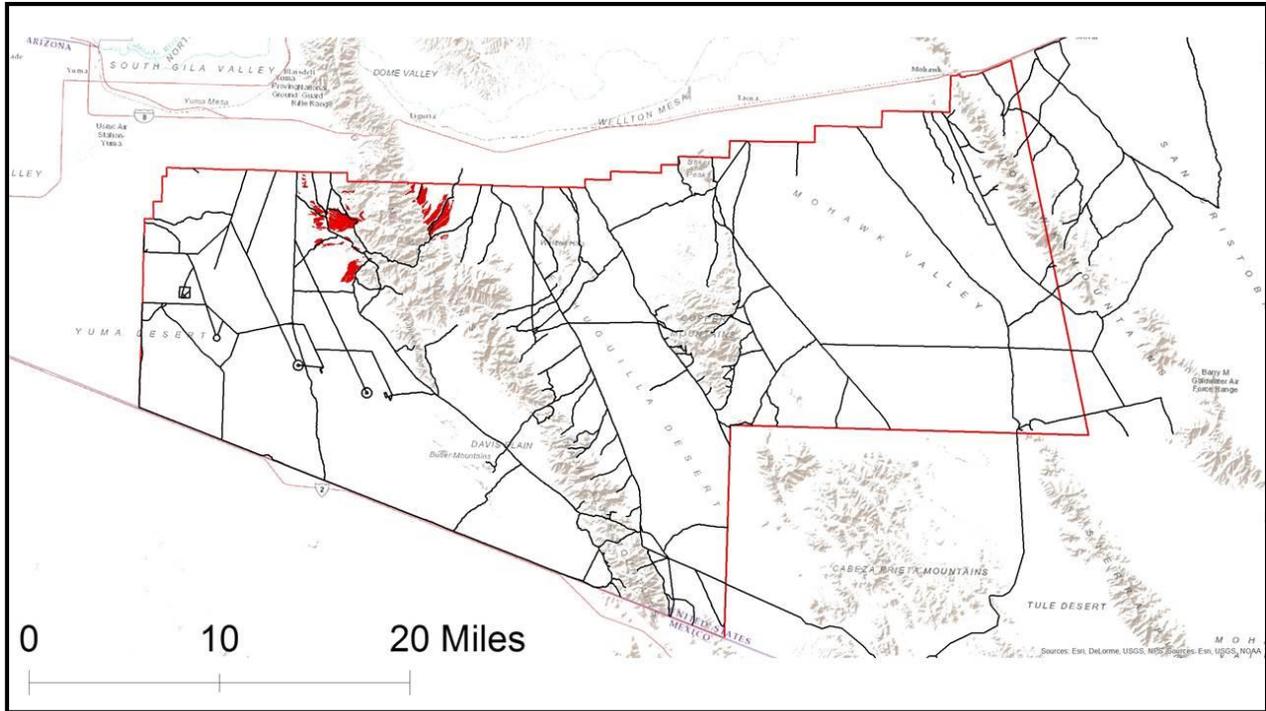


Figure 58. Distribution of Creosote-White Bursage-Ocotillo on ridges (115) on the BMGR West

**Description:** Creosote (*Larrea tridentata*) and ocotillo are co-dominant, typically with 1-4% canopy cover. White bursage (*Ambrosia dumosa*) and brittle bush are common associates. Ironwood trees were present at eight of ten relevés, but they are uncommon or rare, with less than 0.5% cover.

**Location:** Restricted to distinctive ridges abutting the north end of the Gila Mountains, on both the east and west sides. These ridges are at one to nine million years old, and are the fanglomerate remains of debris swept out of Gila Mountains during a stage of tectonic uplift (Schenker 1977).

**Field Identification:** Long stony ridges holding plenty of ocotillo.

**Photo Identification:** Very easy to spot – see Figure 59.



Figure 59. The ridges are deeply furrowed at this location on the northeast side of the Gila Mountains. Image area is 1.7 miles across.

**Vegetation:** Creosote-White Bursage-Ocotillo on ridges

**Alliance/Association/Subassociation codes:** 1 / 11 / 115

**Number of Sample Sites (relevés):** 10

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	10	4 (3-5)	1-4% (1-9%)	0.9
<i>Fouquieria splendens</i> Ocotillo	10	4 (3-5)	1-4% (1-9%)	2.9
<i>Encelia farinosa</i> Brittlebush	10	3 (1-5)	<1% (<1-9%)	0.7
<i>Ambrosia dumosa</i> White bursage	9	3 (0-3)	<1% (<1%)	0.3
<i>Olneya tesota</i> Ironwood	8	2 (2-3)	<1% (<1%)	
<i>Fagonia laevis</i> Fagonia	6	1.5 (0-4)	<1% (<1-4%)	0.3
<i>Plantago ovata</i> Woolly plantain	6	3 (0-3)	<1% (<1-9%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	6	1 (0-3)	<1% (<1-4%)	1.0
<i>Hibiscus denudatus</i> Rock hibiscus	5	0.5 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	5	0.5 (0-3)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	5	0.5 (0-3)	<1% (<1%)	0.8
<i>Krameria grayi</i> Ratany	5	1 (0-3)	<1% (<1%)	0.5
<i>Echinocactus polycephalus</i> Cottontop cactus	5	2 (0-2)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	4	0 (0-3)	<1% (<1-4%)	0.9
<i>Opuntia basilaris</i> Beavertail cactus	4	0 (0-2)	<1% (<1%)	
<i>Allonia incarnata</i>	3	0 (0-3)	<1% (<1-9%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	3	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	3	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	3	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Cylindropuntia echinocarpa</i> Silver cholla	3	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	3	0 (0-2)	<1% (<1%)	
<i>Euphorbia eriantha</i>	2	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	2	0 (0-3)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i> Silverleaf	2	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-2)	<1% (<1%)	
<i>Boerhavia sp.</i>	1	0 (0-3)	<1% (<1-14%)	
<i>Dalea mollis</i>	1	0 (0-3)	<1% (<1%)	
<i>Chorizanthe corrugata</i>	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-2)	<1% (<1%)	
<i>Lotus rigidus</i>	1	0 (0-2)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-2)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	1	0 (0-1)	<1% (<1%)	
<i>Bouteloua barbata</i>	1	0 (0-1)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	1	0 (0-1)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	1	0 (0-1)	<1% (<1%)	
<i>Langloisia setosissima</i>	1	0 (0-1)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote - white bursage (11)

**Subassociation:** Creosote - ocotillo - white bursage on plains (116)

**Scientific Name:** *Larrea tridentata* – *Ambrosia dumosa*- *Fouquieria splendens* on plains

**NVC Association:** Most similar to *Larrea tridentata* – *Ambrosia dumosa*- *Fouquieria splendens* shrubland, which is described from Grand Canyon National Park.

**Previous classifications:** Similar to Warren et al (1981) "154.1113", which is *Larrea tridentata* – *Ambrosia deltoidea*- *Fouquieria splendens*. The difference is that there is no *Ambrosia deltoidea* in the BMGR West version of this association, only *Ambrosia dumosa*.



Figure 60. Davis Plain, view south to Vopoki Ridge of the Gila Mountains

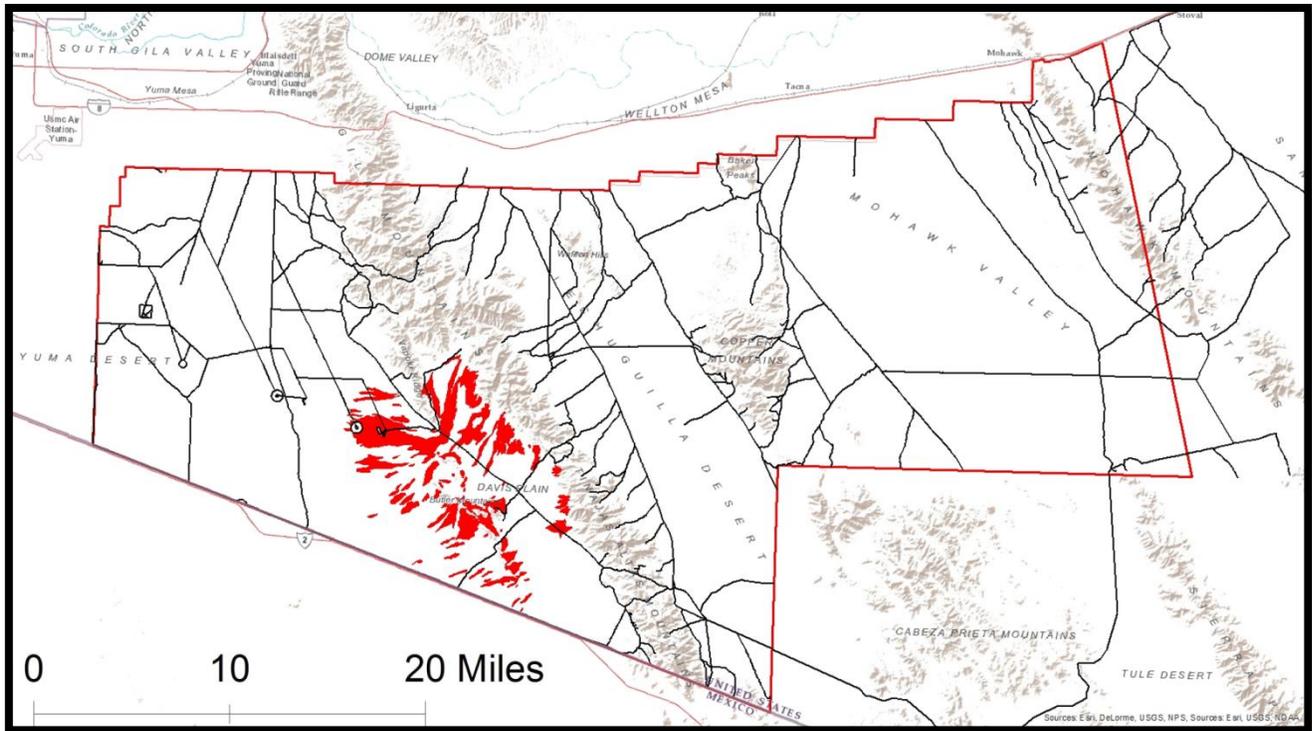


Figure 61. Distribution of Creosote - ocotillo - white bursage on plains (116) on the BMGR West

**Description:** Creosote (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*) are co-dominant, and ocotillo common, with all three species with 1-4 % cover. Common associates are ratany and diamond cholla. The landscape is unique in having deep sandy soils with very few large watercourses. More typical is the small watercourse shown in the photo above, Fig. 60.

**Location:** This subassociation is limited to the Davis Plain and the Butler Mountains, and the valley just west of Vopoki Ridge.

**Field Identification:** Very similar to the white bursage – creosote association, which also can hold much ocotillo. Technically, in that association the white bursage is typically dominant, not creosote; realistically, the two merge seamlessly, and it can be tough to draw a line dividing the two.

**Photo Identification:** Can be distinguished from the similar white bursage-creosote association (see note above) with good imagery by checking the relative abundance of the creosote and white bursage. Also, good imagery shows the presence of ocotillo.

**Vegetation:** Creosote - ocotillo - white bursage on plains

**Alliance/Association/Subassociation codes:** 1 / 11 / 116

**Number of Sample Sites (relevés):** 9

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	9	4 (3-5)	1-4% (1-9%)	0.4
<i>Larrea tridentata</i> Creosote	9	4 (3-5)	1-4% (1-9%)	1.0
<i>Fouquieria splendens</i> Ocotillo	9	3 (3-4)	1-4% (1-9%)	3.9
<i>Krameria grayi</i> Ratany	8	2.5 (1-3)	<1% (<1-4%)	0.5
<i>Cylindropuntia ramosissima</i> Diamond cholla	7	2.5 (0-3)	<1% (<1-4%)	0.4
<i>Encelia farinosa</i> Brittlebush	5	1.5 (0-4)	<1% (<1-4%)	0.6
<i>Pleuraphis rigida</i> Big galleta grass	5	0.5 (0-3)	<1% (<1%)	0.7
<i>Carnegiea gigantea</i> Saguaro	4	0.5 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	3	0 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	3	0 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	3	0 (0-1)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	3	0 (0-1)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	2	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia spp.</i>	1	0(0-1)	<1%(<1%)	
<i>Datura discolor</i>	1	0 (0-3)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	1	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Eriogonum sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	1	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-2)	<1% (<1%)	
<i>Olnya tesota</i> Ironwood	1	0 (0-2)	<1% (<1%)	
<i>Agave deserti</i>	1	0 (0-1)	<1% (<1%)	
<i>Aristida adscensionis</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	1	0 (0-1)	<1% (<1%)	
<i>Porophyllum gracile</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote - white bursage (11)

**Subassociation:** Creosote – Spanish needles - white bursage on sands (117)

**Scientific Name:** *Larrea tridentata* – *Palafoxia arida* - *Ambrosia dumosa* on sands

**NVC Association:** Most similar to *Larrea tridentata* – *Ambrosia dumosa* shrubland.

**Previous classifications:** Not classified. Similar to dune associations, but here the sands are shallow and creosote (*Larrea tridentata*) is the always dominant or co-dominant. On 'true' dunes, creosote is confined to swales, and white bursage (*Ambrosia dumosa*) is generally the dominant, along with specialized sand species.



Figure 62. Photo sites: along border wall, near Butler Mountains. The top photo shows the habitat as it looks much of the year, while the bottom photo shows the dune primrose in the same location after rains in 2014.

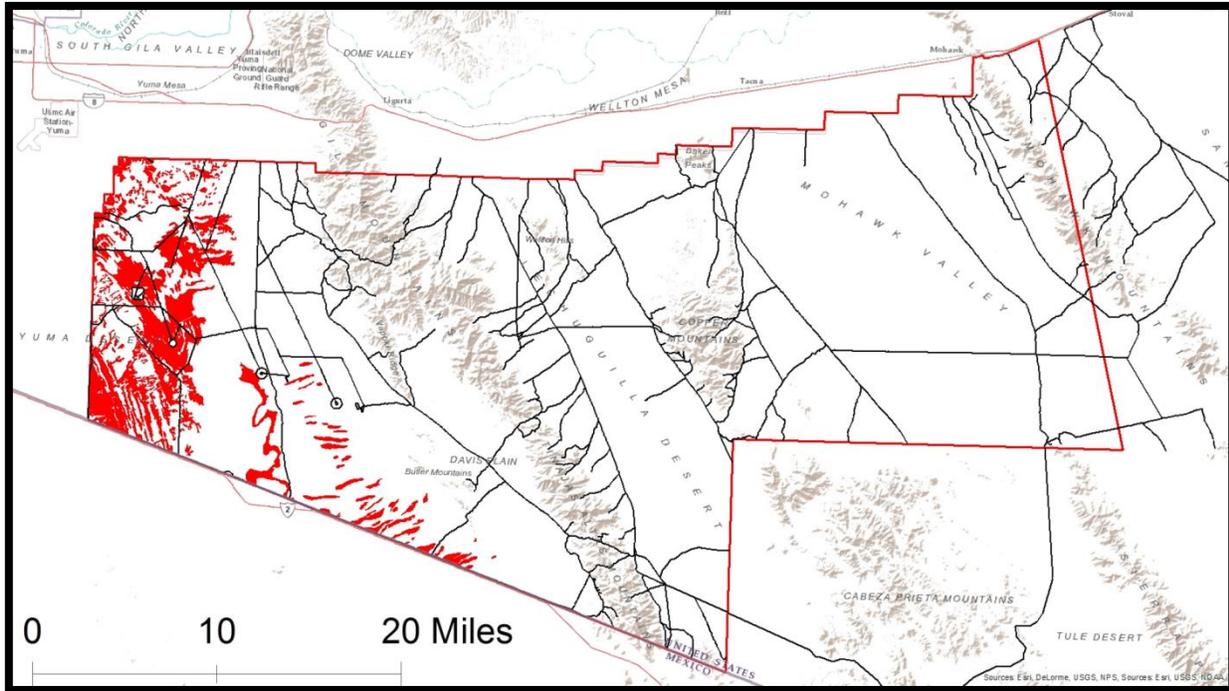


Figure 63. The distribution of creosote – Spanish needles – white bursage on sands (117) on the BMGR West.

**Description:** Creosote is dominant, often sparse, but relatively large (mean height of 1.3 m). The most common perennial associates are white bursage (*Ambrosia dumosa*) and crinklemat (*Tiquilia plicata*). Spanish needles (*Palafoxia arida*) is the most common annual associate.

**Location:** Restricted to sand ridges east of the Yuma Dunes, and abutting the gravels of the Yuma Mesa.

**Field Identification:** As shown in the photos above, the wind-blown sands create a distinctive surface pattern of ripples. Not seen in the photos, but evident on the ground, are the sand ridges, especially east of the Yuma Dunes. Here, along the border road, it's plain to see the slight topographic rise of a sand ridge. Between ridges are blowouts holding only creosote and, during good rains, Woolly plantain (*Plantago ovata*). On the sand ridges, white bursage may be absent in some places along the border, where the 2002-2003 drought was especially severe. The dried stalks of Spanish needles and dune primrose persist through the dry season.

**Photo Identification:**



Figure 64. Image showing sand ridge in center of photo, the pale slash running southwest to northeast. This is along the international border, south of the Butler Mountains.

**Vegetation:** Creosote – Spanish needles - white bursage on sands

**Alliance/Association/Subassociation codes:** 1 / 11 / 117

**Number of Sample Sites (relevés):** 9

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	9	5 (4-5)	1-4% (<1-9%)	1.3
<i>Palafoxia arida</i> Spanish needles	6	3 (0-3)	<1% (<1-4%)	
<i>Ambrosia dumosa</i> White bursage	6	2.5 (0-4)	<1% (<1-4%)	0.5
<i>Brassica tournefortii</i> Sahara mustard	6	2 (0-3)	<1% (<1-60%)	0.7
<i>Plantago ovata</i> Wooly plantain	6	2 (0-3)	<1% (<1-4%)	
<i>Tiquilia plicata</i> Crinklemat	5	2 (0-3)	<1% (<1-4%)	
<i>Penstemon parryi</i>	4	1 (0-2)	<1% (<1%)	
<i>Oenothera deltoides</i> Dune primrose	4	0.5 (0-3)	<1% (<1%)	
<i>Schismus arabicus</i> Arabian grass	4	0 (0-3)	<1% (<1-4%)	
<i>Cryptantha angustifolia</i> Pick-me-not	3	0 (0-3)	<1% (<1-14%)	
<i>Dalea mollissima</i> Silky dalea	3	0 (0-3)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	3	0 (0-3)	<1% (<1-4%)	1.0
<i>Psoralea emoryi</i> Indigobush	3	0 (0-3)	<1% (<1-4%)	0.9
<i>Tiquilia palmeri</i> Crinklemat	3	0 (0-3)	<1% (<1%)	
<i>Abronia villosa</i> Sand verbena	2	0 (0-3)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	2	0 (0-3)	<1% (<1-4%)	
<i>Baileya pleniradiata</i>	2	0 (0-3)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-3)	<1% (<1%)	
<i>Aristida purpurea</i>	2	0 (0-2)	<1% (<1%)	
<i>Astragalus sabulonum</i>	2	0 (0-2)	<1% (<1%)	
<i>Ditaxis serrata</i> Silverbush	2	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Dithyrea californica</i>	2	0 (0-2)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	2	0 (0-2)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	2	0 (0-2)	<1% (<1%)	
<i>Acacia constricta</i>	1	0 (0-3)	<1% (<1%)	
Annual grass	1	0 (0-3)	<1% (<1-4%)	
<i>Aristida californica</i>	1	0 (0-3)	<1% (<1%)	
<i>Baileya pauciflora</i>	1	0 (0-3)	<1% (<1%)	
<i>Camissonia claviformis</i>	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	1	0 (0-3)	<1% (<1%)	
<i>Kallstroemia californica</i>	1	0 (0-3)	<1% (<1%)	
<i>Lupinus arizonicus</i>	1	0 (0-3)	<1% (<1%)	
<i>Chaenactis stevioides</i>	1	0 (0-2)	<1% (<1%)	
<i>Helianthus niveus</i>	1	0 (0-2)	<1% (<1%)	
<i>Mentzelia albicaulis</i>	1	0 (0-2)	<1% (<1%)	
<i>Psilostrophe cooperi</i>	1	0 (0-2)	<1% (<1%)	
<i>Stephanomeria schottii</i>	1	0 (0-2)	<1% (<1%)	
<i>Tidestromia lanuginosa</i>	1	0 (0-2)	<1% (<1%)	
<i>Allonia incarnata</i>	1	0 (0-1)	<1% (<1%)	
<i>Mentzelia multiflora</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – triangle leaf bursage (12)

**Subassociation:** Creosote – triangle leaf bursage (120)

**Scientific Name:** *Larrea tridentata* – *Ambrosia deltoidea* shrubland

**NVC Association:** Most similar to *Larrea tridentata* – *Ambrosia dumosa* shrubland, except this vegetation has *Ambrosia dumosa* instead of *Ambrosia deltoidea*.

**Previous classifications:** Warren et al (1981) include this as part of 154.1111, which, in their scheme, includes either/both *Ambrosia dumosa* and *A. deltoidea*, sub-dominant to *Larrea tridentata*.



Figure 65. Relevé MMNW – 48, in the Mohawk Valley, the view northwest to the Mohawk Mountains.

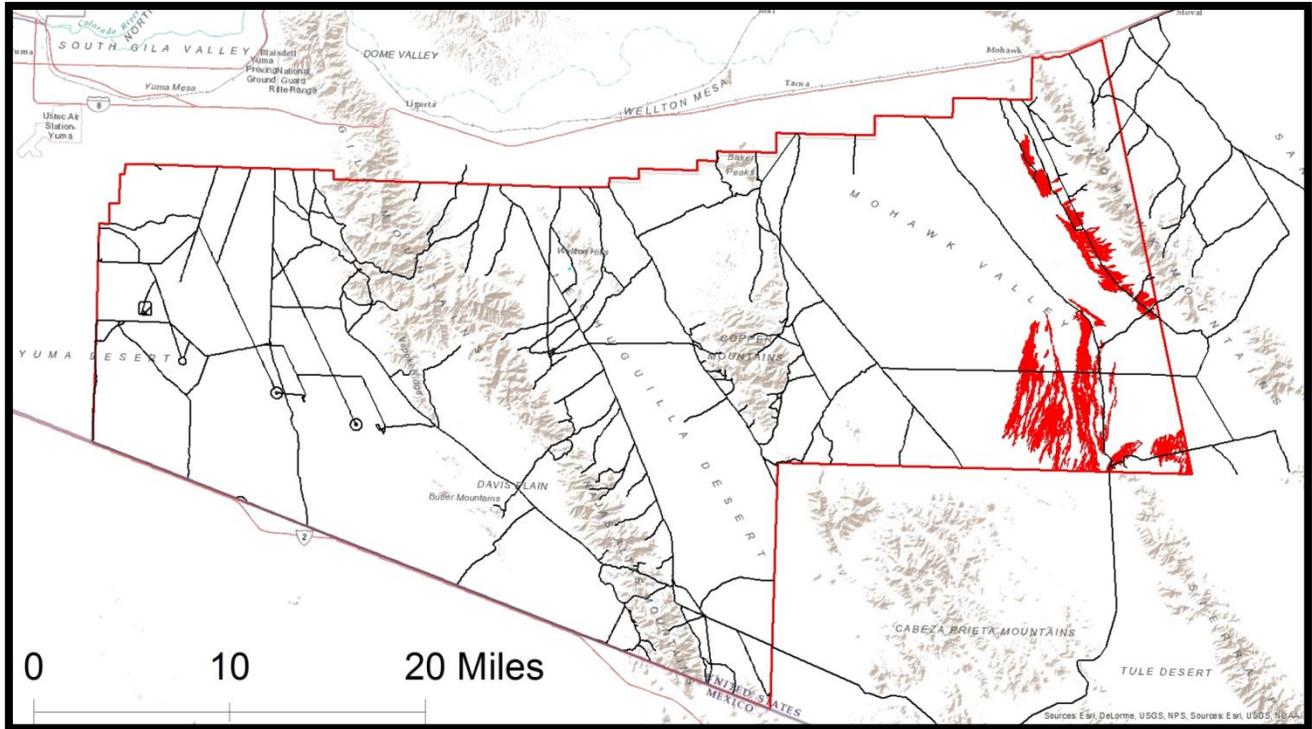


Figure 66. Distribution of creosote – triangle leaf bursage (120) on the BMGR West.

**Description:** Creosote (*Larrea tridentata*) is dominant, and triangle-leaf bursage common and preferring runnels or shallow depressions. White bursage (*Ambrosia dumosa*) and mesquite are uncommon, rare or absent. Big galleta (*Pleuraphis rigida*) is occasionally common, but only present at 5 of the 11 relevés

**Location:** Limited to the eastern half of the Mohawk Valley, typically on slopes of 1 to 3%, bordering areas of creosote/mesquite floodplains, or as islands within loosely braided creosote/mesquite floodplain in valley bottoms, or between gravely interfluves that held creosote/white bursage. This association vanishes to the north and west, mirroring the demise of summer precipitation, and suggesting a link between the two.

**Field Identification:** White bursage, mesquite, ironwood and palo verde are uncommon, rare, or absent in this association. It can be tough to draw the line between this association and creosote/mesquite floodplain when the latter has very few mesquite. One difference between the two is the higher densities of triangle leaf bursage in floodplains, where it can reach 40% cover, and often alternates with areas of very low cover or hardly anything. In contrast, *A. deltoidea* does not exceed 14% cover percent cover overall in this creosote/triangle-leaf association.

**Photo Identification:** The creosote/triangle-leaf bursage association was generally identified and mapped by what it *lacked*. There were no trees, or less than one/hectare; it did not have

the coarser grain alluvial outwash associated with creosote/white bursage; it did not have the distinct regular dispersion of pure creosote flats; and it did not have the large barren areas that often bordered the creosote/mesquite floodplain.

Vegetation: *Larrea tridentata* – *Ambrosia deltoidea*

Alliance/Association/Subassociation codes: 1 / 12 / 120

Number of Sample Sites (relevés): 11

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	11	5(3-5)	5-9% (1-9%)	1.1
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	11	3(3-5)	1-4% (<1-14%)	0.5
<i>Ambrosia dumosa</i> White bursage	5	0(0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	5	0(0-2)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	5	0(0-3)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	4	0(0-3)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	3	0(0-2)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	2	0(0-1)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	2	0(0-3)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	1	0(0-1)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0(0-1)	<1% (<1%)	
<i>Cryptantha sp.</i> Pick-me-not	1	0(0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0(0-0)	<1% (<1%)	
<i>Lepidium sp.</i>	1	0(0-3)	<1% (<1%)	
<i>Malvaceae sp.</i>	1	0(0-3)	<1% (<1%)	
<i>Oenothera sp.</i>	1	0(0-3)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	1	0(0-2)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0(0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage -triangle leaf bursage (13)

**Subassociation:** Creosote – white bursage - triangle leaf bursage (130)

**Scientific Name:** *Larrea tridentata* – *Ambrosia dumosa* - *Ambrosia deltoidea* shrubland.

**NVC Association:** Most similar to *Larrea tridentata* – *Ambrosia dumosa* shrubland, except with *Ambrosia dumosa* present with *Ambrosia deltoidea*.

**Previous classifications:** Warren et al (1981) include this as part of 154.1111, which, in their scheme, includes either/both *Ambrosia dumosa* and *A. deltoidea*, sub-dominant to *Larrea tridentata*.



Figure 67. Relevé MMSW-42, in the Mohawk Valley, the view northeast to the Mohawk Mountains.

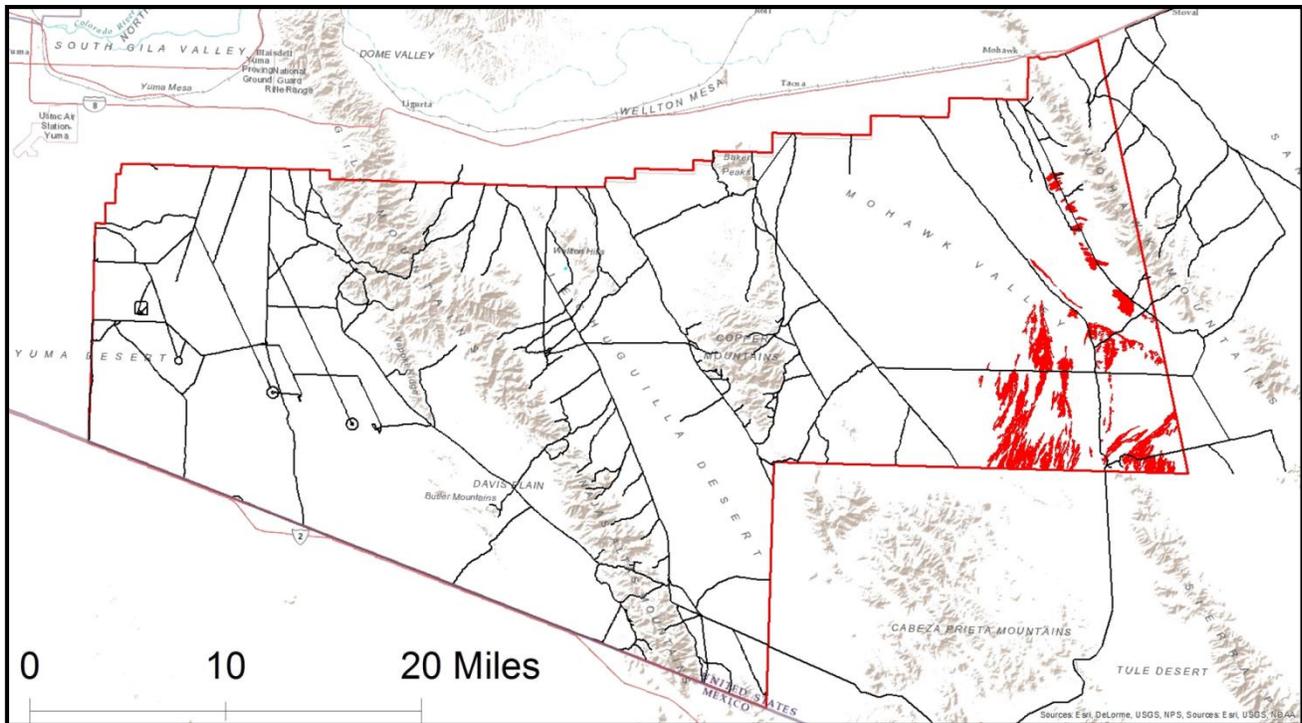


Figure 68. Distribution of creosote – triangle leaf bursage (130) on the BMGR West.

**Description:** Creosote (*Larrea tridentata*) is dominant or co-dominant. Both species of *Ambrosia* are present, and typically common, with white bursage, *A. dumosa*, prevailing on the interfluves, and *A. deltoidea*, triangle leaf bursage, in the runnels between. *Pleuraphis rigida* (big galleta) was on 6 of 11 relevés, but never co-dominant. Scattered palo verde and ironwood are uncommon but present on 4 of 11 sites.

**Location:** This association is found on the eastern half of the Mohawk Valley, as well as between the Mohawk Dunes and Mohawk Mountains, southeast of the Mohawk Playa. It's typically on slopes of 1 to 5%, just downslope of the creosote/bursage/palo verde/ironwood association (170). Here, below the “treeline”, there are small rises of relatively coarse alluvium, dissected by runnels and finer soils. The result is a matrix of the *Ambrosia deltoidea* and *A. dumosa* associations. If the mapping unit were very small – say, 10 by 10 meters – it would be possible to split this association.

**Field Identification:** Walking perpendicular to the runnels, you encounter both species of *Ambrosia*.

**Photo Identification:** The characteristic pattern is thin dark lines of *A. deltoidea* in runnels that also hold an occasional mesquite. Between the runnels are the broader but more sparsely vegetated interfluves. In other words, it was a matrix of both bursage associations, and was often used as catch-all for those areas that did not cleanly fall into one or the other creosote/bursage association.

**Vegetation:** Creosote – white bursage - triangle leaf bursage

**Alliance/Association/Subassociation codes:** 1 / 13 / 130

**Number of Sample Sites (relevés):** 11

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	11	5(3-5)	1-4% (1-14%)	1.1
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	11	3(2-5)	1-4% (<1-14%)	0.5
<i>Ambrosia dumosa</i> White bursage	11	3(2-3)	1-4% (<1-4%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	6	1(0-3)	<1% (<1%)	0.8
<i>Ferocactus wislizeni</i> Fishhook barrel	3	0(0-1)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	2	0(0-3)	<1% (<1-4%)	0.4
<i>Olneya tesota</i> Ironwood	2	0(0-2)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	2	0(0-1)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	1	0(0-1)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0(0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	2	0(0-2)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	1	0(0-1)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	1	0(0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0(0-3)	<1% (<1-9%)	0.6
<i>Cylindropuntia ramosissima</i>	1	0(0-2)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote-white bursage-triangle leaf bursage (13)

**Subassociation:** Creosote-white bursage-triangle leaf bursage, burned (132)

**Scientific Name:** *Larrea tridentata* – *Ambrosia dumosa* - *Ambrosia deltoidea* shrubland.

**NVC Association:** There is a very general ‘Recently Disturbed or Modified’.

**Previous classifications:** Osmer et al. (2009) mapped and named this vegetation unit in the North Tactical Range of BMGR East, assigning subassociation code 132, which is retained here.

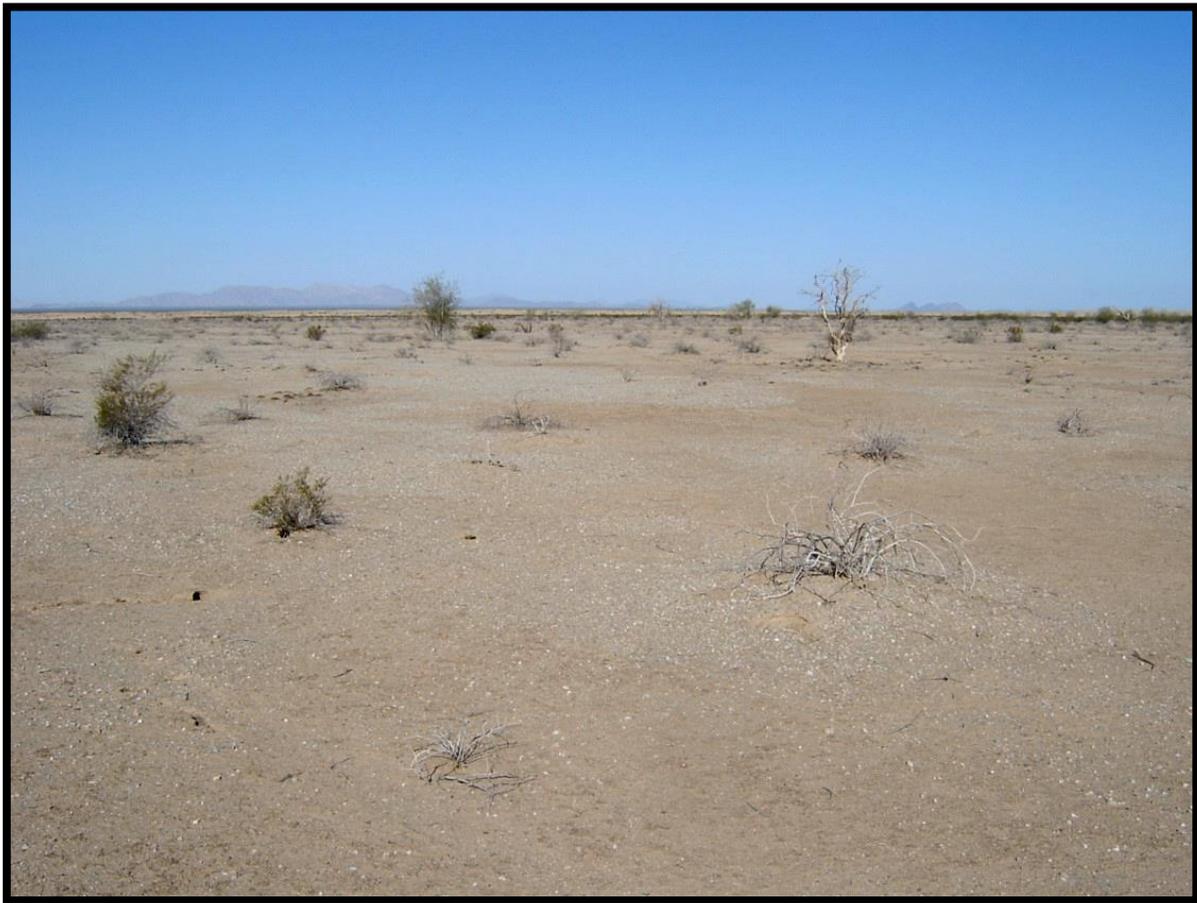


Figure 69. Relevé MMSW-28, on east side of Mohawk Dunes, showing a recently burned area.

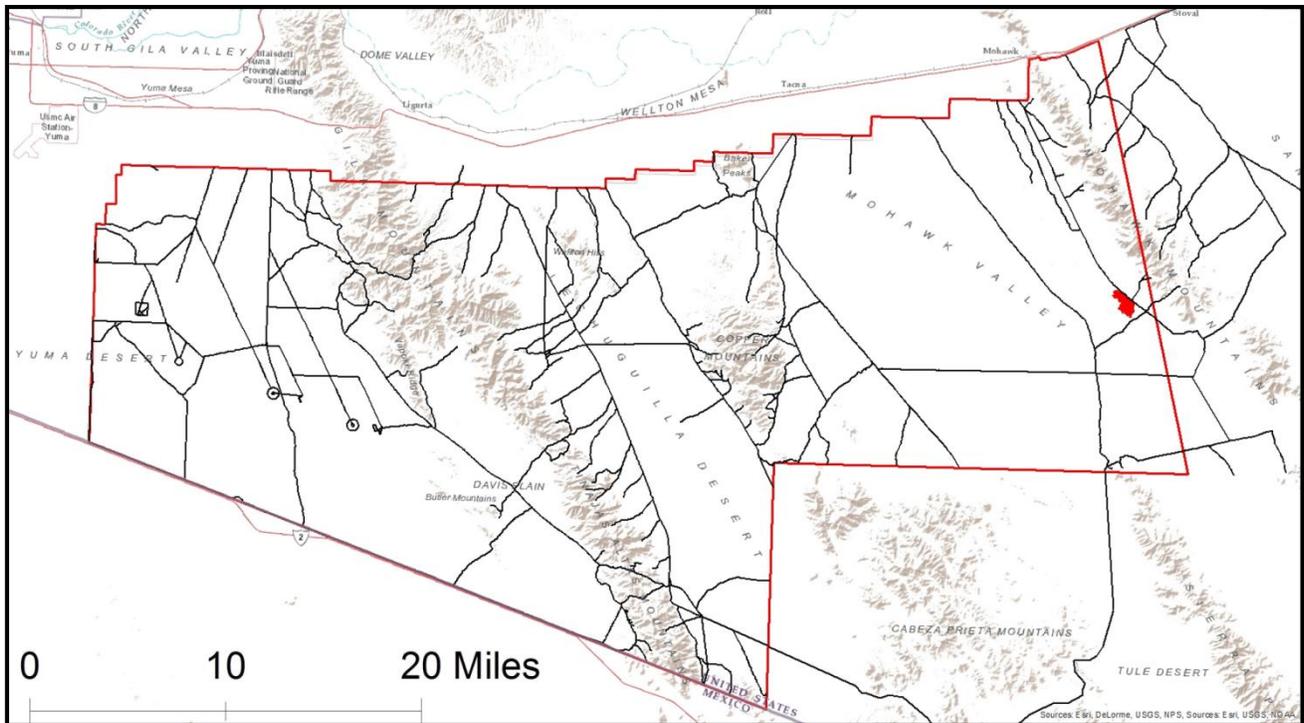


Figure 70. Distribution of recently burned creosote – white bursage – triangle leaf bursage on the BMGR West.

**Description:** This subassociation is the same as 130, except that it has been recently burned. About 200 ha burned between September 2003 and November 2005. The site was visited in 2009, when the photo above was taken. The burned stalks of the invasive mustard, *Brassica tournefortii*, littered the site, and was the only species recovering at the time besides a few creosote (*Larrea tridentata*).

**Location:** Only encountered once, towards the south end of the Mohawk Dunes, between the Papago Well Road and the dunes.

**Field Identification:** Burned.

**Photo Identification:**



Figure 71. Image from Nov 2005. Burned area is to left. Note how the Papago Well Road acted as a fire break.

**Vegetation:** Creosote – white bursage - triangle leaf bursage recently burned

**Alliance/Association/Subassociation codes:** 1 / 13 / 132

**Number of Sample Sites (relevés):** 1

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	1	5(5)	1(1)	
<i>Brassica tournefortii</i> Sahara mustard	1	3(3)	1(1)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	2(2)	1(1)	
<i>Olneya tesota</i> Ironwood	1	1(1)	1(1)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – teddy bear cholla (14)

**Subassociation:** Creosote - white bursage –teddy bear cholla (141)

**Scientific Name:** *Larrea tridentata*- *Ambrosia dumosa*-*Cylindropuntia bigelovii* shrubland

**NVC Association:** *Cylindropuntia bigelovii* shrubland. It was originally described from the Grand Canyon, which lacks creosote. Instead, it occurs with brittlebush, which is also a common associate in this study.

**Previous classifications:** This is a subassociation of association 14, with the latter previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003). However, that mapping unit is characterized by triangle-leaf bursage, not white bursage, and will now be distinguished as subassociation 140. Finally, this is generally a pediment association, and it can be also be seen as a more arid version of Warren et al.'s 154.1212.



Figure 72. Relevé TA-5, near the Tinajas Altas Mountains.

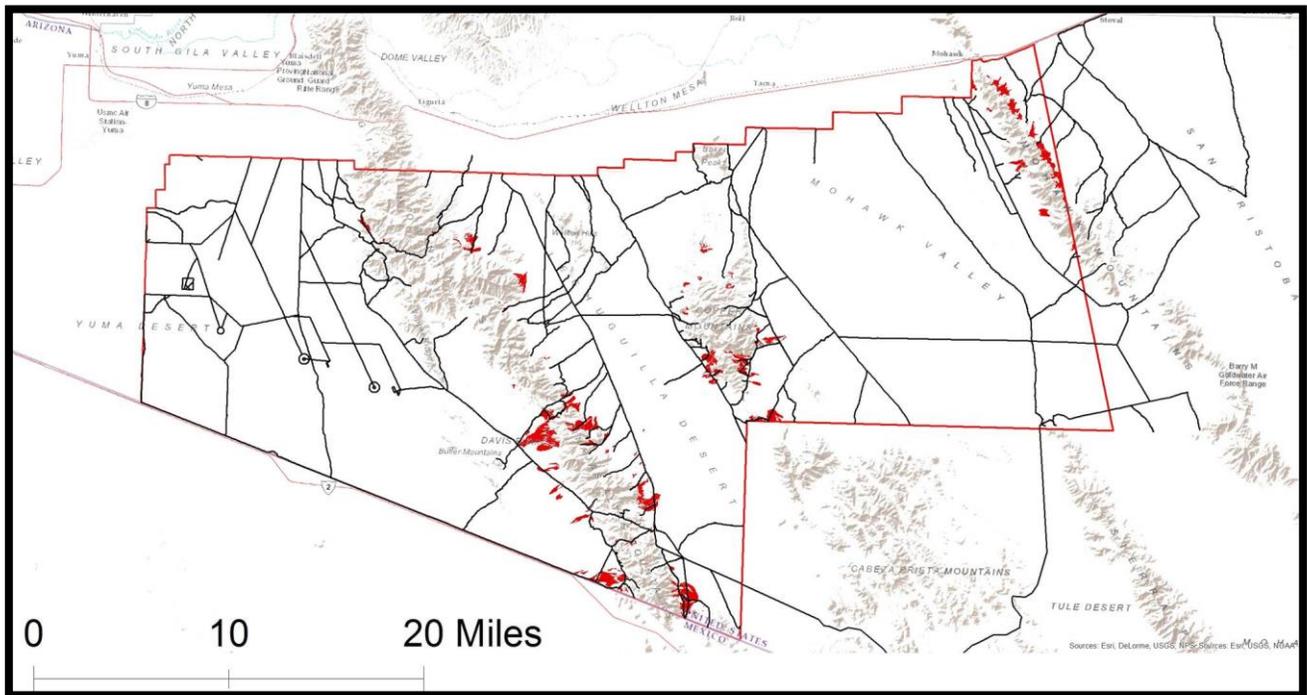


Figure 73. Distribution of creosote - white bursage - teddy bear cholla (141) on the BMGR West

**Description:** The diagnostic species for this association is teddy bear cholla, also known as jumping cholla (*Opuntia bigelovii*=*Cylindropuntia bigelovii*). Its median canopy cover is estimated at 1-4%. The cholla is most always accompanied by brittlebush (*Encelia farinosa*), creosote (*Larrea tridentata*), and white bursage (*Ambrosia dumosa*), with each typically adding 1-4% cover. Ocotillo, ironwood, and saguaro (*Carnegiea gigantea*) are generally uncommon, yet appear at most of the 21 relevés.

As mentioned above, a similar association was mapped in the eastern portion of the CPNWR and adjoining BLM lands, which is very similar to the present vegetation, except *Ambrosia deltoidea* is the associate bursage on the CPNWR, not *Ambrosia dumosa*. Also, *Encelia farinosa* is far more common on the BMGR West than the CPNWR –it is present in all 21 relevés on the BMGR West, as opposed to four of 17 on the eastern CPNWR and BLM lands.

Note that there is a similar teddy bear cholla vegetation in which white bursage is dominant over or co-dominant with creosote (subassociation 241) and in some cases holds ironwood and palo verde (242).

**Location:** This association is usually tucked up against mountain slopes. But because *Cylindropuntia bigelovii* is not frost-sensitive, it can occur on coarse alluvial outwash that carries the plant far downslope into the cold night air of the valleys, such as it does southwest of Cipriano

Pass. Because it's propagated asexually from its stems, pieces of cholla can be carried off by arroyos and form new populations.

There was a striking lack of this association on the west side of the Mohawk Mountains, at least compared to the east side, and in the northern Gila Mountains. In the Mohawks, this curious distribution reflects the abundance of teddy bear cholla on the mountain slopes: it is far more common on the east side than the west. A fair guess is that the distribution is related to basin-and-range faulting, because the east side rises in a single steep ramp to the summit ridge, while the west is broken into cliffs.

**Field Identification:** This association was mapped by hiking along the lower limit of the teddy bear cholla (*Cylindropuntia bigelovii*), the diagnostic species. Binoculars were useful for spotting distant individuals, which were included in the range unless they were over one hundred meters (328 feet) from the rest of the population. The upper bounds were the 20% slope limit, because this association was originally described as a pediment association (Malusa, 2003). The teddy bear cholla ranges well beyond 20%, up the steepest slopes, and it is occasionally a dominant species in the 'mountain' association (154.1631).

**Photo Identification:** Aerial photos couldn't discern the range of *Cylindropuntia bigelovii* until very recently (2014), but in those areas mapped earlier (i.e., the eastern side of the BMGR West) they could be used to draw the line between this creosote-dominant association and those further upslope and typically dominated by white bursage (241 and 242). Trees were used as a proxy for creosote dominance. For instance, if palo verde and/or ironwood were common – say, over five percent cover – then it was presumed bursage would be dominant or co-dominant, and mapped as 242. If the trees were uncommon, less than five percent cover, then it was presumed creosote was dominant or co-dominant. If tree cover was between five and ten percent, it was impossible to say whether the creosote or bursage would be dominant; nonetheless, these areas were mapped as 241 or 242 – the bursage dominated association.

