Zapata Bladderpod
***Physaria thamnophila* (Rollins & E.A. Shaw) O'Kane & Al-Shehbaz**
(Synonym: *Lesquerella thamnophila* Rollins & E.A. Shaw)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Texas Coastal Ecological Services Field Office
Corpus Christi, TX

5-YEAR REVIEW
Zapata Bladderpod / *Physaria thamnophila* (Rollins & E.A. Shaw) O'Kane & Al-Shehbaz

(Syn. *Lesquerella thamnophila* Rollins and E.A. Shaw)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest (Region 2)
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1.2 Methodology used to complete the review:

This review considers both new and previously existing information from Federal and State agencies, non-governmental organizations, academia, and the general public. Information used in the preparation of the review include the Texas Parks and Wildlife Department (TPWD) Natural Diversity Database (TXNDD), final reports of Section 6-funded projects, monitoring reports, scientific publications, unpublished documents, personal communications from botanists familiar with the species, and Internet web sites. The 5-year review was prepared without peer review by personnel of the Austin Ecological Services Field Office.

1.3 Background:

U.S. Fish and Wildlife Service (USFWS) listed Zapata bladderpod as endangered without critical habitat on November 22, 1999 (64 FR 63745). The State of Texas listed Zapata bladderpod as endangered on July 18, 2001.

The first use of technical terms and words with arcane meanings in the lexicons of science and government are underlined, and are defined in the glossary on pages 39-41. For convenience, the first uses of scientific units are spelled out, and are also summarized on page 38. Photographic credits are on page 38.

1.3.1 FR Notice citation announcing initiation of this review:

February 11, 2009 (74 FR 6917).

1.3.2 Listing history

<u>Original Listing</u>

Federal Register notice: 64 FR 63745.
Date listed: November 22, 1999.
Entities listed: *Lesquerella thamnophila* (Zapata bladderpod)
Classification: Endangered; Critical Habitat designation was deferred.
Critical Habitat Designation: December 22, 2000 (65 FR 81182).

1.3.3 Associated rulemakings: n/a

1.3.4. Review History.

No previous 5-year review has been conducted for Zapata bladderpod. Other review documents include:

Status Report on *Lesquerella thamnophila* (Poole 1989).

1.3.5 Species' Recovery Priority Number at start of 5-year review:

The Recovery Priority Number for Zapata bladderpod was 5C, meaning that it is a distinct species, has a high degree of threat, and a low recovery potential. The letter "C" indicates that the species is, or may be, in conflict with construction or other development projects of other forms of economic activity.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Zapata bladderpod (*Lesquerella thamnophila*) Recovery Plan.
Date issued: July 14, 2004
Dates of previous revisions, if applicable: n/a

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy.

The Distinct Population Segment policy applies only to vertebrate animals.

2.2 Recovery Criteria

2.2.1 Does this species have a final, approved recovery plan?

Yes.

2.2.1.1 Does the recovery plan contain objective, measurable criteria?

Yes.

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

The recovery criteria should be revised to reflect new information on the species' ecology and the revised recovery planning guidance (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2010).

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

Recovery Plan Criteria

> ***1)*** *Maintain or establish 12 fully protected, geographically distinct, self-sustaining populations of the Zapata bladderpod within the historical and geographical range of the species in the United States*:
>
> *Each population should consist of at least 2,000 reproductive individuals at a size class structure reflecting that plants are reproducing and becoming naturally established within the population. These populations