**Vegetation:** Creosote – white bursage – teddy bear cholla

**Alliance/Association/Subassociation codes:** 1 / 14 / 141

**Number of Sample Sites (relevés):** 21

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	21	4 (3-5)	1-4% (1-14%)	1.1
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	21	3 (3-5)	1-9% (<1-25%)	0.8
<i>Encelia farinosa</i> Brittlebush	21	3 (2-5)	1-4% (<1-25%)	0.8
<i>Ambrosia dumosa</i> White bursage	19	3 (0-4)	1-4% (<1-9%)	0.5
<i>Fouquieria splendens</i> Ocotillo	17	2 (0-5)	<1% (<1-4%)	3.7
<i>Carnegiea gigantea</i> Saguaro	16	2 (0-3)	<1% (<1-4%)	
<i>Olneya tesota</i> Ironwood	16	1 (0-3)	<1% (<1-4%)	3.2
<i>Krameria grayi</i> Ratany	14	2 (0-3)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	14	1 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	13	2 (0-3)	<1% (<1-4%)	0.9
<i>Parkinsonia microphylla</i> Yellow Paloverde	9	0 (0-2)	<1% (<1-4%)	3.0
<i>Cylindropuntia ramosissima</i> Diamond cholla	8	0 (0-3)	<1% (<1-4%)	0.6
<i>Echinocereus engelmannii</i> Hedgehog cactus	8	0 (0-2)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	7	0 (0-3)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	6	0 (0-3)	<1% (<1%)	0.7
<i>Bursera microphylla</i> Elephant tree	6	0 (0-2)	<1% (<1%)	1.7

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Pleuraphis rigida</i> Big galleta grass	5	0 (0-3)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	4	0 (0-3)	<1% (<1-4%)	1.3
<i>Hyptis emoryi</i> Desert lavender	3	0 (0-3)	<1% (<1-4%)	
<i>Horsfordia alata</i> Velvet mallow	3	0 (0-2)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	2	0 (0-3)	<1% (<1-4%)	
<i>Senna covesii</i>	2	0 (0-3)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	2	0 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	2	0 (0-2)	<1% (<1%)	0.8
<i>Ditaxis lanceolata</i>	2	0 (0-2)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	2	0 (0-1)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	2	0 (0-1)	<1% (<1%)	
<i>Mammillaria spp.</i>	1	0(0-1)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	0 (0-3)	<1% (<1%)	0.5
<i>Lepidium lasiocarpum</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-2)	<1% (<1%)	
<i>Agave deserti</i>	1	0 (0-1)	<1% (<1%)	
<i>Asclepias albicans</i>	1	0 (0-1)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	1	0 (0-1)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	1	0 (0-1)	<1% (<1%)	
<i>Erodium texanum</i>	1	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia microphylla x florida</i> (hybrid)	1	0 (0-1)	<1% (<1%)	
<i>Porophyllum gracile</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote floodplain (15)

**Subassociation:** Creosote - mesquite – triangle leaf bursage floodplain (150)

**Scientific Name:** *Larrea tridentata*-*Prosopis glandulosa*- *Ambrosia deltoidea* floodplain.

**NVC Association:** An undefined variant of the *Larrea tridentata* association

**Previous classifications:** Warren et al (1981) call this 154.1115R.

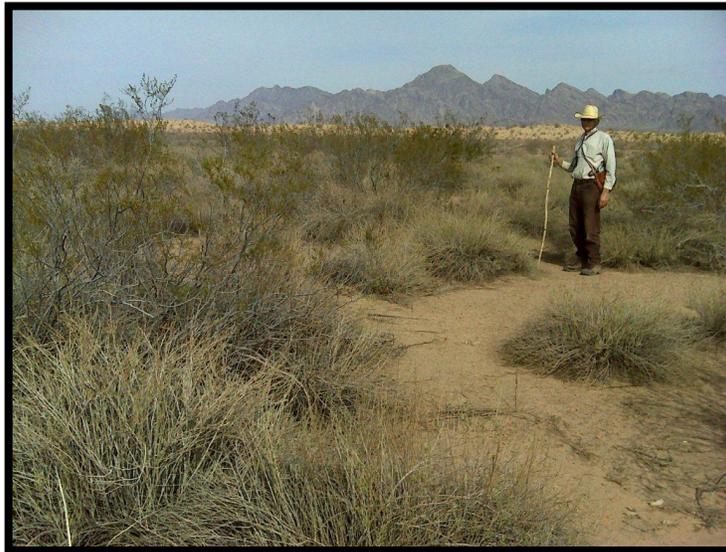


Figure 74. Relevé MMSW-38, near Mohawk Dunes, with Pete Sundt amid dense triangle leaf bursage.



Figure 75. Relevé MMNW-44, also near Mohawk Dunes. The grey shrubs are leafless mallows.

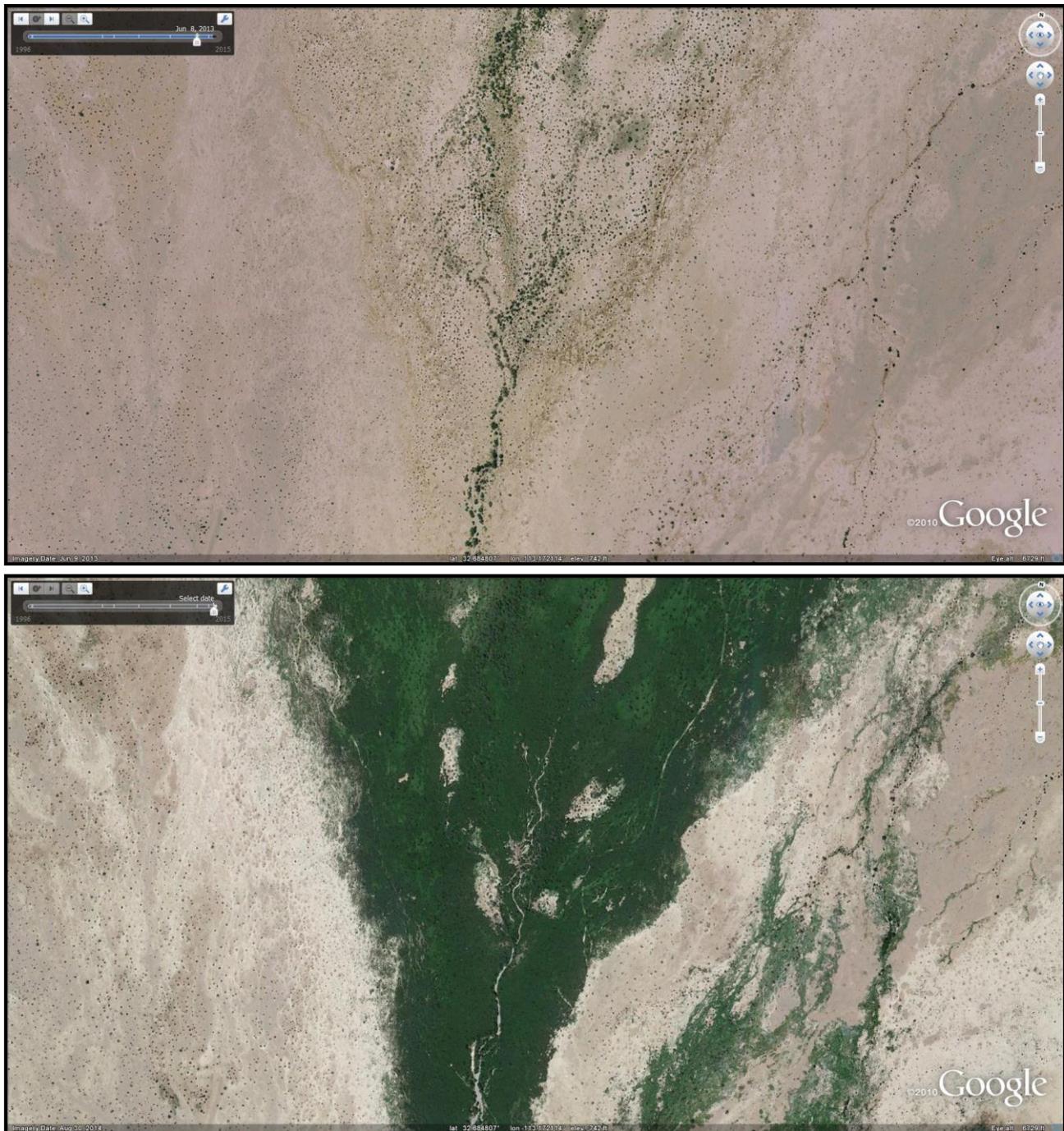


Figure 76. Images showing the 'inland delta' of Ten Mile Wash, which is on the BMGR East, from June 2013 (top) and August 2014 (bottom), showing the effect of summer flooding. Image shows an area 1.3 miles wide. During the course of this study, we did not have the good fortune to document such flooding on the BMGR West, but never-the-less mapped the areas that would be prone to such flooding. The evidence: abundant dried stalks of amaranth and mallow, and scattered mesquite and wolfberry, which are usually restricted to riparian areas. In the lower image, the trees are likely mesquite and blue palo verde; the shrubs are triangle leaf bursage, and the annuals are mallow, amaranth, *Allionia* and *Boerhavia* spp.

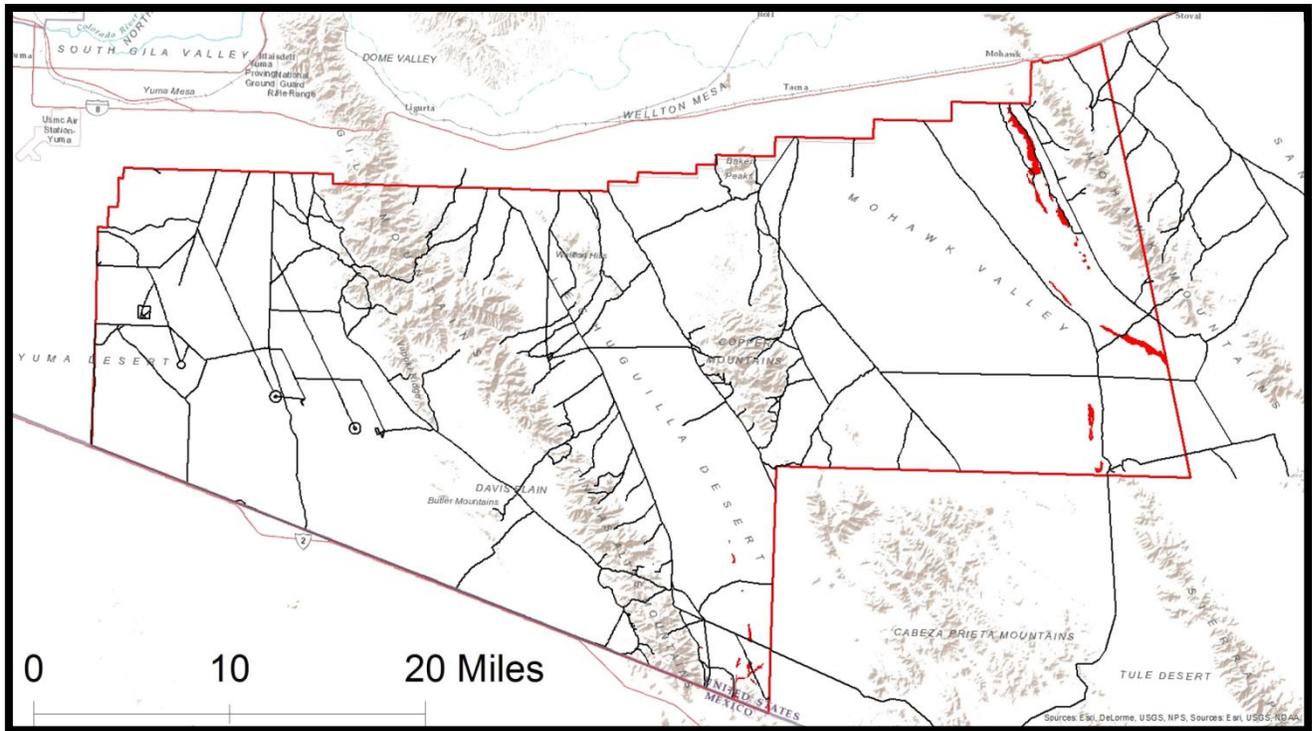


Figure 77. Distribution of creosote-mesquite-triangle leaf bursage floodplain on the BMGR West.

**Description:** This association is found where occasional sheet flooding has allowed the growth of scattered mesquite and along with patches, occasionally dense, of *Ambrosia deltoidea* and mallow (*Sphaeralcia coulteri*) in an area otherwise characterized by creosote (*Larrea tridentata*). Big galleta grass (*Pleuraphis rigida*) was at eight of the 14 relevés. The presence of the big galleta grass is puzzling, because it is a sand-loving species, and the floodplains are the opposite: soils are often fine, tending towards clays rather than sands.

Similar to the big galleta, *Brassica tournefortii*: it's usually in sandy habitat, but was found at seven of 14 floodplain relevés. A similar pattern is found in a similar floodplain that's found in the western BMGR West (see subassociation 151, below).

Statistically, Creosote is typically co-dominant (and relatively tall, with a median height of 1.3 meters). As indicated in the range of "prominence" in the table below, there is plenty of variation in the species roster, with both the mesquite and bursage ranging from dominant to absent. *Sphaeralcia coulteri* was also widely variable, ranging from co-dominant to absent.

Floodplains lack a well-defined channel (as well as a well-defined border). They may border large arroyos (beds wider than five meters/16 feet) that occasionally breach their banks. But floodplains, as defined here, occur mainly along the valley bottom between the Mohawk Mountains and Mohawk Dunes, in a variety of creosote or creosote/bursage associations that lack distinct watercourses.

There were also largely barren areas associated with floodplains. They were included within this association where they held more than 1% cover, particularly of *Sphaeralcia coulteri* or mesquite, species that are typical of the denser growth of the floodplain, and not the creosote/bursage desert beyond.

The invasive *Brassica tournefortii* was present at 7 of 14 sites.

**Location:** Common in the valley bottom between the Mohawk Mountains and Mohawk Dunes, in areas of low relief (less than 3% slope). Also in the upper watershed of Coyote Wash and La Jolla Wash, where the Camino del Diablo crosses the divide between these two drainages. This valley drains into the Mohawk Playa, with the exception of the northern end of the study area, which drains to the Gila. The association is also common on the south end of the Mohawk Dunes, where occasional sheet flooding from the south pools up against the dunefield. Finally, the association is also found where the Mohawk Wash enters the BMGR West near the Point of the Pintas. Further west, this association is replaced by another floodplain vegetation, 151 (see below), with the exception of upper Coyote and La Jolla Washes.

**Field Identification:** Dense patches of triangle-leaf bursage, mallow, big galleta grass are interspersed by barrens, dotted with mesquite both vigorous and dying, and large creosote. As mentioned above, the barren areas bordering denser vegetation were included in this association, particularly where there were mud cracks and silt. Truly barren areas, with less than 1% vegetation cover, were mapped as 154.1820 (floodplain barren or playa). Floodplains that grade into and out of drainages upslope near the toe of the mountain, with relatively well-defined channels, were typically mapped not as floodplain, but as 170 (creosote/bursage with scattered trees). Further from the mountain front, they were mapped as floodplain. It is primarily a matter of slope.

**Photo Identification:** Typically a largely barren area, speckled with what appeared to be large creosote or small mesquite, surrounded an area of dense vegetation.

**Vegetation:** Creosote – mesquite-triangle leaf bursage

**Alliance/Association/Subassociation codes:** 1 / 15 / 150

**Number of Sample Sites (relevés):** 14

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	14	4 (2-5)	5-14% (<1-25%)	1.3
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	9	2.5 (0-5)	1-4% (<1-60%)	0.6
<i>Sphaeralcea coulteri</i> Mallow	8	3 (0-4)	<1% (<1-9%)	0.7
<i>Prosopis glandulosa</i> Mesquite	8	2 (0-5)	<1% (<1-25%)	2.9
<i>Pleuraphis rigida</i> Big galleta grass	8	2 (0-3)	<1% (<1-9%)	0.7
<i>Brassica tournefortii</i> Sahara mustard	7	1 (0-3)	<1% (<1-4%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	6	0 (0-2)	<1% (<1%)	
<i>Ambrosia dumosa</i> White bursage	3	0 (0-3)	<1% (<1-4%)	0.5
<i>Lycium sp.</i> Wolfberry	3	0 (0-3)	<1% (<1-4%)	0.9
<i>Krameria grayi</i> Ratany	2	0 (0-3)	<1% (<1-4%)	0.6
<i>Olneya tesota</i> Ironwood	2	0 (0-2)	<1% (<1%)	
Annual grass	1	0 (0-3)	<1% (<1%)	
<i>Astragalus sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Phacelia ambigua</i>	1	0 (0-3)	<1% (<1%)	
<i>Tidestromia lanuginosa</i>	1	0 (0-3)	<1% (<1%)	
<i>Castela emoryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0 (0-2)	<1% (<1%)	
<i>Lycium andersonii</i>	1	0 (0-2)	<1% (<1%)	
<i>Palafoxia arida</i>	1	0 (0-2)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-2)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote floodplain (15)

**Subassociation:** Creosote – white bursage – blue palo verde floodplain (151)

**Scientific Name:** *Larrea tridentata*- *Ambrosia dumosa*-*Parkinsonia florida* floodplain.

**NVC Association:** An undefined variant of the *Larrea tridentata* association

**Previous classifications:** none.



Figure 78. Relevé WSE-29, along Coyote Wash in the Wellton Hills



Figure 79. Near relevé WSE-37, Coyote Wash, south end of Wellton Hills



Figure 80. Relevé RB-5, along Coyote Wash, about 5 miles east of Raven Butte



Figure 81. Relevé FSW – 27, just west of Foothill Boulevard., 2.3 miles north of Tracker. The dead mallows are the only clue that this can hold luxuriant growth, if only once every five years or so.

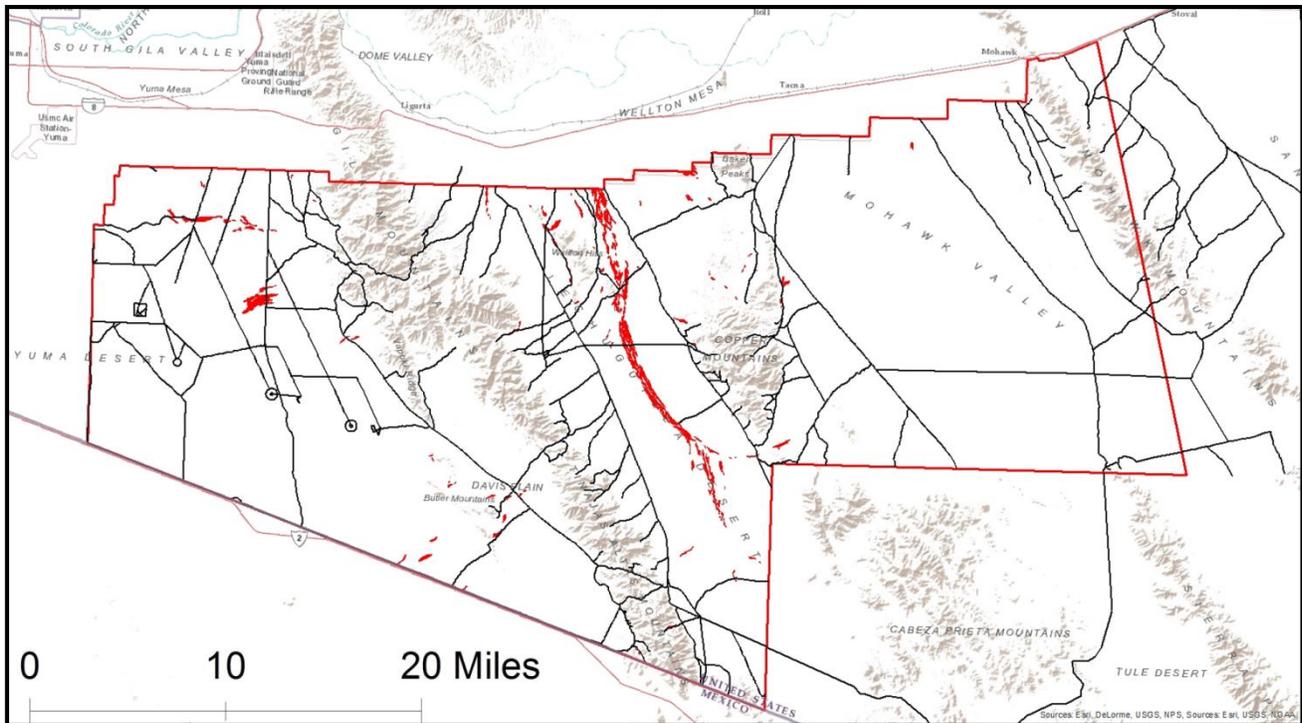


Figure 82. Distribution of Creosote – white bursage – blue palo verde floodplain (151) on the BMGR West.

**Description:** This association is found fringing major watercourses, as well as ‘islands’ in braided watercourses, and finally at the fans where large watercourses fade into the desert, forming ‘deltas’ away from the mountain front.

Creosote (*Larrea tridentata*) is typically co-dominant, and very tall, with a median height of 1.3 m. Associates are highly variable: white bursage (*Ambrosia dumosa*) in 8 out of 10 samples, wolfberry (*Lycium*, 5 out of 10), blue palo verde (*Parkinsonia florida*, 8/10). Big galleta grass, cheesebush (*Hymenoclea salsola*), and desert lavender (*Hyptis emoryi*) were less frequently encountered, yet all were occasionally the dominant or co-dominant species. In other words, this association is highly variable, and more defined by landform than dominant species. Cover is also highly variable, as shown in the photographs above.

The invasive mustard, *Brassica tournefortii*, was present at 7 of 10 sites.

**Location:** Largely in the Lechuguilla Valley in areas of low relief (less than 2% slope), associated with sheet flooding from Coyote Wash. The association also occurs along the SE flank of the Wellton Hills, and west of the Gila Mountains along County 17<sup>th</sup> wash, and an unnamed wash about 2.5 miles north of Tracker.

**Field Identification:** *Lycium* and *Hymenoclea* are the key genera, because they are not found on the valley floor where there is not occasional flooding (a personal observation, not a fact). If these species were absent, then unusually dense or tall patches of *Larrea* sufficed to define the association. As mentioned above, the largely barren areas bordering denser vegetation

were included in this association. A special case was closed basins, a sort of floodplain that's distinguished by occasionally filling with water – i.e., a playa. These were mapped as such, as subassociation 152 (below). Truly barren areas, with less than 1% vegetation cover, were mapped as 'barrens', vegetation code '0'.

**Photo Identification:** Most floodplain in the BMGR West is flatland, and associated with valley bottoms. Typically there is a largely barren area, speckled with what appeared to be large creosote or small palo verde, surrounding an area of dense vegetation, or perhaps the bank of an arroyo. Floodplains that grade into and out of drainages upslope near the toe of the mountain, with relatively well-defined channels, were typically mapped not as floodplain, but as part of association 17 (creosote/bursage with scattered trees). Further from the mountain front, they were mapped as floodplain. It is primarily a matter of slope.

**Vegetation:** Creosote – white bursage – blue palo verde floodplain

**Alliance/Association/Subassociation codes:** 1 / 15 / 151

**Number of Sample Sites (relevés):** 10

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	10	5 (1-5)	5-9% (<1-14%)	1.3
<i>Ambrosia dumosa</i> White bursage	8	3 (0-3)	1-4% (<1-4%)	0.5
<i>Parkinsonia florida</i> Blue paloverde	8	2 (0-3)	<1% (<1-14%)	4.4
<i>Brassica tournefortii</i> Sahara mustard	7	3 (0-3)	<1% (<1-9%)	
<i>Lycium sp.</i> Wolfberry	5	1 (0-4)	<1% (<1-4%)	1.1
<i>Hymenoclea salsola</i> Cheesebush	4	0 (0-5)	<1% (<1-9%)	0.9
<i>Pleuraphis rigida</i> Big galleta grass	4	0 (0-5)	<1% (<1-60%)	1.0
<i>Encelia farinosa</i> Brittlebush	4	0 (0-3)	<1% (<1-4%)	0.6
<i>Olneya tesota</i> Ironwood	4	0 (0-3)	<1% (<1-4%)	3.2
<i>Atriplex polycarpa</i> Cattle saltbush	3	0 (0-3)	<1% (<1-4%)	1.1
<i>Sphaeralcea coulteri</i> Mallow	3	0 (0-3)	<1% (<1-4%)	1.3
<i>Plantago ovata</i> Wooly plantain	2	0 (0-3)	<1% (<1-9%)	
<i>Sphaeralcea emoryi</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	2	0 (0-2)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	2	0 (0-2)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	1	0 (0-4)	<1% (<1-4%)	1.5
<i>Lepidium sp.</i>	1	0 (0-3)	<1% (<1-9%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	1	0 (0-3)	<1% (<1-4%)	0.4
<i>Lepidium lasiocarpum</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Amsinckia sp.</i>	1	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Carnegiea gigantea</i> Saguaro	1	0 (0-3)	<1% (<1%)	
<i>Cryptantha angustifolia</i> Pick-me-not	1	0 (0-3)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-3)	<1% (<1%)	
<i>Orobanche cooperi</i>	1	0 (0-3)	<1% (<1%)	
<i>Phacelia pedicellata</i>	1	0 (0-3)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-3)	<1% (<1%)	
<i>Chaenactis carphoclinia</i>	1	0 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-2)	<1% (<1%)	
<i>Encelia frutescens</i> Button brittlebush	1	0 (0-2)	<1% (<1%)	
<i>Eriastrum diffusum</i>	1	0 (0-2)	<1% (<1%)	
<i>Eschscholzia minutiflora</i>	1	0 (0-2)	<1% (<1%)	
<i>Acacia greggii</i> Catclaw	1	0 (0-1)	<1% (<1%)	
<i>Cucurbita digitata</i>	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-1)	<1% (<1%)	
<i>Datura discolor</i>	1	0 (0-1)	<1% (<1%)	
<i>Ephedra trifurca</i> Mormon tea	1	0 (0-1)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote floodplain (15)

**Subassociation:** Creosote – white bursage playa/floodplain (152)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa* playa/floodplain

**NVC Association:** An undefined variant of the *Larrea tridentata* association.

**Previous classifications:** none in southwestern Arizona.



Figure 83. Relevé WH-21, at the south end of the Wellton Hills.



Figure 84. Relevé MMSW-37, within the Mohawk Dunes.



Figure 85. Relevé MSE-2, a wind-excavated ("deflated") flat in the Mohawk Valley.

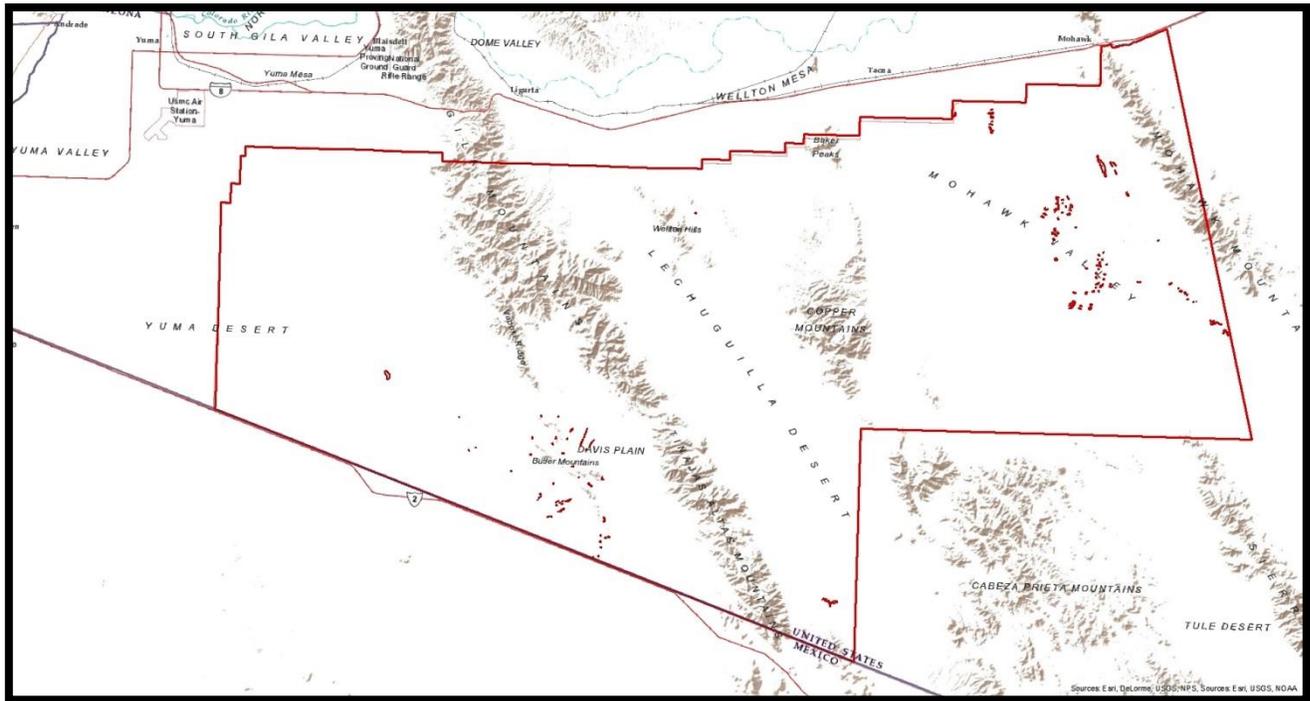


Figure 86. Distribution of Creosote – white bursage playa/floodplain (152) on the BMGR West.

**Description:** This mapping unit includes (a) a natural barren within a floodplain that is at least 1 hectare; (b) true playas, with closed drainages. In either case, this association has no obvious watercourse (channel), and holds less than 1% vegetation cover – unless it rains a lot. Then there may be unusual species not found elsewhere on the range, such as hog potato (*Hoffmannseggia glauca*) and the salt heliotrope (*Heliotropium curassavicum*). The hog potato is a perennial that persists below ground.

This mapping unit does not include barrens that are associated with pavements (subassociation 171), or barrens that typically run along ridges (often subtle), which were mapped as simply 'barren – no vegetation' (alliance = 0). The latter does not collect runoff.

**Location:** The largest playa is the Mohawk Playa, on the east side of the dunes. There are several smaller playas within swales at the southern end of the dune field. Finally, they are fairly common in the northern Mohawk Valley and in the region around the Butler Mountains, where they are associated with aeolian erosion, or 'blowouts.'

**Field Identification:** Very little vegetation in an area with no obvious outlet for precipitation. Some playas, however, sit atop saddles between watersheds ('perched playas'). A good example is the playa along the Camino between the High Tanks and Cabeza Prieta, where the road passes through an area between the watersheds of Coyote Wash and La Jolla Wash.

**Photo Identification:** Same as the field identification.

**Vegetation:** Creosote – white bursage playa/floodplain

**Alliance/Association/Subassociation codes:** 1 / 15 / 152

**Number of Sample Sites (relevés):** 4

Taxon	Sites	Median Prominence (Range)	Median Cover (Range)	Avg Height (m)
		5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare		
<i>Larrea tridentata</i> Creosote	3	4.5 (0-5)	<1% (<1-4%)	0.9
<i>Ambrosia dumosa</i> White bursage	3	1.5 (0-4)	<1% (<1%)	0.3
<i>Brassica tournefortii</i> Sahara mustard	2	1 (0-2)	<1% (<1%)	
<i>Hoffmannseggia glauca</i>	1	0 (0-4)	<1% (<1%)	0.1
<i>Prosopis glandulosa</i> Mesquite	1	0 (0-4)	<1% (<1%)	1.5
<i>Castela emoryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Heliotropium curassavicum</i>	1	0 (0-2)	<1% (<1%)	
<i>Malvella sagittifolia</i>	1	0 (0-2)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	1	0 (0-2)	<1% (<1%)	
<i>Camissonia boothii</i>	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage – big galleta grass (16)

**Subassociation:** Creosote – white bursage – big galleta grass (160)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa* - *Pleuraphis rigida* shrubland

**NVC Association:** The closest parallel is the *Ambrosia dumosa* / *Pleuraphis rigida* Dwarf-shrubland association from sand dunes, which lacks *Larrea tridentata* as the co-dominant/dominant species. The BMGR West does hold *Ambrosia dumosa* – *Pleuraphis rigida*, but it is classified as association 26. The vegetation described below has *Larrea tridentata* (creosote) as the dominant or co-dominant species.

**Previous classifications:** Not classified. However, Turner and Brown (1982) suggest that *Larrea tridentata*/*Pleuraphis rigida* is a series (the level above association, similar to alliance) of the Lower Colorado subdivision of the Sonoran Desert.



Figure 87. Relevé WSE-36, the view SE to the Copper Mountains.

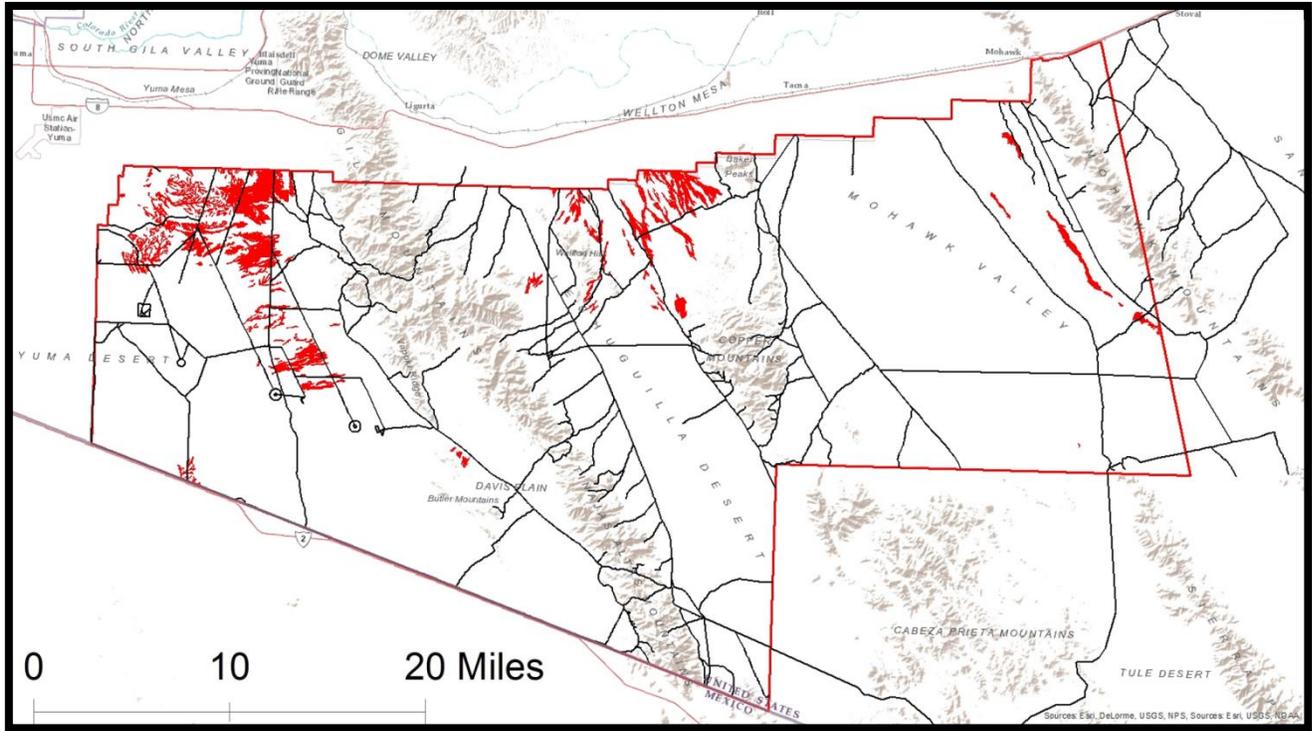


Figure 88. Distribution of creosote – white bursage – big galleta grass on the BMGR West

**Description:** Creosote (*Larrea tridentata*) averages 1.2 m in height, and with a median cover of 5-9%. Big galleta grass is the real hallmark of this vegetation, always with at least 1% cover, and ranging up to 14% cover. White bursage (*Ambrosia dumosa*) is at 23 of 26 relevés, and at those three sites without white bursage there is usually a very simple vegetation of just creosote and big galleta grass.

The invasive mustard *Brassica tournefortii* was found at 13 of 26 relevés.

**Location:** Generally below 1000 feet (330 m) in elevation. This association is strongly tied to the sandy bajadas and valley bottoms bordering the Mohawk Dunes, the northwest side of the Copper Mountains, between Baker Wash and the Wellton Hills, and the region west of the Gila Mountains and east of the Yuma Mesa. There is an outlier along the international border; see map above.

**Field Identification:** Creosote should be dominant or co-dominant in this association, and *Pleuraphis rigida* common, with a cover of at least 1%. In 3 relevés, *Pleuraphis rigida* is dominant over creosote, yet these areas were included in this association, because this was an exception. Such places resemble the sand dune association described below (154.1261), except the present association lacks other dune species, like *Ephedra trifurca* and *Psoralea emoryi*.

**Photo Identification:** The pattern of vegetation is similar to creosote flat, with regular dispersion between the plants, particularly when the vegetation is almost entirely creosote and big galleta grass.

**Vegetation:** Creosote – white bursage – big galleta grass

**Alliance/Association/Subassociation codes:** 1 / 16 / 160

**Number of Sample Sites (relevés):** 26

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	26	5 (3-5)	5-9% (1-14%)	1.2
<i>Pleuraphis rigida</i> Big galleta grass	26	3 (3-5)	1-4% (1-14%)	0.9
<i>Ambrosia dumosa</i> White bursage	23	3 (0-4)	1-4% (<1-14%)	0.5
<i>Brassica tournefortii</i> Sahara mustard	13	2 (0-3)	<1% (<1-4%)	0.7
<i>Fouquieria splendens</i> Ocotillo	12	1 (0-3)	<1% (<1-4%)	3.5
<i>Krameria grayi</i> Ratany	10	1 (0-3)	<1% (<1-4%)	0.6
<i>Krameria erecta</i> Ratany	10	0 (0-4)	<1% (<1-4%)	0.5
<i>Cylindropuntia ramosissima</i> Diamond cholla	9	0 (0-3)	<1% (<1-4%)	0.4
<i>Cylindropuntia echinocarpa</i> Silver cholla	8	0 (0-3)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	8	0 (0-2)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	6	0 (0-2)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	5	0 (0-3)	<1% (<1-9%)	
<i>Olneya tesota</i> Ironwood	5	0 (0-2)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	4	0 (0-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	4	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	4	0 (0-1)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	3	0 (0-3)	<1% (<1%)	
<i>Dalea mollis</i>	3	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	3	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Aristida sp.</i>	2	0 (0-3)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	2	0 (0-3)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	2	0 (0-2)	<1% (<1%)	
<i>Ditaxis serrata</i> Silverbush	2	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-2)	<1% (<1%)	
<i>Palafoxia arida</i> Spanish needles	2	0 (0-2)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	2	0 (0-2)	<1% (<1%)	
<i>Stillingia linearifolia</i>	2	0 (0-2)	<1% (<1%)	
<i>Tiquilia palmeri</i> Crinklemat	2	0 (0-2)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	2	0 (0-1)	<1% (<1%)	
<i>Orobanche co</i>	2	0 (0-1)	<1% (<1%)	
<i>Eriogonum sp.</i>	1	0(0-3)	<1% (<1%)	
<i>Allonia incarnata</i>	1	0 (0-3)	<1% (<1%)	
<i>Bouteloua barbata</i>	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Penstemon parryi</i>	1	0 (0-3)	<1% (<1%)	
<i>Schismus arabicus</i> Arabian grass	1	0 (0-3)	<1% (<1%)	
<i>Schismus barbatus</i>	1	0 (0-3)	<1% (<1%)	
<i>Cryptantha angustifolia</i> Pick-me-not	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia eriantha</i>	1	0 (0-2)	<1% (<1%)	
<i>Sphaeralcea emoryi</i>	1	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Tidestromia oblongifolia</i>	1	0 (0-2)	<1% (<1%)	
<i>Abronia villosa</i> Sand verbena	1	0 (0-1)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	0 (0-1)	<1% (<1%)	
<i>Camissonia claviformis</i>	1	0 (0-1)	<1% (<1%)	
<i>Castela emoryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-1)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-1)	<1% (<1%)	
<i>Opuntia wrightiana</i>	1	0 (0-1)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – triangle-leaf bursage – yellow paloverde/ironwood (170)

**Scientific Name:** *Larrea tridentata*-*Ambrosia deltoidea*/*Parkinsonia microphylla* shrubland

**NVC Association:** No similar association within the creosote (*Larrea*) alliance. There is a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland listed (yellow palo verde – creosote), but no supporting data. The NVC website places this Shrubland within the "Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub" alliance.

**Previous classifications:** Classified similarly as 170 in Malusa (2003). Based on Warren et al. (1981) 154.1112, which is described as a “middle bajada” association, with *Parkinsonia microphylla* (yellow paloverde =*Cercidium microphyllum*) present at 25 of 41 sites. In the present study’s scheme, however, *Parkinsonia microphylla* or *Olneya tesota* must be present to be included in this association, so this association would not include the treeless habitat in Warren et al.’s 154.1112.

The “mixed-scrub” series of the Lower Colorado Subdivision mentioned by Turner and Brown (1982) is clearly different, with a “poorer representation or absence of Little-leaf (foothill) Palo Verde” (*Parkinsonia microphylla*) and *Ambrosia deltoidea* “conspicuously lacking.” Both of these species are characteristic of the association described below. Hence, in a BLP classification, this would be an undescribed association of the creosote-bursage series, 154.11.



Figure 89. Photo location: MMNW-24, on west side of Mohawk Mountains., with yellow paloverde and ironwood.

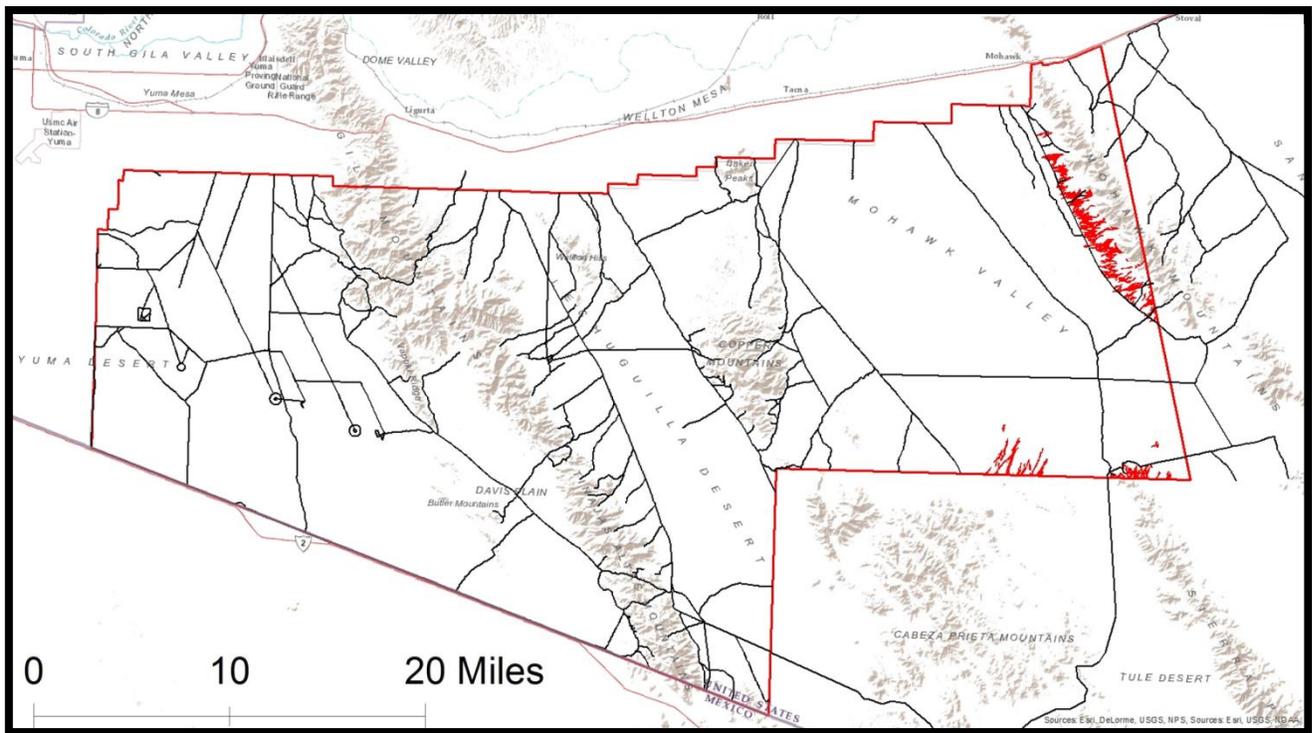


Figure 90. Distribution of Creosote – triangle-leaf bursage – yellow paloverde/ironwood (170) on the BMGR West

**Description:** *Larrea tridentata* is the most abundant species, with the highest median prominence (5) and cover (5-9%). *Ambrosia deltoidea* is a close second. The association is nonetheless recognized by the presence of ironwood (*Olneya tesota*), typically with 1-4% cover. Foothill palo verde (*Parkinsonia microphylla*) is present at all 3 sites, but usually uncommon. *Krameria grayi* and/or *Krameria erecta* (both species of ratany) were at 2 of 3 relevés. In the eastern CPNWR (Malusa 2003), saguaro and chain-fruit cholla are conspicuous members of this association. Neither species made an appearance in this association in the BMGR West.

**Location:** Limited to the Mohawk Mountains and the southern Mohawk Valley, on slopes of 2 to 20%, typically just below or alongside the desert pavements (subassociation 171). Further west, beyond the limits of *Ambrosia deltoidea*, this subassociation is replaced by 177, which is characterized by *Ambrosia dumosa*, as well as palo verde and/or ironwood.

Yellow paloverde and ironwood prefer slopes and coarser outwash materials from the mountains. On the BLM lands to the east, near Ajo, they are most commonly found on soils of the Gunsight-Rillito-Carrizo complex; also common are the Gunsight-Cipriano complex and the Gunsight-Chuckwalla complex. The recurring element of the three complexes is Gunsight soils, which are characterized by extremely gravelly loams and a very limy layer at

a depth of 5 to 24 inches. Such soils are generally close to the mountain fronts, but occasionally are transported (or form) far into the valleys.

**Field Identification:** At its lower elevational limit, this association grades into creosote/bursage communities, so it is easy enough to draw the line where the *Parkinsonia microphylla* and/or *Olneya tesota* become conspicuous. When mapping the limits of a population, the lower bounds were drawn to include the lowest trees, unless there were over 100 meters (330 feet) separating the tree from the rest of the population. For small, outlying populations of these trees, there must be at least 10 individuals in a 100-meter square (1 hectare) to be mapped.

At its upper limit this association abuts pediment associations, such as '141', recognized by the presence of the indicator species *Cylindropuntia bigelovii*, and '175', defined by bar-and-swale landform and the presence of *Cylindropuntia acanthocarpa*.

**Photo Identification:** *Parkinsonia microphylla* and *Olneya tesota* are generally easy to identify on the photos. At their lower limits they can be confused with mesquite (*Prosopis*). As for the upper limit of this association, it most often abutted a field-mapped pediment association with cholla (e.g., teddy bear cholla), or a mountain association with greater than 20% slope.

**Vegetation:** Creosote – triangle leaf bursage – yellow paloverde/ironwood

**Alliance/Association/Subassociation codes:** 1 / 17 / 170

**Number of Sample Sites (relevés):** 3

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Larrea tridentata</i> Creosote	3	5(4-5)	5-9% (5-14%)	1.0
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	3	3 (3-4)	5-9% (1-9%)	0.5
<i>Olneya tesota</i> Ironwood	3	3 (2-3)	1-4% (<1-9%)	3.5
<i>Parkinsonia microphylla</i> Yellow Paloverde	3	2 (1-2)	<1% (<1%)	4.0
<i>Krameria grayi</i> Ratany	2	1 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	2	1 (0-3)	<1% (<1%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	1	0 (0-3)	<1% (<1%)	0.7
<i>Plantago sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Cryptantha angustifolia</i> Pick-me-not	1	0 (0-3)	<1% (<1%)	
<i>Lepidium sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Oenothera sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Ambrosia dumosa</i> White bursage	1	0 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	1	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-2)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	1	0 (0-1)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-2)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – white bursage/paloverde-ironwood pavements (171)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa*/*Parkinsonia*-*Olneya* shrubland on pavements

**NVC Association:** No similar association within the creosote (*Larrea*) alliance. There is a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland listed (yellow palo verde – creosote), but no supporting data. The NVC website places this Shrubland within the "Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub" alliance.

**Previous classifications:** Also coded as 171 in Malusa (2003) and subsequent maps in southwest Arizona.



Figure 91. The south end of the Copper Mountains. This vegetation type is characterized by interfluves with no vegetation for at least 50% of the land surface, and with dense vegetation in the fluves (watercourses). There may or may not be 'pavements' of small interlocking stones, as shown below in Figure 92.



Figure 92. Typical pavement on the northwest side of the Gila Mountains.

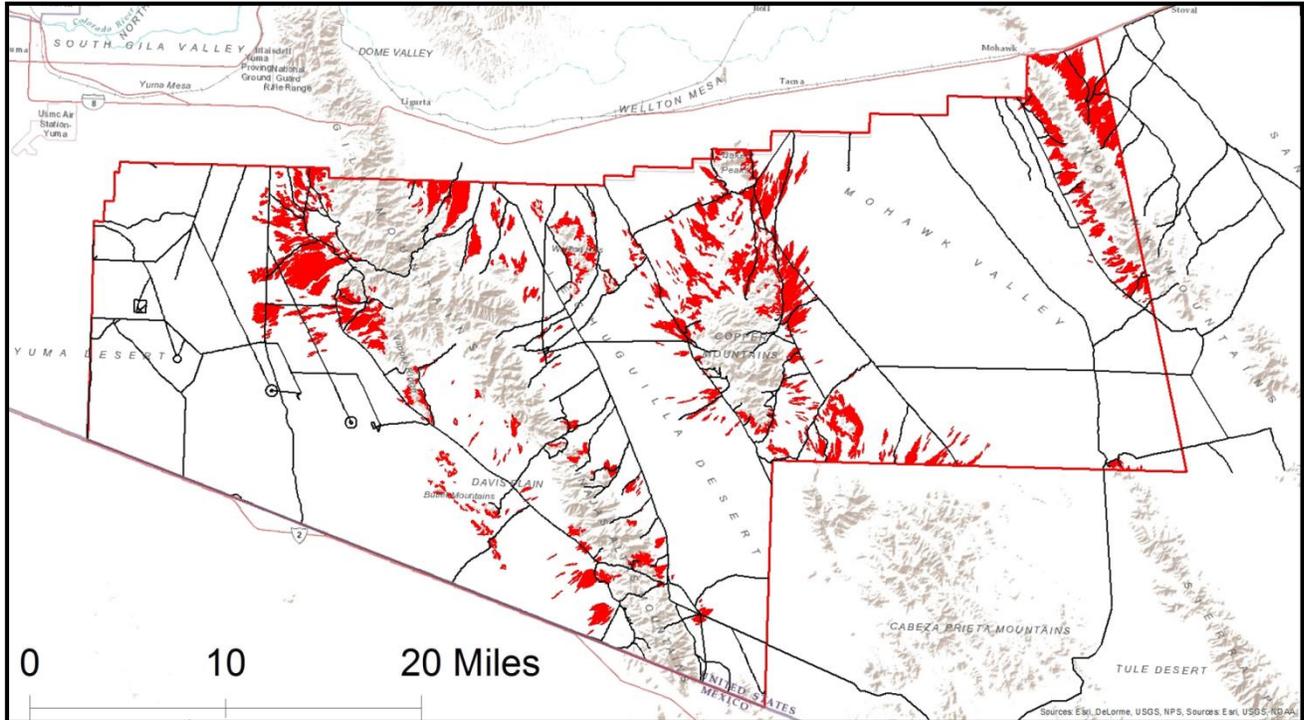


Figure 93. Distribution of creosote – white bursage/paloverde-ironwood pavements (171) on the BMGR West

**Description:** This is one of many subassociations in an association for which creosote (*Larrea tridentata*) and/or bursage are typically dominant or co-dominant, with palo verde and ironwood common associates. In the case of pavements, creosote and white bursage are co-dominant, with 1-4 percent cover each. There are three common associates, present at most sites: ironwood, brittlebush and ratany, but none have a median cover over 1%. Yellow paloverde (*Parkinsonia microphylla*) was present in 13 of 20 relevés, but only along the bajadas of the Copper, Cabeza Prieta, and Mohawk Mountains. Further west, in the Wellton Hills, and Gila/Tinajas Altas Mountains, the yellow paloverde was absent. Saguaros were also present at 13 of 20 relevés.

The diagnostic feature of pavements is nude interfluves – nothing but bare earth between the runnels. Usually the surface is a desert pavement - neatly spaced, tightly packed stones – but occasionally they are a bit sloppier and looser. Sometimes there are not stones or gravel, but simply a barren soil surface – all that matters for this vegetation unit is that more than 50% of the surface is devoid of vegetation. The runnels, or fluves, hold dense and varied vegetation that includes either palo verde or ironwood. The associate species are very similar to other subassociations with this association, with subtle changes in the abundance, particularly in brittlebush and *Krameria*. In other words, the structure and not the identity of the vegetation distinguished this mapping unit.

**Location:** Throughout the BMGR West (and much of CPNWR), at the foot of the mountains, on alluvial fans much dissected by runnels, on slopes of 2-10%. This association can be found on soils derived from any rock type on the range. Two key ingredients in forming nude interfluves appear to be (1) pebbles on a very old undisturbed surface; and (2) aridity on the order of less than seven inches annually.

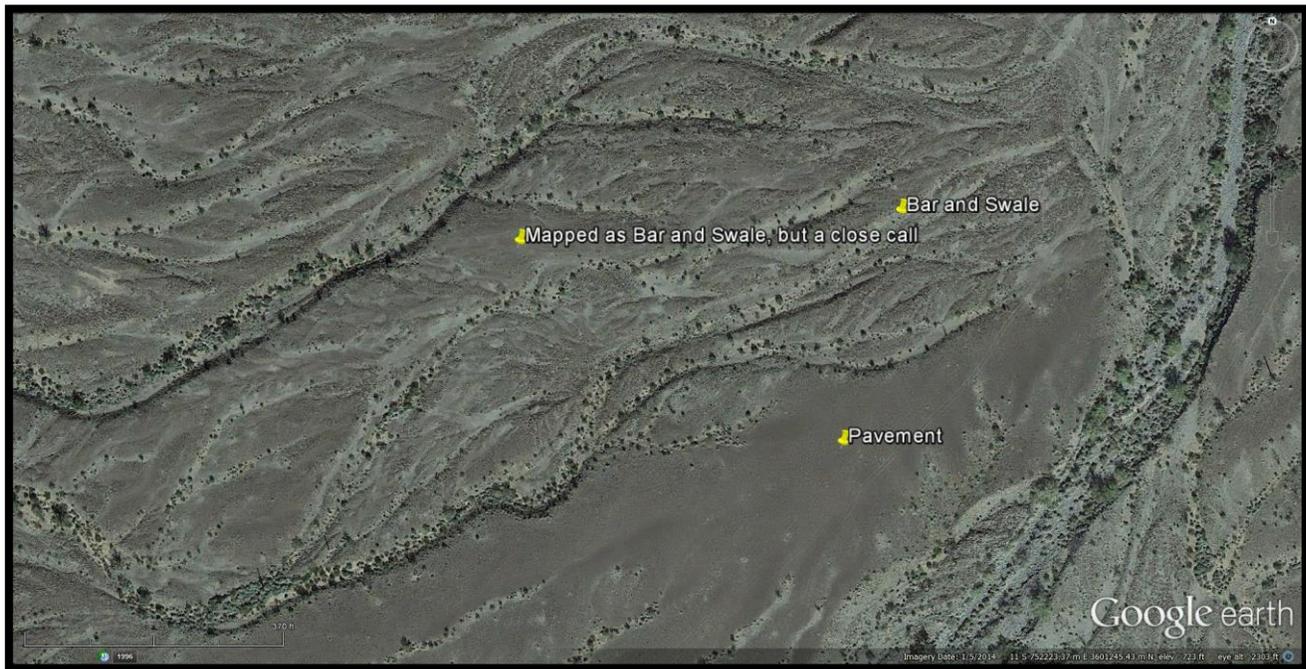
Downslope, this association usually ends abruptly in the creosote/scattered trees association (17). Upslope, it grades into the teddy-bear cholla pediment subassociation (141) or the bar and swale fans (175 – see below).

**Field Identification:** The surface is at least 50% devoid of vegetation. Naturally, most every site on the BMGR West is, at some level of analysis, more than 50% devoid of vegetation. But in this association can you walk perpendicular to the drainages and count off numbers like so: 7 paces past creosote and bursage, then 23 paces of nothing but stones or gravel, then 10 of vegetation, and 29 without, and so forth. The pacing is necessary to determine the extent of the pavements and to determine the overall percent cover of the species. Some samples were 80% nude pavements – a strange and wonderful sight.

**Photo Identification:** On the photos, the pavements appear as broad bands of stony interfluves thinly striped with vegetation. Most are dark, almost black, yet the pavements that reach furthest from the mountain front into the valleys are often the color of ash. In general, however, it is easy to spot a pavement, as shown in the image below from the northeast side of the Gila Mountains. Image area is about 0.3 miles across.



Figure 94. Image above shows distinctive pattern of pavements. The image below shows a more complicated pattern, in which it was difficult to assign as either pavement or bar and swale (subassociation 175).



**Vegetation:** Creosote – white bursage/ yellow paloverde-ironwood on pavements

**Alliance/Association/Subassociation codes:** 1 / 17 / 171

**Number of Sample Sites (relevés):** 20

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	20	4 (3-5)	1-4% (<1-9%)	1.0
<i>Ambrosia dumosa</i> White bursage	20	4 (2-5)	1-4% (<1-9%)	0.4
<i>Olneya tesota</i> Ironwood	18	3 (0-3)	<1% (<1-4%)	4.4
<i>Encelia farinosa</i> Brittlebush	17	3 (0-4)	<1% (<1-9%)	0.8
<i>Krameria grayi</i> Ratany	16	3 (0-3)	<1% (<1-4%)	0.5
<i>Parkinsonia microphylla</i> Yellow Paloverde	13	2.5 (0-4)	<1% (<1-4%)	2.9
<i>Carnegiea gigantea</i> Saguaro	13	1 (0-2)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	12	2 (0-5)	<1% (<1-4%)	3.6
<i>Pleuraphis rigida</i> Big galleta grass	10	0.5 (0-4)	<1% (<1-4%)	0.7
<i>Cylindropuntia ramosissima</i> Diamond cholla	9	0 (0-3)	<1% (<1-4%)	0.7
<i>Brassica tournefortii</i> Sahara mustard	8	0 (0-3)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	8	0 (0-3)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	8	0 (0-3)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	8	0 (0-3)	<1% (<1%)	0.7
<i>Lycium sp.</i> Wolfberry	6	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	5	0 (0-2)	<1% (<1%)	0.4
<i>Echinocactus polycephalus</i> Cottontop cactus	5	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	4	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ditaxis neomexicana</i> Silverleaf	4	0 (0-3)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	4	0 (0-3)	<1% (<1%)	
<i>Parkinsonia florida</i> Yellow paloverde	4	0 (0-2)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	3	0 (0-4)	<1% (<1-4%)	0.5
<i>Euphorbia eriantha</i>	3	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	3	0 (0-3)	<1% (<1%)	
<i>Marina parryi</i>	3	0 (0-3)	<1% (<1%)	
<i>Erioneuron pulchellum</i>	3	0 (0-2)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	3	0 (0-2)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	2	0 (0-3)	<1% (<1%)	
<i>Chaenactis carphoclinia</i>	2	0 (0-3)	<1% (<1%)	
<i>Cryptantha angustifolia</i> Pick-me-not	2	0 (0-3)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-3)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	2	0 (0-3)	<1% (<1%)	
<i>Senna covesii</i>	2	0 (0-3)	<1% (<1%)	0.5
<i>Camissonia cardiophylla</i>	2	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-2)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	2	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	2	0 (0-2)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	2	0 (0-2)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	2	0 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	2	0 (0-1)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Phacelia pedicellata</i>	1	0 (0-3)	<1% (<1%)	
<i>Dalea mollis</i>	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i>	1	0 (0-2)	<1% (<1%)	
<i>Encelia frutescens</i> Button brittlebush	1	0 (0-2)	<1% (<1%)	
<i>Eriastrum diffusum</i>	1	0 (0-2)	<1% (<1%)	
<i>Langloisia setosissima</i>	1	0 (0-2)	<1% (<1%)	
<i>Nama demissum</i>	1	0 (0-2)	<1% (<1%)	
<i>Porophyllum gracile</i>	1	0 (0-2)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-2)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-2)	<1% (<1%)	
<i>Acacia greggii</i> Catclaw	1	0 (0-1)	<1% (<1%)	
<i>Bouteloua barbata</i>	1	0 (0-1)	<1% (<1%)	
<i>Datura discolor</i>	1	0 (0-1)	<1% (<1%)	
<i>Phacelia sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Prosopis velutina</i>	1	0 (0-1)	<1% (<1%)	
<i>Stillingia linearifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Ziziphus obtusifolia</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – white bursage/yellow paloverde-ironwood bar/swale (175)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa*/*Parkinsonia*-*Olneya* shrubland on bar/swale

**NVC Association:** No similar association within the creosote (*Larrea*) alliance. There is a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland listed (yellow palo verde – creosote), but no supporting data. The NVC website places this Shrubland within the "Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub" alliance.

**Previous classifications:** Only mapped in on the BMGR West; apparently not found further east on the Goldwater.



Figure 95. Relevé MSW-5, in the Copper Mountains, near Betty Lee Canyon. The common cactus in the fore- and mid-ground is *Cylindropuntia acanthocarpa*, or buckhorn cholla.

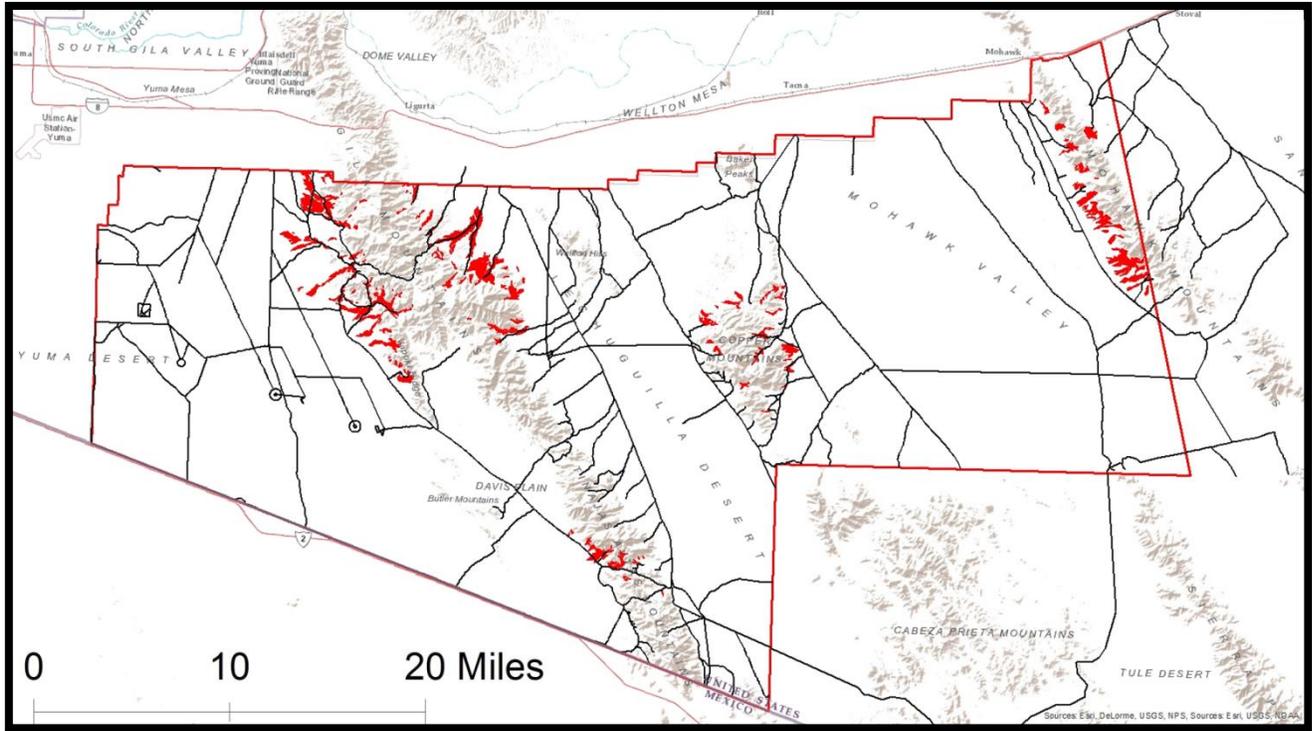


Figure 96. Distribution of Creosote – white bursage/yellow paloverde-ironwood bar/swale (175) on the BMGR West.

**Description:** At the foot of the mountains, these fans are the remnants of debris flows. With time enough, they will become pavements (Schenker 1977). They are characterized by long and roughly parallel bar-and-swale landforms. *Larrea* is typically dominant, and white bursage (*Ambrosia dumosa*) and brittlebush (*Encelia farinosa*) are common and always present. All three species have a median cover value of 1-4%. Ironwood is at 29 of 32 relevés, and is typically common, though its median cover is less than 1%. *Cylindropuntia acanthocarpa* (buckhorn cholla) is present at 21 of 32 relevés, typically common, and along with *Fagonia* (22 of 32 relevés), serves to floristically distinguish this from the pavements subassociation. However, the landform is the obvious difference.

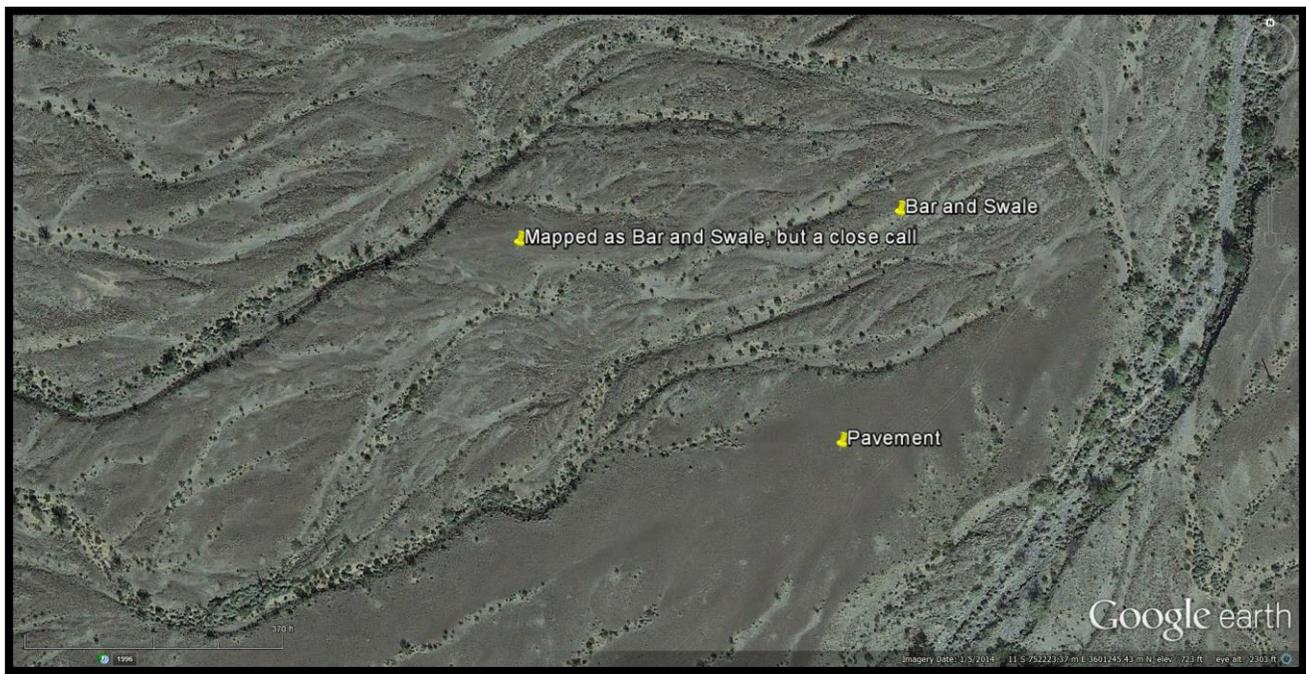
**Location:** Along the toe of the Copper, Mohawk, Tinajas Altas, and Gils Mountains, on slopes of 3 to 10%, where large canyons have loosed debris flows. This association is much more common on the west side than the east side of the Mohawks – the exact opposite pattern of teddy bear cholla (14) distribution. The reason is likely the same: basin-and-range faulting. The association is not in the Baker Peaks or Wellton Hills, apparently because they lack watersheds large enough to motivate large debris flows.

**Field Identification:** The telltale landform – bar-and-swale – and the presence of buckhorn cholla are distinctive.

**Photo Identification:** See the image below.



Figure 97. Image above shows distinctive pattern of bar and swale at center. The image below shows a more complicated pattern, in which it was difficult to assign as either bar and swale or pavement (subassociation 171).



**Vegetation:** Creosote – white bursage/ yellow paloverde-ironwood on bar/swale fans

**Alliance/Association/Subassociation codes:** 1 / 17 / 175

**Number of Sample Sites (relevés):** 32

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	32	5 (2-5)	1-4% (<1-9%)	1.0
<i>Ambrosia dumosa</i> White bursage	32	3 (2-4)	1-4% (<1-4%)	0.4
<i>Encelia farinosa</i> Brittlebush	32	3 (1-5)	1-4% (<1-9%)	0.8
<i>Olneya tesota</i> Ironwood	29	3 (0-3)	<1% (<1-4%)	3.0
<i>Fouquieria splendens</i> Ocotillo	25	2 (0-3)	<1% (<1-4%)	3.4
<i>Hibiscus denudatus</i> Rock hibiscus	24	2 (0-3)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	23	2(0-3)	<1% (<1%)	4.0
<i>Fagonia californica</i> Fagonia	22	2 (0-3)	<1% (<1-4%)	0.3
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	21	3 (0-4)	<1% (<1-4%)	0.9
<i>Krameria grayi</i> Ratany	20	2 (0-3)	<1% (<1-4%)	0.7
<i>Pleuraphis rigida</i> Big galleta grass	14	0 (0-3)	<1% (<1-4%)	0.9
<i>Parkinsonia florida</i> Blue paloverde	12	0 (0-3)	<1% (<1%)	3.0
<i>Lycium sp.</i> Wolfberry	12	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i>	9	0 (0-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	8	0 (0-4)	<1% (<1-9%)	2.8
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	7	0 (0-3)	<1% (<1-4%)	0.9
<i>Hyptis emoryi</i> Desert lavender	7	0 (0-3)	<1% (<1-4%)	
<i>Caesalpinia virgata</i> Wand holdback	6	0 (0-3)	<1% (<1-4%)	0.8
<i>Plantago ovata</i> Wooly plantain	6	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Krameria erecta</i> Ratany	6	0 (0-2)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	5	0 (0-3)	<1% (<1%)	1.2
<i>Chorizanthe rigida</i> Spineflower	5	0 (0-3)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	4	0 (0-4)	<1% (<1-4%)	1.2
<i>Cylindropuntia ramosissima</i> Diamond cholla	4	0 (0-3)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	4	0 (0-2)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	4	0 (0-2)	<1% (<1%)	
<i>Psoralea schottii</i>	3	0 (0-3)	<1% (<1%)	1.3
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	3	0 (0-3)	<1% (<1-4%)	0.6
<i>Acacia greggii</i> Catclaw	3	0 (0-2)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	3	0 (0-2)	<1% (<1%)	
<i>Chorizanthe corrugata</i>	3	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	3	0 (0-2)	<1% (<1%)	
<i>Eschscholzia minutiflora</i>	2	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	2	0 (0-3)	<1% (<1%)	
<i>Lotus rigidus</i>	2	0 (0-3)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	2	0 (0-3)	<1% (<1%)	
<i>Dalea mollis</i>	2	0 (0-2)	<1% (<1%)	
<i>Datura discolor</i>	2	0 (0-2)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	2	0 (0-2)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	2	0 (0-2)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	2	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Marina parryi</i>	2	0 (0-2)	<1% (<1%)	
<i>Phacelia sp.</i>	2	0 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	2	0 (0-1)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	2	0 (0-1)	<1% (<1%)	0.3
<i>Psathyrotes ramosissima</i>	1	0 (0-3)	<1% (<1%)	
<i>Chaenactis stevioides</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Camissonia cardiophylla</i>	1	0 (0-2)	<1% (<1%)	
<i>Chaenactis carphoclinia</i>	1	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	1	0 (0-2)	<1% (<1%)	
<i>Erioneuron pulchellum</i>	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia eriantha</i>	1	0 (0-2)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	1	0 (0-2)	<1% (<1%)	
<i>Horsfordia alata</i> Velvet mallow	1	0 (0-2)	<1% (<1%)	
<i>Horsfordia newberryi</i> Velvet mallow	1	0 (0-2)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-2)	<1% (<1%)	
<i>Agave deserti</i>	1	0 (0-1)	<1% (<1%)	
<i>Dalea sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Ditaxis sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Erodium texanum</i>	1	0 (0-1)	<1% (<1%)	
<i>Euphorbia sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-1)	<1% (<1%)	
<i>Justicia californica</i>	1	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
Chuparosa				
<i>Perityle emoryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Sarcostemma cynanchoides</i> Climbing milkweed	1	0 (0-1)	<1% (<1%)	
<i>Trichoptilium incisum</i>	1	0 (0-1)	<1% (<1%)	
<i>Trixis californica</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – white bursage/ironwood-blue paloverde (176)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa*/*Olneya* – *Parkinsonia florida* shrubland

**NVC Association:** No similar association within the creosote (*Larrea*) alliance. There is a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland listed (yellow palo verde – creosote), but no supporting data. The NVC website places this Shrubland within the "Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub" alliance.

**Previous classifications:** Not found further east on the Goldwater. Most similar to Warren et al (1981) "154.1112," which is described as a "middle bajada" association, with *Parkinsonia microphylla* (= *Cercidium microphyllum*) present at 25 of 41 sites. However, there is no *P. microphylla* in this BMGR West association. Also, *Parkinsonia florida* or *Olneya tesota* must be present to be included in this association, so this association would not include the treeless habitat in Warren et al.'s 154.1112.



Figure 98. Relevé near FSW-25, on the west side of the Gila Mountains.



Figure 99. Relevé RB-12, near the intersection of Cipriano Pass Road and 25E (Camino East).

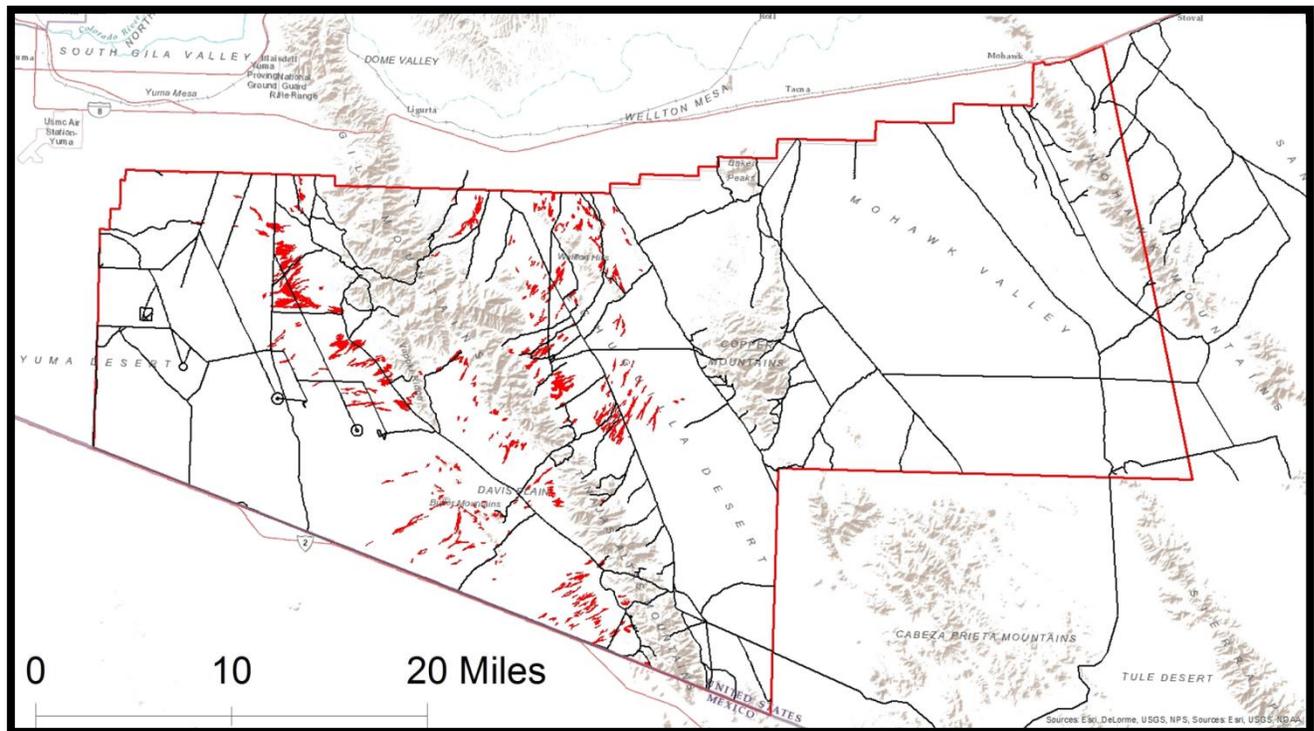


Figure 100. Distribution of creosote – white bursage/ironwood-blue paloverde (176) on the BMGR West

**Description:** Yellow paloverde, *Parkinsonia microphylla*, is absent from the western half of the BMGR West. Exactly why is something of a mystery, particularly since it reappears at Telegraph Pass at the northern end of the Gila Mountains.

In this subassociation, creosote (*Larrea tridentata*) is always dominant/co-dominant, and always in the company of ironwood, which is occasionally co-dominant. White bursage (*Ambrosia dumosa*) is at 12 of the 13 relevés, and typically common, while brittlebush is at 11 of 13 relevés, and typically uncommon. Blue palo verde doesn't succumb to whatever is holding back the yellow palo verde, but neither is it abundant: it's found at 8 of 13 relevés, and is typically uncommon. Saguaro and ocotillo are also at 8 of 13 relevés. Wolfberry (*Lycium sp.*) is at 6 of 13 relevés, and jimsonweed (*Datura discolor*) is at 8 of 13 relevés. Wolfberry and jimsonweed are usually associated with watercourses on bajadas, and their presence speaks of the typical location of this association: (a) where arroyos are beginning to form, or, (b) where arroyos fade away into a "delta."

**Location:** This subassociation replaces the yellow paloverde subassociation (177) in the western BMGR West. It can extend, in narrow bands, remarkably far from the mountain front, as it does southwest of the Tinajas Altas and Butler Mountains, reaching the international border.

**Field Identification:** At its lower limit, this association grades into creosote/bursage communities, so it is easy enough to draw the line where the *Parkinsonia florida* and/or *Olneya tesota* become conspicuous. When mapping the limits of a population, the lower bounds were drawn to include the lowest trees, unless there were over 100 meters (330 feet) separating the tree from the rest of the population. For small, outlying populations of these trees, there must be at least 10 individuals in a 100-meter square (1 hectare) to be mapped.

At its upper limit this association may abut pediment associations, such as '141', recognized by the presence of the indicator species *Cylindropuntia bigelovii*, and '175', defined by bar-and-swale landform (and often the presence of *Cylindropuntia acanthocarpa*.) The association may also abut floodplain (151) and large arroyos (810). In areas of low relief, large arroyos are often braided, with numerous channels. Side channels can rejoin the main channel, or wander off into progressively smaller channels, until there are no clear channels over a meter wide. In the latter case, if there are ironwood and blue palo verde trees, it was recognized as the present association (176). However, such places may also be floodplain (151), if instead there are large barrens and isolated blue palo verde (often dead or dying).

**Photo Identification:** It is relatively easy to distinguish this association from neighboring creosote/bursage associations without trees (e.g. 100, 110), simply by the dark dots of the trees. If the neighboring association is an arroyo, the 'one meter' rule used to define active watercourses works fine except when the watercourse is highly braided, with channels rapidly changing width. In such cases a longer stretch of the arroyo was considered – say, 100 meters – and the average width of the bed was guessed at, based on the imagery. If less than a meter, it was mapped as the present association.

Most difficult was distinguishing between this association and floodplain based entirely on photographs, since smaller species (e.g., brittlebush) were tough to see. In such cases the

areas attributed as floodplain typically had barrens and narrow dense stripes of dense vegetation, along with small trees, all of which were visible from the image (see description of 150, above). More than most associations, this distinction was subjective and based on opinions formed during field observations; in other words, some areas mapped in the present association could easily be interpreted as floodplain.



Figure 101. In this image, the subassociation 176 is at center right. The other vegetation includes 280 (white bursage – creosote), 110 (creosote – white bursage), and 811 (watercourse). Image shows an area about 0.5 miles wide (0.9 km), along Camino de Oeste, on west side of Gila Mountains, just north of Spook Canyon.

**Vegetation:** Creosote – white bursage/ironwood-blue paloverde

**Alliance/Association/Subassociation codes:** 1 / 17 / 176

**Number of Sample Sites (relevés):** 13

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	13	5 (4-5)	1-9% (<1-14%)	1.2
<i>Olneya tesota</i> Ironwood	13	3 (1-4)	1-4% (<1-4%)	3.4
<i>Ambrosia dumosa</i> White bursage	12	3 (0-4)	<1-4% (<1-4%)	0.5
<i>Encelia farinosa</i> Brittlebush	11	2 (0-3)	<1% (<1-4%)	0.8
<i>Parkinsonia florida</i> Blue paloverde	8	2 (0-3)	<1% (<1-4%)	3.4
<i>Fouquieria splendens</i> Ocotillo	8	1 (0-3)	<1% (<1-4%)	5.0
<i>Carnegiea gigantea</i> Saguaro	8	1 (0-3)	<1% (<1%)	
<i>Datura discolor</i>	8	1 (0-3)	<1% (<1-4%)	
<i>Brassica tournefortii</i> Sahara mustard	7	1 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	6	0 (0-3)	<1% (<1-4%)	0.5
<i>Krameria grayi</i> Ratany	6	0 (0-3)	<1% (<1-4%)	
<i>Lycium sp.</i> Wolfberry	6	0 (0-3)	<1% (<1-9%)	1.0
<i>Pleuraphis rigida</i> Big galleta grass	6	0 (0-3)	<1% (<1-4%)	
<i>Justicia californica</i> Chuparosa	4	0 (0-1)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	3	0 (0-30)	<1% (<1-4%)	1.6
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	3	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	3	0 (0-3)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	3	0 (0-3)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	3	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Plantago ovata</i> Wooly plantain	3	0 (0-3)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	3	0 (0-3)	<1% (<1-14%)	1.2
<i>Cylindropuntia echinocarpa</i> Silver cholla	3	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	3	0 (0-1)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	2	0 (0-3)	<1% (<1%)	
<i>Ditaxis serrata</i> Silverbush	2	0 (0-3)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	2	0 (0-3)	<1% (<1-4%)	3.3
<i>Schismus arabicus</i> Arabian grass	2	0 (0-3)	<1% (<1-4%)	
<i>Fagonia californica</i> Fagonia	2	0 (0-2)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	2	0 (0-1)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	2	0 (0-1)	<1% (<1%)	
<i>Schismus barbatus</i>	1	0(0-1)	<1% (<1%)	
<i>Cryptantha angustifolia</i> Pick-me-not	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Hibiscus denudatus</i> Rock hibiscus	1	0 (0-3)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-3)	<1% (<1%)	
<i>Orobanche sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Palafoxia arida</i> Spanish needles	1	0 (0-3)	<1% (<1-4%)	0.6
<i>Acacia greggii</i> Catclaw	1	0 (0-2)	<1% (<1%)	
<i>Camissonia claviformis</i>	1	0 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	1	0 (0-2)	<1% (<1%)	
<i>Phacelia ambigua</i>	1	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Tiquilia plicata</i> Crinklemat	1	0 (0-2)	<1% (<1%)	
<i>Aristida purpurea</i>	1	0 (0-1)	<1% (<1%)	
<i>Asclepias subulata</i>	1	0 (0-1)	<1% (<1%)	
<i>Datura sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-1)	<1% (<1%)	
<i>Mentzelia sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Monoptilon bellioides</i>	1	0 (0-1)	<1% (<1%)	
<i>Perityle emoryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Proboscidea parviflora</i>	1	0 (0-1)	<1% (<1%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-1)	<1% (<1%)	
<i>Stillingia linearifolia</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – white bursage/ironwood-yellow paloverde (177)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa*/ *Olneya* –*Parkinsonia microphylla* shrubland

**NVC Association:** No similar association within the creosote (*Larrea*) alliance. There is a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland listed (yellow palo verde – creosote), but no supporting data. The NVC website places this Shrubland within the "Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub" alliance.

**Previous classifications:** Most similar to Warren et al (1981) "154.1112," which is described as a "middle bajada" association, with *Parkinsonia microphylla* (= *Cercidium microphyllum*) present at 25 of 41 sites. However, there is no *P. microphylla* in this BMGR West association. Also, *Parkinsonia florida* or *Olneya tesota* must be present to be included in this association, so this association would not include the treeless habitat in Warren et al.'s 154.1112.

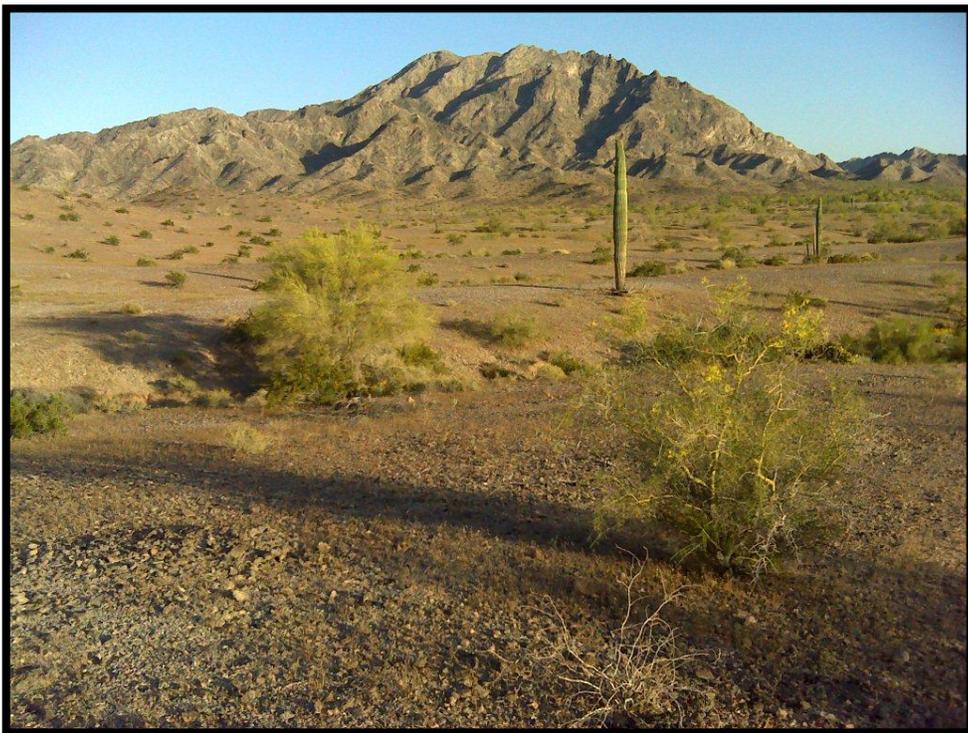


Figure 102. Relevé WSE-12, between Baker Tanks and Copper Mountains.

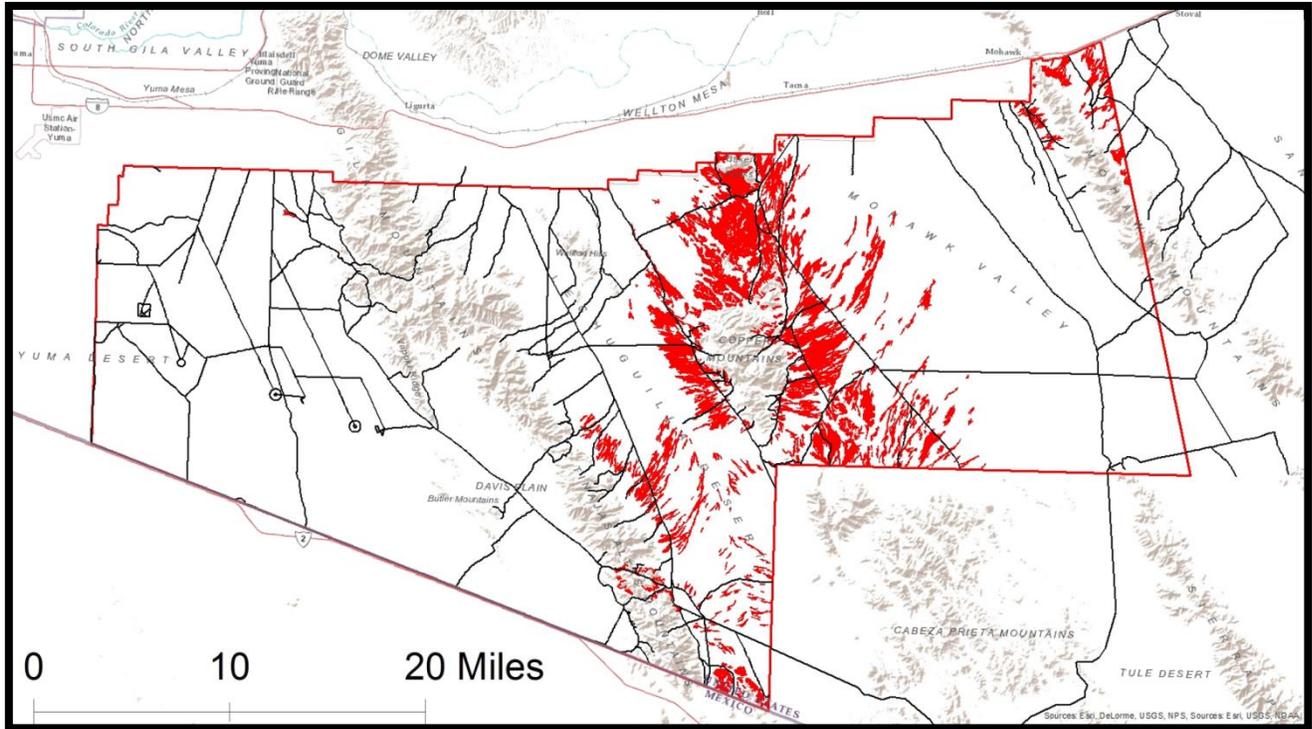


Figure 103. Distribution of creosote – white bursage – ironwood/yellow palo verde (177) on the BMGR West

**Description:** Creosote/white bursage with sparse leguminous trees. *Larrea tridentata* is the most abundant species, with the highest median prominence (5, 'dominant') and cover (5-9%). The most common associates (and occasional co-dominants) are white bursage (*Ambrosia dumosa*), yellow palo verde (*Parkinsonia microphylla*), and ironwood (*Olneya tesota*). Tree cover is typically 1-4% for the palo verde, and less than 1% for the ironwood, despite occurring at 16 of 20 relevés. Saguaros are also present at 16 of 20 relevés. *Krameria grayi* was at 15 of 20 relevés.

**Location:** Widespread on bajadas and rolling hills, at the north end of the Mohawk Mountains, the Copper Mountains., and the east side of the Tinajas Altas Mountains, including Tinajas Altas Pass.

**Field Identification:** At its lower elevational limit, this association grades into creosote/bursage communities, so it is easy enough to draw the line where the trees *Parkinsonia microphylla* and/or *Olneya tesota* become conspicuous. When mapping the limits of a population, the lower bounds were drawn to include the lowest trees, unless there were over 100 meters (330 feet) separating the tree from the rest of the population. For small, outlying populations of these trees, there must be at least 10 individuals in a 100-meter square (1 hectare) to be mapped.

At its upper limit this association abuts pediment associations, such as '141', recognized by the presence of the indicator species *Cylindropuntia bigelovii*, and '175', defined by bar-and-swale landform and the presence of *Cylindropuntia acanthocarpa*.

**Photo Identification:** As with the related "176" (blue palo verde bajada) it is relatively easy to distinguish this association from neighboring creosote/bursage associations without trees (e.g. 100, 110), simply by the dark dots of the trees. If the neighboring association is an arroyo, the 'one meter' rule works fine except when the watercourse is highly braided, with channels rapidly changing width. In such cases a longer stretch of the arroyo was considered – say, 100 meters - and the average width of the bed was guessed at, based on the imagery. Most difficult was distinguishing between this association and floodplain based entirely on photographs, since smaller species (e.g., brittlebush) were tough to see. In such cases the areas attributed as floodplain typically had barrens and narrow dense stripes of dense vegetation, along with small trees, all of which were visible from the image. More than most associations, this distinction was subjective and based on opinions formed during field observations.

**Vegetation:** Creosote – white bursage/ironwood-Yellow paloverde

**Alliance/Association/Subassociation codes:** 1 / 17 / 177

**Number of Sample Sites (relevés):** 20

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	20	5 (3-5)	1-4% (1-14%)	1.0
<i>Ambrosia dumosa</i> White bursage	20	3 (2-4)	1-4% (<1-9%)	0.5
<i>Parkinsonia microphylla</i> Yellow Paloverde	19	3 (0-4)	1-4% (<1-4%)	3.0
<i>Encelia farinosa</i> Brittlebush	19	3 (0-4)	<1% (<1-4%)	0.7
<i>Olneya tesota</i> Ironwood	16	2 (0-4)	<1% (<1-4%)	3.8
<i>Carnegiea gigantea</i> Saguaro	16	1 (0-3)	<1% (<1-4%)	7.0
<i>Krameria grayi</i> Ratany	15	2 (0-3)	<1% (<1-4%)	0.6
<i>Fouquieria splendens</i> Ocotillo	8	0 (0-3)	<1% (<1-4%)	
<i>Brassica tournefortii</i> Sahara mustard	7	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	7	0 (0-3)	<1% (<1-4%)	0.5
<i>Lycium sp.</i> Wolfberry	7	0 (0-3)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	7	0 (0-3)	<1% (<1-4%)	0.8
<i>Cylindropuntia echinocarpa</i> Silver cholla	6	0 (0-3)	<1% (<1-4%)	
<i>Fagonia californica</i> Fagonia	5	0 (0-5)	<1% (<1-9%)	0.2
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	5	0 (0-3)	<1% (<1-4%)	1.1
<i>Echinocactus polycephalus</i> Cottontop cactus	4	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	3	0 (0-3)	<1% (<1%)	0.5
<i>Euphorbia polycarpa</i>	3	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Prosopis glandulosa</i> Mesquite	3	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	3	0 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	2	0 (0-3)	<1% (<1-4%)	0.5
<i>Lepidium lasiocarpum</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Dalea mollissima</i> Silky dalea	2	0 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	2	0 (0-2)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	2	0 (0-2)	<1% (<1%)	
Annual grass	1	0 (0-3)	<1% (<1%)	
<i>Camissonia cardiophylla</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Chaenactis carphoclinia</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Chorizanthe corrugata</i>	1	0 (0-3)	<1% (<1%)	
<i>Erodium texanum</i>	1	0 (0-3)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	1	0 (0-3)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	1	0 (0-3)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	1	0 (0-3)	<1% (<1-4%)	1.4
<i>Lesquerella tenella</i>	1	0 (0-3)	<1% (<1%)	
<i>Mentzelia involucrata</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Perityle emoryi</i>	1	0 (0-3)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	1	0 (0-3)	<1% (<1%)	
<i>Plantago sp.</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-3)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	1	0 (0-2)	<1% (<1%)	
<i>Bouteloua barbata</i>	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i>	1	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Erioneuron pulchellum</i>	1	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	1	0 (0-2)	<1% (<1%)	
<i>Trichoptilium incisum</i>	1	0 (0-2)	<1% (<1%)	
<i>Agave deserti</i>	1	0 (0-1)	<1% (<1%)	
<i>Allonia incarnata</i>	1	0 (0-1)	<1% (<1%)	
<i>Asclepias albicans</i>	1	0 (0-1)	<1% (<1%)	
<i>Datura sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-1)	<1% (<1%)	
<i>Hesperocallis undulate</i>	1	0 (0-1)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-1)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	1	0 (0-1)	<1% (<1%)	
<i>Marina parryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – white bursage – paloverde/ironwood (17)

**Subassociation:** Creosote – white bursage/ironwood-blue paloverde – club cholla (178)

**Scientific Name:** *Larrea tridentata*-*Ambrosia dumosa*/*Olneya* –*Parkinsonia florida*-*Grusonia wrightiana* shrubland

**NVC Association:** No similar association within the creosote (*Larrea*) alliance.

**Previous classifications:** None. Previously undescribed. The club cholla *Grusonia wrightiana* lives only in southwestern Arizona.



Figure 104. Photo site: west side of Gila Mountains, along Foothills Boulevard, about three miles south of the BMGR West north boundary.



Figure 105. Photo site: west side of Gila Mountains, along Foothills Boulevard, about three miles south of BMGR West northern boundary.

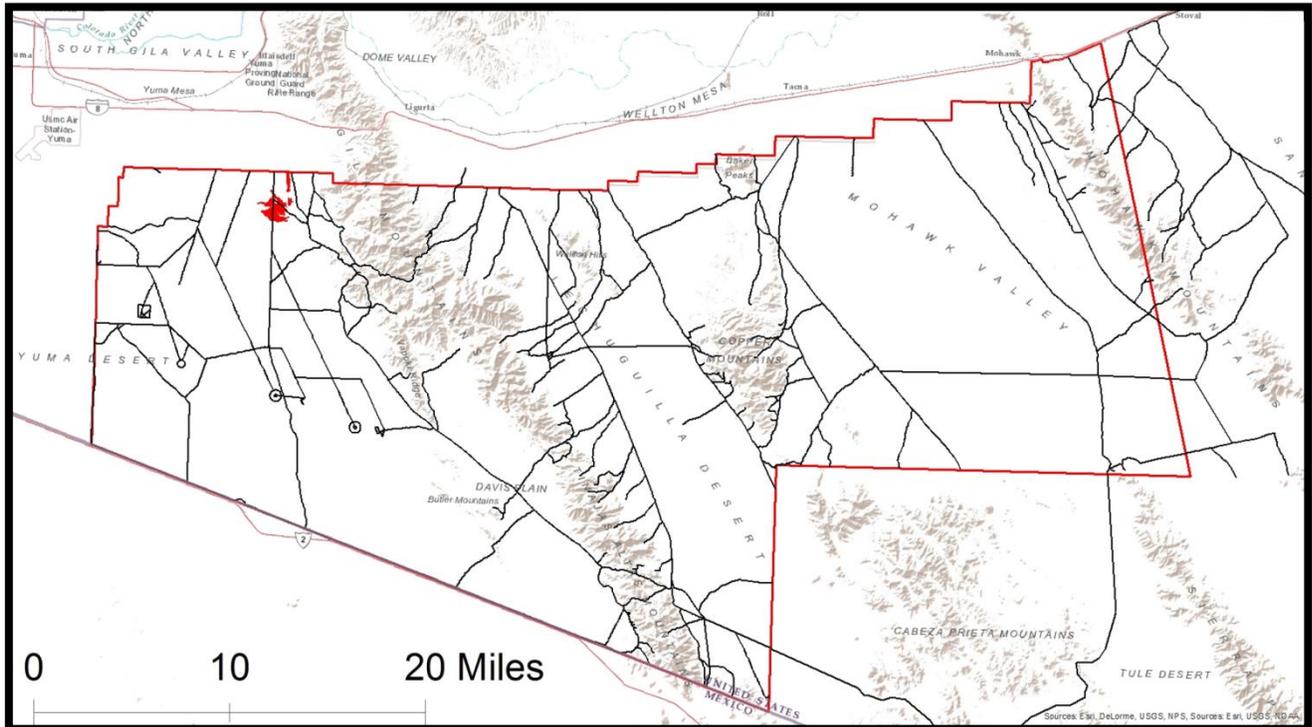


Figure 106. Distribution of creosote – white bursage – ironwood/yellow palo verde – club cholla (178) on the BMGR West. Outliers can be found along the border near the Tinajas Atlas Mountains, in scattered populations smaller than the minimum mapping unit of one hectare.

**Description:** Creosote – white bursage (*Ambrosia dumosa*) with sparse leguminous trees and the notable presence of the club cholla, *Grusonia wrightiana*. This species can form large mats with a mean height of 0.4 m (about 2 feet) and often 2 to 5 meters across. Such a large mass acts as a windbreak and a sand trap, forming large raised mounds of cactus and sand. Creosote, *Larrea tridentata*, is the most abundant species, with the highest median prominence (5, 'dominant') and cover (1-9%). The most common associates are *Ambrosia dumosa*, club cholla, big galleta grass (*Pleuraphis rigida*), and ironwood (*Olneya tesota*) - all with 1-4% cover. Less abundant, with less than 1 percent cover but nevertheless present at all four relevés, were ocotillo, ratany (*Krameria erecta*), and the exotic *Brassica tournefortii*, Sahara mustard.

**Location:** Common on the bajadas at the north-western end of the Gila Mountains, but hardly anywhere else on BMGR West. There are scattered populations along the international frontier near the Tinajas Altas Mountains, but these were judged too small to map. This association has been seen on the CPNWR (personal observation, Malusa), but not yet mapped.

**Field Identification:** The club cholla is conspicuous, and so are two of its associates, ironwood, and big galleta grass. The threshold for mapping was at least 1percent cover of the cholla, which was checked by point transects in the field.

**Photo Identification:** See Figure 107 below. The large mats of club cholla were apparent on the imagery. Some are truly huge, as can be seen by the mats in the blue circles below, on this image showing an area about 1.5 km across (0.9 miles). Foothill Boulevard is the road to the left. The other common association in this photo are pavements (171).

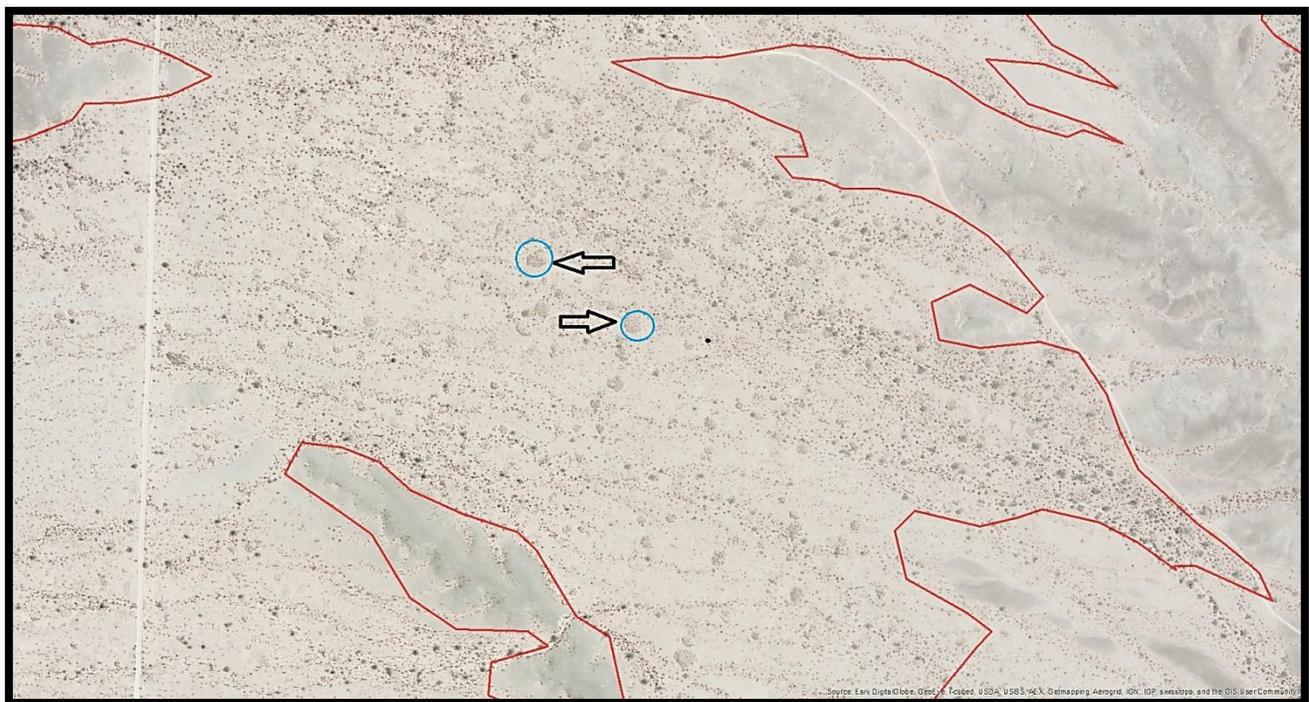


Figure 107. Blue circles show large hummocks of club cholla near Foothills Blvd (on left).

**Vegetation:** Creosote – white bursage/ironwood-blue paloverde – club cholla

**Alliance/Association/Subassociation codes:** 1 / 17 / 178

**Number of Sample Sites (relevés):** 4

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	4	5 (5)	1-9% (1-9%)	1.2
<i>Ambrosia dumosa</i> White bursage	4	3 (3)	1-4% (<1-4%)	0.5
<i>Grusonia wrightiana</i> Club cholla	4	3 (3)	1-4% (1-4%)	0.4
<i>Pleuraphis rigida</i> Big galleta grass	4	3 (3)	1-4% (1-4%)	0.9
<i>Olneya tesota</i> Ironwood	4	3 (3)	1-4% (<1-4%)	3.3
<i>Brassica tournefortii</i> Sahara mustard	4	3 (3)	<1% (<1-4%)	
<i>Fouquieria splendens</i> Ocotillo	4	2.5 (1-3)	<1% (<1-4%)	
<i>Krameria erecta</i> Ratany	4	2.5 (1-3)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	3	1.5 (0-2)	<1% (<1-4%)	
<i>Krameria grayi</i> Ratany	2	1 (0-3)	<1% (<1-4%)	0.7
<i>Aristida sp.</i>	2	0.5 (0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	2	0.5 (0-2)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	2	0.5 (0-1)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	2	0.5 (0-1)	<1% (<1%)	
<i>Ditaxis serrata</i> Silverbush	2	0.5 (0-1)	<1% (<1%)	
<i>Ferocactus polycephalus</i>	2	0.5 (0-1)	<1% (<1%)	
<i>Allonia sp.</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Euphorbia sp.</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Nyctaginaceae sp.</i>	1	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Tidestromia oblongifolia</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Plantago ovata</i> Woolly plantain	1	0 (0-3)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-3)	<1% (<1%)	
<i>Penstemon parryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Proboscidea sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Schismus sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Stillingia linearifolia</i>	1	0 (0-2)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	1	0 (0-1)	<1% (<1%)	
<i>Marina parryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Orobanche cooperi</i>	1	0 (0-1)	<1% (<1%)	
<i>Sphaeralcea sp.</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Creosote (1)

**Association:** Creosote – fagonia– white bursage (19)

**Subassociation:** Creosote – fagonia– white bursage on steep slopes (191)

**Scientific Name:** *Larrea tridentata* – *Fagonia californica* (= *laevis*) - *Ambrosia dumosa* shrubland on steep slopes

**NVC Association:** *Larrea tridentata* – *Ambrosia dumosa* shrubland

**Previous classifications:** Previously undescribed from SW Arizona.



Figure 108. Relevé near WH-14, west side of the Wellton Hills, the view south. The blond tufts are *Fagonia*.



Figure 109. Relevé MMSW-21, on the southwestern side of the Mohawk Mountains.

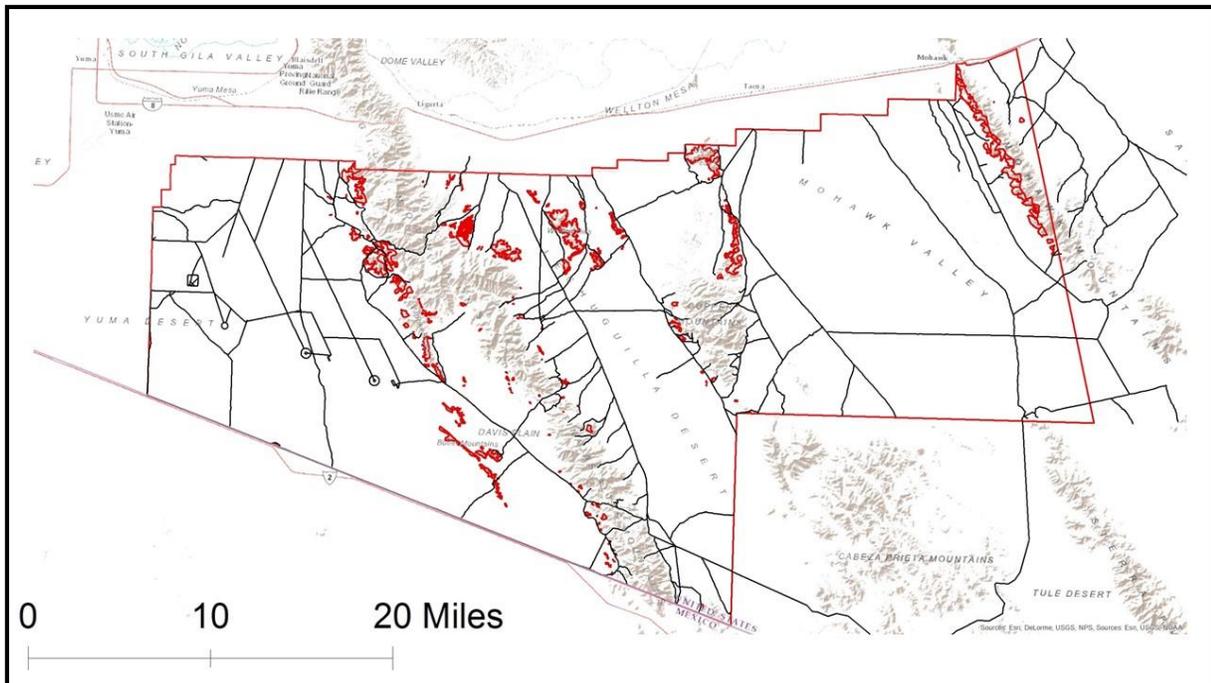


Figure 110. Distribution of creosote – fagonia - white bursage (191) on the BMGR West.

**Description:** Barren, usually rocky, mountain slopes with a sparse cover of creosote, fagonia, and white bursage (*Ambrosia dumosa*). This is the only creosote-dominant association/subassociation from steep mountain slopes; all others are from bajadas, ridges, hills, and valleys. Brittlebush can be locally abundant, but what distinguishes this vegetation is a lack of species larger than creosote – there is less than 1 percent cover for each of the following species: ironwood, paloverde, elephant tree, lavender and Mormon tea.

Similar to subassociation 113, which is also 'treeless'; however, it is found on slopes < 20% (hills), not mountains. The "20%" cut-off between hill and mountain is an arbitrary choice, with roots back to the Warren et al (1981), who noted a change in vegetation at the 20% slope break. The change is apparent in the present study area when comparing the hill (113) and mountain (191) subassociations within the Goldwater - West. On the mountain slopes, fagonia, white bursage, and big galleta grass are more common, with 1-4 percent cover versus <1% on the hills. Annuals, such as six-weeks three awn (*Aristida adscensionis*) can be very common after favorable rains.

In mountains with relatively large watersheds, there will typically be watercourses holding significant desert lavender (*Hyptis emoryi*). These are mapped separately as subassociation 830, lavender/hollyleaf bursage-brittlebush.

**Location:** On slopes >-20%, on darker metamorphic rocks most common in the northern part of the range, especially the central Gila Mountains between Fortuna Mine and Sheep Mountain, Wellton Hills, Baker Peaks, and the west side of the Mohawk Mountains. However, as if to defy a general explanation, the pale granites of the Butler Mountains were also part of this subassociation. The east side of the Mohawks held enough trees to be part of a different subassociation, brittlebush-creosote-white bursage/yellow palo verde (631).

**Field Identification:** Less than 1 percent cover for each of the following species: ironwood, paloverde, elephant tree, lavender and Mormon tea. Areas that were mostly rock were included.

**Photo Identification:** Ironwood, paloverde, and elephant tree could be seen on the imagery, and cover estimated. See figure below. Lavender and Mormon tea at cover values >1% were typically restricted to watercourses or higher and cooler northern aspects.

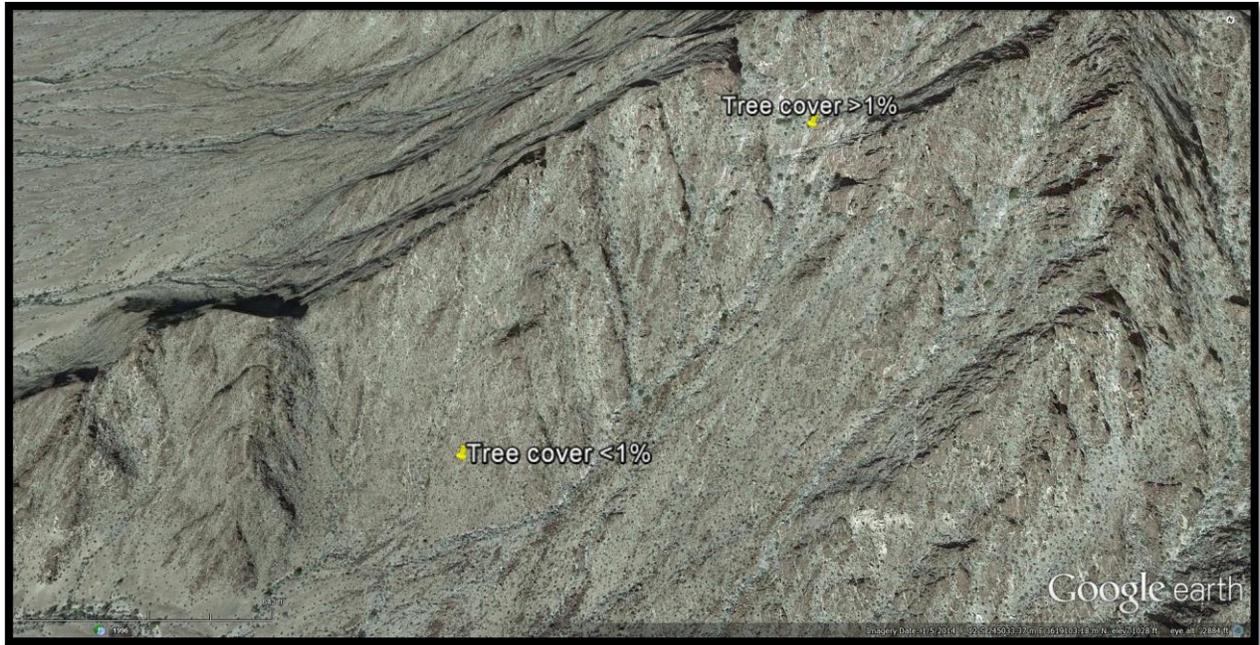


Figure 111. Above, an example of imagery (tilted 45 degrees to show relief) showing differences in tree cover on a south-facing slope in the Mohawk Mountains. Image covers an area about 1.15 km wide (0.7 miles).



Figure 112. Above, *Fagonia californica* (= *F. laevis*) in spring flower. This short shrub, typically only 0.2 m tall (six inches), is more often without leaves and flowers, and looks like a large scouring pad, with congested stems and sharp stipules at the nodes.

**Vegetation:** Creosote – fagonia– white bursage on mountains (> 20% slope)

**Alliance/Association/Subassociation codes:** 1 / 19 / 191

**Number of Sample Sites (relevés):** 44

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Larrea tridentata</i> Creosote	44	4 (1-5)	1-4% (<1-14%)	1.0
<i>Ambrosia dumosa</i> White bursage	44	3 (1-5)	1-4% (<1-9%)	0.3
<i>Fagonia californica</i> Fagonia	43	3 (0-5)	1-4% (<1-9%)	0.2
<i>Encelia farinosa</i> Brittlebush	30	2 (0-5)	<1% (<1-14%)	0.6
<i>Pleuraphis rigida</i> Big galleta grass	20	0 (0-3)	<1% (<1-4%)	0.8
<i>Sphaeralcea ambigua</i> Mallow	20	0 (0-3)	<1% (<1-4%)	0.4
<i>Fouquieria splendens</i> Ocotillo	19	0 (0-3)	<1% (<1-4%)	3.3
<i>Hyptis emoryi</i> Desert lavender	18	0 (0-4)	<1% (<1-4%)	1.1
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	14	0 (0-3)	<1% (<1-4%)	0.8
<i>Aristida adscensionis</i> Six-weeks three-awn	15	0 (0-3)	<1% (<1-4%)	
<i>Hibiscus denudatus</i> Rock hibiscus	13	0 (0-3)	<1% (<1-4%)	0.4
<i>Ferocactus cylindraceus</i> California barrel	14	0 (0-3)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	14	0 (0-3)	<1% (<1-4%)	0.5
<i>Parkinsonia microphylla</i> Yellow Paloverde	11	0 (0-2)	<1% (<1%)	3.0
<i>Eriogonum inflatum</i> Desert trumpet	9	0 (0-4)	<1% (<1-4%)	0.6
<i>Ditaxis lanceolata</i> Silverleaf	9	0 (0-2)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	8	0 (0-3)	<1% (<1%)	0.4
<i>Trixis californica</i>	8	0 (0-3)	<1% (<1%)	0.6
<i>Pleurocoronis plurisetia</i> Arrowleaf	8	0 (0-4)	<1% (<1-4%)	0.5

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ephedra aspera</i> Mormon tea	7	0 (0-3)	<1% (<1-4%)	0.5
<i>Mentzelia albicaulis</i>	7	0 (0-3)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	6	0 (0-2)	<1% (<1%)	
<i>Peucephyllum schottii</i>	7	0 (0-2)	<1% (<1%)	1.0
<i>Carnegiea gigantea</i> Saguaro	6	0 (0-1)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	6	0 (0-3)	<1% (<1%)	0.4
<i>Olneya tesota</i> Ironwood	5	0 (0-3)	<1% (<1%)	3.8
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	4	0 (0-3)	<1% (<1-9%)	0.7
<i>Opuntia basilaris</i> Beavertail Cactus	5	0 (0-2)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	5	0 (0-3)	<1% (<1%)	
<i>Perityle emoryi</i>	5	0 (0-3)	<1% (1-4%)	
<i>Nicotiana obtusifolia</i>	5	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	4	0 (0-2)	<1% (<1%)	2.0
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	4	0 (0-3)	<1% (<1-4%)	
<i>Mentzelia involucreta</i>	4	0 (0-3)	<1% (<1-4%)	
<i>Erioneuron pulchellum</i>	4	0 (0-2)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	3	0 (0-3)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	3	0 (0-3)	<1% (<1-4%)	
<i>Chorizanthe rigida</i> Spineflower	3	0 (0-2)	<1% (<1%)	
<i>Physalis crassifolia</i>	3	0 (0-2)	<1% (<1%)	
<i>Mammillaria spp.</i>	3	0 (0-1)	<1% (<1%)	
<i>Agave deserti</i>	2	0 (0-3)	<1% (<1-4%)	0.6
<i>Aristida sp.</i>	2	0 (0-3)	<1% (<1%)	
<i>Asclepias albicans</i>	2	0 (0-3)	<1% (<1%)	1.9

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Chorizanthe corrugata</i>	2	0 (0-3)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	2	0 (0-3)	<1% (<1-4%)	
<i>Eriogonum thomasii</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Eriogonum wrightii</i>	2	0 (0-3)	<1% (<1%)	0.4
<i>Jatropha cuneata</i> Limberbush	2	0 (0-3)	<1% (<1-4%)	1.6
<i>Aristida purpurea</i>	2	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	2	0 (0-1)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-4)	<1% (<1-4%)	
<i>Allonia incarnata</i>	1	0 (0-3)	<1% (<1%)	
Annual grass	1	0 (0-3)	<1% (<1%)	0.1
<i>Cryptantha angustifolia</i> Pick-me-not	1	0 (0-3)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-3)	<1% (<1%)	
<i>Lepidium lasiocarpum</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Lupinus sparsiflorus</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Camissonia cardiophylla</i>	1	0 (0-2)	<1% (<1%)	
<i>Cryptantha racemosa</i>	1	0 (0-2)	<1% (<1%)	0.3
<i>Dalea mollissima</i> Silky dalea	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-2)	<1% (<1%)	
<i>Fagonia pachyacantha</i>	1	0 (0-2)	<1% (<1%)	
<i>Lotus strigosus</i>	1	0 (0-2)	<1% (<1%)	
<i>Psathyrotes ramosissima</i>	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	1	0 (0-1)	<1% (<1%)	
<i>Ditaxis sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Euphorbiaceae spp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Marina parryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Mirabilis bigelovii</i> Wishbone bush	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage-Creosote-Teddy Bear Cholla (24)

**Subassociation:** White Bursage-Creosote-Teddy Bear Cholla (241)

**Scientific Name:** *Ambrosia dumosa* - *Larrea tridentata* - *Opuntia bigelovii* shrubland

**NVC Association:** None. There is an *Ambrosia dumosa* - *Larrea tridentata* Dwarf-shrubland, *Ambrosia dumosa* - *Encelia farinosa* Dwarf-shrubland, and an '*Opuntia bigelovii* Shrubland'. The first lacks supporting data, and the latter two are described from the Grand Canyon, which lacks ironwood and palo verde.

**Previous classifications:** This is a subassociation of association 24, previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003). However, that mapping unit is characterized by triangle-leaf bursage (*Ambrosia deltoidea*), not white bursage (*Ambrosia dumosa*). Finally, this is generally a pediment association, and it can be also seen as a more arid version of Warren et al.'s 154.1212.



Figure 113. Relevé TA-34, Tinajas Altas Mountains.



Figure 114. Relevé RB-11, Tinajas Altas Mountains, looking north to the flat-topped Raven Butte.

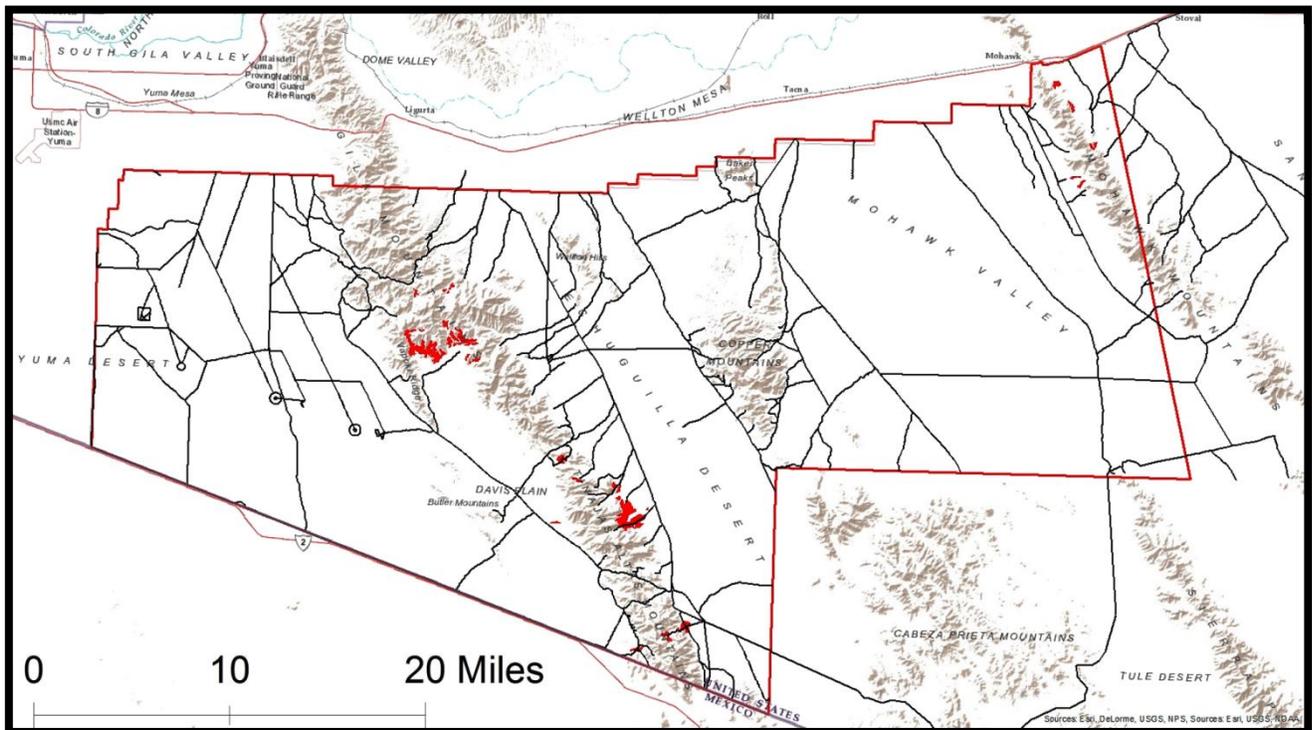


Figure 115. Distribution of White Bursage-Creosote-Teddy Bear Cholla (241) on the BMGR West.

**Description:** The diagnostic species for this association is teddy bear cholla, also known as jumping cholla (*Opuntia bigelovii*=*Cylindropuntia bigelovii*). The cholla typically has a 1-4% cover, as does the bursage, *Ambrosia dumosa*. However, the latter is usually dominant/codominant, a fact which distinguishes this subassociation (241) from the similar '141', which is creosote dominant/codominant. Yet except for the swap in dominance from creosote (*Larrea tridentata*) to bursage, the two subassociations are very similar, with brittlebush as a common associate, and a host of prickly species: ocotillo, buckhorn cholla, and saguaro.

The association is also similar to 242 (White Bursage-Creosote-Ironwood-Teddy Bear Cholla), which has significantly more ironwood.

**Location:** This association is tucked against the mountain front in the Gila and Tinajas Altas Mountains, especially at the head of the Davis Plain, and south of Raven Butte, with a few outliers in the northern Mohawk Mountains. These are among the most arid places on the range.

**Field Identification:** This association was mapped by hiking along the mountain front, mapping the extent of the teddy bear cholla (*Cylindropuntia bigelovii*), the diagnostic species. Binoculars were useful for spotting distant individuals, which were included in the range unless they were over one hundred meters (328 feet) from the rest of the population. The upper bounds were the 20% slope limit, because this association was described as a pediment association (Malusa, 2003). The teddy bear cholla ranges well beyond 20%, up the steepest slopes, and it is occasionally a dominant species in the mountain associations. On some upper bajadas, both elephant tree and teddy-bear cholla were present. If elephant tree were common (prominence of '3' or more), the area was mapped as an elephant tree bajada, '275'.

**Photo Identification:** Photos couldn't discern the range of *Cylindropuntia bigelovii*, so this was field mapped by hiking the limits of the cholla. In places beyond the reach of field investigators, it was difficult to tell the difference between the present subassociation and other teddy bear cholla subassociations (154.1141, and 154.1242). In short, areas clearly dominated by creosote were 154.1141, and areas with obvious tree cover over 1% were 154.1242. All other areas – bursage dominant, yet few trees – fell into the present subassociation.

**Vegetation:** White bursage - creosote – teddy bear cholla

**Alliance/Association/Subassociation codes:** 2 / 24 / 241

**Number of Sample Sites (relevés):** 10

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	10	4.5 (3-5)	1-4% (<1-9%)	0.5
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	10	3 (3-5)	1-4% (<1-9%)	0.8
<i>Encelia farinosa</i> Brittlebush	10	3 (2-4)	<1% (<1-4%)	0.8
<i>Larrea tridentata</i> Creosote	10	3 (1-4)	1-4% (<1-9%)	1.2
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	8	2 (0-3)	<1% (<1-4%)	
<i>Fouquieria splendens</i> Ocotillo	7	2 (0-5)	<1% (<1-9%)	3.7
<i>Carnegiea gigantea</i> Saguaro	7	2 (0-3)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	7	1 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	5	0.5 (0-3)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	5	0.5 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	5	0.5 (0-1)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	4	0 (0-3)	<1% (<1-4%)	0.5
<i>Krameria grayi</i> Ratany	4	0 (0-3)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	4	0 (0-2)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	3	0 (0-3)	<1% (<1-4%)	1.3
<i>Acacia greggii</i> Catclaw	3	0 (0-2)	<1% (<1%)	
<i>Horsfordia alata</i> Velvet mallow	3	0 (0-2)	<1% (<1%)	
<i>Trixis californica</i>	3	0 (0-1)	<1% (<1%)	
<i>Chorizanthe corrugata</i>	2	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Parkinsonia microphylla</i> Yellow Paloverde	2	0 (0-3)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-2)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	2	0 (0-2)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	2	0 (0-2)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	2	0 (0-2)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	2	0 (0-1)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	2	0 (0-1)	<1% (<1%)	
<i>Lepidium lasiocarpum</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Plantago ovata</i> Wooly plantain	1	0 (0-3)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-2)	<1% (<1%)	
<i>Mammillaria tetrancistra</i>	1	0 (0-2)	<1% (<1%)	
<i>Nyctaginaceae-G. sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Agave deserti</i>	1	0 (0-1)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	1	0 (0-1)	<1% (<1%)	
<i>Chaenactis sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-1)	<1% (<1%)	
<i>Dalea sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Ditaxis lanceolata</i>	1	0 (0-1)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	1	0 (0-1)	<1% (<1%)	
<i>Mentzelia sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Mirabilis bigelovii</i> Wishbone bush	1	0 (0-1)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage-Creosote-Teddy Bear Cholla (24)

**Subassociation:** White Bursage-Creosote-Ironwood-Teddy Bear Cholla (242)

**Scientific Name:** *Ambrosia dumosa* - *Larrea tridentata*/*Olneya tesota*/*Opuntia bigelovii* shrubland

**NVC Association:** None. There is an *Ambrosia dumosa* - *Larrea tridentata* Dwarf-shrubland, *Ambrosia dumosa* - *Encelia farinosa* Dwarf-shrubland, and an '*Opuntia bigelovii* Shrubland'. The first lacks supporting data, and the latter two are described from the Grand Canyon, which lacks ironwood and palo verde.

**Previous classifications:** This is a subassociation of association 24, previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003). However, that mapping unit is characterized by triangle-leaf bursage, not white bursage (*Ambrosia dumosa*). Finally, this is generally a pediment association, and it can be also seen as a more arid version of Warren et al.'s 154.1212.



Figure 116. Relevé BP-21, at south end of Copper Mountains.

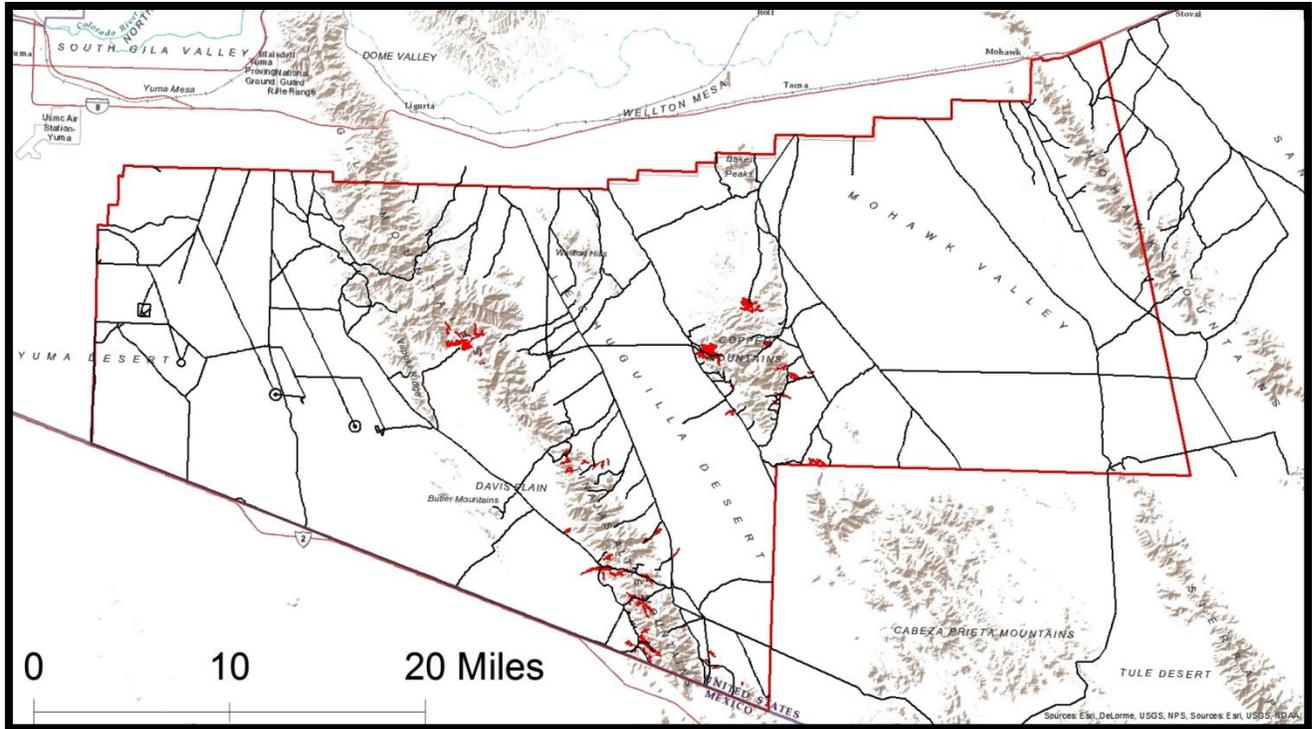


Figure 117. Distribution of White Bursage-Creosote-Ironwood-Teddy Bear Cholla (242) on the BMGR West.

**Description:** The diagnostic species for this association is teddy bear cholla, also known as jumping cholla (*Opuntia bigelovii*=*Cylindropuntia bigelovii*). White bursage (*Ambrosia dumosa*) is typically dominant/co-dominant. Common associates include brittlebush (*Encelia farinosa*), *Carnegiea gigantea*, *Larrea*, and *Olneya tesota*.

The association is similar to 241 (White Bursage-Creosote-Teddy Bear Cholla), but with significantly more ironwood (*Olneya tesota*).

**Location:** The head of the Davis Plain in the Gila Mountains, and the interior canyon floors of the Tinajas Altas and Copper Mountains.

**Field Identification:** This association was mapped by hiking along the extent of the teddy bear cholla (*Cylindropuntia bigelovii*), the diagnostic species. The upper bounds were the 20% slope limit, because this association was described as a pediment association (Malusa, 2003). The teddy bear cholla ranges well beyond 20%, up the steepest slopes, and it is occasionally a dominant species in the mountain associations. On some upper bajadas, both elephant tree and teddy-bear cholla were present. If elephant tree were common (prominence of '3' or more), the area was mapped as an elephant tree bajada (275).

**Photo Identification:** Photos couldn't discern the range of *Cylindropuntia bigelovii*, so this was field mapped by hiking the limits of the cholla. Once it was established that the cholla were common in a canyon, the imagery could be used to determine if there were sufficient cover of ironwood (>1%) to be classified within this subassociation.

**Vegetation:** White Bursage-Creosote-*Ironwood*-Teddy Bear Cholla

**Alliance/Association/Subassociation codes:** 2 / 24 / 242

**Number of Sample Sites (relevés):** 4

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	4	4 (3-4)	1-9% (1-9%)	0.5
<i>Larrea tridentata</i> Creosote	4	3.5 (2-4)	1-4% (<1-9%)	1.1
<i>Encelia farinosa</i> Brittlebush	4	3 (2-4)	1-4% (<1-9%)	0.8
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	4	3 (2-3)	1-9% (<1-9%)	1.0
<i>Olneya tesota</i> Ironwood	4	3 (2-3)	1-4% (<1-4%)	3.8
<i>Carnegiea gigantea</i> Saguaro	4	2.5 (2-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	3	2.5 (0-4)	<1% (<1-4%)	3.0
<i>Fagonia californica</i> Fagonia	3	1.5 (0-2)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	2	1.5 (0-3)	<1% (<1-4%)	3.6
<i>Cylindropuntia echinocarpa</i> Silver cholla	2	1 (0-3)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	2	0.5 (0-3)	<1% (<1-4%)	0.5
<i>Echinocereus engelmannii</i> Hedgehog cactus	2	0.5 (0-2)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	2	0.5 (0-2)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	2	0.5 (0-1)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	2	0.5 (0-1)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	2	0 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	1	0 (0-3)	<1% (<1-4%)	
<i>Lepidium lasiocarpa</i>	1	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Nama demissum</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Phacelia ambigua</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Senna covesii</i>	1	0 (0-3)	<1% (<1%)	0.6
<i>Plantago ovata</i> Wooly plantain	1	0 (0-3)	<1% (<1-4%)	
<i>Atriplex polycarpa</i> Cattle saltbush	1	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-2)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	1	0 (0-2)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	1	0 (0-1)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-1)	<1% (<1%)	
<i>Mirabilis bigelovii</i> Wishbone bush	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage-Big Galleta Grass (26)

**Subassociation:** White Bursage-Big Galleta Grass on Dunes (260)

**Scientific Name:** *Ambrosia dumosa* / *Pleuraphis rigida* shrubland on dunes

**NVC Association:** *Ambrosia dumosa* / *Pleuraphis rigida* sparse dwarf-shrubland.

**Previous classifications:** This is a subassociation of association 26, previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003). This association is now divided into two subassociations, 260 and 261, based primarily on landform.



Figure 118. Relevé VRSE-1, Yuma Dunes, near Foothill Boulevard and the international border. The vegetation is unusually sparse at this location, with only a clump of Mormon tea (*Ephedra trifurca*) in the foreground.



Figure 119. Relevé M-2, Mohawk Dunes, about two miles north of Mohawk Playa.



Figure 120. Relevé YSE-4, at the north boundary of the BMGR West, near the P111 facility.



Figure 121. Relevé CP-37, at the toe of the Butler Mountains. Note the abundance of brittlebush, *Encelia farinosa*. This is atypical, but was nonetheless included as part of this association largely because of the obvious landform, deep sands.

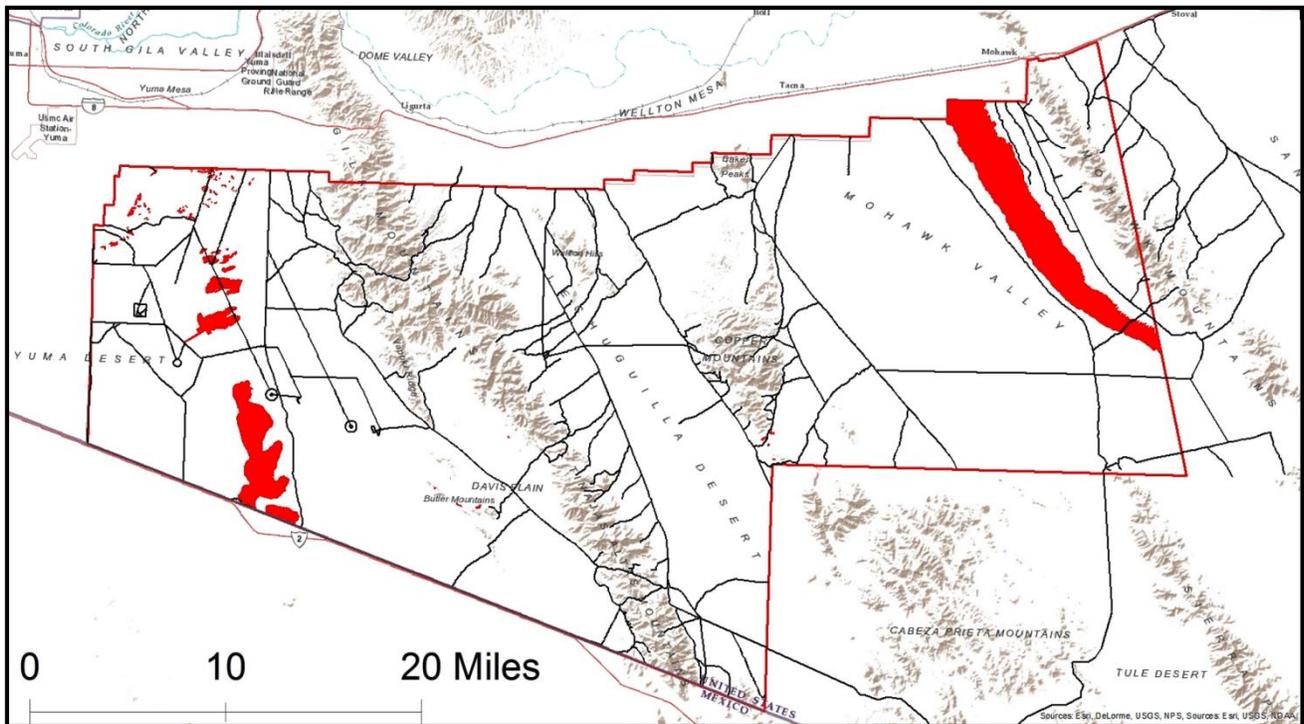


Figure 122. Distribution of White Bursage-Big Galleta Grass on Dunes (260) on the BMGR West. Note the few small outliers between the south end of the Copper Mountains and the Cabeza Prieta Mountains.

**Description:** Moving sands heaped into dunes, with typically marked differences between the crests and swales. *Ambrosia dumosa* and *Pleuraphis rigida* are typically codominant on sandy crests, while *Larrea tridentata* is common in the swales between. Occasionally the swales are large enough (>1 ha) to be mapped as playas (they are closed drainages). Usually, however, the swales are included as part of the dune field (polygon). In a few areas that were isolated dunes without swales, where winds have pushed a sand hill against a slope.

The NVC association for dunes, *Ambrosia dumosa* / *Pleuraphis rigida* sparse dwarf-shrubland, is apparently based on the crests of the Algodones Dunes and Yuma Dunes, excluding the swales. In the NVC description below, note the lack of creosote (*Larrea tridentata*), which is quite common on swales within dune fields on the Goldwater West.

"Sparse, desert sand dune association. Occurs on active to partially stabilized desert sand dunes in the northern Sonoran desert, between 88 and 305 m (290-1000 feet) of elevation. *Ambrosia dumosa* and *Pleuraphis rigida* (= *Hilaria rigida*) codominate, though a number of other dune-adapted, shrubby perennial plants may occur. Occasionally common are *Ephedra trifurca*... *Croton wigginsii*, *Eriogonum deserticola*, and *Psoralea emoryi*....Diagnostic species include *Abronia villosa* var. *villosa*, *Dicoria canescens* and the rare taxa *Chamaesyce* (= *Euphorbia*) *platysperma*, *Croton wigginsii*, *Eriogonum deserticola*, *Helianthus niveus* ssp. *tephrodes*, *Palafoxia arida* var. *gigantea*, and *Psoralea emoryi*."

All of these species occur within the dunes as mapped in this study of the Goldwater – West (see data table below). In addition, see Felger et al (2003) for a complete description of the Mohawk Dunes.

**Location:** Mostly in the Mohawk Dunes and Yuma Dunes, at opposite ends of Goldwater – West. There were also several small dunes in Big Pass, between the Copper Mountains and the Cabeza Prieta Mountains. These dunes lacked *Psoralea emoryi* and *Ephedra trifurca* – common species at the Mohawk and Yuma Dunes – and held unusually large ocotillo. Yet they were nonetheless wind-deposited sands, with other dune species such as sand verbena. Finally, there were several dunes piled up against the granite slopes of the Butler Mountains.

**Field Identification:** *Ambrosia dumosa* and/or *Pleuraphis rigida* are dominant, and one or more of the following species must be present: *Psoralea emoryi*, *Ephedra trifurca*, *Abronia villosa*, *Oenothera deltoides*, *Stephanomeria schottii*, *Eriogonum deserticola*, *Croton wigginsii*. Also, there should be a characteristic dune landform. On bajadas where *Ambrosia dumosa* and/or *Pleuraphis rigida* are dominant yet there is no dune landform (nor the above species) were mapped as 262 (below).

**Photo Identification:** The wind-blown sands that are favored by *Ambrosia dumosa*/*Pleuraphis rigida* form a distinctive crest/swale pattern (Fig. 123).



Figure 123. Above, an image of the west side of the Mohawk Dunes, of an area about 2.4 km (1.5 miles) across. Note characteristic crest/swale of dune landform.

**Vegetation:** White Bursage-Big Galleta Grass on Dunes

**Alliance/Association/Subassociation codes:** 2 / 26 / 260

**Number of Sample Sites (relevés):** 32

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Pleuraphis rigida</i> Big galleta grass	32	3 (2-5)	1-4% (<1-9%)	0.8
<i>Larrea tridentata</i> Creosote	31	3 (0-5)	1-4% (<1-9%)	1.2
<i>Ambrosia dumosa</i> White bursage	31	4 (0-5)	1-4% (<1-14%)	0.7
<i>Ephedra trifurca</i> Mormon tea	17	1.5 (0-5)	<1% (<1-9%)	0.9
<i>Brassica tournefortii</i> Sahara mustard	14	0 (0-3)	<1% (<1-9%)	0.2
<i>Palafoxia arida</i> Spanish needles	13	0 (0-3)	<1% (<1-4%)	2.3
<i>Oenothera deltoides</i> Dune primrose	12	0 (0-3)	<1% (<1-4%)	
<i>Abronia villosa</i> Sand verbena	11	0 (0-3)	<1% (<1-4%)	
<i>Psoralea emoryi</i> Indigobush	10	0 (0-3)	<1% (<1-4%)	0.6
<i>Krameria erecta</i> Ratany	8	0 (0-4)	<1% (<1-9%)	0.6
<i>Krameria grayi</i> Ratany	7	0 (0-3)	<1% (<1-4%)	0.4
<i>Cryptantha angustifolia</i> Pick-me-not	7	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	6	0 (0-2)	<1% (<1%)	0.6
<i>Fouquieria splendens</i> Ocotillo	6	0 (0-5)	<1% (<1-14%)	3.3
<i>Hesperocallis undulata</i> Ajo lily	5	0 (0-3)	<1% (<1%)	
<i>Dithyrea californica</i>	5	0 (0-3)	<1% (<1%)	
<i>Schismus arabicus</i> Arabian grass	4	0 (0-3)	<1% (<1%)	
<i>Eriogonum deserticola</i>	4	0 (0-5)	<1% (<1-4%)	0.8
<i>Olneya tesota</i> Ironwood	3	0 (0-2)	<1% (<1%)	
<i>Grusonia wrightiana</i> Club cholla	3	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Euphorbia platysperma</i>	3	0 (0-2)	<1% (<1%)	
<i>Tiquilia plicata</i> Crinklemat	3	0 (0-3)	<1% (<1-4%)	
<i>Tiquilia palmeri</i> Crinklemat	3	0 (0-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	3	0 (0-3)	<1% (<1%)	2.0
<i>Palafoxia arida</i>	3	0 (0-3)	<1% (<1%)	
<i>Lupinus arizonicus</i>	3	0 (0-3)	<1% (<1%)	
<i>Astragalus sabulorum</i>	3	0 (0-3)	<1% (<1%)	
<i>Dicorea canescens</i>	2	0 (0-1)	<1% (<1%)	
<i>Psilostrophe cooperi</i>	2	0 (0-2)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	2	0 (0-2)	<1% (<1%)	
<i>Aristida californica</i>	2	0 (0-2)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	2	0 (0-2)	<1% (<1%)	
<i>Schismus barbatus</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Plantago ovata</i> Woolly plantain	2	0 (0-3)	<1% (<1%)	
<i>Oenothera primiveris</i> Dune primrose	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-3)	<1% (<1%)	1.0
<i>Chaenactis stevioides</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Helianthus niveus</i>	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-1)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	1	0 (0-1)	<1% (<1%)	
<i>Baileya pauciflora</i>	1	0 (0-1)	<1% (<1%)	
<i>Astragalus sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Streptanthella longirostris</i>	1	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Phacelia ambigua</i>	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	1	0 (0-2)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	1	0 (0-2)	<1% (<1%)	
<i>Stephanomeria schottii</i>	1	0 (0-3)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-3)	<1% (<1%)	
<i>Croton wigginsii</i>	1	0 (0-3)	<1% (<1%)	0.7
<i>Baileya pleniradiata</i>	1	0 (0-3)	<1% (<1%)	
<i>Asclepias subulata</i>	1	0 (0-3)	<1% (<1%)	1.7
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	0 (0-3)	<1% (<1%)	0.3
<i>Parkinsonia florida</i> Blue paloverde	1	0(0-2)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage-Big Galleta Grass (26)

**Subassociation:** White Bursage-Big Galleta Grass on Fans (261)

**Scientific Name:** *Ambrosia dumosa* / *Pleuraphis rigida* shrubland on fans

**NVC Association:** *Ambrosia dumosa* / *Pleuraphis rigida* sparse dwarf-shrubland.

**Previous classifications:** This is a subassociation of association 26, previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003). This association is now divided into two subassociations, 260 and 261, based primarily on landform.



Figure 124. Relevé WSE-20, between the Wellton Hills and Baker Peaks.



Figure 125. Relevé WH-3, looking southeast to the Copper Mountains.

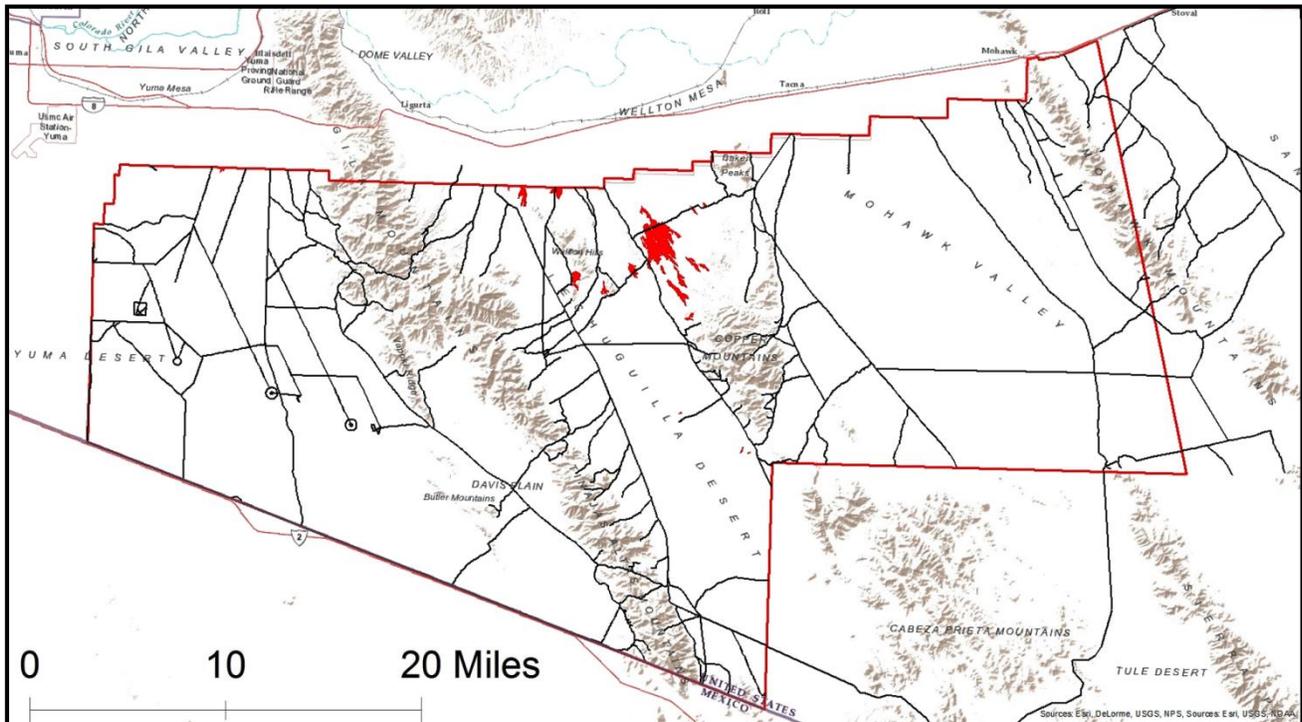


Figure 126. Distribution of White Bursage-Big Galleta Grass on Fans (261) on the BMGR West.

**Description:** Sandy fans with *Ambrosia dumosa* typically dominant/co-dominant, and abundant, too – the median cover was 5 -9 %. Creosote (*Larrea tridentata*) and big galleta grass (*Pleuraphis rigida*) are common, and occasionally dominant or codominant, with 1-4% median cover. Only slightly less common, *Krameria grayi* also held 1-4percent cover at the 8 of 10 relevés at which it was present. The exotic mustard, *Brassica tournefortii*, was present at all 10 relevés, indicating that it is especially prone to invasion. Trees are rare or absent. Slopes were 1-3%.

**Location:** Restricted to the bajadas northwest of the Copper Mountains, and among the Wellton Hills to the northern boundary of the BMGR West. The restricted range is associated with the alluvial fans originating from the Miocene age sedimentary rocks of the northern Copper Mountains, which includes the conglomerate rock that holds Baker Tanks.

**Field Identification:** *Ambrosia dumosa* and/or big galleta grass (*Pleuraphis rigida*) are dominant/co-dominant, and the big galleta grass must have at least 1% cover. Creosote can be common, or even co-dominant, but not dominant. The landform is relatively flat, with no obvious dune features. The following dune species are **absent:** *Psoralea emoryi*, *Ephedra trifurca* (Mormon tea), *Abronia villosa*, *Oenothera primiveris*, *Oenothera deltoides*, and *Stephanomeria schottii*.

**Photo Identification:** A lack of trees and the presence of many runnels with small speckles of bursage (not the larger creosote) were the best clues. This was difficult to discern by photo alone, and so far as possible the boundaries were marked in the field.

Vegetation: White Bursage-Big Galleta Grass on Fans

Alliance/Association/Subassociation codes: 2 / 26 / 261

Number of Sample Sites (relevés): 10

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	10	4 (3-5)	5-9% (1-14%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	10	3 (3-5)	1-4% (1-14%)	0.9
<i>Larrea tridentata</i> Creosote	10	3 (3-4)	1-9% (1-14%)	1.0
<i>Brassica tournefortii</i> Sahara mustard	10	3 (1-3)	<1-4% (<1-14%)	
<i>Krameria grayi</i> Ratany	8	2.5 (0-4)	<1-4% (<1-4%)	0.6
<i>Fouquieria splendens</i> Ocotillo	8	2 (0-3)	<1% (<1-4%)	4.1
<i>Cylindropuntia ramosissima</i> Diamond cholla	7	3 (0-3)	<1% (<1-4%)	0.4
<i>Krameria erecta</i> Ratany	5	0.5 (0-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	5	0.5 (0-3)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	5	0.5 (0-2)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	3	0 (0-3)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	2	0 (0-2)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	2	0 (0-1)	<1% (<1%)	
<i>Encelia frutescens</i> Button brittlebush	2	0 (0-1)	<1% (<1%)	
<i>Plantago ovata</i> Wooly plantain	1	0 (0-3)	<1% (<1-4%)	
<i>Chorizanthe rigida</i> Spineflower	1	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-3)	<1% (<1%)	
<i>Lepidium lasiocarpum</i>	1	0 (0-3)	<1% (<1%)	
<i>Schismus barbata</i>	1	0 (0-3)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-3)	<1% (<1%)	
<i>Aristida purpurea</i>	1	0 (0-2)	<1% (<1%)	
<i>Dalea mollis</i>	1	0 (0-2)	<1% (<1%)	
<i>Euphorbia eriantha</i>	1	0 (0-2)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	1	0 (0-2)	<1% (<1%)	
<i>Lesquerella tenella</i>	1	0 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	1	0 (0-1)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** Bursage/Elephant Tree (27)

**Subassociation:** White Bursage/Elephant Tree on alluvium/pediment (275)

**Scientific Name:** *Ambrosia dumosa*/*Bursera microphylla* on alluvium/pediment

**NVC Association:** None. However, there is a higher level to which this association likely belongs, the *Bursera microphylla* - *Jatropha cuneata* - *Pachycereus schottii* Desert Scrub Group.

**Previous classifications:** This is a subassociation of association 27, previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003), and characterized by the dominance/co-dominance of triangle-leaf bursage, and associates including organ pipe cactus and jumping bean. In the Goldwater – West, this association is characterized by the dominance/co-dominance of white bursage (*Ambrosia dumosa*), and is divided into two subassociations based on landform: 275, typically on course alluvium with a slope < 20%; and 276, on mountain slopes with >20% slope.

In the Warren et al. (1981) scheme for Organ Pipe, their '154.1271' is the most similar, because it is the only unit with elephant tree in all the relevés. However, organ pipe cactus is ubiquitous as well, a species entirely lacking from the present subassociation.



Figure 127. Relevé BM-5, on the west side of the Tinajas Altas Mountains. The darkest plants are elephant trees.

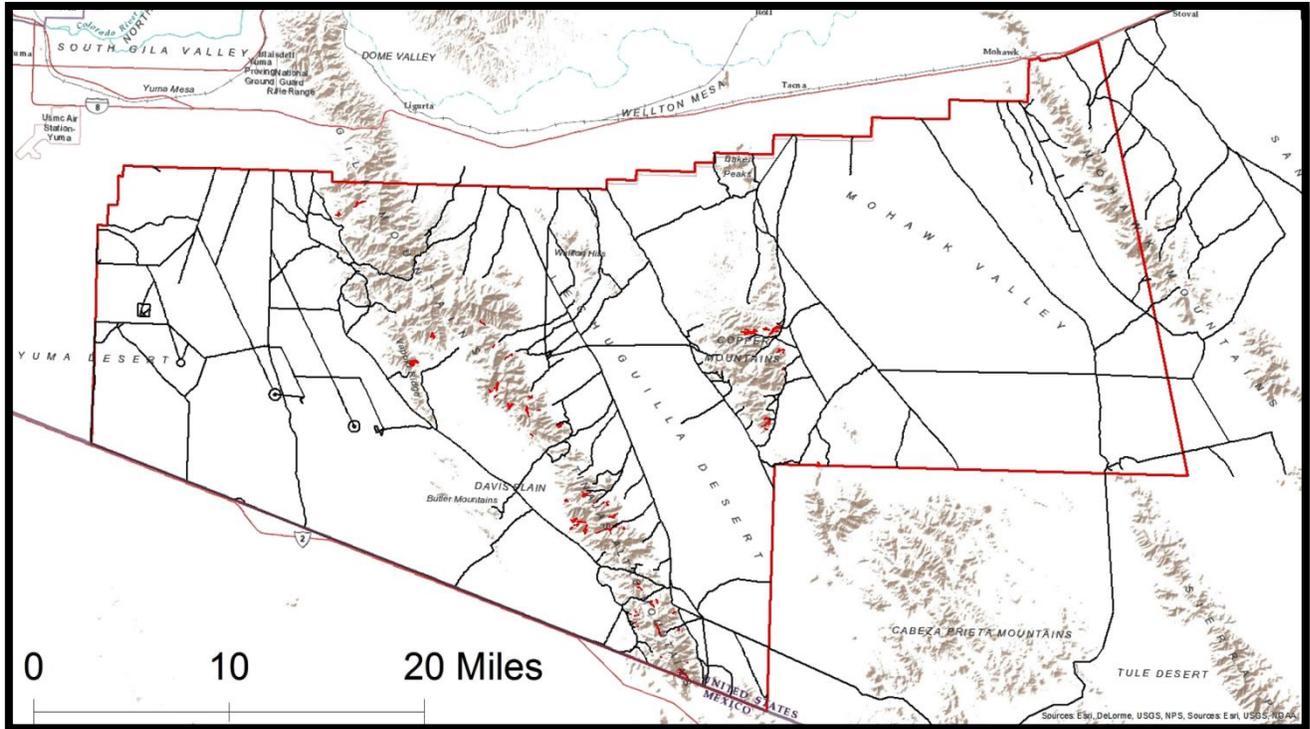


Figure 128. Distribution of White Bursage-Elphant Tree on alluvium/pediment (275) on the BMGR West.

**Description:** White bursage (*Ambrosia dumosa*) and elephant tree (*Bursera microphylla*) are the hallmarks, ranging from common to dominant, and with cover values from 1 – 14%. These two species typically dominate the mountain slopes above, but they are larger in the present subassociation: the elephant tree averages 2.9 m versus 1.6 m on the slope, and the bursage is 0.4 m versus 0.3 on the slope.

In all 7 relevés there were also *Fagonia californica*, *Hyptis emoryi*, *Encelia farinosa*, and *Krameria grayi*. Ironwood trees were in 5 of 7 relevés, but typically uncommon.

**Location:** On toe-slopes in canyons in the Gila, Copper, and Tinajas Altas Mountains, on poorly consolidated rubble derived from granitic rocks. The landform is similar to the bar/swale fans (175) further downslope, but the species composition is very different on the higher toe-slopes, with larger and more frost-sensitive species, such as the elephant tree. Occasionally, as on the west side of the Tinajas Altas Mountains, the elephant tree extends far from the toe slope onto what appears to be a pediment.

**Field Identification:** Elephant tree are common (prominence of three or more). Field mapping was aided by a spotting scope. If elephant tree was common on slopes above a toe-slope that could not be directly observed, it was inferred the elephant tree was likely below. If teddy-bear cholla (*Cylindropuntia bigelovii*) were also present, the area was mapped as the present subassociation. In other words, the elephant tree trumps the cholla.

**Photo Identification:** Photos were not useful, as the elephant trees were tough to distinguish from palo verde and large *Jatropha cuneata*.

**Vegetation:** White Bursage-Elephant Tree on alluvium/pediment

**Alliance/Association/Subassociation codes:** 2 / 27 / 275

**Number of Sample Sites (relevés):** 7

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	7	5 (3-5)	1-9% (1-14%)	0.4
<i>Bursera microphylla</i> Elephant tree	7	3 (3-5)	1-4% (1-9%)	2.9
<i>Fagonia californica</i> Fagonia	7	3 (3)	1-4% (<1-4%)	0.3
<i>Encelia farinosa</i> Brittlebush	7	3 (2-3)	<1-4% (<1-9%)	0.6
<i>Hyptis emoryi</i> Desert lavender	7	2 (1-3)	<1% (<1-4%)	
<i>Krameria grayi</i> Ratany	7	1 (1-3)	<1% (<1-4%)	
<i>Larrea tridentata</i> Creosote	5	3 (0-3)	<1-4% (<1-4%)	1.2
<i>Olneya tesota</i> Ironwood	5	2 (0-3)	<1% (<1-4%)	3.5
<i>Fouquieria splendens</i> Ocotillo	5	1 (0-3)	<1% (<1-4%)	2.4
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	5	1 (0-3)	<1% (<1-4%)	0.8
<i>Ephedra aspera</i> Mormon tea	4	2 (0-3)	<1% (<1-9%)	0.6
<i>Acacia greggii</i> Catclaw	4	1 (0-2)	<1% (<1%)	
<i>Trixis californica</i>	4	1 (0-1)	<1% (<1%)	
<i>Sphaeralcea ambigua</i> Mallow	3	0 (0-3)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	3	0 (0-2)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	3	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	2	0 (0-3)	<1% (<1%)	1.6
<i>Pleuraphis rigida</i> Big galleta grass	2	0 (0-3)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-2)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	2	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	1 (0-1)	<1% (<1%)	
<i>Salazaria mexicana</i>	1	1 (0-1)	<1% (<1%)	
<i>Horsfordia alata</i> Velvet mallow	1	1 (0-1)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-3)	<1% (<1%)	1.0
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-3)	<1% (<1-4%)	0.4
<i>Parkinsonia microphylla</i> Yellow paloverde	1	0 (0-3)	<1% (<1%)	
<i>Perityle emoryi</i>	1	0 (0-3)	<1% (<1-9%)	
<i>Agave deserti</i>	1	0 (0-2)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	1	0 (0-2)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	1	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	1	0 (0-2)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-1)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	1	0 (0-1)	<1% (<1%)	
<i>Pleurocoronis plurisetia</i> Arrowleaf	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** Bursage-Elephant Tree (27)

**Subassociation:** White Bursage-Elephant Tree-Brittlebush on mountains (276)

**Scientific Name:** *Ambrosia dumosa*/*Bursera microphylla*/*Encelia farinosa* on mountains

**NVC Association:** None. However, there is a higher level to which this association likely belongs, the *Bursera microphylla* - *Jatropha cuneata* - *Pachycereus schottii* Desert Scrub Group

**Previous classifications:** This is a subassociation of association 27, previously mapped in eastern CPNWR and adjoining BLM lands (Malusa 2003), and characterized by the dominance/co-dominance of triangle-leaf bursage, and associates including organ pipe cactus and jumping bean. (The Cabeza/BLM project excluded lands with >20% slope.) In the Goldwater – West, this association is characterized by the dominance/co-dominance of white bursage (*Ambrosia dumosa*), and is divided into two subassociations based on landform: 275, typically on bajadas with a slope < 20%; and 276, on mountain slopes with >20% slope.

In the Warren et al. (1981) scheme for Organ Pipe, their '154.1271' is the most similar, because it is the only unit with elephant tree in all the relevés. However, organ pipe cactus is ubiquitous as well, a species entirely lacking from the present subassociation.



Figure 129. Relevé BP-23, in the southern Copper Mountains. The large shrubby trees at left center are elephant trees.



Figure 130. Relevé CP-27, the view southwest from the Tinajas Altas Mountains to the Butler Mountains (BMGR West) and the Sierra el Rosario (Mexico). Elephant trees are common in the fore and middle ground.



Figure 131. Jim Malusa admires a fine specimen of elephant tree in the Tinajas Altas Mountains.

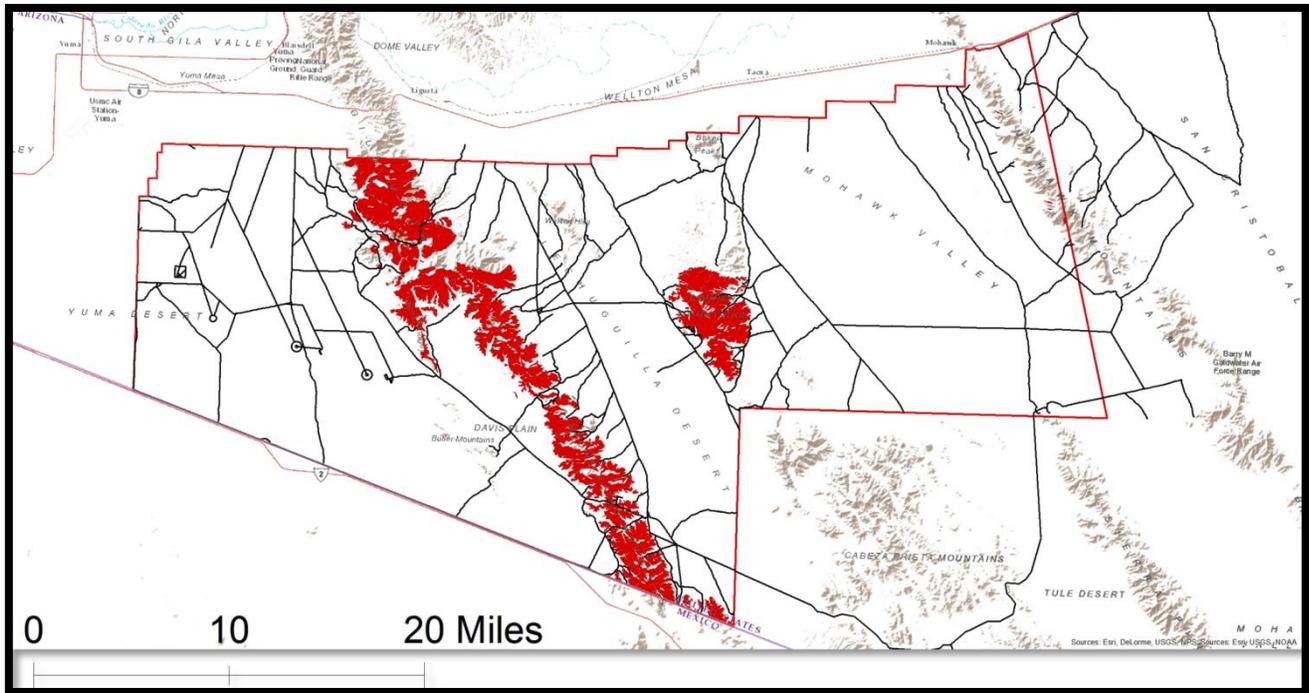


Figure 132. Distribution of White Bursage-Elephant Tree on mountains (276) on the BMGR West. Hardly visible at this scale are five small populations in the Mohawk Mts.

**Description:** A diverse mountain assemblage, with 79 species. Elephant tree is typically common, with 1-4% cover, and is present in all plots. White bursage (*Ambrosia dumosa*) is the most common species, typically codominant, with 1-4% cover.

The diversity can be bewildering for a vegetation mapper: there are 15 species that are dominant or co-dominant in at least one of the 51 relevés. Consequently, this subassociation is actually several combined – it would take much more field work to accurately map which species is dominant in a given hectare. Nevertheless, the median prominence values give a good picture of mountain slopes with white bursage and elephant tree, with common associates brittlebush (*Encelia farinosa*), lavender (*Hyptis emoryi*), and mallow (*Sphaeralcea ambigua*).

**Location:** Prefers granite, and typically southern exposures. Mostly in the Tinajas Altas Mountains, the southern Copper Mountains, and the Gila Mountains. Also in a few canyons in the Mohawk Mountains, usually on steep slopes facing northeast, and shaded from the summer morning sun by a high ridge. Elephant tree is mostly absent from the darker metamorphic rocks of the northern Copper Mountains and the central Gila Mountains. There were no elephant trees encountered in the Wellton Hills or Baker Peaks. Cooler or higher northern exposures are characterized by Mormon tea, *Ephedra* (see association 40).

**Field Identification:** Slopes >20% on which elephant trees are present, and typically common. In 7 of the 51 relevés, elephant trees were rare or uncommon, yet they were included in this mapping unit if there were deemed not part of the *Rhus kearnyi* subassociation (141) or the

*Ephedra aspera* subassociation (140), both of which occur on granite mountains. Large areas of mostly bare rock were included in this mapping unit if it were bracketed by elephant tree on both sides.

**Photo Identification:** Photos were not useful, as the elephant trees were indistinguishable from palo verde and large *Jatropha cuneata*. Mapping was in the field, sometimes with the assistance of a spotting scope. Each mountain range was climbed to the summit, during which the height to which elephant tree persists. Typically, the species did not range over 2500 feet on south facing slopes, presumably because of frost.

**Vegetation:** White Bursage-Elephant Tree on mountains

**Alliance/Association/Subassociation codes:** 2 / 27 / 276

**Number of Sample Sites (relevés):** 51

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	51	4 (3-5)	1-4% (1-14%)	0.3
<i>Bursera microphylla</i> Elephant tree	51	3 (1-5)	1-4% (<1-14%)	1.6
<i>Encelia farinosa</i> Brittlebush	46	3 (0-5)	<1% (<1-25%)	0.6
<i>Hyptis emoryi</i> Desert lavender	42	3 (0-5)	<1% (<1-25%)	1.2
<i>Sphaeralcea ambigua</i> Mallow	42	3 (0-4)	<1% (<1-9%)	0.5
<i>Fouquieria splendens</i> Ocotillo	41	2 (0-4)	<1% (<1-9%)	3.5
<i>Larrea tridentata</i> Creosote	37	2 (0-4)	<1% (1-9%)	1.2
<i>Pleuraphis rigida</i> Big galleta grass	36	3 (0-3)	<1% (<1-4%)	0.9
<i>Fagonia californica</i> Fagonia	35	2 (0-4)	<1% (<1-9%)	0.3
<i>Agave deserti</i>	34	2 (0-3)	<1% (<1-4%)	0.6
<i>Ephedra aspera</i> Mormon tea	32	2 (0-4)	<1% (<1-9%)	0.6
<i>Hibiscus denudatus</i> Rock hibiscus	32	2 (0-4)	<1% (<1-4%)	0.6
<i>Pleurocoronis pluriseta</i> Arrowleaf	31	2 (0-4)	<1% (<1-9%)	0.5
<i>Krameria grayi</i> Ratany	30	1 (0-3)	<1% (<1-4%)	0.5
<i>Trixis californica</i>	29	1 (0-3)	<1% (<1-4%)	
<i>Eriogonum inflatum</i> Desert trumpet	23	0 (0-3)	<1% (<1-9%)	0.4
<i>Ditaxis lanceolata</i> Silverleaf	20	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	20	0 (0-3)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	19	0 (0-4)	<1% (<1-9%)	1.0

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Parkinsonia microphylla</i> Yellow Paloverde	19	0 (0-4)	<1% (<1-9%)	2.6
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	19	0 (0-3)	<1% (<1-4%)	0.4
<i>Peucephyllum schottii</i>	17	0 (0-3)	<1% (<1-4%)	0.8
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	16	0 (0-3)	<1% (<1-4%)	0.5
<i>Asclepias albicans</i>	16	0 (0-3)	<1% (<1%)	1.1
<i>Carnegiea gigantea</i> Saguaro	16	0 (0-2)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	14	0 (0-3)	<1% (<1-4%)	0.6
<i>Ferocactus cylindraceus</i> California barrel	14	0 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	13	0 (0-3)	<1% (<1-4%)	3
<i>Eriogonum fasciculatum</i> Flattop buckwheat	12	0 (0-3)	<1% (<1-9%)	0.4
<i>Acacia greggii</i> Catclaw	11	0 (0-3)	<1% (<1%)	1.5
<i>Lycium sp.</i> Wolfberry	10	0 (0-4)	<1% (<1-9%)	1.0
<i>Lotus rigidus</i>	10	0 (0-3)	<1% (<1-4%)	0.3
<i>Mirabilis bigelovii</i> Wishbone bush	10	0 (0-3)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	10	0 (0-3)	<1% (<1%)	
<i>Eriogonum wrightii</i>	9	0 (0-3)	<1% (<1-4%)	0.3
<i>Nolina bigelovii</i> Desert Beargrass	9	0 (0-3)	<1% (<1-4%)	
<i>Perityle emoryi</i>	7	0 (0-3)	<1% (<1-4%)	
<i>Caesalpinia virgata</i> Wand holdback	6	0 (0-3)	<1% (<1-4%)	0.9
<i>Erioneuron pulchellum</i>	5	0 (0-2)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	4	0 (0-4)	<1% (<1-9%)	1.3
<i>Porophyllum gracile</i>	4	0 (0-3)	<1% (<1-4%)	0.4
<i>Gallium stellatum</i>	4	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
Bedstraw				
<i>Krameria erecta</i> Ratany	4	0 (0-2)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	4	0 (0-1)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	3	0 (0-3)	<1% (<1-9%)	0.9
<i>Aristida adscensionis</i> Six-weeks three-awn	3	0 (0-3)	<1% (<1-4%)	
<i>Viguiera deltoidea</i>	3	0 (0-3)	<1% (<1%)	0.7
<i>Cheilanthes parryi</i>	3	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	3	0 (0-2)	<1% (<1%)	
<i>Gymnosperma glutinosa</i>	3	0 (0-2)	<1% (<1%)	
<i>Horsfordia alata</i> Velvet mallow	3	0 (0-2)	<1% (<1%)	
<i>Horsfordia neomexicana</i> Velvet mallow	3	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	3	0 (0-2)	<1% (<1%)	
<i>Rhus kearnyi</i> Kearny's sumac	3	0 (0-2)	<1% (<1%)	1.1
<i>Echinocereus engelmannii</i> Hedgehog cactus	3	0 (0-1)	<1% (<1%)	
<i>Physalis crassifolia</i>	3	0 (0-1)	<1% (<1%)	
<i>Lupinus arizonica</i>	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	2	0 (0-2)	<1% (<1%)	
<i>Heteropogon contortus</i>	2	0 (0-2)	<1% (<1%)	
<i>Phacelia sp.</i>	2	0 (0-2)	<1% (<1%)	
<i>Thamnosma montana</i>	2	0 (0-2)	<1% (<1%)	0.5
<i>Aristida purpurea</i>	2	0 (0-1)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-3)	<1% (<1-4%)	
<i>Plantago ovata</i> Wooly plantain	1	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Brassica tournefortii</i> Sahara mustard	1	0 (0-2)	1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	1	0 (0-2)	<1% (<1%)	
<i>Gilia stellata</i>	1	0 (0-2)	<1% (<1%)	
<i>Mentzelia multiflora</i>	1	0 (0-2)	<1% (<1%)	
<i>Schismus barbatus</i>	1	0 (0-2)	<1% (<1%)	
<i>Argythamnia brandegeei</i>	1	0 (0-1)	<1% (<1%)	
<i>Aristida sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Aristida sp. (perennial)</i>	1	0 (0-1)	<1% (<1%)	
<i>Asclepias subulata</i>	1	0 (0-1)	<1% (<1%)	
<i>Chylismia arenaria</i>	1	0 (0-1)	<1% (<1%)	
<i>Crososoma bigelovii</i>	1	0 (0-1)	<1% (<1%)	
<i>Macharanthera pinnatifida</i>	1	0 (0-1)	<1% (<1%)	
<i>Nicotiana obtusifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Penstemon pseudospectabilis</i>	1	0 (0-1)	<1% (<1%)	
<i>Psorothamnus schottii</i>	1	0 (0-1)	<1% (<1%)	1.3

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage – Creosote (28)

**Subassociation:** White Bursage- Creosote – Ocotillo (280)

**Scientific Name:** *Ambrosia dumosa*-*Larrea tridentata*-*Fouquieria splendens* shrubland.

**NVC Association:** *Ambrosia dumosa*-*Larrea tridentata* var. *tridentata* Dwarf-shrubland.

**Previous classifications:** Warren et al. (1981) classify similar lands as 154.1111, but with this distinction: their scheme includes either/both *Ambrosia dumosa* and *A. deltoidea*, sub-dominant to *Larrea tridentata*. In the BMGR West, there are large areas that are clearly dominated by white bursage (*Ambrosia dumosa*).



Figure 133. Relevé WH-30, near northern boundary of the BMGR West and Ave 25E, the view southwest to the Gila Mountains.



Figure 134. Relevé EOBP-9, near the Mohawk Drag, looking east to the Mohawk Mountains. Ocotillo is usually common in this subassociation, but as this photo shows, not always.

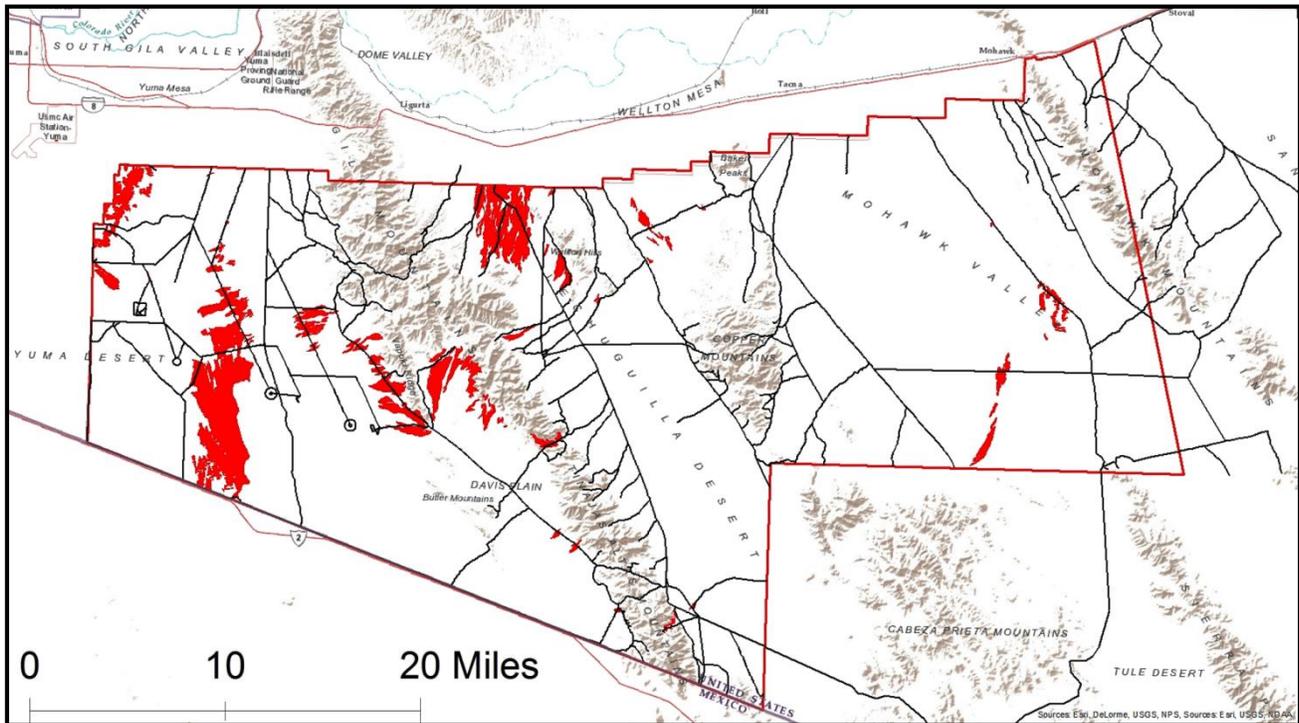


Figure 135. Distribution of White Bursage- Creosote – Ocotillo (280) on the BMGR West.

**Description:** Sandy fans and ridges where *Ambrosia dumosa* is dominant to, occasionally, co-dominant with creosote (*Larrea tridentata*). *A. dumosa* has a median cover of 5-9%, compared with 1-4% for *Larrea*. Ocotillo (*Fouquieria splendens*) is at 20 of 25 relevés, and is typically common; it especially abundant near the Gila Mountains, but is absent from relevés far from the mountain front. *Krameria grayi* is also at 20 of 25 relevés, and big galleta grass (*Pleuraphis rigida*) and diamond cholla (*Cylindropuntia ramosissima*) are at 17 and 16 relevés, respectively. Paloverde and ironwood trees are never common, and are present at only four and eight of the relevés, respectively.

**Location:** Localized but abundant in several locations: (a) the northern Lechuguilla Valley, especially northwest of the Wellton Hills; (b) near the Davis Plain and Vopoki Ridge in the southern Gila Mountains; (c) the west side of the Yuma Dunes; (d) along the ASH highway in the northwest corner of the BMGR West; and (e) a north-south trending band in the central Mohawk Valley, curiously adjacent to the range limit of the triangle-leaf bursage.

It is usually in relatively flat areas with slopes of 1 to 2%.

**Field Identification:** The bursage is dominant/codominant. Trees are absent, rare, or uncommon. Each of the following species must be < 1% cover: big galleta grass, palo verde, and ironwood.

**Photo Identification:** The most recent imagery is good enough to see both the bursage and creosote bush, and decide which is the most common. On older imagery, the bursage dominant areas were apparent from a lack of tell-tale polka-dots of large creosote. With any imagery, in the western reaches of Goldwater West it can be difficult to discern between various *A. dumosa* associations (Fig. 136).



Figure 136. Example from the west side of the Yuma Dunes, near the international frontier. White bursage is dominant across the image area, yet the right side was mapped as dunes because of the wind-scalloped features. In reality, the transition is very gradual on the west side of the dunes; on the east side (not shown), in the lee of prevailing winds, it's relatively abrupt, and easy to draw the line. Image is 1.5 miles (2.4 km) across.

**Vegetation:** *Ambrosia dumosa*/*Larrea tridentata* (White bursage/creosote)

**Alliance/Association/Subassociation codes:** 2 / 28 / 280

**Number of Sample Sites (relevés):** 25

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	25	5 (3-5)	5-9% (<1-14%)	0.5
<i>Larrea tridentata</i> Creosote	25	3 (3-4)	1-4% (<1-14%)	1.0
<i>Fouquieria splendens</i> Ocotillo	20	3 (0-5)	<1% (<1-4%)	3.4
<i>Krameria grayi</i> Ratany	20	2 (0-4)	<1% (<1-9%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	17	2 (0-3)	<1% (<1-4%)	0.7
<i>Cylindropuntia ramosissima</i> Diamond cholla	16	2 (0-3)	<1% (<1%)	0.4
<i>Encelia farinosa</i> Brittlebush	13	1 (0-4)	<1% (<1-4%)	0.8
<i>Brassica tournefortii</i> Sahara mustard	13	1 (0-4)	<1% (<1-14%)	
<i>Olneya tesota</i> Ironwood	8	0 (0-2)	<1% (<1%)	3.0
<i>Cylindropuntia echinocarpa</i> Silver cholla	6	0 (0-3)	<1% (<1-4%)	0.7
<i>Carnegiea gigantea</i> Saguaro	6	0 (0-2)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	4	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	4	0 (0-1)	<1% (<1%)	
<i>Chorizanthe rigida</i> Spineflower	3	0 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	3	0 (0-3)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	3	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Echinocereus engelmannii</i> Hedgehog cactus	2	0 (0-2)	<1% (<1%)	
<i>Orobanche cooperi</i>	2	0 (0-1)	<1% (<1%)	
<i>Palafoxia arida</i> Spanish needles	1	0 (0-3)	<1% (<1-4%)	
<i>Phacelia sp.</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Plantago ovata</i> Woolly plantain	1	0 (0-3)	<1% (<1-4%)	
<i>Agave deserti</i>	1	0 (0-3)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	1	0 (0-3)	<1% (<1%)	
<i>Plantago sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	1	0 (0-20)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-2)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-2)	<1% (<1%)	
<i>Acacia greggii</i> Catclaw	1	0 (0-1)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	1	0 (0-1)	<1% (<1%)	
<i>Chorizanthe corrugata</i>	1	0 (0-1)	<1% (<1%)	
<i>Datura discolor</i>	1	0 (0-1)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	1	0 (0-1)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	1	0 (0-1)	<1% (<1%)	
<i>Penstemon parryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	1	0 (0-1)	<1% (<1%)	
<i>Psoralea schottii</i>	1	0 (0-1)	<1% (<1%)	
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-1)	<1% (<1%)	
<i>Tiquilia palmeri</i> Crinklemat	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage – Creosote/PaloVerde/Ironwood (29)

**Subassociation:** White Bursage- Creosote – Yellow PaloVerde (291)

**Scientific Name:** *Ambrosia dumosa* / *Larrea tridentata* / *Parkinsonia microphylla* shrubland.

**NVC Association:** None. There is an *Ambrosia dumosa*-*Larrea tridentata* var. *tridentata* Dwarf-shrubland, but it does not include yellow palo verde. There is also a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland, but is part of the *Carnegiea gigantea* - *Parkinsonia microphylla* - *Ambrosia deltoidea* Mixed Cacti Desert Scrub Group. *Ambrosia deltoidea* does not occur in this subassociation.

**Previous classifications:** Not previously mapped outside of the Goldwater Range – yet there is something similar mentioned in Warren et al. (1981) vegetation map for Organ Pipe Cactus NM. There is a vegetation listed as 154.1263, called "*Cercidium microphyllum* (= *Parkinsonia microphylla*)-*Encelia farinosa*-*Ambrosia dumosa* association". It is found on southerly slopes (20 – 45 percent) and nearly level mesa tops..." The latter is associated with "extensive caliche accumulation." Given this description, it is not a good match.



Figure 137. Relevé WSE-19, on a bajada below the Copper Mountains.

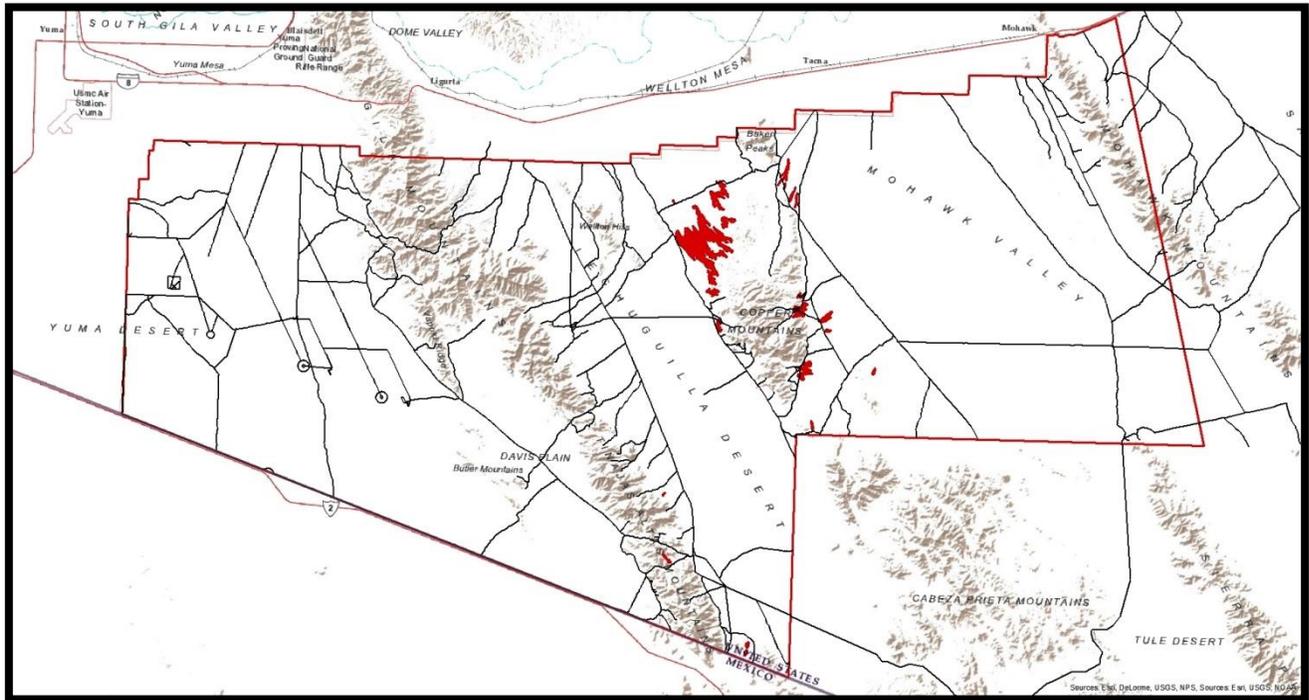


Figure 138. Distribution of White Bursage- Creosote – Yellow Paloverde (291) on the BMGR West.

**Description:** This is similar to the oft-photographed "Arizona Upland", except sparser, and with white bursage (*Ambrosia dumosa*) instead of triangle-leaf bursage. White bursage and creosote (*Larrea tridentata*) are typically codominant, and with 5-9% cover. Yellow paloverde is common, with 1-4% cover. Ironwood is typically common at all 7 relevés, yet cover is low, usually < 1%. Within the Goldwater West, this is most similar to subassociation 292, where ironwood replaces the yellow paloverde as the dominant tree. Saguaro, Ocotillo (*Fouquieria splendens*) and brittlebush (*Encelia farinosa*) are also common, and present at all 6, 5 and 5 of the 7 sites, respectively.

**Location:** Mostly limited to bajadas below the Copper Mountains, on slopes of 1 to 5%.

**Field Identification:** Yellow paloverdes are over 1% cover; creosote is not dominant.

**Photo Identification:** Tree cover was estimated from imagery, but it was not possible to distinguish between ironwood and yellow paloverde. This was not a problem after the western limit to the yellow paloverde was established through field work.

**Vegetation:** White Bursage- Creosote – Yellow PaloVerde

**Alliance/Association/Subassociation codes:** 2 / 29 / 291

**Number of Sample Sites (relevés):** 7

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	7	4 (4-5)	5-9% (1-14%)	0.4
<i>Larrea tridentata</i> Creosote	7	4 (3-4)	5-9% (1-9%)	1.2
<i>Parkinsonia microphylla</i> Yellow Paloverde	7	3 (3-4)	1-4% (<1-9%)	3.3
<i>Olneya tesota</i> Ironwood	7	3 (1-3)	<1% (<1-9%)	3.1
<i>Carnegiea gigantea</i> Saguaro	6	2 (0-3)	<1% (<1-4%)	
<i>Encelia farinosa</i> Brittlebush	5	2 (0-3)	<1% (<1-9%)	1.1
<i>Brassica tournefortii</i> Sahara mustard	5	2 (0-3)	<1% (<1-4%)	
<i>Fouquieria splendens</i> Ocotillo	5	2 (0-3)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	5	1 (0-4)	<1% (<1-9%)	0.7
<i>Krameria grayi</i> Ratany	4	2 (0-4)	<1% (<1%)	0.5
<i>Cylindropuntia ramosissima</i> Diamond cholla	4	1 (0-3)	<1% (<1-4%)	0.4
<i>Fagonia californica</i> Fagonia	3	0 (0-3)	<1% (<1-4%)	0.2
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	3	0 (0-3)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	3	0 (0-3)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	3	0 (0-3)	<1% (<1%)	
<i>Euphorbia eriantha</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Krameria erecta</i> Ratany	2	0 (0-3)	<1% (<1-4%)	0.4
<i>Lycium sp.</i> Wolfberry	2	0 (0-3)	<1% (<1-4%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	2	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	2	0 (0-2)	<1% (<1%)	
<i>Cryptantha sp.</i> Pick-me-not	1	0 (0-3)	<1% (<1-4%)	
<i>Eriogonum inflatum</i> Desert trumpet	1	0 (0-3)	<1% (<1-4%)	
<i>Geraea canescens</i> Desert sunflower	1	0 (0-3)	<1% (<1-4%)	
<i>Psorothamnus fremontii</i>	1	0 (0-3)	<1% (<1-4%)	0.7
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-3)	<1% (<1-4%)	
<i>Nama demissum</i>	1	0 (0-3)	<1% (<1%)	
<i>Phacelia ambigua</i>	1	0 (0-3)	<1% (<1%)	
<i>Atriplex polycarpa</i> Cattle saltbush	1	0 (0-2)	<1% (<1%)	
<i>Dalea mollissima</i> Silky dalea	1	0 (0-2)	<1% (<1%)	
<i>Eschscholzia minutiflora</i>	1	0 (0-2)	<1% (<1%)	
<i>Horsfordia neomexicana</i>	1	0 (0-2)	<1% (<1%)	
<i>Acacia greggii</i> Catclaw	1	0 (0-1)	<1% (<1%)	
<i>Agave deserti</i>	1	0 (0-1)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	1	0 (0-1)	<1% (<1%)	
<i>Brandegea bigelovii</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-1)	<1% (<1%)	
<i>Encelia frutescens</i> Button brittlebush	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-1)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	1	0 (0-1)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	1	0 (0-1)	<1% (<1%)	
<i>Marina parryi</i>	1	0 (0-1)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	1	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Prosopis glandulosa</i> Mesquite	1	0 (0-1)	<1% (<1%)	1.1
<i>Sphaeralcea ambigua</i> Mallow	1	0 (0-1)	<1% (<1%)	
<i>Trichoptilium incisum</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Bursage (2)

**Association:** White Bursage – Creosote/PaloVerde/Ironwood (29)

**Subassociation:** White bursage-Creosote-Brittlebush/Ironwood (292)

**Scientific Name:** *Ambrosia dumosa* - *Larrea tridentata* –*Encelia farinosa*/*Olneya tesota* shrubland.

**NVC Association:** None. There is an *Ambrosia dumosa*-*Larrea tridentata* var. *tridentata* Dwarf-shrubland, but it does not include yellow palo verde. There is also a *Parkinsonia microphylla* - *Larrea tridentata* Shrubland, but is part of the *Carnegiea gigantea* - *Parkinsonia microphylla* - *Ambrosia deltoidea* Mixed Cacti Desert Scrub Group. *Ambrosia deltoidea* does not occur in this subassociation.

**Previous classifications:** Not previously mapped outside of the Goldwater Range.



Figure 139. Relevé BP-22, on the SE side of the Copper Mountains, with the white bursage in the foreground, robust and blooming after rains.



Figure 140. Relevé TA-45, on the west side of Tinajas Altas Pass, showing a more desiccated version of the mapping unit.

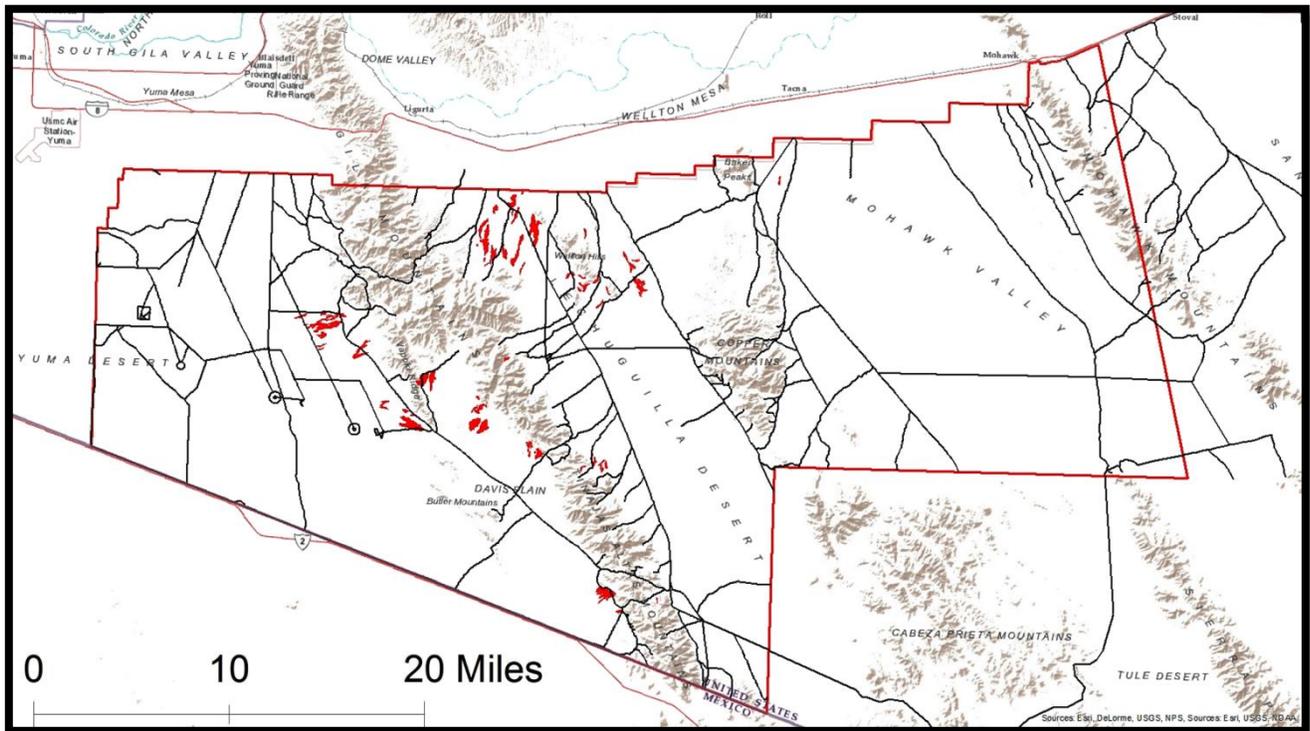


Figure 141. Distribution of White Bursage- Creosote – Yellow PaloVerde (291) on the BMGR West.

**Description:** On bajadas where arroyos fan out into distributaries. White bursage and creosote are typically codominant, and with 5-9% cover. Ironwood and brittlebush are common, with 1-4% cover. All other species are typically with <1% cover. This subassociation is a more arid version of subassociation 291. Diamond cholla and ocotillo are at 7 of 9 relevés, and saguaros at 6 of 9.

**Location:** The Wellton Hills, Gila Mountains, and Tinajas Altas Mountains.

**Field Identification:** Ironwood with over 1% cover; creosote (*Larrea tridentata*) is not dominant; yellow paloverde is absent.

**Photo Identification:** Tree cover was estimated from imagery, but it was not possible to distinguish between ironwood and yellow paloverde. This was not a problem after the western limit to the yellow paloverde was established through field work.

**Vegetation:** White Bursage-Creosote-Brittlebush/Ironwood

**Alliance/Association/Subassociation codes:** 2 / 29 / 292

**Number of Sample Sites (relevés):** 9

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	9	4 (3-5)	5-9% (1-9%)	0.4
<i>Larrea tridentata</i> Creosote	9	4 (3-4)	5-9% (<1-9%)	1.1
<i>Encelia farinosa</i> Brittlebush	9	3 (1-5)	1-4% (<1-9%)	0.9
<i>Olneya tesota</i> Ironwood	9	3 (3)	1-4% (<1-9%)	3.1
<i>Cylindropuntia ramosissima</i> Diamond cholla	7	2 (0-3)	<1% (<1-4%)	0.4
<i>Fouquieria splendens</i> Ocotillo	7	2 (0-3)	<1% (<1-4%)	3.1
<i>Carnegiea gigantea</i> Saguaro	6	2 (0-3)	<1% (<1-4%)	
<i>Lycium sp.</i> Wolfberry	6	2 (0-3)	<1% (<1-4%)	1.1
<i>Parkinsonia florida</i> Blue paloverde	5	1 (0-3)	<1% (<1-4%)	3.4
<i>Krameria grayi</i> Ratany	5	3 (0-3)	<1% (<1%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	3	0 (0-3)	<1% (<1-4%)	0.9
<i>Brassica tournefortii</i> Sahara mustard	2	0 (0-3)	<1% (<1-4%)	
<i>Chorizanthe rigida</i> Spineflower	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-3)	<1% (<1-4%)	
<i>Plantago ovata</i> Wooly plantain	1	0 (0-3)	<1% (<1-4%)	
<i>Rafinesquia neomexicana</i>	1	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-3)	<1% (<1%)	
<i>Atriplex hymenelytra</i> Desert Holly	1	0 (0-2)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-2)	<1% (<1%)	
<i>Eschscholzia minutiflora</i>	1	0 (0-2)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-2)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	1	0 (0-2)	<1% (<1%)	
<i>Sphaeralcea sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Atriplex polycarpa</i> Cattle saltbush	1	0 (0-1)	<1% (<1%)	
<i>Datura discolor</i>	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-1)	<1% (<1%)	
<i>Hesperocallis undulata</i> Ajo lily	1	0 (0-1)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	1	0 (0-1)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-1)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Mormon Tea (4)

**Association:** Mormon Tea-Agave/White Bursage (40)

**Subassociation:** Mormon Tea-Agave/White Bursage (400)

**Scientific Name:** *Ephedra aspera*-*Agave deserti*-*Ambrosia dumosa* shrubland.

**NVC Association:** *Nolina bigelovii* shrubland is described from southern California as such: "*This shrubland is characterized by the subshrub Nolina bigelovii, forming an open, emergent canopy over a low (<1 m tall) shrub layer that is composed of succulents and microphyllous evergreen and deciduous species. Common species may include Ferocactus cylindraceus, Coleogyne ramosissima, Encelia farinosa, Eriogonum fasciculatum, Acacia greggii, Agave deserti, Hyptis emoryi, Ericameria linearifolia, Simmondsia chinensis, and Ambrosia dumosa. Emergent individuals of Juniperus californica or Fouquieria splendens up to 5 m in height, may also be present.*"

This description doesn't match well with the observed vegetation on the BMGR West. A closer match is the NVC *Ambrosia dumosa - Ephedra (fasciculata, nevadensis)* Dwarf-shrubland. This is reported from the Grand Canyon, with several species in common (e.g., *Acacia greggii, Machaeranthera pinnatifida*). *Ephedra nevadensis* is closely related to *Ephedra aspera* (some would say a synonym). But most of the associated species are different, as well as the landform: the Grand Canyon association occurs 'on moderately sloping gradients (10-15 degrees), but has also been seen on nearly flat surfaces.'" The subassociation described here is on steep mountain slopes or canyon bottoms, with brittlebush an important associate.

**Previous classifications:** Not previously mapped in SW Arizona.



Figure 142. Relevé WH-53, on the north slope of Sheep Mountain. The tall shrubs are *Nolina bigelovii*, desert beargrass. Mormon tea is the low dense shrub.



Figure 143. Relevé RB-16, one mile southwest of Raven Butte. The subassociation is at its lower limit at this location. Mormon tea (*Ephedra aspera*) is the shrub in the foreground.



Figure 144. Relevé BP-10, near the summit of the Copper Mountains, one of only two mountains in Arizona to hold the rare mint *Salvia vaseyi*. The other range is the Sierra Pinta in CPNWR.

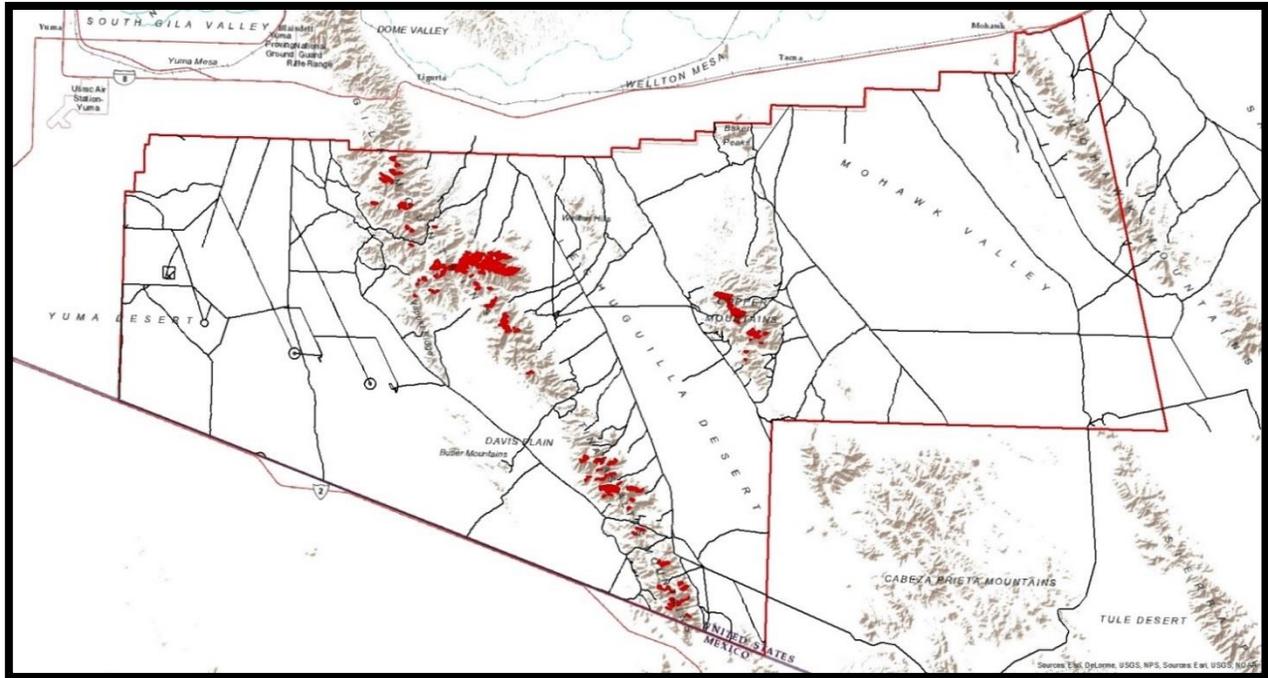


Figure 145. Distribution of Mormon Tea-Agave/White Bursage (400) on the BMGR West.

**Description** This is the 'alpine' habitat – steep north slopes - and is typically dominated by a 5-9 percent cover of Mormon tea (*Ephedra aspera*). The most common associates are *Agave deserti* and *Ambrosia dumosa*, both with 1-4% cover. Brittlebush, spiny aster (*Machaeranthera pinnatifida*), and arrowleaf (*Pleurocoronis pluriseta*) are slightly less common, but nonetheless present at 13, 11, and 11, respectively, of the 13 relevés. It is apparently too cold for elephant trees and saguaros, which occasionally are present but are never common. There are, however, a host of species unique to this habitat, including goldeneye (*Viguiera parishii*), buckwheat (*Erigonum fasciculatum*), desert beargrass (*Nolina bigelovii*), and a pair of sages, *Salvia mohavensis* and *Salvia vaseyi*, with the latter being a rare plant known from only one other mountain range in Arizona, the Sierra Pinta in the CPNWR.

**Location:** On north facing granite slopes usually above 1500 feet in Gila, Copper, and Tinajas Altas Mountains. It is notably absent from the darker metamorphic Mohawk Mountains, despite their 2800 foot elevation.

**Field Identification:** Mapping was mostly from the field, sometimes with the assistance of a spotting scope. Each mountain range was climbed to the summit, and often several summits, to determine the elevational limits of several species. Specifically, either Mormon tea (*Ephedra aspera*), goldeneye (*Viguiera parishii*), buckwheat (*Erigonum fasciculatum*) must have over 1% cover. Also, Kearny's sumac (*Rhus kearnyi*) must be less than 1% cover. If the sumac exceeded this cover, it was classified as subassociation 410 (see below).

**Photo Identification:** Imagery could help distinguish Kearny's sumac, and estimate coverage. However, the sumac favors north-slope canyons, which are often in shadow.

**Vegetation:** Mormon Tea-Agave/White Bursage

**Alliance/Association/Subassociation codes:** 4 / 40 / 400

**Number of Sample Sites (relevés):** 13

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ephedra aspera</i> Mormon tea	13	4 (3-5)	5-9% (1-9%)	0.7
<i>Agave deserti</i>	13	3 (3-4)	1-4% (<1-9%)	0.5
<i>Sphaeralcea ambigua</i> Mallow	13	3 (2-3)	<1% (<1-4%)	0.6
<i>Encelia farinosa</i> Brittlebush	13	3 (1-4)	<1% (<1-9%)	0.6
<i>Ambrosia dumosa</i> White bursage	12	3 (0-5)	1-4% (<1-9%)	0.3
<i>Fouquieria splendens</i> Ocotillo	12	2 (0-3)	<1% (<1-4%)	
<i>Machaeranthera Pinnatifida</i> Spiny goldenweed	11	3 (0-4)	<1% (<1-4%)	0.5
<i>Pleurocoronis pluriseta</i> Arrowleaf	11	3 (0-4)	<1% (<1-4%)	0.6
<i>Krameria grayi</i> Ratany	10	2 (0-4)	<1% (<1-4%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	10	2 (0-3)	<1% (<1-4%)	
<i>Hyptis emoryi</i> Desert lavender	9	2 (0-3)	<1% (<1-4%)	1.5
<i>Galium stellatum</i> Bedstraw	9	1 (0-3)	<1% (<1-4%)	0.4
<i>Larrea tridentata</i> Creosote	8	1 (0-4)	<1% (<1-4%)	1.6
<i>Lotus rigidus</i>	7	1 (0-3)	<1% (<1-4%)	0.5
<i>Trixis californica</i>	7	1 (0-3)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	7	1 (0-2)	<1% (<1-4%)	0.8
<i>Rhus kearnyi</i> Kearny's sumac	7	1 (0-2)	<1% (<1%)	
<i>Viguiera parishii</i> Goldeneye	6	0 (0-5)	<1% (<1-14%)	0.8
<i>Eriogonum fasciculatum</i> Flattop buckwheat	6	0 (0-4)	<1% (<1-9%)	0.4

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Mirabilis bigelovii</i> Wishbone bush	6	0 (0-4)	<1% (<1-9%)	0.3
<i>Nolina bigelovii</i> Desert beargrass	6	0 (0-4)	<1% (<1-9%)	2.1
<i>Bursera microphylla</i> Elephant tree	5	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	4	0 (0-3)	<1% (<1-9%)	0.8
<i>Erigeron oxyphyllus</i>	4	0 (0-3)	<1% (<1-4%)	0.4
<i>Eriogonum wrightii</i>	4	0 (0-3)	<1% (<1-4%)	0.4
<i>Bebbia juncea</i> Sweetbush	3	0 (0-3)	<1% (<1-4%)	
<i>Acacia greggii</i> Catclaw	3	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i>	3	0 (0-2)	<1% (<1%)	
<i>Menodora scabra</i>	2	0 (0-3)	<1% (<1-4%)	0.4
<i>Achnatherum speciosum</i>	2	0 (0-3)	<1% (<1%)	0.4
<i>Teucrium glandulosum</i>	2	0 (0-3)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-2)	<1% (<1%)	
<i>Gymnosperma glutinosum</i> Gumhead	2	0 (0-2)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	2	0 (0-2)	<1% (<1%)	
<i>Perityle emoryi</i>	2	0 (0-2)	<1% (<1%)	
<i>Porophyllum gracile</i>	2	0 (0-2)	<1% (<1%)	
<i>Penstemon pseudospectabilis</i>	2	0 (0-1)	<1% (<1-4%)	0.7
<i>Abronia villosa</i> Sand verbena	2	0 (0-1)	<1% (<1%)	
<i>Nicotiana obtusifolia</i>	2	0 (0-1)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	2	0 (0-1)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	1	0 (0-3)	<1% (<1-4%)	
<i>Phacelia pedicellata</i>	1	0 (0-3)	<1% (<1-4%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Salvia vaseyi</i>	1	0 (0-3)	<1% (<1%)	
<i>Thamnosma montana</i>	1	0 (0-3)	<1% (<1%)	0.6
<i>Brickellia atrectyloides</i>	1	0 (0-2)	<1% (<1%)	0.4
<i>Cheilanthes parryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i>	1	0 (0-2)	<1% (<1%)	
<i>Ziziphus obtusifolia</i>	1	0 (0-2)	<1% (<1%)	
<i>Asclepias albicans</i>	1	0 (0-1)	<1% (<1%)	
<i>Camissonia spp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	1	0 (0-1)	<1% (<1%)	
<i>Dudleya arizonica</i>	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-1)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0 (0-1)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	1	0 (0-1)	<1% (<1%)	
<i>Salvia mohavensis</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Mormon Tea (4)

**Association:** Arrowleaf/Sumac/Beargrass/MormonTea (41)

**Subassociation:** Arrowleaf/Sumac-Beargrass/MormonTea-Lavender (410)

**Scientific Name:** *Pleurocoronis pluriseta*/*Rhus kearnyi*-*Nolina bigelovii*/*Ephedra aspera*-*Hyptis emoryi* shrubland.

**NVC Association:** *Nolina bigelovii* shrubland is listed, but is described from California, without mention of *Rhus kearnyi* and indicator species of the subassociation listed here. However, the present subassociation from the BMGR West is very likely a member of the higher level "Sonoran Granite Outcrop Desert Scrub Group".

**Previous classifications:** Not previously mapped.



Figure 146. Relevé CP -2, one mile south of Raven Butte, Tinajas Altas Mountains. The large green shrub is *Rhus kearnyi*, Kearny's sumac.



Figure 147. Relevé CP-20, Skull Canyon, Gila Mountains, one mile north of Cipriano Pass. The dark shrubs are *Rhus kearnyi*.



Figure 148. Relevé WH-54, near summit of Sheep Mountain, Gila Mountains.

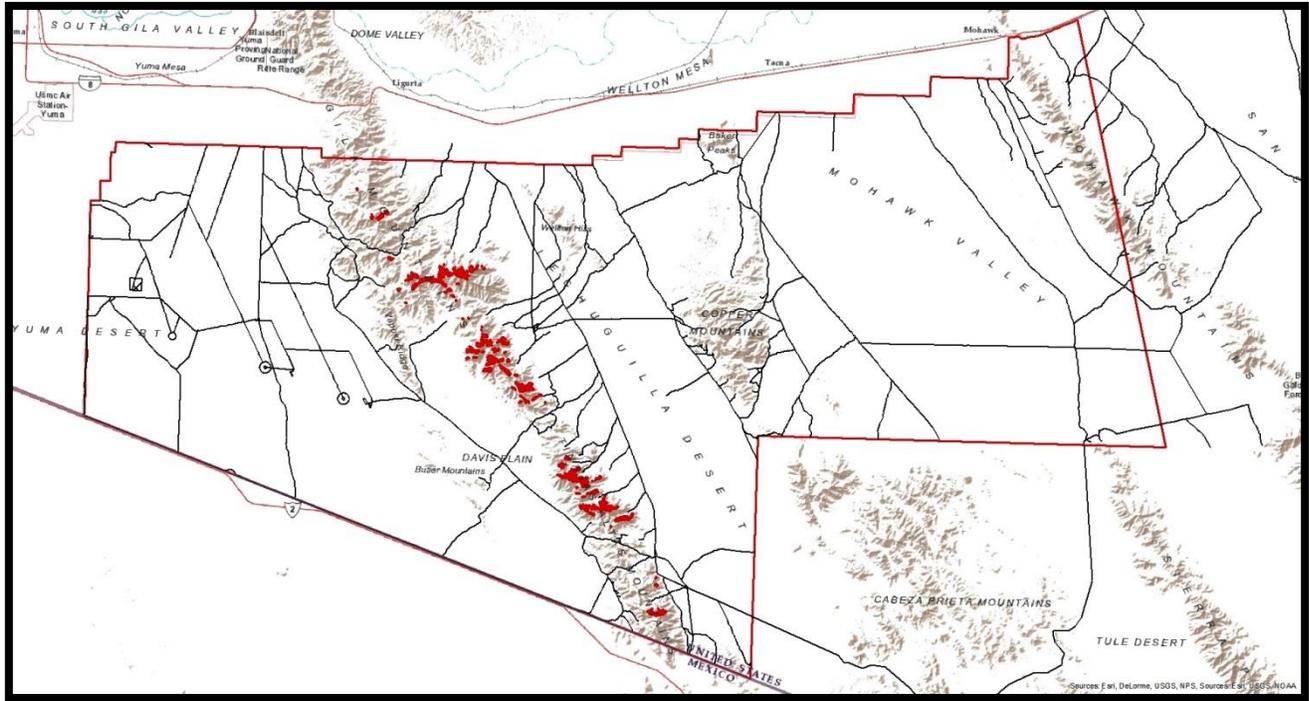


Figure 149. Distribution of Arrowleaf/Sumac-Beargrass/MormonTea-Lavender (410) on the BMGR West.

**Description:** Kearny's sumac (*Rhus kearnyi*) is a densely branch shrub or small tree up to 10 feet tall, with surprisingly large and leathery evergreen 1 to 3 inches long. There's nothing else like it on the Goldwater Range – and nowhere else in the United States, as well, with the exception of the Cabeza Prieta Mountains. The sumac typically has 1-4% cover, although this is counting the large expanses of bare rock that often surround it. Four other species were also found in all 10 of the relevés: arrowleaf (*Pleurocoronis pluriseta*, 5-9% cover), Mormon tea (*Ephedra aspera*, 1-4% cover), desert lavender (*Hyptis emoryi*, 1-4% cover), and desert beargrass (*Nolina bigelovii*, 1-4% cover). The most common associates are spiny aster (*Machaeranthera pinnatifida*) and gumhead (*Gymnosperma glutinosum*).

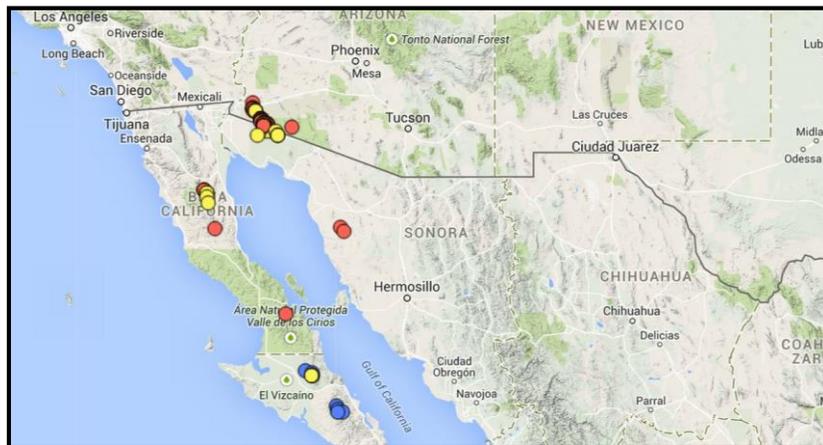


Figure 150. Distribution of *Rhus kearnyi*, showing all three subspecies. Data from SEINet, swbiodiversity.org.

**Location:** Among granite domes and cliffs in the Gila and Tinajas Altas Mountains, almost always on steep north facing slopes. Within Goldwater West, its northernmost locale is in the canyon just NW of the Golden Dream mine, and is accessible from the old trail leading down to Fortuna Canyon. At the southern limit in the Tinajas Altas Mountains, Kearny's sumac extends down almost to the desert floor in places with favorable runoff.

**Field Identification:** Mapping was mostly from the field, sometimes with the assistance of a spotting scope. Each mountain range was climbed to the summit, and often several summits, to determine the elevational limits of several species. Specifically, Kearny's sumac (*Rhus kearnyi*) must be greater than 1% cover. If the sumac had less than 1% cover, and Mormon tea exceeded 1% cover, it was classified as subassociation 400 (see above).

**Photo Identification:** Imagery could help distinguish Kearny's sumac, and estimate coverage. However, the sumac favors northslope canyons, which are often in shadow.



Figure 151. The leaves and flowers of *Rhus kearnyi*, Kearny's sumac.

**Vegetation:** Arrowleaf/Sumac-Beargrass/MormonTea-Lavender

**Alliance/Association/Subassociation codes:** 4 / 40 / 410

**Number of Sample Sites (relevés):** 10

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Pleurocoronis pluriseta</i> Arrowleaf	10	4 (3-5)	5-9% (1-9%)	0.5
<i>Rhus kearnyi</i> Kearny's sumac	10	3.5 (3-4)	1-4% (1-9%)	1.5
<i>Ephedra aspera</i> Mormon tea	10	3 (3-4)	1-4% (<1-9%)	0.7
<i>Hyptis emoryi</i> Desert lavender	10	3 (3-4)	1-4% (<1-9%)	1.5
<i>Nolina bigelovii</i> Desert beargrass	10	3 (1-4)	1-4% (<1-9%)	1.9
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	9	3 (0-4)	<1% (<1-9%)	0.6
<i>Gymnosperma glutinosum</i> Gumhead	9	3 (0-3)	<1% (<1-4%)	0.5
<i>Agave deserti</i>	9	2 (0-3)	<1% (<1-4%)	
<i>Ambrosia dumosa</i> White bursage	9	2 (0-3)	<1% (<1-4%)	
<i>Sphaeralcea ambigua</i> Mallow	8	3 (0-3)	<1-4% (<1-9%)	0.7
<i>Trixis californica</i>	7	1 (0-3)	<1% (<1-4%)	
<i>Galium stellatum</i> Bedstraw	6	1.5 (0-3)	<1% (<1-4%)	0.4
<i>Encelia farinosa</i> Brittlebush	6	1 (0-3)	<1% (<1-4%)	0.4
<i>Eriogonum fasciculatum</i> Flattop buckwheat	5	1 (0-4)	<1% (<1-9%)	0.4
<i>Lotus rigidus</i>	5	1 (0-3)	<1% (<1-4%)	0.4
<i>Crossosoma bigelovii</i>	5	0.5 (0-3)	<1% (<1-4%)	
<i>Bursera microphylla</i> Elephant tree	5	0.5 (0-3)	<1% (<1%)	1.5
<i>Mirabilis bigelovii</i> Wishbone bush	5	0.5 (0-3)	<1% (<1%)	
<i>Asclepias albicans</i>	5	0.5 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Eriogonum wrightii</i>	4	0 (0-3)	<1% (<1-4%)	0.4
<i>Lycium sp.</i> Wolfberry	4	0 (0-3)	<1% (<1-4%)	1.4
<i>Bebbia juncea</i> Sweetbush	4	0 (0-3)	<1% (<1%)	0.9
<i>Brickellia atractyloides</i>	4	0 (0-3)	<1% (<1%)	0.3
<i>Fouquieria splendens</i> Ocotillo	3	0 (0-3)	<1% (<1-4%)	
<i>Acacia greggii</i> Catclaw	3	0 (0-3)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	3	0 (0-2)	<1% (<1%)	
<i>Viguiera deltoidea</i>	2	0 (0-4)	<1% (<1-9%)	0.9
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-3)	<1% (<1-4%)	
<i>Peucephyllum schottii</i>	2	0 (0-3)	<1% (<1%)	
<i>Pleuraphis rigida</i> Big galleta grass	2	0 (0-3)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	2	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia acanthocarpa</i>	2	0 (0-2)	<1% (<1%)	
<i>Porophyllum gracile</i>	2	0 (0-2)	<1% (<1%)	0.8
<i>Thamnosma montana</i>	2	0 (0-2)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	1	0 (0-4)	<1% (<1-9%)	1.3
<i>Erigeron oxyphyllus</i>	1	0 (0-3)	<1% (<1-4%)	0.5
<i>Menodora scabra</i>	1	0 (0-3)	<1% (<1-4%)	0.5
<i>Viguiera parishii</i> Goldeneye	1	0 (0-3)	<1% (<1-4%)	0.8
<i>Achnatherum speciosum</i>	1	0 (0-3)	<1% (<1%)	0.4
<i>Camissonia arenaria</i>	1	0 (0-3)	<1% (<1%)	
<i>Gilia stellata</i>	1	0 (0-3)	<1% (<1%)	
<i>Horsfordia alata</i> Velvet mallow	1	0 (0-3)	<1% (<1%)	1.7
<i>Penstemon pseudospectabilis</i>	1	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Phacelia pedicellata</i>	1	0 (0-3)	<1% (<1%)	
<i>Aristida sp. (perennial)</i>	1	0 (0-2)	<1% (<1%)	
<i>Camissonia sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Cheilanthes parryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Dudleya arizonica</i>	1	0 (0-2)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	1	0 (0-2)	<1% (<1%)	
<i>Lotus sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Nicotiana obtusifolia</i>	1	0 (0-2)	<1% (<1%)	0.8
<i>Opuntia basilaris</i> Beavertail cactus	1	0 (0-2)	<1% (<1%)	
<i>Psathyrotes ramosissima</i>	1	0 (0-2)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-1)	<1% (<1%)	
<i>Jatropha cuneata</i> Limberbush	1	0 (0-1)	<1% (<1%)	
<i>Larrea tridentata</i> Creosote	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-1)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Disturbed (5)

**Association:** Disturbed (50)

**Subassociation:** Disturbed (500)

**Scientific Name:** None.

**NVC Association:** Recently Disturbed or Modified.

**Previous classifications:** Previously mapped (Malusa 2003) in the CPNWR as veg code "4".

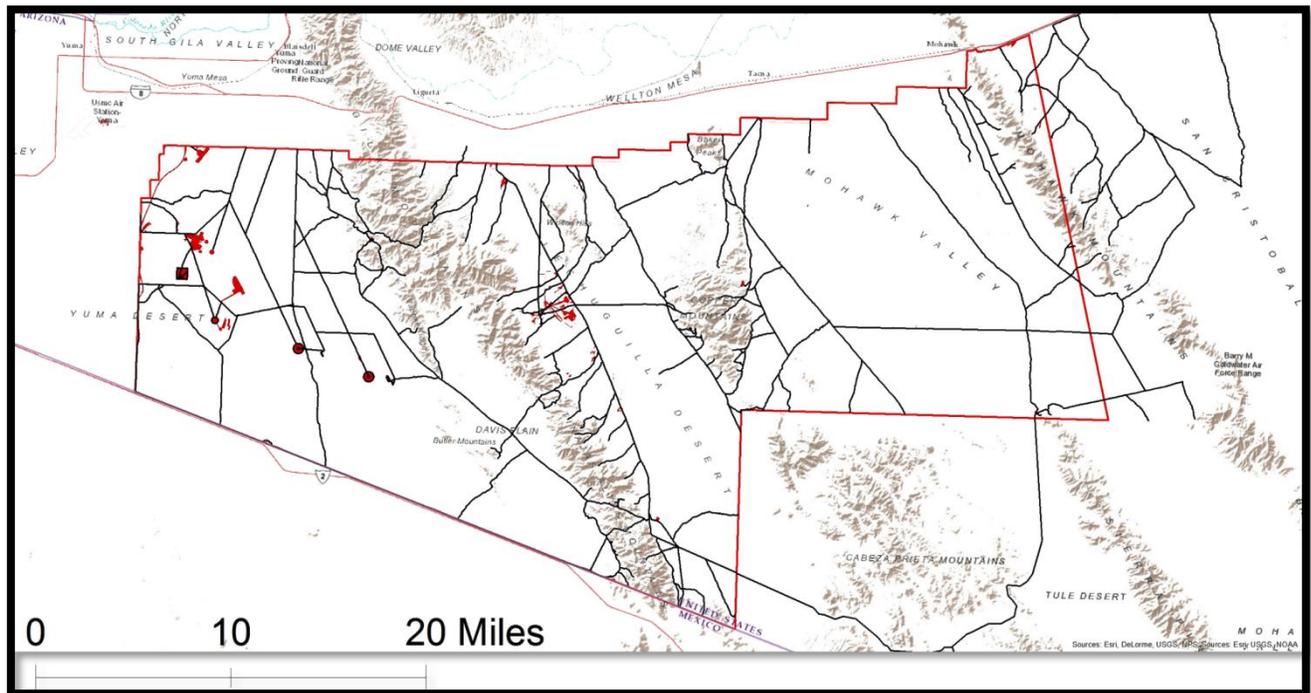


Figure 152. Distribution of Disturbed Lands (500) on the BMGR West.

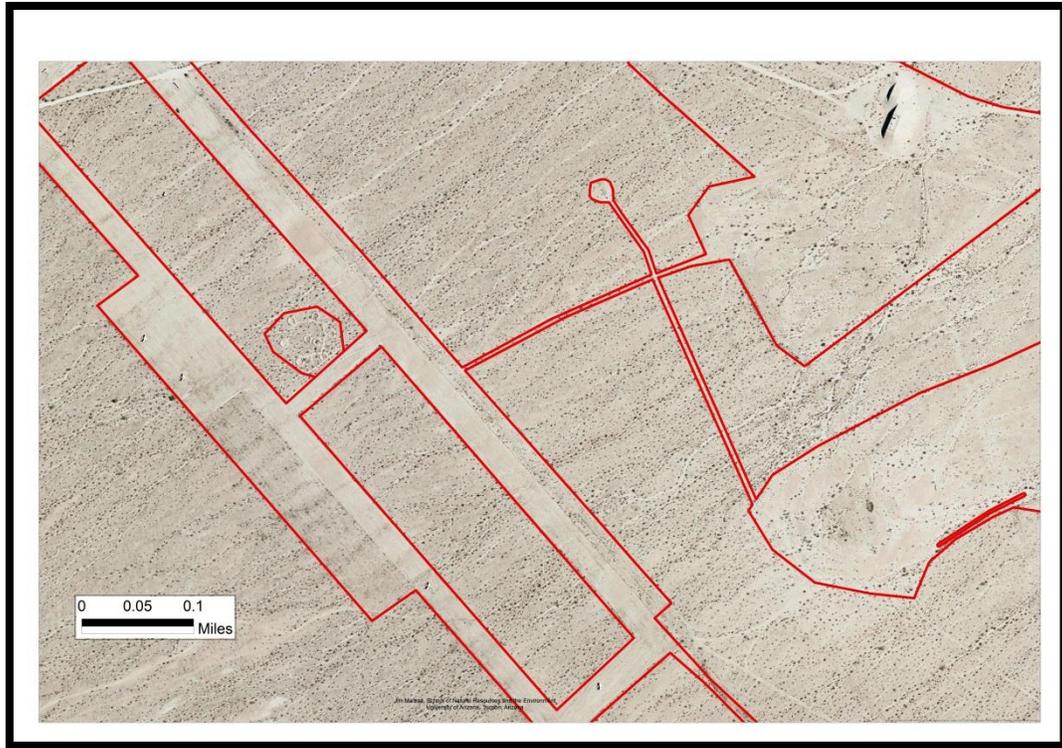


Figure 153. Example of disturbance polygons in old laser range north of Cipriano Pass.

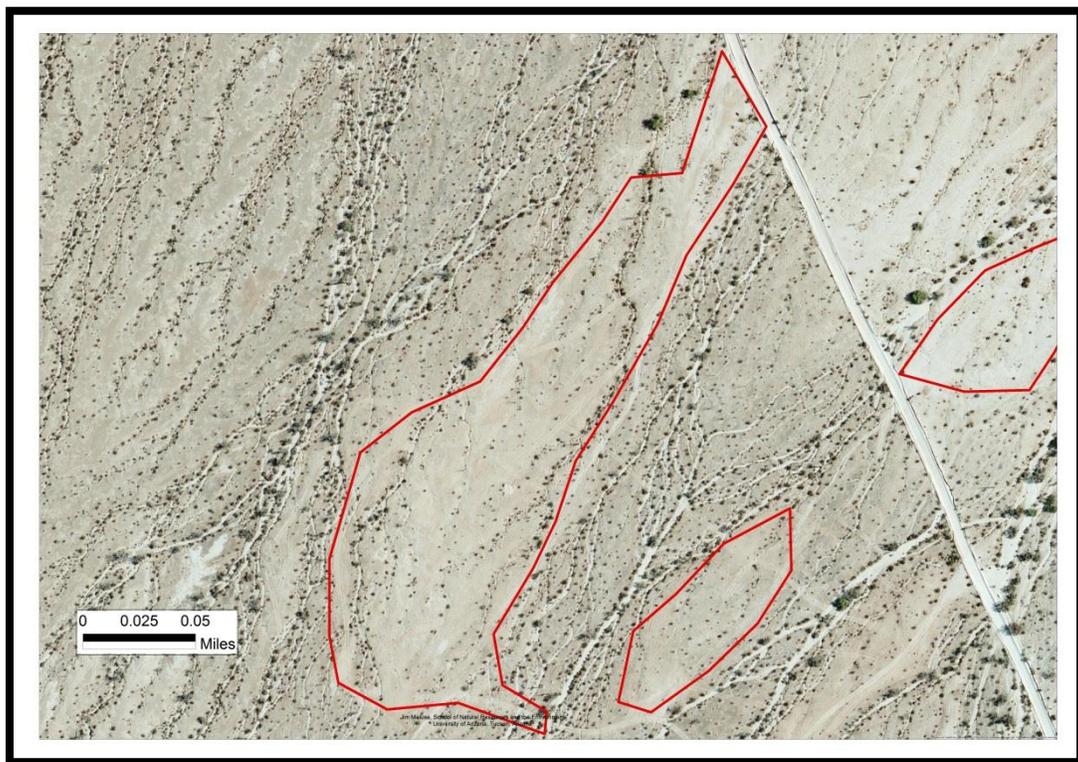


Figure 154. Example of disturbance polygons along the Camino East, just north of Cipriano Pass.

**Description:** "Disturbed" lands are all those places larger than the Minimum Mapping Unit of one hectare (2.4 acres) that appear to have vegetation visibly altered and often simply wiped out. Such lands were mapped because they are often where exotic species first invade. Regularly used roads as indicated in the BMGR West roads layer ("Gold Standard") were not mapped in this mapping unit.

**Location:** Mostly in the Hazard Areas west of the Gila/Tinajas Altas Mountains, but with significant acreage in the former laser area on the east side of the Gila Mountains, north of Cipriano Pass.

**Field Identification:** Mapping was done mostly from imagery, and when convenient field-checked on the ground.

**Photo Identification:** Places larger than one hectare (2.4 acres), off road, with apparent damage to the vegetation and/or soils. This includes desert pavements with extensive tracks.



Figure 155. Fresh vehicle tracks about one mile north of Cipriano Pass, March 5, 2012.

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Brittlebush (6)

**Association:** Brittlebush-Creosote-WhiteBursage/YellowPaloVerde (63)

**Subassociation:** Brittlebush-Creosote-WhiteBursage/YellowPaloVerde (631)

**Scientific Name:** *Encelia farinosa* / *Larrea tridentata* / *Ambrosia dumosa* / *Parkinsonia microphylla* shrubland

**NVC Association:** Currently not described, but most similar to the *Encelia farinosa* Shrubland, or the *Larrea tridentata* - *Ambrosia dumosa* - *Fouquieria splendens* Shrubland. However, the latter is described from the Grand Canyon, and lacks yellow paloverde, a key species in this subassociation.

**Previous classifications:** Similar to the "154.1263" of Warren et al. (1981) in Organ Pipe Cactus NM; however, the organ pipe cactus was present in 6 of their 11 relevés, and this species was not found in anywhere on the BMGR West. Not mapped in previous work in the CPNWR (Malusa 2003), but likely present on mountains with > 20% slope.



Figure 156. Relevé MMSW-14, the view south from near the summit of Mohawk Mountains.

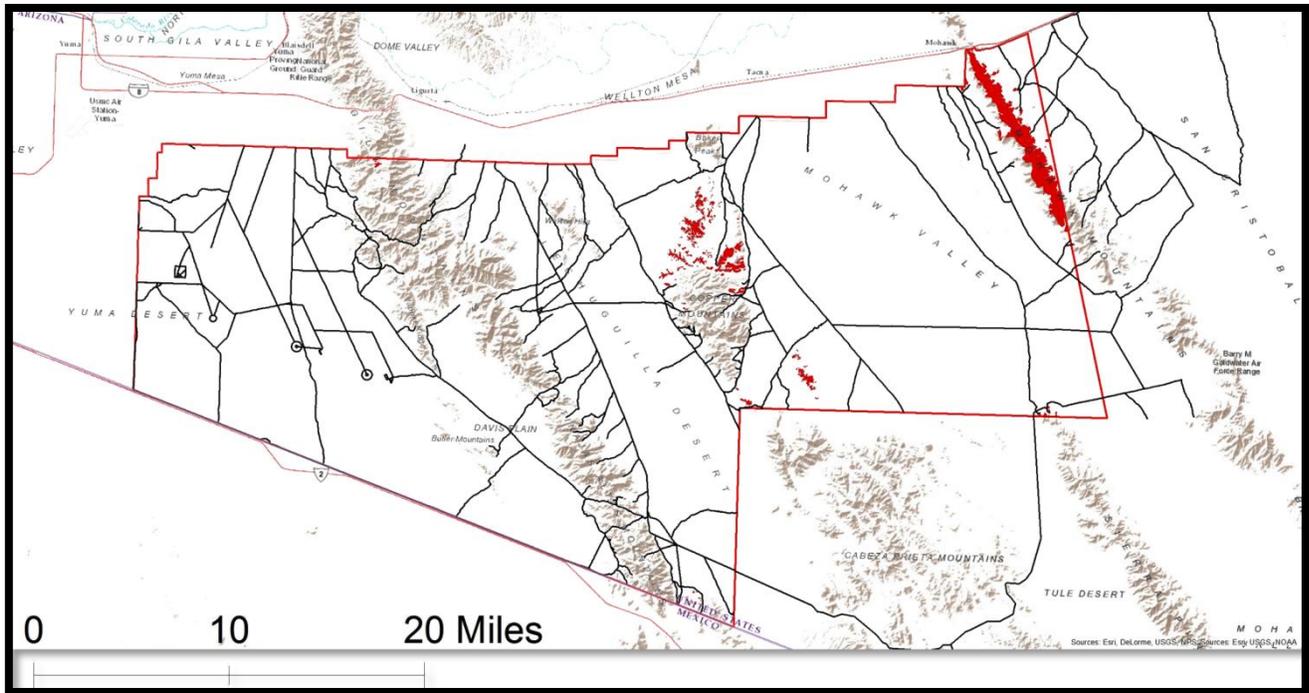


Figure 157. Distribution of Brittlebush-Creosote-WhiteBursage/YellowPaloVerde (631) on the BMGR West.

**Description:** Mountain slopes >20% slope, featuring four species that are typically common and with 1-4% cover: Yellow paloverde (*Parkinsonia microphylla*), brittlebush (*Encelia farinosa*), creosote (*Larrea tridentata*), and white bursage (*Ambrosia dumosa*). Associated species are many, but only ocotillo (*Fouquieria splendens*) was statistically 'common', and present at 21 of 28 relevés. Four other species were at more than the half of the relevés: jumping cholla (*Cylindropuntia bigelovii*), buckhorn cholla (*Cylindropuntia acanthocarpa*), fagonia (*Fagonia californica*), and agave (*Agave deserti*). At more mesic exposures and drainages, there were occasional surprises, such as the pretty little mint, *Teucrium cubense*, found in the Mohawk Mountains. Sixty-seven species were recorded in the relevés.

**Location:** The east side of the Mohawk Mountains, and the rugged hills rising from the pediment between the Copper Mountains and the Baker Peaks. These places are built from metamorphic rocks; in contrast, the granites of the Copper Mountains hold plenty of areas that would fit this mapping unit except that they also have elephant tree, which places them in a different subassociation (276). For the same reason, the present association is also absent from the Tinajas Altas and Gila Mountains, with a notable exception: at the northern edge of the Goldwater West in the Gila Mountains, this subassociation reappears in a curious geologic setting, on steep slopes of colluvium. This persists at least as far north as Telegraph Pass, where a traveler on the Interstate would get the impression that yellow paloverde is common further south in the Gila, when in fact it is mostly absent.

**Field Identification:** Steep mountain slopes with yellow paloverde with at least 1% cover, but without at least 1percent cover of these 'tree' species: *Bursera microphylla* and *Rhus*

*kearnyi*. These latter two species are indicators species for other mountain vegetation types (276 and 410).

**Photo Identification:** The photos were used to distinguish trees and estimate their ground cover. However, field work was required to discern which areas held palo verde and which held elephant tree or Kearny's sumac.

**Vegetation:** Brittlebush-Creosote-WhiteBursage/YellowPaloVerde

**Alliance/Association/Subassociation codes:** 6 / 63 / 631

**Number of Sample Sites (relevés):** 28

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Parkinsonia microphylla</i> Yellow Paloverde	28	3 (3-5)	1-4% (<1-9%)	2.8
<i>Larrea tridentata</i> Creosote	28	3 (2-5)	1-4% (<1-9%)	1.1
<i>Ambrosia dumosa</i> White bursage	27	3 (0-5)	1-4% (<1-14%)	0.3
<i>Encelia farinosa</i> Brittlebush	26	3.5 (0-5)	1-4% (<1-9%)	0.5
<i>Fouquieria splendens</i> Ocotillo	21	3 (0-3)	<1% (<1-4%)	0.4
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	19	2 (0-5)	<1% (<1-14%)	0.7
<i>Cylindropuntia Acanthocarpa</i> Buckhorn cholla	17	1.5 (0-4)	<1% (<1-4%)	0.7
<i>Fagonia californica</i> Fagonia	16	2 (0-4)	<1% (<1-4%)	0.2
<i>Agave deserti</i>	15	1.5 (0-4)	<1% (<1-4%)	0.6
<i>Krameria grayi</i> Ratany	12	0 (0-3)	<1% (<1-9%)	0.6
<i>Sphaeralcea ambigua</i> Mallow	11	0 (0-5)	<1% (<1-9%)	0.5
<i>Hyptis emoryi</i> Desert lavender	11	0 (0-4)	<1% (<1-4%)	
<i>Ephedra aspera</i> Mormon tea	9	0 (0-3)	<1% (<1-4%)	0.4
<i>Carnegiea gigantea</i> Saguaro	9	0 (0-2)	<1% (<1%)	
<i>Trixis californica</i>	9	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	8	0 (0-3)	<1% (<1-4%)	0.5
<i>Pleuraphis rigida</i> Big galleta grass	8	0 (0-2)	<1% (<1-4%)	
<i>Hibiscus denudatus</i> Rock hibiscus	7	0 (0-3)	<1% (<1-4%)	0.5
<i>Lycium sp.</i> Wolfberry	6	0 (0-3)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Machaeranthera pinnatifida</i>	6	0 (0-3)	<1% (<1%)	0.3
<i>Bursera microphylla</i> Elephant tree	5	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i>	4	0 (0-3)	<1% (<1%)	
<i>Euphorbia polycarpa</i>	3	0 (0-3)	<1% (<1-4%)	
<i>Menodora scabra</i>	2	0 (0-3)	<1% (<1-4%)	0.3
<i>Acacia greggii</i> Catclaw	2	0 (0-3)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	2	0 (0-3)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	2	0 (0-3)	<1% (<1%)	
<i>Aristida purpurea</i>	2	0 (0-3)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	2	0 (0-3)	<1% (<1%)	
<i>Crossosoma bigelovii</i>	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i>	2	0 (0-3)	<1% (<1%)	
<i>Perityle emoryi</i>	2	0 (0-3)	<1% (<1%)	
<i>Pleurocoronis pluriseta</i> Arrowleaf	2	0 (0-3)	<1% (<1%)	
<i>Viguiera parishii</i> Goldeneye	2	0 (0-3)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	2	0 (0-2)	<1% (<1%)	
<i>Echinocactus polycephalus</i>	2	0 (0-2)	<1% (<1%)	
<i>Ferocactus cylindraceus</i>	2	0 (0-2)	<1% (<1%)	
<i>Nicotiana obtusifolia</i>	2	0 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	2	0 (0-2)	<1% (<1%)	
<i>Thamnosma montana</i>	2	0 (0-2)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	2	0 (0-1)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	2	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Allonia incarnata</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Asclepias albicans</i>	1	0 (0-3)	<1% (<1%)	1.8
<i>Dudleya arizonica</i>	1	0 (0-3)	<1% (<1%)	
<i>Ephedra trifurca</i> Mormon tea	1	0 (0-3)	<1% (<1%)	
<i>Mentzelia involucrata</i>	1	0 (0-3)	<1% (<1%)	
<i>Peucephyllum schottii</i>	1	0 (0-3)	<1% (<1%)	0.6
<i>Teucrium cubense</i>	1	0 (0-3)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-2)	<1% (<1%)	
<i>Eriogonum fasciculatum</i> Flatop buckwheat	1	0 (0-2)	<1% (<1%)	
<i>Eriogonum wrightii</i>	1	0 (0-2)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-2)	<1% (<1%)	
<i>Galium stellatum</i>	1	0 (0-2)	<1% (<1%)	
<i>Gymnosperma glutinosum</i> Gumhead	1	0 (0-2)	<1% (<1%)	
<i>Horsfordia newberryi</i> Velvet mallow	1	0 (0-2)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0 (0-2)	<1% (<1%)	
<i>Lotus rigidus</i>	1	0 (0-2)	<1% (<1%)	
<i>Marina parryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Mirabilis bigelovii</i> Wishbone bush	1	0 (0-2)	<1% (<1%)	
<i>Palafoxia arida</i> Spanish needles	1	0 (0-2)	<1% (<1%)	
<i>Ziziphus obtusifolia</i>	1	0 (0-2)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i>	1	0 (0-1)	<1% (<1%)	
<i>Janusia gracilis</i>	1	0 (0-1)	<1% (<1%)	
<i>Salvia mohavensis</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Brittlebush (6)

**Association:** Brittlebush-Creosote (67)

**Subassociation:** Brittlebush-Creosote on Dark Rocks (670)

**Scientific Name:** *Encelia farinosa* -*Larrea tridentata* shrubland on dark rocks

**NVC Association:** Currently not described, but most similar to the *Encelia farinosa* Shrubland. This association, however, is not described in any detail.

**Previous classifications:** Similar to several of the brittlebush association of Warren et al. (1981) in Organ Pipe Cactus NM, including "154.1261", "154.1262", and "154.1263". Brittlebush is dominant or co-dominant in all of these. However, the yellow paloverde is also a key species in Organ Pipe. Within the BMGR West there were no yellow paloverde on any of the seven relevés. However, there was a place in the Sierra De Lechuguilla along the border that had both basalt and abundant brittlebush, but because it also had much yellow paloverde, it was placed in the subassociation 631 (above).

The Natural Resource Conservation Service (the soil mappers) has created an Ecological Site Description for "Hyperthermic Steep South Slopes" in the Mohave Desert (MLRA 30): "*This site is dominated by brittlebush (Encelia farinosa), and creosote bush (Larrea tridentata) is an important secondary shrub.*"

A similar Ecological Site Description for Arizona's Sonoran Desert (MLRA 40) would be "Basalt Hills 3-7 inch precipitation zone". It lists brittlebush as a characteristic species, but also includes yellow paloverde and bush muhly grass, neither of which were found in the present subassociation.



Figure 158. Relevé RB-3, the south side of Raven Butte, with the brittlebush in spring bloom. Note the abundance of brittlebush and trees on the surrounding bajada, which are another brittlebush subassociation (691).

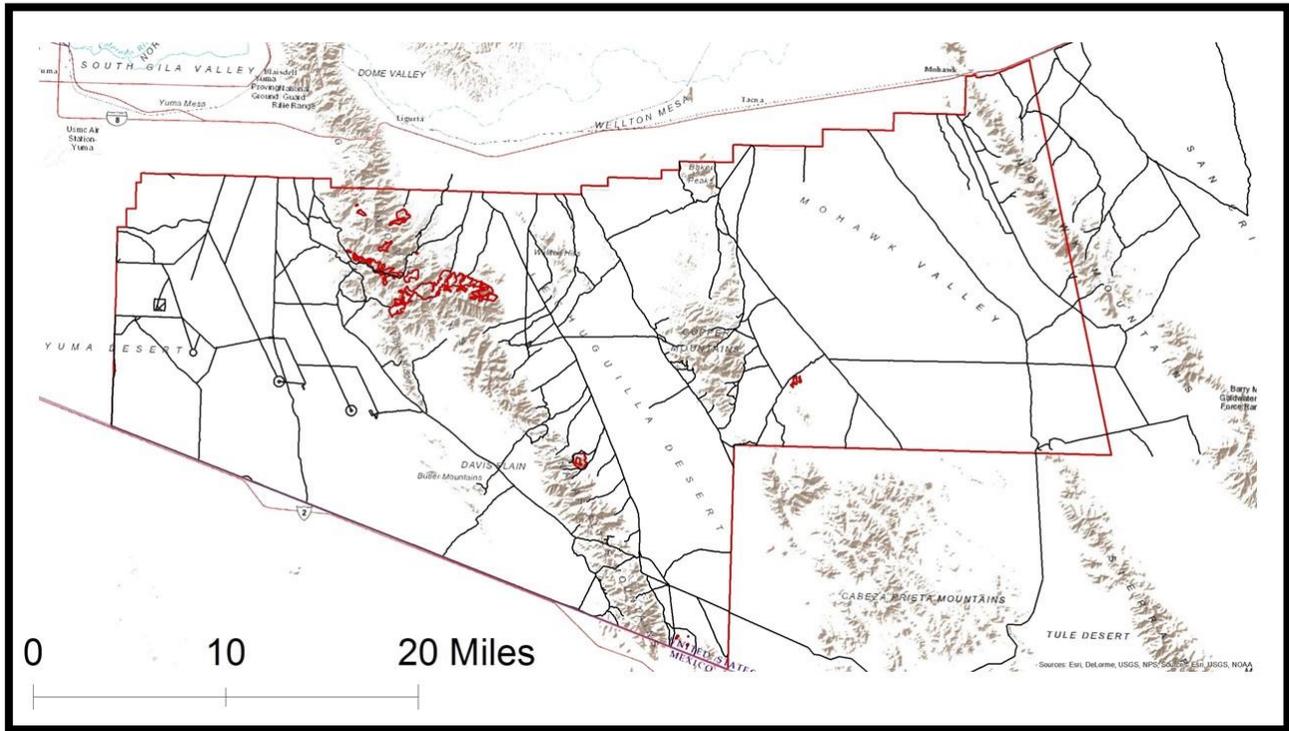


Figure 159. Distribution of Brittlebush-Creosote on Basalt (670) on the BMGR West.

**Description:** A simple assemblage comprised mostly of brittlebush and creosote (*Larrea tridentata*), with the brittlebush always dominant/co-dominant, and typically with 5-9% cover. Creosote was present in all 7 relevés, yet typically uncommon, with <1% cover. Blue paloverde was at 5 of 7 relevés, uncommon at most, with <1% cover. White bursage (*Ambrosia dumosa*), so often an important player on mountain slopes, was present in 4 of 7 relevés, typically uncommon, with <1% cover.

Four of the seven relevés are on basalt, while three are on metamorphic rocks are likely schist, and definitely dark.

**Location:** Raven Butte, on the east side of the Tinajas Altas; and just north of the 'Crash Hills' in the pass between the Copper Mountains and Buck Peak of the Cabeza Prieta Mountains.

**Field Identification:** Basalt or dark metamorphic rock, usually schist.

**Photo Identification:** Very dark rock is the big clue. Second, if the rock is schist, those places within this subassociation were part of the main spine of the Gila Mountains. Smaller schist hills that stood alone, as well all of the Wellton Hills, were not consistently dominated by brittlebush, and were instead mapped as creosote-fagonia-brittlebush subassociation, "191."

**Vegetation:** Brittlebush-Creosote on Dark Rocks

**Alliance/Association/Subassociation codes:** 6 / 67 / 670

**Number of Sample Sites (relevés):** 7

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Encelia farinosa</i> Brittlebush	7	5 (4-5)	5-9% (5-14%)	0.7
<i>Larrea tridentata</i> Creosote	7	3 (1-3)	<1-4% (<1-9%)	0.9
<i>Parkinsonia florida</i> Blue paloverde	5	1 (0-3)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	4	2 (0-3)	<1% (<1-4%)	
<i>Ambrosia dumosa</i> White bursage	4	2 (0-4)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	3	0 (0-3)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	3	0 (0-2)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	3	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia Acanthocarpa</i> Buckhorn cholla	3	0 (0-2)	<1% (<1%)	
<i>Foquieria splendens</i> Ocotillo	3	0 (0-3)	<1% (<1-4%)	
<i>Hibiscus denudatus</i> Rock hibiscus	3	0 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	3	0 (0-2)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	2	0 (0-1)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-3)	<1% (<1-4%)	
<i>Pleuraphis rigida</i> Big galleta grass	2	0 (0-3)	<1% (<1%)	
<i>Perytyle emoryi</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Argythamnia brandegeei</i>	1	0 (0-1)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	1	0 (0-3)	<1% (<1-4%)	
<i>Hyptis emoryi</i> Desert lavender	1	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Krameria erecta</i> Ratany	1	0 (0-1)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	1	0 (0-1)	<1% (<1%)	
<i>Sphaeralcea ambigua</i> Mallow	1	0 (0-1)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Brittlebush (6)

**Association:** Brittlebush-Creosote-WhiteBursage (68)

**Subassociation:** Brittlebush-WhiteBursage-Creosote on Fans (681)

**Scientific Name:** *Encelia farinosa* – *Ambrosia dumosa* - *Larrea tridentata* shrubland

**NVC Association:** *Encelia farinosa* Shrubland, or the *Larrea tridentata* - *Ambrosia dumosa* - *Fouquieria splendens* Shrubland, with the latter described from the Grand Canyon.

**Previous classifications:** Nothing similar in Warren et al. (1981), in which all the brittlebush dominant mapping units are on mountains. Not mapped in previous work in the eastern Cabeza Prieta (Malusa 2003), but likely present in the western half of this wildlife refuge.



Figure 160. Relevé WSE-46, with the Wellton Hills in the background. The golden plants are brittlebush (*Encelia farinosa*).

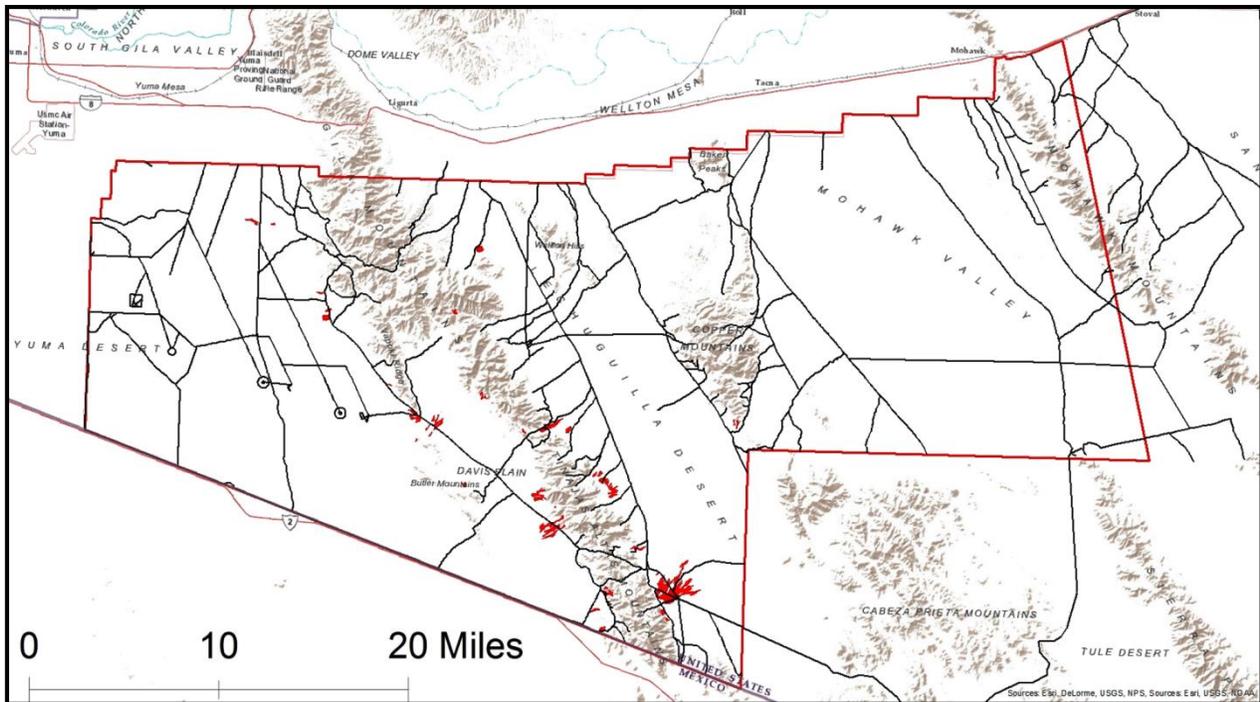


Figure 161. Distribution of Brittlebush-WhiteBursage-Creosote on Fans (681) on the BMGR West.

**Description:** Brittlebush (*Encelia farinosa*) is typically dominant, with 5-9% cover. Only two other species are typically common: white bursage (*Ambrosia dumosa*) and creosote (*Larrea tridentata*), typically with 1-4% cover. The brittlebush is the real standout, especially in the spring, when the blooming alluvial fans can be seen for miles. Ocotillo (*Fouquieria splendens*) is found at 9 out of the 10 relevés. Trees are uncommon or rare.

**Location:** Mostly at the base of the Tinajas Altas Mountains, where large arroyos emerge from the constraints of the canyons and spread into fans with many small drainages.

**Field Identification:** Brittlebush (*Encelia farinosa*) must be dominant/codominant, and trees (ironwood or paloverde) must be less than 1% cover. If the tree cover is greater than 1%, it is subassociation 691 (below)

**Photo Identification:** Very difficult without sub-meter resolution imagery. Brittlebush and white bursage both favor runnels, and appear much the same, so it's not possible to assign dominance without fieldwork. In general, the limits of this subassociation were determined in the field.



Figure 162. Relevé VR-19, on the west side of Vopoki Ridge in the southern Gila Mountains, with brittlebush in the foreground. Ocotillos are unusually common at this photo point.

**Vegetation:** Brittlebush-WhiteBursage-Creosote on Fans

**Alliance/Association/Subassociation codes:** 6 / 68 / 681

**Number of Sample Sites (relevés):** 10

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Encelia farinosa</i> Brittlebush	10	5 (4-5)	5-9% (<1-14%)	0.9
<i>Ambrosia dumosa</i> White bursage	10	3 (3-4)	1-4% (<1-9%)	0.4
<i>Larrea tridentata</i> Creosote	10	3 (2-4)	1-4% (<1-9%)	1.0
<i>Fouquieria splendens</i> Ocotillo	9	2.5 (0-3)	<1% (<1-4%)	5.8
<i>Krameria grayi</i> Ratany	8	2 (0-3)	<1% (<1-4%)	0.6
<i>Olneya tesota</i> Ironwood	8	2 (0-3)	<1% (<1-4%)	3.1
<i>Pleuraphis rigida</i> Big galleta grass	6	2 (0-3)	<1% (<1-4%)	0.9
<i>Carnegiea gigantea</i> Saguaro	6	1 (0-3)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	5	0.5 (0-3)	<1% (<1-4%)	2.3
<i>Cylindropuntia ramosissima</i>	5	0.5 (0-3)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	3	0 (0-3)	<1% (<1-4%)	
<i>Datura discolor</i>	3	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia echinocarpa</i>	2	0 (0-3)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	2	0 (0-2)	<1% (<1%)	
<i>Acacia greggii</i> Catclaw	2	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop	2	0 (0-1)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	2	0 (0-1)	<1% (<1%)	
<i>Plantago ovata</i> Woolly plantain	2	0 (0-1)	<1% (<1%)	

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Jatropha cuneata</i> Limberbush	1	0 (0-3)	<1% (<1-4%)	1.2
<i>Cylindropuntia acanthocarpa</i>	1	0 (0-3)	<1% (<1%)	
<i>Euphorbia sp.</i>	1	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	1	0 (0-2)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-2)	<1% (<1%)	
<i>Bebbia juncea</i> Sweetbush	1	0 (0-1)	<1% (<1%)	
<i>Dalea mollis</i>	1	0 (0-1)	<1% (<1%)	
<i>Ditaxis lanceolata</i> Silverleaf	1	0 (0-1)	<1% (<1%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	1	0 (0-1)	<1% (<1%)	
<i>Euphorbia eriantha</i>	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	2	0 (0-1)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0 (0-1)	<1% (<1%)	
<i>Lycium sp.</i> Wolfberry	1	0 (0-1)	<1% (<1%)	
<i>Orobanche cooperi</i>	1	0 (0-1)	<1% (<1%)	
<i>Trixis californica</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Brittlebush (6)

**Association:** Brittlebush/Ironwood-BluePaloverde (69)

**Subassociation:** Brittlebush/Ironwood-BluePaloverde on Fans (691)

**Scientific Name:** *Encelia farinosa*/*Olneya tesota*-*Parkinsonia florida* shrubland on fans

**NVC Association:** *Encelia farinosa* Shrubland, or the *Larrea tridentata* - *Ambrosia dumosa* - *Fouquieria splendens* Shrubland, with the latter described from the Grand Canyon.

**Previous classifications:** Nothing similar in Warren et al. (1981), in which all the brittlebush dominant mapping units are on mountains. Not mapped in previous work in the eastern Cabeza Prieta (Malusa 2003), but likely present in the western half of the wildlife refuge.



Figure 163. Relevé VR-12, on the west side of Vopoki Ridge, Gila Mountains, with a large blue paloverde on the left, and abundant blooming brittlebush.



Figure 164. Relevé BP-37, on the west side of the Copper Mountains, with post-bloom brittlebush.

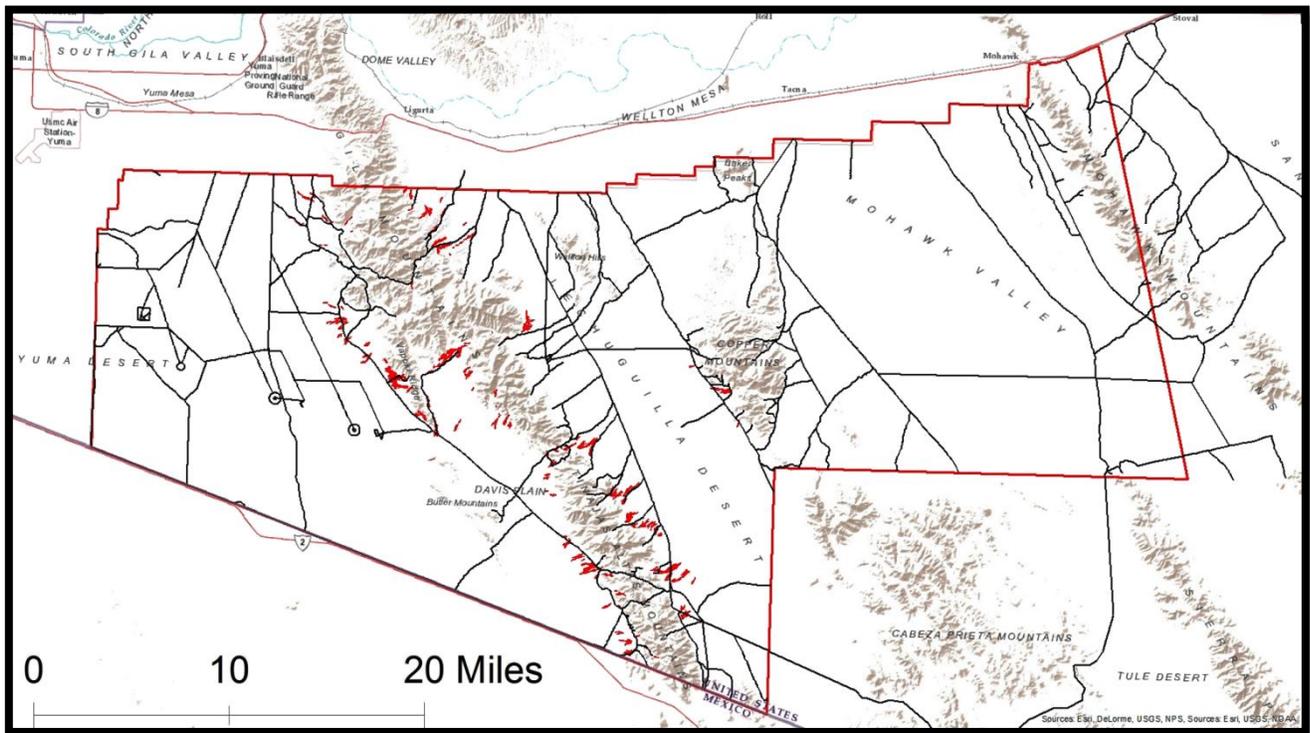


Figure 165. Distribution of Brittlebush/Ironwood-Blue Paloverde on Fans (691) on the BMGR West.

**Description:** Brittlebush (*Encelia farinosa*) is typically dominant, with 1-9% cover. Ironwood (*Olneya tesota*), white bursage (*Ambrosia dumosa*) and creosote (*Larrea tridentata*) are typically common, and with 1-4% cover. In places where ironwood is lacking, blue paloverde (*Parkinsonia florida*) takes up the slack; it's typically uncommon, but that's because it is absent from 3 of the 9 relevés. Where the blue paloverde is present, its cover can be 1-4%. Also, ocotillo (*Fouquieria splendens*) and saguaro (*Carnegiea gigantea*) are present at 7 and 8 of the 9 relevés, respectively.

**Location:** Common at the base of the Gila and Tinajas Altas Mountains, and on the west side of the Copper Mountains. Always it is found where large arroyos emerge from the constraints of the canyons and spread into fans with many small drainages.

**Field Identification:** Brittlebush (*Encelia farinosa*) must be dominant/codominant, and trees (ironwood or paloverde) must be greater than 1% cover. If the tree cover is less than 1%, it is subassociation 681.

**Photo Identification:** Very difficult without sub-meter resolution imagery. Brittlebush and white bursage both favor runnels, and appear much the same, so it's not possible to assign dominance without fieldwork. In general, the limits of this subassociation were determined in the field.

**Vegetation:** Brittlebush/Ironwood-BluePaloverde on Fans

**Alliance/Association/Subassociation codes:** 6 / 69 / 691

**Number of Sample Sites (relevés):** 9

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Encelia farinosa</i> Brittlebush	9	5 (4-5)	1-9% (<1-14%)	0.9
<i>Larrea tridentata</i> Creosote	9	3 (3-4)	1-4% (<4-9%)	1.1
<i>Ambrosia dumosa</i> White bursage	9	3 (2-4)	1-4% (<1-9%)	0.8
<i>Olneya tesota</i> Ironwood	8	3 (0-4)	1-4% (<1-9%)	3.6
<i>Fouquieria splendens</i> Ocotillo	8	2 (0-3)	<1% (<1-4%)	
<i>Carnegiea gigantea</i> Saguaro	7	1 (0-3)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	6	2 (0-3)	<1% (<1-4%)	
<i>Parkinsonia florida</i> Blue paloverde	6	2 (0-3)	<1% (<1-4%)	
<i>Pleuraphis rigida</i> Big galleta grass	5	2 (0-3)	<1% (<1-4%)	1.0
<i>Cylindropuntia ramosissima</i>	5	1 (0-3)	<1% (<1-4%)	
<i>Echinocereus engelmannii</i> Hedgehog cactus	4	0 (0-2)	<1% (<1%)	
<i>Lycium spp.</i>	4	0 (0-1)	<1% (<1%)	
<i>Acacia greggii</i> Catclaw	3	0 (0-1)	<1% (<1%)	
<i>Brassica tournefortii</i> Sahara mustard	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i>	2	0 (0-3)	<1% (<1%)	
<i>Datura discolor</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Dalea mollissima</i> Silky dalea	2	0 (0-2)	<1% (<1%)	
<i>Fagonia californica</i>	2	0 (0-2)	<1% (<1%)	

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Parkinsonia microphylla</i> Yellow Paloverde	2	0 (0-2)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	1	0 (0-3)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0 (0-3)	<1% (<1%)	
<i>Hymenoclea salsola</i> Cheesebush	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis lanceolata</i> Silverleaf	1	0 (0-1)	<1% (<1%)	
<i>Echinocactus polycephalus</i> Cottontop cactus	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus wislizeni</i> Fishhook barrel	1	0 (0-1)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	1	0 (0-1)	<1% (<1%)	
<i>Mammillaria spp</i>	1	0 (0-1)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	1	0 (0-1)	<1% (<1%)	
<i>Trixis californica</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Saltbush (7)

**Association:** DesertHolly-WhiteBursage (71)

**Subassociation:** DesertHolly-WhiteBursage-WandHoldback (710)

**Scientific Name:** *Atriplex hymenelytra*-*Ambrosia dumosa*-*Caesalpinia virgata* shrubland

**NVC Association:** Part of the *Atriplex hymenelytra* Shrubland Alliance.

**Previous classifications:** As defined by the presence of *Atriplex hymenelytra*, not previously described in southwestern Arizona. Its occurrence on the Goldwater West is limited to a single location. However, there are other saltbush vegetation types described in Warren et al (1981), as 154.1761, 154.1762, and 154.1763, characterized by *Atriplex polycarpa* and/or *A. canescens*. There is also a saltbush association, with *Atriplex polycarpa*, from the BMGR East from near the Aztec hills and in the San Cristobal Valley (McLaughlin et al, 2006; Shepherd 2011).



Figure 166. Relevé VR-20, at the head of the Davis Plain, above Spook Canyon, with the Gila Mountains in the background.



Figure 167. Relevé VR-1, at the head of the Davis Plain, above Spook Canyon. The desert holly, *Atriplex hymenelytra*, is the silver shrub at the right foreground.



Figure 168. Above, the leaves and flowers of desert holly, *Atriplex hymenelytra*.

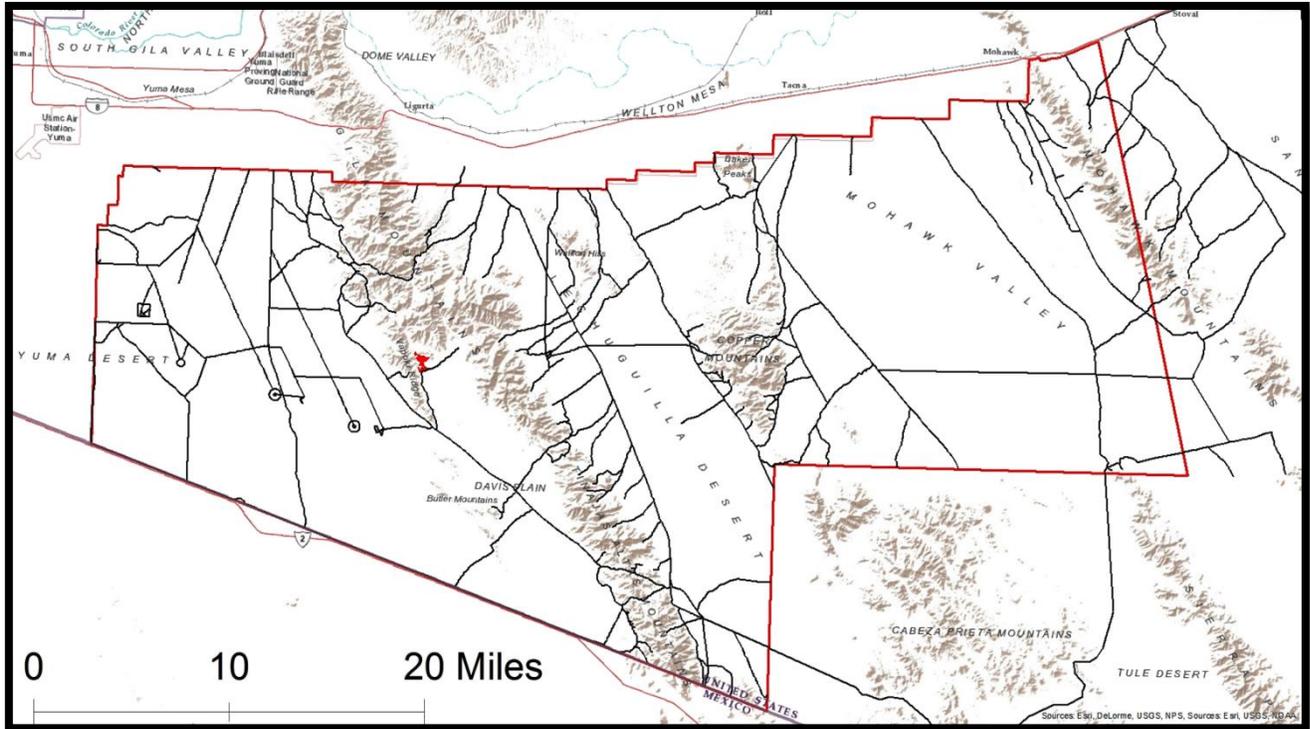


Figure 169. Distribution of Brittlebush-Creosote-WhiteBursage/YellowPaloVerde (631) on the BMGR West, in the Gila Mountains, left of center.

**Description:** Unique in the BMGR West, this vegetation is more typical of the hottest and driest sites in SE California, including Death Valley. White bursage (*Ambrosia dumosa*) and desert holly (*Atriplex hymenelytra*) are typically codominant, with 1-4% cover. Wand holdback (*Caesalpinia virgata*) is common, and also with 1-4% cover. Creosote (*Larrea tridentata*) and ocotillo (*Fouquieria splendens*) are typically common, yet with less than 1% cover. *Psoralea schottii* was present at 2 of 3 relevés, notable because its range, like the desert holly, is mostly in SE California.

**Location:** A single location, almost 60 hectares (144 acres), at the head of the Davis Plain in the Gila Mountains. Here there are rounded hills and ridges – badlands, or malpais – to the north and south of Spook Canyon, precisely where the canyon cuts through Vopoki Ridge, forming a deep gorge just west of the badlands. The rounded hills are heaps of decomposed granite. There were no obvious evaporates to suggest that it was once a lake.

**Field Identification:** Desert Holly (*Atriplex hymenelytra*) has > 1% cover. This species occurs nowhere else on the range.

**Photo Identification:** No distinct feature, and consequently mapped in the field.

**Vegetation:** DesertHolly-WhiteBursage-WandHoldback

**Alliance/Association/Subassociation codes:** 7 / 71 / 710

**Number of Sample Sites (relevés):** 3

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia dumosa</i> White bursage	3	4 (3-5)	1-4% (1-4%)	0.4
<i>Atriplex hymenelytra</i> Desert holly	3	4 (3-5)	1-4% (1-4%)	0.5
<i>Caesalpinia virgata</i> Wand holdback	3	3 (3-4)	1-4% (1-4%)	0.8
<i>Fouquieria splendens</i> Ocotillo	3	3 (3)	<1% (<1-4%)	
<i>Larrea tridentata</i> Creosote	3	3 (1-3)	<1% (<1%)	
<i>Cylindropuntia Ramosissima</i> Diamond cholla	3	1 (1-2)	<1% (<1%)	
<i>Carnegieia gigantea</i> Saguaro	2	2 (0-2)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	2	1 (0-2)	<1% (<1%)	
<i>Oligomeris linifolia</i>	2	2 (0-2)	<1% (<1%)	
<i>Olneya tesota</i> Ironwood	2	2 (0-2)	<1% (<1%)	
<i>Opuntia basilaris</i> Beavertail Cactus	2	2 (0-2)	<1% (<1%)	
<i>Psoralea schottii</i>	2	1 (0-2)	<1% (<1%)	
<i>Fagonia californica</i> Fagonia	1	0 (0-3)	<1% (<1-4%)	0.3
<i>Chorizanthe corrugata</i>	1	0 (0-3)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	1	0 (0-2)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	1	0 (0-2)	<1% (<1%)	
<i>Chaenactis stevioides</i>	1	0 (0-2)	<1% (<1%)	
<i>Geraea canescens</i> Desert sunflower	1	0 (0-2)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	1	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Lycium sp.</i> Wolfberry	1	0 (0-2)	<1% (<1%)	
<i>Mentzelia sp.</i>	1	0 (0-2)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	1	0 (0-1)	<1% (<1%)	
<i>Trixis californica</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Watercourse (8)

**Association:** Mesquite (80)

**Subassociation:** Mesquite Bosque (800)

**Scientific Name:** *Prosopis glandulosa* shrubland.

**NVC Association:** Closest match appears to be *Carnegiea gigantea* / *Prosopis velutina* Wooded Shrubland, described from the Tucson area. However, there are no saguaros (*Carnegiea gigantea*) in the vegetation described here.

**Previous classifications:** Malusa's (2003) map of the eastern Cabeza Prieta and BLM lands near Ajo, gives the association the same code: 80. This vegetation is similar to Warren et al. (1981) 124.711R, the *Prosopis glandulosa* riparian woodland association, described as "open stands of trees 15 to 20 feet tall (4.6 to 6.1 meters), forming continuous corridors along large intermittent drainages." The vegetation on the BMGR West is less impressive as a bosque, but nonetheless classified as such, for lack of a better term.



Figure 170. Relevé MMNW-54, along the northern boundary of the BMGR West, with the Mohawk Mountains in the background.

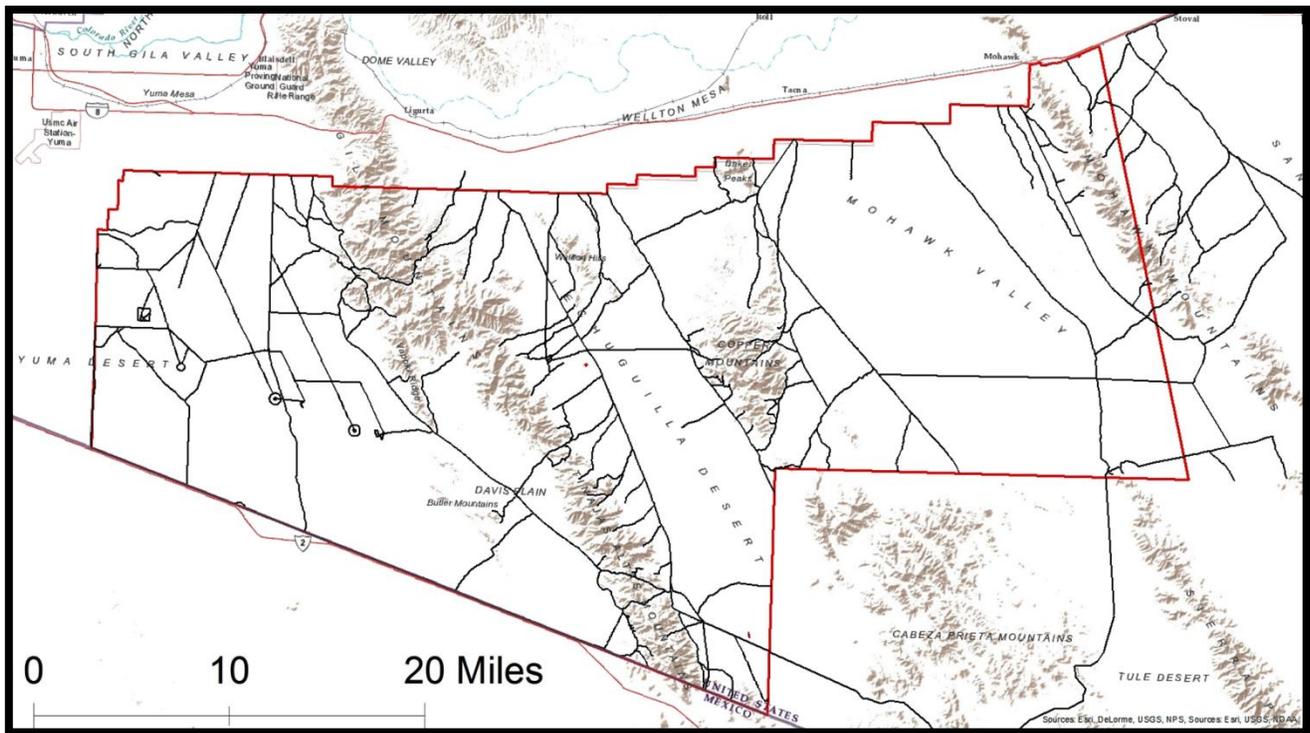


Figure 171. Distribution of Mesquite Bosque (800) on the BMGR West. There are two tiny dots, one in the far NE corner along the boundary, and another in the Lechuguilla Desert, just north of Cipriano Pass.

**Description:** A tangle of big mesquite (4.5 meter), and surrounded by berms that are likely the result of earthmoving equipment. Nonetheless, it is 10 acres of mesquite giving around 50% cover, and uncommon habitat on the Goldwater. Saltbush (*Atriplex polycarpa*) is also present, with 1-4% cover. At the northeastern locale, along interstate 8, Sahara mustard (*Brassica tournefortii*) is abundant.

**Location:** There are only two places that might be called a mesquite bosque, one in the far NE corner along the BMGR West boundary, and another in the Lechuguilla Desert, just north of Cipriano Pass, in the old laser range that was formerly a hazard area.

**Field Identification:** Large mesquite, there is no clear channel in the bosque – only to it, or around it.

**Photo Identification:** The crowns of the trees are plainly visible. See figures below.



Figure 172. The 'bosque' along Interstate 8 in the San Cristobal Valley, about 0.7 miles east of the (now closed) Rest Area.



Figure 173. The 'bosque' in the closed laser range on the east side of the Gila Mountains, north of Cipriano Pass.

Vegetation: *Prosopis glandulosa* shrubland “Bosque”

Alliance/Association/Subassociation codes: 8 / 80 / 800

Number of Sample Sites (relevés): 1 (the Interstate 8 location)

Taxon	Sites	Median Prominence (Range)	Median Cover (Range)	Avg Height (m)
		5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare		
<i>Prosopis glandulosa</i> Mesquite	1	5	7	4.5
<i>Brassica tournefortii</i> Sahara mustard	1	3	5	
<i>Atriplex polycarpa</i> Cattle saltbush	1	3	2	
<i>Lycium sp.</i> Wolfberry	1	3	2	
<i>Ambrosia dumosa</i> White bursage	1	2	1	
<i>Bebbia juncea</i> Sweetbush	1	2	1	
<i>Hymenoclea salsola</i> Cheesebush	1	2	1	
<i>Larrea tridentata</i> Creosote	1	2	1	
<i>Acacia greggii</i> Catclaw	1	1	1	
<i>Encelia farinosa</i> Brittlebush	1	1	1	
<i>Parkinsonia florida</i> Blue paloverde	1	1	1	
<i>Sarcostemma cynanchoides</i>	1	0	1	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Watercourse (8)

**Association:** Wolfberry (81)

**Subassociation:** Mesquite/Wolfberry-Catclaw-Cheesebush (810)

**Scientific Name:** *Prosopis glandulosa*/ *Lycium* spp.- *Acacia greggii*-*Hymenoclea salsola* shrubland.

**NVC Association:** Closest match appears to be *Carnegiea gigantea* / *Prosopis velutina* Wooded Shrubland, described from the Tucson area. However, there are no saguaros (*Carnegiea gigantea*) in the vegetation described here. There is also a *Prosopis velutina* - *Acacia greggii* Shrubland, but it is described from the Chihuahuan Desert, not the Sonoran. Finally, there is a *Hymenoclea salsola* Wash Shrubland listed, but it falls under the *Chilopsis linearis* - *Fallugia paradoxa* - *Prunus fasciculata* Desert Wash Group, and none of these species were encountered on the Goldwater West.

**Previous classifications:** Malusa's (2003) map of the eastern Cabeza Prieta and BLM lands near Ajo, gives the association the same code: 81. The vegetation described here is quite similar. It is also similar to Warren et al. (1981) 154.1215R, the *Cercidium floridum* (= *Parkinsonia florida*)-*Prosopis glandulosa*-*Ambrosia ambrosioides* association.



Figure 174. Relevé CW-4, along upper Coyote Wash near Coyote Water.

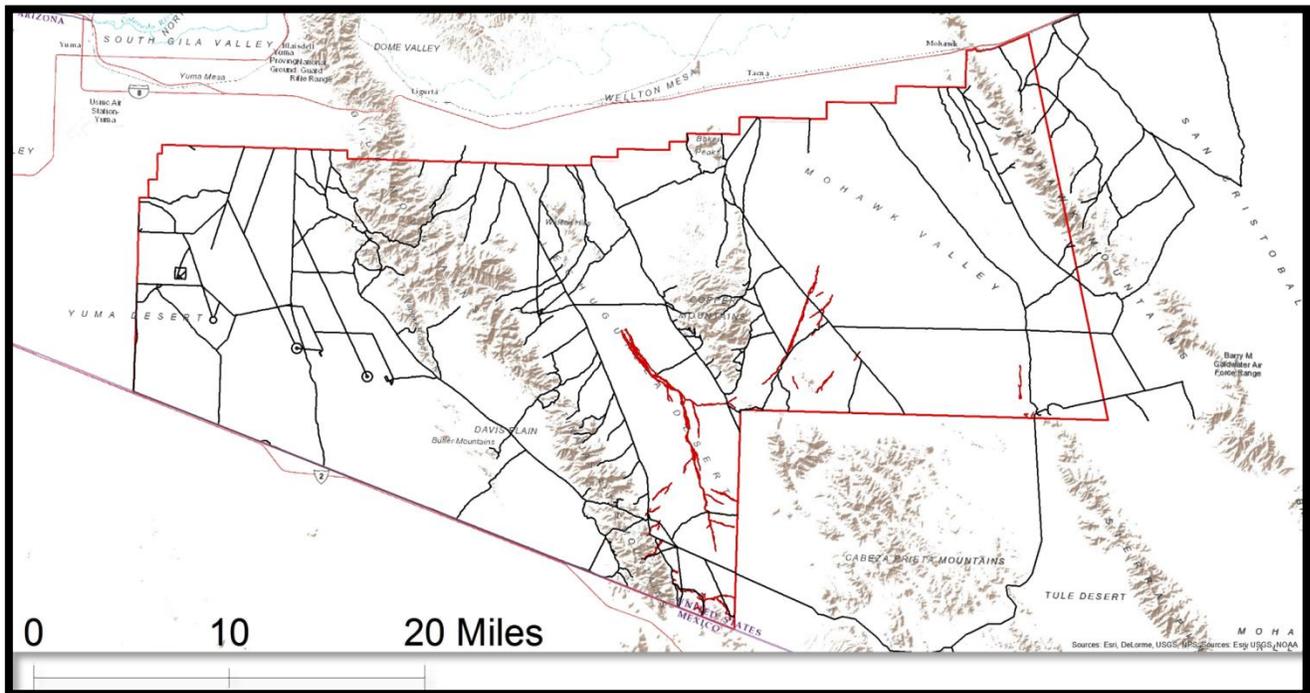


Figure 175. Distribution of Mesquite/Wolfberry-Catclaw-Cheesebush (810) on the BMGR West. Further downslope (north), the large washes are mapped as (811).

**Description:** Along watercourses (also known as washes or arroyos) with beds greater than five meters (16 feet) wide, the banks are lined with mesquite (*Prosopis glandulosa*) and cheesebush (*Hymenoclea salsola*), typically common, often dominant, with cover values from 10-25%. The ubiquity of cheesebush is the main difference between these large arroyos in the Goldwater West, and locations further east in the CPNWR. Common associates include wolfberry (*Lycium sp.*), catclaw (*Acacia greggii*), and blue paloverde (*Parkinsonia florida*), with cover ranging from 5-25%. The mesquite average 3.8 meters tall, the blue paloverde, 4.7 meters.

**Location:** At elevations above 700 feet, on slopes of 1-3%, in the center of the Lechuguilla Valley (Coyote Wash); the large arroyo draining NE from Big Pass, known as Bonfire Wash, between the Copper Mountains and the Cabeza Prieta Mountains; La Jolla Wash in the Sierra de Lechuguilla; several large washes draining the southeastern Tinajas Altas; and a large wash near the Point of the Pintas.

**Field Identification:** The width of the open channel is at least five meters (16 feet), over at least 50% of the watercourse surveyed. If the channel was braided so that the islands between were riparian habitat, then the widths of the two strands of the braid were summed. If the islands between were a different association, then the strands were mapped separately, which sometimes resulted in a large arroyo turning into two or more small washes, then rejoining as a large wash.

Creosote/mesquite floodplain often bordered large watercourses. If the proportion of mesquite or palo verde trees exceeded that of creosote or bursage, the association was mapped as part of the watercourse.

**Photo Identification:** The width of the open channel was measured directly from the photos.

**Vegetation:** Mesquite/Wolfberry-Catclaw-Cheesebush shrubland

**Alliance/Association/Subassociation codes:** 8 / 81 / 810

**Number of Sample Sites (relevés):** 7

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Prosopis glandulosa</i> Mesquite	7	3 (0-5)	10-14% (<1-60%)	3.8
<i>Hymenoclea salsola</i> Cheesebush	7	3 (2-5)	15-25% (<1-60%)	1.0
<i>Lycium sp.</i> Wolfberry	6	3 (0-5)	15-25% (<1-60%)	1.8
<i>Acacia greggii</i> Catclaw	6	3 (0-5)	5-9% (<1-60%)	2.1
<i>Sarcostemma cynanchoides</i> Climbing milkweed	6	3 (0-3)	1-4% (<1-25%)	
<i>Parkinsonia florida</i> Blue paloverde	5	3 (0-3)	5-9% (<1-25%)	4.7
<i>Larrea tridentata</i> Creosote	5	2 (0-3)	<1% (<1-4%)	1.8
<i>Brassica tournefortii</i> Sahara mustard	5	3 (0-3)	<1% (<1-60%)	
<i>Encelia frutescens</i> Button brittlebush	5	2 (0-4)	<1% (<1-60%)	0.9
<i>Encelia farinosa</i> Brittlebush	4	2 (0-3)	<1% (<1-25%)	1.1
<i>Atriplex polycarpa</i> Cattle saltbush	3	0 (0-3)	<1% (<1-14%)	1.1
<i>Brandegea bigelovii</i>	3	0 (0-3)	<1% (<1-4%)	
<i>Olneya tesota</i> Ironwood	3	0 (0-3)	<1% (<1-14%)	4.9
<i>Ambrosia dumosa</i> White bursage	3	0 (0-3)	<1% (<1-9%)	0.5
<i>Bebbia juncea</i> Sweetbush	2	0 (0-3)	<1% (<1-9%)	0.8
<i>Pleuraphis rigida</i> Big galleta grass	2	0 (0-4)	<1% (<1-25%)	0.7
<i>Ambrosia ambrosioides</i>	2	0 (0-2)	<1% (<1%)	
<i>Schismus arabicus</i> Arabian grass	2	0 (0-3)	<1% (<1%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	1	0 (0-3)	<1% (<1-14%)	3.2

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Hyptis emoryi</i> Desert lavender	1	0 (0-3)	<1% (<1%)	1.8
<i>Marina parryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	1	0 (0-3)	<1% (<1-14%)	0.4
<i>Allonia incarnata</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Psorothamnus spinosus</i> Smoketree	1	0 (0-3)	<1% (<1-4%)	2.0
<i>Sphaeralcea ambigua</i> Mallow	1	0 (0-3)	<1% (<1-4%)	
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-3)	<1% (<1-4%)	
<i>Malvaceae</i>	1	0 (0-2)	<1% (<1-4%)	
<i>Aristida californica</i>	1	0 (0-2)	<1% (<1%)	
<i>Muhlenbergia porteri</i>	1	0 (0-2)	<1% (<1%)	
<i>Stephanomeria pauciflora</i>	1	0 (0-2)	<1% (<1%)	
<i>Baccharis sarothroides</i>	1	0 (0-1)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Watercourse (8)

**Association:** Wolfberry (81)

**Subassociation:** Ironwood/Brittlebush-Wolfberry-Cheesebush (811)

**Scientific Name:** *Olneya tesota/ Encelia farinosa- Lycium spp.- Hymenoclea salsola* shrubland.

**NVC Association:** None. The NVC has no associations listed under ironwood (*Olneya*).

**Previous classifications:** This vegetation is a more arid version of the similar Mesquite/Wolfberry-Catclaw-Cheesebush (810) detailed above. Both are members of the wolfberry alliance (81), which includes the 154.181 of Malusa (2003) – "*Prosopis velutina/Parkinsonia floridum/Acacia greggii/Lycium*" – as well as Warren et al (1981) 154.1215R, the *Cercidium floridum (=Parkinsonia florida)-Prosopis glandulosa-Ambrosia ambrosiodes* association.



Figure 176. Relevé MSW-16, along Betty Lee Wash in the Copper Mountains. The bright green shrub is cheesebush (*Hymenoclea salsola*).



Figure 177. Relevé FM-30, Fortuna Wash in the Gila Mountains.



Figure 178. Relevé CP-15, on the east side of the Gila Mountains.

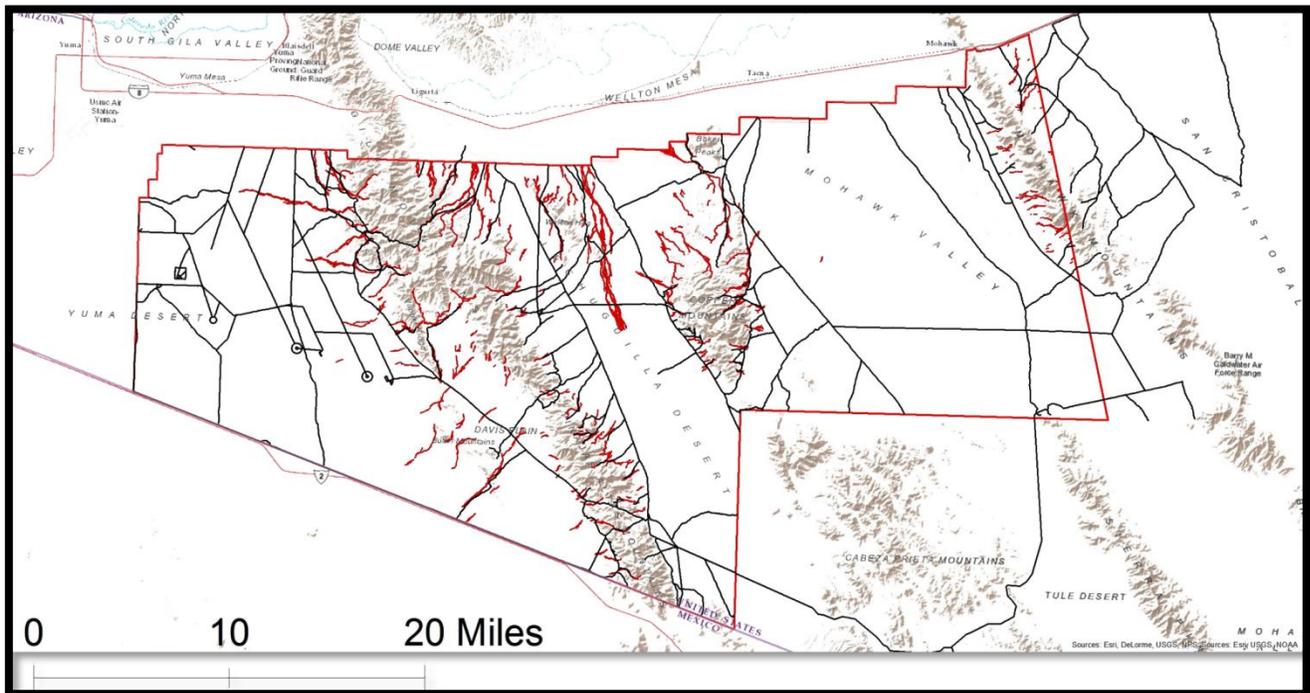


Figure 179. Distribution of Ironwood/Brittlebush-Wolfberry-Cheesebush (811) on the BMGR West.

**Description:** Diverse vegetation along watercourses (also known as washes or arroyos) with beds greater than five meters (16 feet) wide. There were 16 relevés, and no single species appeared in all 16. Ironwood, at 14 of 16 relevés, was typically common, with 1-9% cover, and averaged 5.5 meters tall. Brittlebush (*Encelia farinosa*) was at 13 of 16 relevés, yet typically had higher cover: 10-25%. Common associates were wolfberry and lavender, each also at 13 of 16 relevés, but with only 1-4% cover. Cheesebush (*Hymenoclea salsola*) was also typically common, with higher coverage (5-9%), but was at only 11 of 16 relevés. Note, too, the presence of creosote bush at 12 of 16 relevés, with low cover values (less than 1%), but of unusual size, averaging 1.9 meters tall.

All of these species (except the creosote (*Larrea tridentata*)) were ranked codominant or dominant at one or more relevés. This diversity is in part because the mapping unit is drawn by simply measuring the width of the channel – if it's over five meters wide, it's either 810 (mesquite arroyo, above), or the present subassociation (811). The distinction between wide and narrow arroyos has its roots in early mapping, when the image quality did not allow much more than simply observing the width of the channel. Modern imagery should allow this mapping unit to be divided up into true floristic units, based on species, not channel width.

**Location:** At elevations below 700 feet, on slopes of 1-3%, throughout the range, with the exception of the Mohawk Valley, and the southwest extent of the range, near the Yuma Dunes, where there are no arroyos.

**Field Identification:** The width of the open channel is at least five meters (16 feet), over at least 50% of the watercourse surveyed. If the channel was braided so that the islands between were riparian habitat, then the widths of the two strands of the braid were summed. If the islands between were a different association, then the strands were mapped separately, which sometimes resulted in a large arroyo turning into two or more small washes, then rejoining as a large wash.

Creosote/mesquite floodplain often bordered large watercourses. If the proportion of mesquite or palo verde trees exceeded that of creosote or bursage, the association was mapped as part of the watercourse.

**Photo Identification:** The width of the open channel was measured directly from the photos.

**Vegetation:** Ironwood/Brittlebush-Wolfberry-Cheesebush

**Alliance/Association/Subassociation codes:** 8 / 81 / 811

**Number of Sample Sites (relevés):** 16

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Olneya tesota</i> Ironwood	14	3 (0-4)	1-9% (<1-60%)	5.5
<i>Encelia farinosa</i> Brittlebush	13	3 (0-5)	10-25% (<1-60%)	0.9
<i>Hyptis emoryi</i> Desert lavender	13	3 (0-4)	1-4% (<1-25%)	2.1
<i>Lycium sp.</i> Wolfberry	13	3 (0-4)	<1-4% (<1-40%)	1.3
<i>Larrea tridentata</i> Creosote	12	2.5 (0-3)	<1% (<1-9%)	1.9
<i>Parkinsonia florida</i> Blue paloverde	11	3 (0-4)	1-4% (<1-25%)	5.5
<i>Hymenoclea salsola</i> Cheesebush	11	3 (0-4)	5-9% (<1-40%)	1.0
<i>Acacia greggii</i> Catclaw	11	3 (0-3)	1-9% (<1-25%)	2.1
<i>Ambrosia dumosa</i> White bursage	10	1.5 (0-3)	<1% (<1-4%)	
<i>Bebbia juncea</i> Sweetbush	9	1 (0-5)	<1% (<1-60%)	1.0
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	9	1 (0-3)	<1% (<1-14%)	0.7
<i>Brassica tournefortii</i> Sahara mustard	7	0 (0-3)	<1% (<1-9%)	
<i>Pleuraphis rigida</i> Big galleta grass	7	0 (0-3)	<1% (<1-9%)	0.8
<i>Fagonia californica</i> Fagonia	7	0 (0-3)	<1% (<1-4%)	
<i>Ditaxis lanceolata</i> Silverbush	6	0 (0-3)	<1% (<1-4%)	
<i>Justicia californica</i> Chuparosa	5	0 (0-4)	<1% (<1-40%)	1.3
<i>Horsfordia alata</i> Velvet mallow	5	0 (0-3)	<1% (<1-4%)	1.7
<i>Trixis californica</i>	5	0 (0-3)	<1% (<1-4%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	5	0 (0-3)	<1% (<1-9%)	5.6

<b>Taxon</b>	<b>Sites</b>	<b>Median Prominence (Range)</b> 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	<b>Median Cover (Range)</b>	<b>Avg Height (m)</b>
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	4	0 (0-3)	<1% (<1%)	
<i>Sphaeralcea ambigua</i> Mallow	4	0 (0-2)	<1% (<1%)	
<i>Encelia frutescens</i> Button brittlebush	3	0 (0-4)	<1% (<1-25%)	0.9
<i>Prosopis glandulosa</i> Mesquite	3	0 (0-4)	<1% (<1-14%)	
<i>Brandegea bigelovii</i>	3	0 (0-3)	<1% (<1-9%)	
<i>Krameria grayi</i> Ratany	3	0 (0-3)	<1% (<1-4%)	
<i>Bursera microphylla</i> Elephant tree	3	0 (0-3)	<1% (<1-4%)	
<i>Mirabilis bigelovii</i> Wishbone bush	3	0 (0-2)	<1% (<1%)	
<i>Sarcostemma cyanchoides</i>	2	0 (0-5)	<1% (<1-25%)	
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	2	0 (0-4)	<1% (<1-25%)	
<i>Horsfordia newberryi</i> Velvet mallow	2	0 (0-3)	<1% (<1-14%)	2.3
<i>Psoralea argophylla</i> Smoketree	2	0 (0-3)	<1% (<1-9%)	3.6
<i>Carnegiea gigantea</i> Saguaro	2	0 (0-3)	<1% (<1%)	
<i>Datura discolor</i>	2	0 (0-2)	<1% (<1%)	
<i>Lycium andersonii</i>	2	0 (0-2)	<1% (<1%)	
<i>Stephanomeria pauciflora</i>	2	0 (0-2)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	2	0 (0-1)	<1% (<1%)	
<i>Allonia incarnata</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Eriogonum inflatum</i> Desert trumpet	1	0 (0-3)	<1% (<1-4%)	
<i>Jatropha cuneata</i> Limberbush	1	0 (0-3)	<1% (<1-4%)	1.0
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-3)	<1% (<1-4%)	
<i>Eschscholzia minutiflora</i>	1	0 (0-3)	<1% (<1%)	
<i>Sphaeralcea emoryi</i>	1	0 (0-3)	<1% (<1%)	

<i>Taxon</i>	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia ambrosioides</i>	1	0 (0-2)	<1% (<1%)	
<i>Aristida adscensionis</i> Six-weeks three-awn	1	0 (0-2)	<1% (<1%)	
<i>Chaenactis stevioides</i>	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	1	0 (0-2)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-2)	<1% (<1%)	
<i>Hibiscus denudatus</i> Rock hibiscus	1	0 (0-2)	<1% (<1%)	
<i>Bouteloua aristidoides</i>	1	0 (0-1)	<1% (<1%)	
<i>Ditaxis serrata</i> Silverbush	1	0 (0-1)	<1% (<1%)	
<i>Eriogonum trichopes</i>	1	0 (0-1)	<1% (<1%)	
<i>Krameria erecta</i> Ratany	1	0 (0-1)	<1% (<1%)	
<i>Machaeranthera pinnatifida</i> Spiny goldenweed	1	0 (0-1)	<1% (<1%)	
<i>Mammillaria sp.</i> Pincushion cactus	1	0 (0-1)	<1% (<1%)	
<i>Pennisetum ciliare</i>	1	0 (0-1)	<1% (<1%)	
<i>Physalis crassifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Proboscidea althaeifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Sphaeralcea sp.</i>	1	0 (0-1)	<1% (<1%)	
<i>Stillingia linearifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Viguiera deltoidea</i>	1	0 (0-1)	<1% (<1%)	
<i>Ziziphus obtusifolia</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Watercourse (8)

**Association:** Wolfberry (81)

**Subassociation:** Ironwood/Brittlebush-Wolfberry-White Bursage (812)

**Scientific name:** *Olneya tesota*/*Encelia farinosa*- *Lycium spp.*-*Ambrosia dumosa* shrubland.

**NVCS association:** None. The NVC has no associations listed under ironwood (*Olneya*).

**Previous classifications:** Most similar to the 154.1214R of both Warren et al (1981) in Organ Pipe Cactus NM and Malusa (2003) in eastern Cabeza Prieta and surrounding BLM lands; however, it is characterized by *Ambrosia deltoidea*, which is only present in the extreme SE corner of the Goldwater West. This earlier unit was called "*Ambrosia deltoidea*/*Larrea tridentata*-*Lycium spp*/*Parkinsonia spp* along watercourses with beds less than 5m wide (Bursage/Creosote/Wolfberry/Palo Verde) association."

Notably, these earlier and more-eastern mapping units of watercourses also have wolfberry (*Lycium*) among the most common species, so they can be considered members of the same association (81) as the present association in the Goldwater West.



Figure 180. Relevé EOBP-11, on the boundary with the CPNWR, 3.3 miles northeast of Buck Peak.



Figure 181. Relevé MSW-2, almost 3 miles southeast of the Baker Tanks, narrow and well-defined.



Figure 182. Relevé MSW-31, on the west side of the Mohawk Mountains, showing a poorly defined watercourse just above the point at which it fades into distributaries on the bajadas.

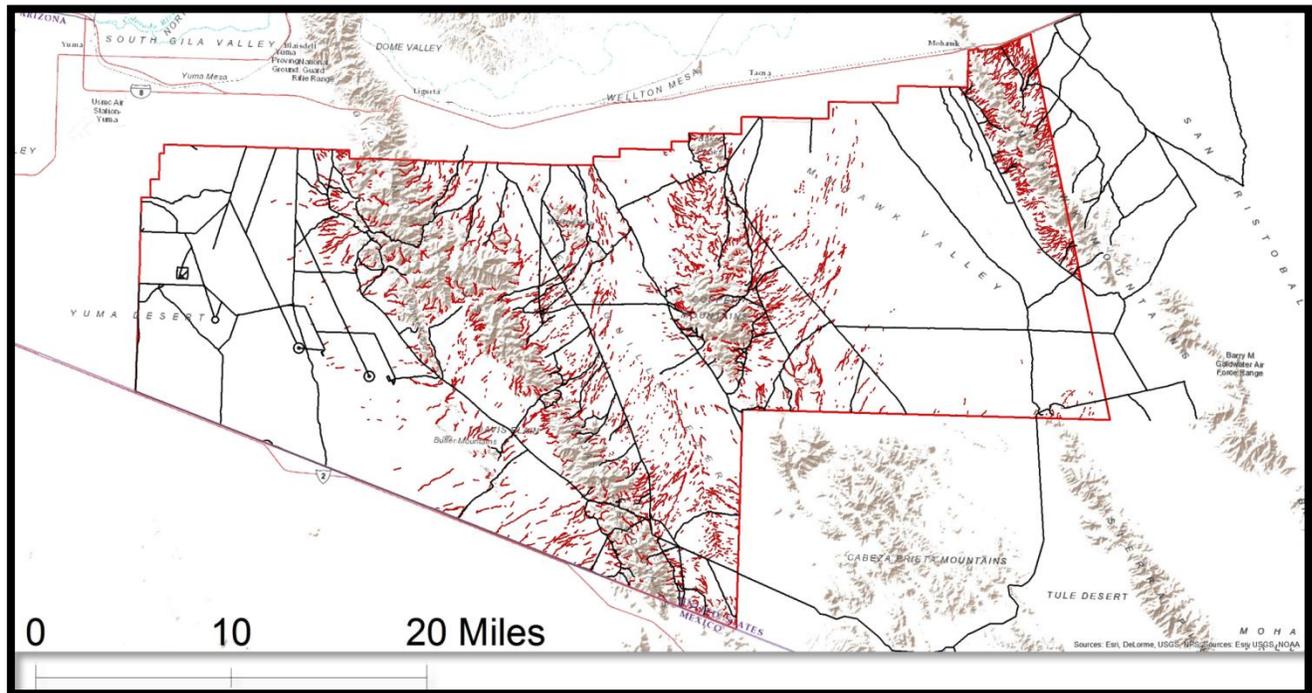


Figure 183. Distribution of Ironwood/Brittlebush-Wolfberry-White Bursage (812) on the BMGR West.

**Description:** Along watercourses (known as washes or arroyos) with beds less than five meters (16 feet) wide. On the eastern side of the Mohawk Valley, and further east to Tucson, *Ambrosia deltoidea* is an important species in this association. However, in the western half of the Mohawk Valley, and all points further west, *A. deltoidea* is not present. In contrast, *Ambrosia dumosa* is always present, and typically common. Similarly, ironwood replaces yellow paloverde (*Parkinsonia microphylla*) as the key tree species.

*Olneya* is a common and occasionally dominant associate, present in all 18 relevés, typically with 10-14% cover. Brittlebush (*Encelia farinosa*), is at 16 of 18 relevés, but typically has higher cover, 15-25%. Wolfberry is at 15 of 18 relevés, with 5-9% cover; white bursage (*Ambrosia dumosa*) is at 16 of 18 relevés, with only 1-4% cover. Creosote (*Larrea tridentata*) is also common, at 14 of 18 relevés, and with 5-9% cover. This was the only mapping unit with the invasive buffelgrass, found in Fortuna Canyon in the Gila Mountains.

In all, 11 species within this mapping unit were ranked codominant or dominant at one or more relevés. This diversity is in part because the mapping unit is drawn by simply measuring the width of the channel – if it's over five meters wide, it's either 810 or 811, or the present subassociation (812). The distinction between wide and narrow arroyos has its roots in early mapping, when the image quality did not allow much more than simply observing the width of the channel. Modern imagery should allow this mapping unit to be divided up into true floristic units, based on species, not channel width.

**Location:** On slopes of 1-20%, between the mountains and valley bottom, typically closer to the mountain front than the valley center. Downslope, the arroyos fan out into a variety of creosote/bursage/palo verde/ironwood associations. Upslope, they are part of the lavender (*Hyptis*) association (83).

**Field Identification:** The width of the open channel is at less than five meters (16 feet), over at least 50% of the watercourse surveyed. If the channel was so narrow that the vegetation was simply a single strand, rather than two strands on either side of the channel, then the arroyo was not mapped separately, but considered part of the surrounding vegetation.

**Photo Identification:** The smallest mapped watercourses had to have a visible open channel, while the largest had to be less than five meters (16 feet) wide. Width was measured directly off the computer screen. Pavements were judged a bit differently, since the smallest hydrologic disturbance creates what appears as strip through the habitat; however, field experience reveals most of these to be too small to be considered arroyos. Hence, a 1-meter wide stripe across a pavement would not be mapped as an arroyo; typically, the watercourse through a pavement must be two-meters across.

Vegetation: Ironwood/Brittlebush-Wolfberry-White bursage

Alliance/Association/Subassociation codes: 8 / 81 / 812

Number of Sample Sites: 18

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Olneya tesota</i> Ironwood	18	3 (2-5)	10-14% (<1-40%)	4.9
<i>Encelia farinosa</i> Brittlebush	16	3 (0-5)	15-25% (<1-80%)	1.0
<i>Ambrosia dumosa</i> White bursage	16	3 (0-4)	1-4% (<1-40%)	0.5
<i>Lycium sp.</i> Wolfberry	15	3 (0-4)	5-9% (<1-40%)	1.3
<i>Larrea tridentata</i> Creosote	14	3 (0-5)	5-9% (<1-60%)	1.3
<i>Hyptis emoryi</i> Desert lavender	11	2 (0-5)	<1% (<1-40%)	2.2
<i>Parkinsonia florida</i> Blue paloverde	10	1.5 (0-3)	<1% (<1-25%)	4.5
<i>Acacia greggii</i> Catclaw	10	1 (0-3)	<1% (<1-14%)	2.3
<i>Krameria grayi</i> Ratany	10	1 (0-3)	<1% (<1-9%)	
<i>Pleuraphis rigida</i> Big galleta grass	9	0.5 (0-4)	<1% (<1-25%)	0.8
<i>Bebbia juncea</i> Sweetbush	9	0.5 (0-3)	<1% (<1-25%)	1.1
<i>Fagonia californica</i> Fagonia	9	0.5 (0-3)	<1% (<1-14%)	0.4
<i>Brassica tournefortii</i> Sahara mustard	8	0 (0-3)	<1% (<1-14%)	
<i>Parkinsonia microphylla</i> Yellow Paloverde	7	0 (0-4)	<1% (<1-25%)	4.6
<i>Ditaxis lanceolata</i> Silverbush	6	0 (0-3)	<1% (<1-14%)	
<i>Hibiscus denudatus</i> Rock hibiscus	6	0 (0-3)	<1% (<1-9%)	
<i>Trixis californica</i>	6	0 (0-3)	<1% (<1-4%)	
<i>Hymenoclea salsola</i> Cheesebush	5	0 (0-3)	<1% (<1-25%)	0.9
<i>Sarcostemma cynanchoides</i> Climbing milkweed	5	0 (0-3)	<1% (<1-14%)	
<i>Carnegiea gigantea</i> Saguaro	5	0 (0-3)	<1% (<1-4%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Ambrosia deltoidea</i> Triangle-leaf bursage	3	0 (0-5)	<1% (<1-25%)	0.8
<i>Bursera microphylla</i> Elephant tree	3	0 (0-5)	<1% (<1-25%)	1.9
<i>Justicia californica</i> Chuparosa	3	0 (0-5)	<1% (<1-40%)	1.0
<i>Encelia frutescens</i> Button brittlebush	3	0 (0-3)	<1% (<1-14%)	1.0
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	3	0 (0-3)	<1% (<1-4%)	
<i>Sphaeralcea ambigua</i> Mallow	3	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia ramosissima</i> Diamond cholla	3	0 (0-2)	<1% (<1%)	
<i>Horsfordia alata</i> Velvet mallow	3	0 (0-2)	<1% (<1%)	
<i>Prosopis glandulosa</i> Mesquite	2	0 (0-3)	<1% (<1-14%)	5.0
<i>Prosopis velutina</i>	2	0 (0-3)	<1% (<1-9%)	2.9
<i>Ephedra aspera</i> Mormon tea	2	0 (0-3)	<1% (<1-4%)	
<i>Fouquieria splendens</i> Ocotillo	2	0 (0-3)	<1% (<1-4%)	
<i>Ambrosia ambrosioides</i>	2	0 (0-2)	<1% (<1-4%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	2	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-1)	<1% (<1%)	
<i>Lycium andersonii</i>	1	0 (0-4)	<1% (<1-14%)	1.3
<i>Brandegea bigelovii</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Euphorbia polycarpa</i>	1	0 (0-3)	<1% (<1-4%)	0.2
<i>Horsfordia newberryi</i> Velvet mallow	1	0 (0-3)	<1% (<1-4%)	1.1
<i>Perityle emoryi</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Sphaeralcea coulteri</i> Mallow	1	0 (0-3)	<1% (<1-4%)	
<i>Argythamnia brandegeei</i>	1	0 (0-2)	<1% (<1%)	
<i>Aristida sp. (perennial)</i>	1	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Heteropogon contortus</i>	1	0 (0-2)	<1% (<1%)	
<i>Marina parryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Mirabilis bigelovii</i> Wishbone bush	1	0 (0-2)	<1% (<1%)	
<i>Orobanche cooperi</i>	1	0 (0-2)	<1% (<1%)	
<i>Pennisetum ciliare</i> Buffelgrass	1	0 (0-2)	<1% (<1%)	
<i>Cylindropuntia echinocarpa</i> Silver cholla	1	0 (0-1)	<1% (<1%)	
<i>Datura discolor</i>	1	0 (0-1)	<1% (<1%)	
<i>Euphorbia eriantha</i>	1	0 (0-1)	<1% (<1%)	
<i>Ferocactus cylindraceus</i> California barrel	1	0 (0-1)	<1% (<1%)	
<i>Nicotiana obtusifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Peniocereus greggii</i>	1	0 (0-1)	<1% (<1%)	
<i>Porophyllum gracile</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Watercourse (8)

**Association:** Lavender/Hollyleaf bursage (83)

**Subassociation:** Lavender/Hollyleaf bursage – Brittlebush (830)

**Scientific name:** *Hyptis emoryi* (= *H. albida*)/*Ambrosia ilicifolia* – *Encelia farinosa* shrubland.

**NVCS association:** *Hyptis emoryi* intermittently flooded shrubland alliance.

**Previous classifications:** Not previously described in southwest Arizona, but likely present in the Cabeza Prieta NWR at slopes greater than 20 %.



Figure 184. Relevé BP-13, in the Copper Mountains, one mile south of Betty Lee Tank. The silvery shrubs along the watercourse are desert lavender, *Hyptis emoryi*. Also common in this location is Elephant tree (*Bursera microphylla*), in the right foreground.



Figure 185. Relevé MMNW-23, in the Mohawk Mountains.

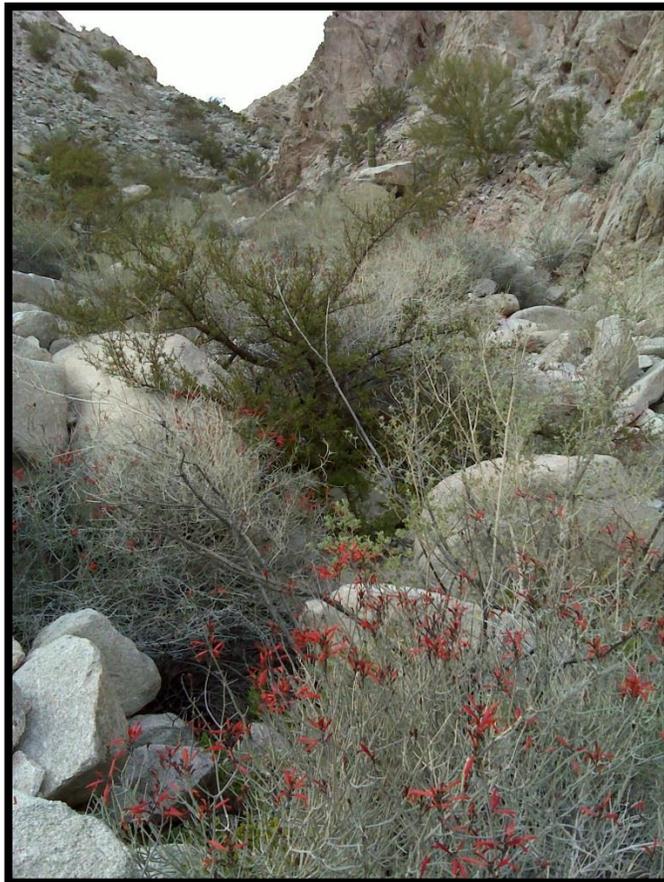


Figure 186. Relevé TA-37, in Frontera Canyon in the Tinajas Altas Mountains, with chuparosa in bloom (*Justicia californica*).

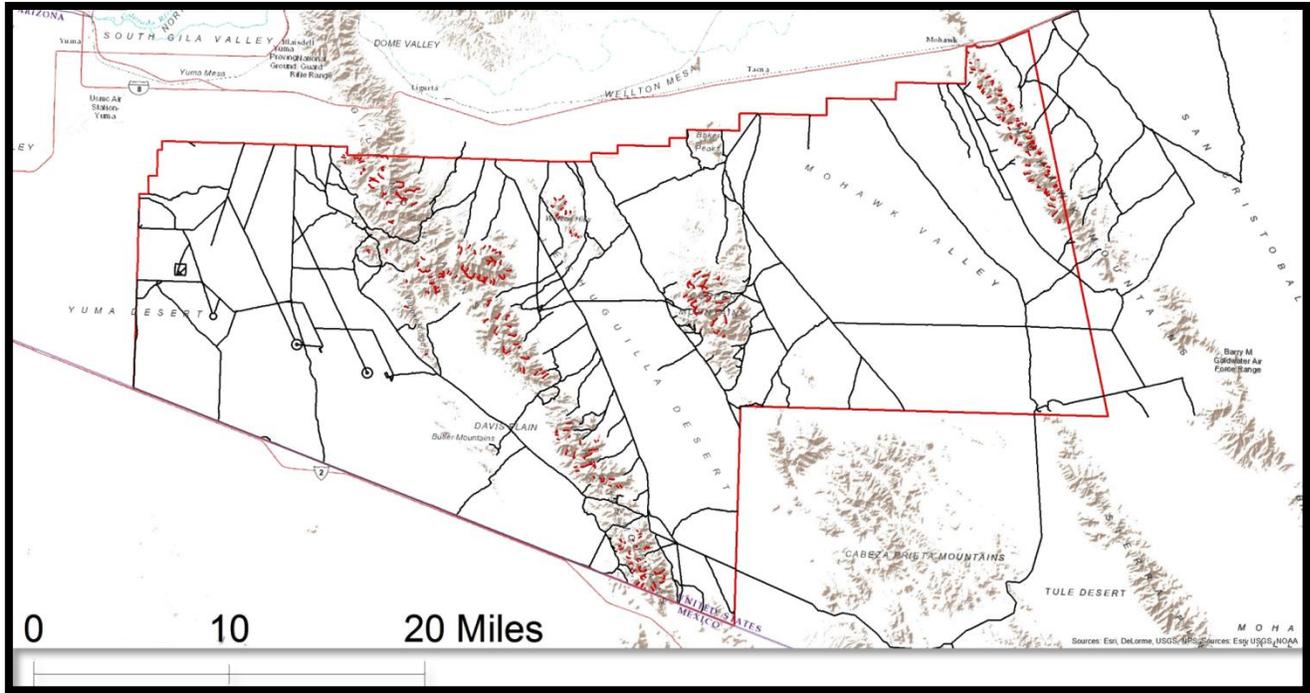


Figure 187. Distribution of Lavender/Hollyleaf bursage – Brittlebush (830) on the BMGR West.

**Description:** Where mountain slopes exceed 20%, larger watercourses are dominated by desert lavender, *Hyptis emoryi* (= *H. albid*). Cover is typically 10-14%, and they average 1.5 meters tall. Also common, and present at 11 of the 12 relevés, were hollyleaf bursage (*Ambrosia ilicifolia*) and brittlebush (*Encelia farinosa*), typically with 1-4 % cover. The perennial mallow (*Sphaeralcea ambigua*) was at all 12 relevés, yet its cover was typically <1%. *Trixis (Trixis californica)* and catclaw (*Acacia greggii*) are also common, found at 10 and 9 of 12 relevés, respectively, and typically with <1% cover. Ironwood is notably uncommon, found at only 3 of 12 relevés.

This mapping unit was a catch-all that aims to delimit watercourse habitat that is significantly different from the mountain slopes. The top four species (*Hyptis emoryi*, *Sphaeralcea ambigua*, *Encelia farinosa*, *Ambrosia ilicifolia*) are consistent throughout the Goldwater West, but several species others were highly local. For instance, elephant tree (*Bursera microphylla*) is at 8 of 12 relevés, but is missing from the Wellton Hills and much of the Mohawk Mountains.

**Location:** In canyon bottoms throughout the mountains of the Goldwater West, with the exception of the Baker Peaks and the Butler Mountains, which are apparently too small and dry.

**Field Identification:** *Hyptis emoryi* is the dominant species in watercourses with >20% slope. It was possible to spot the *Hyptis* from a distance with binoculars.

**Photo Identification:** Can distinguish *Hyptis emoryi* only with the latest sub-meter imagery; otherwise, must be mapped from the field.

**Vegetation:** Lavender/Hollyleaf bursage – Brittlebush

**Alliance/Association/Subassociation codes:** 8 / 83 / 830

**Number of Sample Sites (relevés):** 12

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Hyptis emoryi</i> Desert lavender	12	4 (3-5)	10-14% (5-25%)	1.5
<i>Sphaeralcea ambigua</i> Mallow	12	3 (2-3)	<1% (<1-9%)	0.7
<i>Encelia farinosa</i> Brittlebush	11	3 (0-4)	1-4% (<1-40%)	0.7
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	11	3 (0-3)	1-4% (<1-14%)	0.5
<i>Trixis californica</i> Trixis	10	2 (0-3)	<1% (<1-4%)	
<i>Acacia greggii</i> Catclaw	9	3 (0-3)	<1% (<1-4%)	2.3
<i>Pleurocoronis pluriseta</i> Arrowleaf	9	2 (0-3)	<1% (<1-14%)	
<i>Bursera microphylla</i> Elephant tree	8	2 (0-3)	<1% (<1-25%)	2.1
<i>Lycium sp.</i> Wolfberry	8	2 (0-3)	<1% (<1-4%)	1.2
<i>Parkinsonia microphylla</i> Yellow Paloverde	7	3 (0-4)	1-4% (<1-9%)	3.6
<i>Ephedra aspera</i> Mormon tea	7	1.5 (0-3)	<1% (<1-14%)	0.9
<i>Machaeranthera Pinnatifida</i> Spiny goldenweed	7	0.5 (0-3)	<1% (<1-4%)	
<i>Pleuraphis rigida</i> Big galleta grass	6	0.5 (0-3)	<1% (<1-9%)	
<i>Ambrosia dumosa</i> White bursage	5	0 (0-3)	<1% (<1-4%)	0.4
<i>Ditaxis lanceolata</i> Silverleaf	5	0 (0-3)	<1% (<1-4%)	
<i>Gymnosperma glutinosa</i> Gumhead	5	0 (0-3)	<1% (<1-4%)	
<i>Larrea tridentata</i> Creosote	5	0 (0-2)	<1% (<1%)	
<i>Carnegiea gigantea</i> Saguaro	5	0 (0-1)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Bebbia juncea</i> Sweetbush	4	0 (0-3)	<1% (<1-9%)	
<i>Fagonia californica</i> Fagonia	4	0 (0-3)	<1% (<1-4%)	0.5
<i>Ziziphus obtusifolia</i>	4	0 (0-3)	<1% (<1%)	
<i>Galium stellatum</i> Bedstraw	4	0 (0-2)	<1% (<1%)	
<i>Mirabilis bigelovii</i> Wishbone bush	4	0 (0-2)	<1% (<1%)	
<i>Justicia californica</i> Chuparosa	3	0 (0-4)	<1% (<1-25%)	1.2
<i>Olneya tesota</i> Ironwood	3	0 (0-4)	<1% (<1-9%)	4.8
<i>Crossosoma bigelovii</i>	3	0 (0-3)	<1% (<1-4%)	0.7
<i>Hibiscus denudatus</i> Rock hibiscus	3	0 (0-3)	<1% (<1-4%)	
<i>Asclepias albicans</i>	3	0 (0-3)	<1% (<1%)	
<i>Nolina bigelovii</i> Desert beargrass	3	0 (0-3)	<1% (<1%)	
<i>Krameria grayi</i> Ratany	3	0 (0-2)	<1% (<1%)	
<i>Nicotiana obtusifolia</i>	3	0 (0-2)	<1% (<1%)	
<i>Agave deserti</i>	2	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	2	0 (0-3)	<1% (<1-4%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	2	0 (0-3)	<1% (<1-4%)	
<i>Eriogonum fasciculatum</i> Flattop buckwheat	2	0 (0-3)	<1% (<1-4%)	
<i>Eriogonum wrightii</i>	2	0 (0-3)	<1% (<1-4%)	0.5
<i>Horsfordia alata</i> Velvet mallow	2	0 (0-3)	<1% (<1%)	
<i>Viguiera parishii</i> Goldeneye	2	0 (0-3)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	2	0 (0-2)	<1% (<1%)	
<i>Lotus rigidus</i>	2	0 (0-2)	<1% (<1%)	
<i>Menodora scabra</i>	2	0 (0-2)	<1% (<1%)	

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Penstemon parryi</i>	2	0 (0-2)	<1% (<1%)	
<i>Teucrium glandulosum</i>	2	0 (0-2)	<1% (<1%)	
<i>Eriogonum inflatum</i> Desert trumpet	2	0 (0-1)	<1% (<1%)	
<i>Rhus kearnyi</i> Kearny's sumac	1	0 (0-3)	<1% (<1-14%)	1.2
<i>Salazaria mexicana</i>	1	0 (0-3)	<1% (<1-9%)	
<i>Viguiera deltoidea</i>	1	0 (0-3)	<1% (<1-9%)	
<i>Cheilanthes parryi</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Jatropha cuneata</i> Limberbush	1	0 (0-3)	<1% (<1-4%)	
<i>Lotus strigosus</i>	1	0 (0-3)	<1% (<1-4%)	
<i>Ephedra trifurca</i> Mormon tea	1	0 (0-3)	<1% (<1%)	
<i>Ditaxis neomexicana</i> Silverleaf	1	0 (0-2)	<1% (<1%)	
<i>Horsfordia newberryi</i> Velvet mallow	1	0 (0-2)	<1% (<1%)	
<i>Perityle emoryi</i>	1	0 (0-2)	<1% (<1%)	
<i>Aristida purpurea</i>	1	0 (0-1)	<1% (<1%)	
<i>Erigeron oxyphyllus</i>	1	0 (0-1)	<1% (<1%)	
<i>Parkinsonia florida</i> Blue paloverde	1	0 (0-1)	<1% (<1%)	
<i>Peucephyllum schottii</i>	1	0 (0-1)	<1% (<1%)	
<i>Physalis crassifolia</i>	1	0 (0-1)	<1% (<1%)	
<i>Porophyllum gracile</i>	1	0 (0-1)	<1% (<1%)	
<i>Psoralea spinosa</i> Smoketree	1	0 (0-1)	<1% (<1%)	
<i>Thamnosma montana</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Blue Paloverde (9)

**Association:** Blue PaloVerde/Hollyleaf Bursage (90)

**Subassociation:** Blue PaloVerde/Hollyleaf Bursage on mountains (900)

**Scientific name:** *Parkinsonia florida*/*Ambrosia ilicifolia* shrubland on mountains

**NVCS association:** An undescribed member of the *Parkinsonia florida*-*Olneya tesota* alliance.

**Previous classifications:** Not described in previous mapping from Arizona, but common in California.



Figure 188. Relevé WH-17, in the Wellton Hills. The trees are blue paloverde (*Parkinsonia florida*).

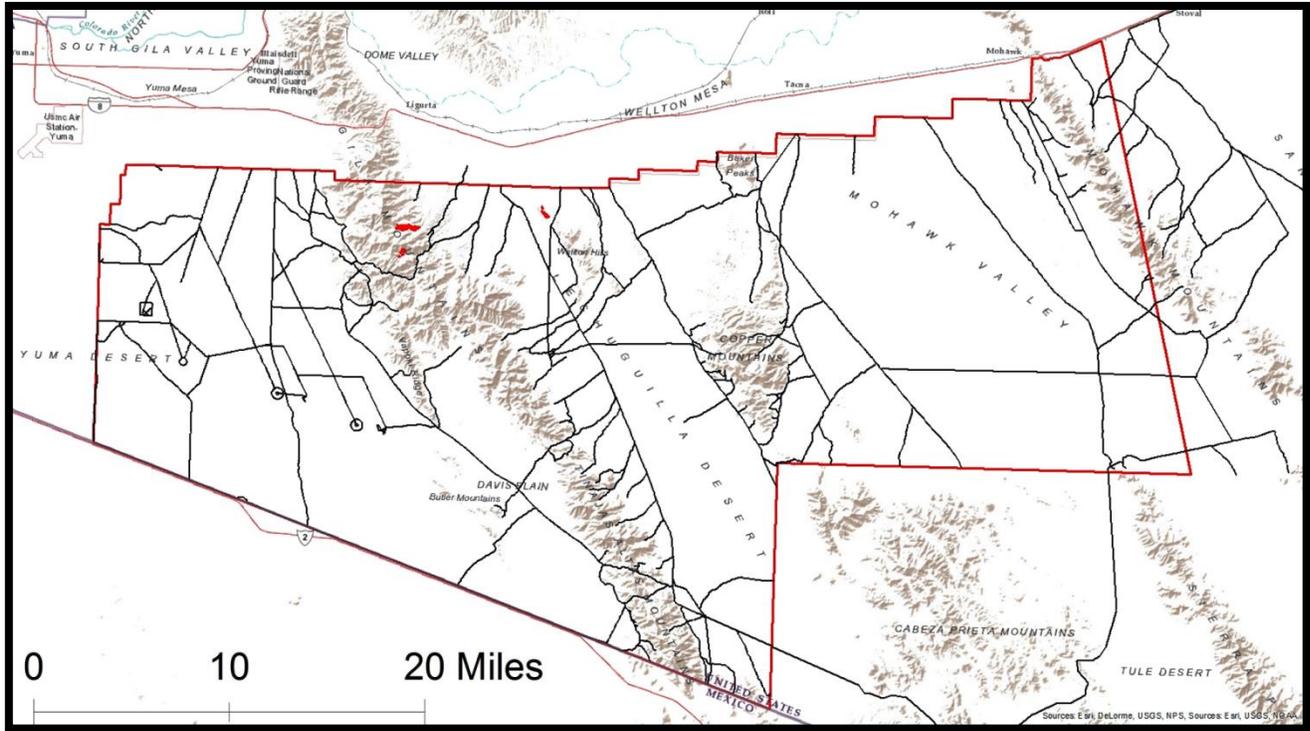


Figure 189. Distribution of Blue PaloVerde/Hollyleaf Bursage (900) on the BMGR West.

**Description:** Sparse blue palo verde (*Parkinsonia florida*), barrel cactus (*Ferocactus cylindraceus* = *F. acanthodes*) and hollyleaf bursage (*Ambrosia ilicifolia*). The blue palo verde and barrel cactus were at all 3 relevés, but only the paloverde reached 1-4 % cover. The hollyleaf bursage was at only 2 of 3 relevés, but had 1 to 4 percent cover at both sites. Common associates at 2 of 3 relevés included mallow (*Sphaeralcea ambigua*) and big galleta grass (*Pleuraphis rigida*).

This subassociation was noted as unusual because we did not expect the blue paloverde to persist in such arid and hot locales. In fact, it doesn't occur over most of the range of the Sonoran Desert in Arizona, where the yellow paloverde (*Parkinsonia microphylla*) is the species of stony hillsides, and the blue palo verde is restricted to washes.

However, the NVC description of the *Parkinsonia florida-Olneya tesota* alliance makes it clear that the blue palo verde occurs on arid slopes in SE California (out of the range of the yellow paloverde.) In Arizona, this subassociation was insufficiently sampled because it was rarely seen.

**Location:** On steep slopes of dark rocks, in the northern Wellton Hills and Gila Mountains.

**Field Identification:** Blue paloverde is on steep slopes, with over 1% cover.

**Photo Identification:** Not useful, because imagery cannot distinguish the blue paloverde from ironwood.

**Vegetation:** *Parkinsonia florida*/*Ambrosia ilicifolia* shrubland on mountains

**Alliance/Association/Subassociation codes:** 9 / 90 / 900

**Number of Sample Sites (relevés):** 3

Taxon	Sites	Median Prominence (Range) 5 = dominant 4 = codominant 3 = common 2 = uncommon 1 = rare	Median Cover (Range)	Avg Height (m)
<i>Parkinsonia florida</i> Blue paloverde	3	3 (3-4)	1-4% (<1-4%)	2.3
<i>Ferocactus cylindraceus</i> California barrel	3	1 (1-2)	<1% (<1%)	
<i>Ambrosia ilicifolia</i> Hollyleaf bursage	2	4 (0-5)	1-4% (<1-4%)	0.4
<i>Sphaeralcea ambigua</i> Mallow	2	3 (0-4)	<1% (<1-4%)	0.9
<i>Pleuraphis rigida</i> Big galleta grass	2	2 (0-3)	<1% (<1-4%)	0.8
<i>Pleurocoronis pluriseta</i> Arrowleaf	2	1 (0-3)	<1% (<1-4%)	0.4
<i>Larrea tridentata</i> Creosote	2	1 (0-1)	<1% (<1%)	
<i>Encelia farinosa</i> Brittlebush	1	0 (0-5)	<1% (<1%)	0.7
<i>Cylindropuntia acanthocarpa</i> Buckhorn cholla	1	0 (0-3)	<1% (<1%)	
<i>Cylindropuntia bigelovii</i> Teddy bear cholla	1	0 (0-3)	<1% (<1%)	
<i>Ephedra aspera</i> Mormon tea	1	0 (0-3)	<1% (<1%)	0.6
<i>Trixis californica</i>	1	0 (0-3)	<1% (<1%)	
<i>Asclepias albicans</i>	1	0 (0-2)	<1% (<1%)	
<i>Fouquieria splendens</i> Ocotillo	1	0 (0-2)	<1% (<1%)	
<i>Ambrosia dumosa</i> White bursage	1	0 (0-1)	<1% (<1%)	
<i>Bursera microphylla</i> Elephant tree	1	0 (0-1)	<1% (<1%)	
<i>Caesalpinia virgata</i> Wand holdback	1	0 (0-1)	<1% (<1%)	
<i>Hyptis emoryi</i> Desert lavender	1	0 (0-1)	<1% (<1%)	
<i>Mentzelia multiflora</i>	1	0 (0-1)	<1% (<1%)	
<i>Peucephyllum schottii</i>	1	0 (0-1)	<1% (<1%)	
<i>Physalis crassifolia</i>	1	0 (0-1)	<1% (<1%)	

**Level of Classification:** Name of vegetation type (numerical code in GIS table)

**Alliance:** Barren (0)

**Association:** Barren (00)

**Subassociation:** Barren (000)

**Scientific name:** Non-vegetated.

**NVCS association:** Non-vegetated. The description from the manual of standards (FDGC, 2008):

"Non-vegetated — A category used to classify lands with limited capacity to support life and typically having less than 1 percent vegetative cover. Vegetation, if present, is widely spaced. Typically, the surface of barren land is sand, rock, exposed subsoil, or salt affected soils."

**Previous classifications:** not mapped previously by Warren et al (1981) or Malusa (2003).

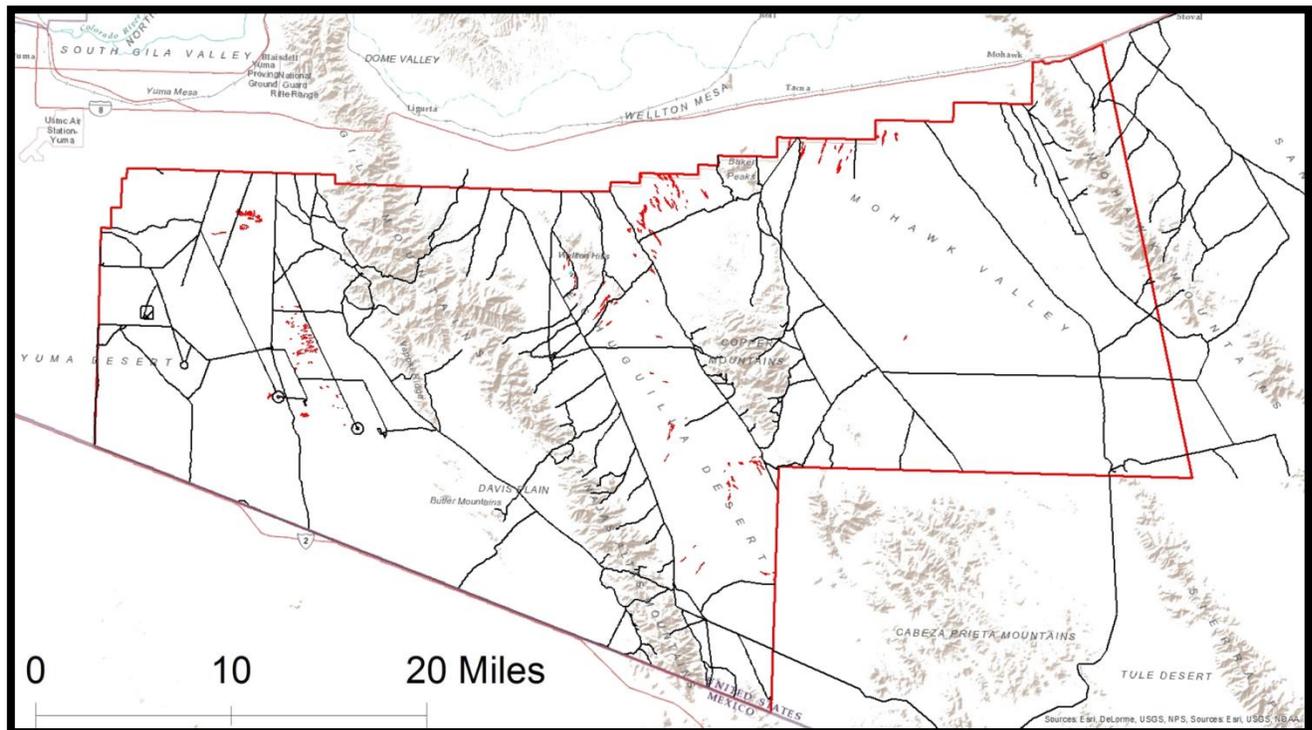


Figure 190. Distribution of Barrens (000) in MCAS- Yuma.

**Description:** Barrens are areas with less the 1% vegetation. Any vegetation found would most always be a lone creosote.

**Location:** On slightly raised interfluves. These were most common along the northern boundary of the BMGR West to the east and west of the Baker Peaks, and in an area just northeast of the Tracker House.

**Field Identification:** Must satisfy three requirements: (a) less than 1% vegetation cover; (b) not a playa (subassociation 152); and (c) not a pavement (subassociation 171), which is characterized by significant vegetation/trees in the fluvial channels.

**Photo Identification:** See example below.

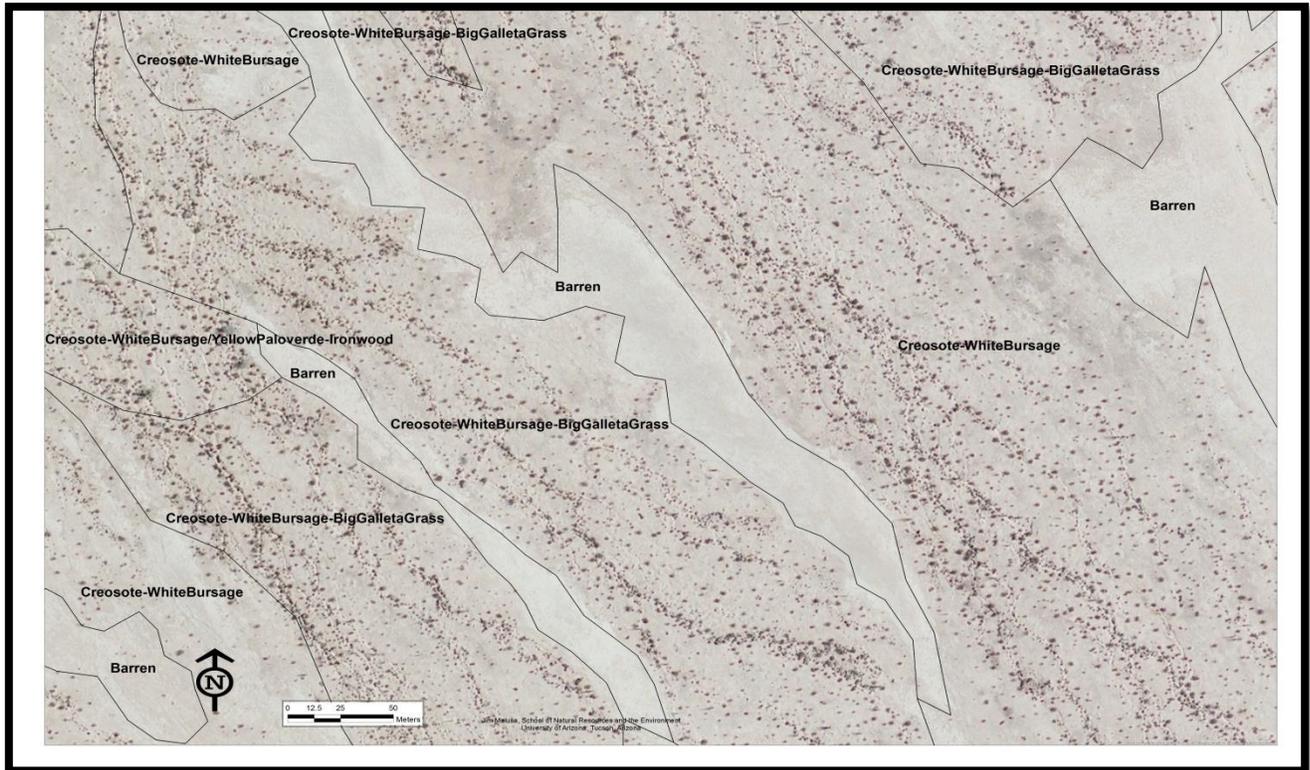


Figure 191. An example of barrens along the northern boundary of the BMGR West, 2 miles west of Baker Peaks.

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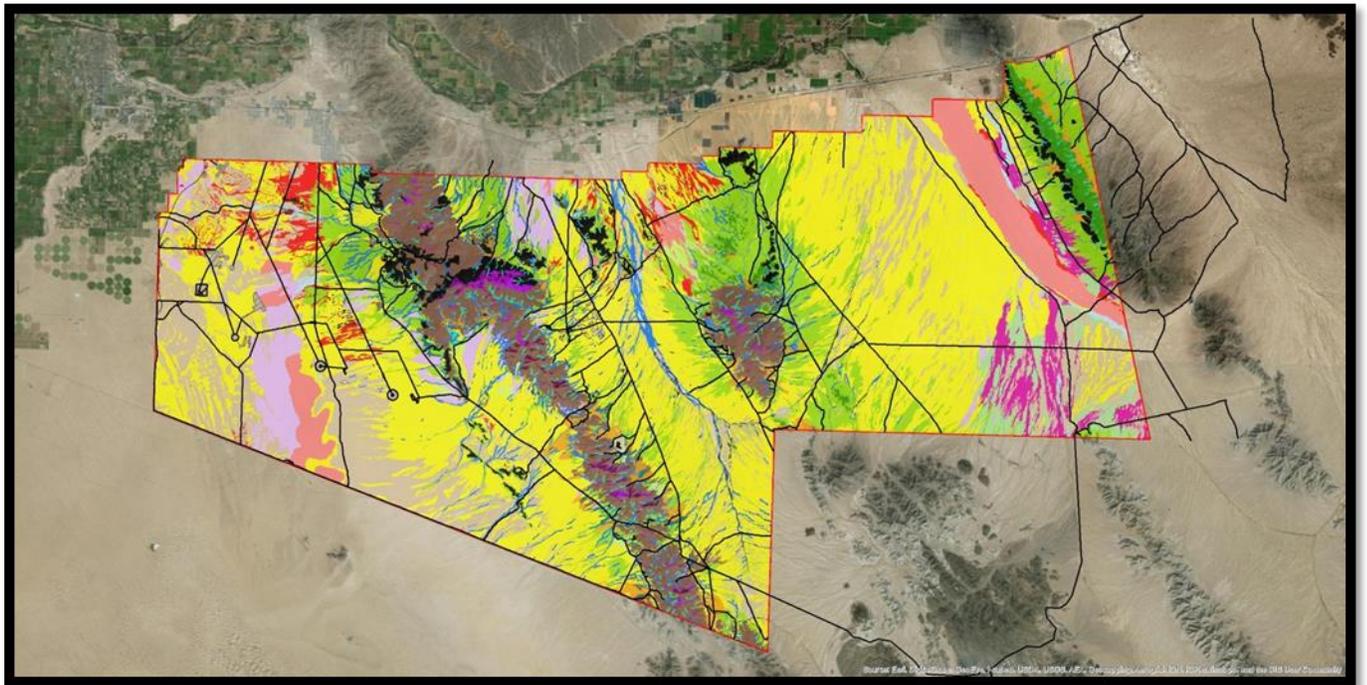
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Vegetation associations of the BMGR West shown with aerial imagery.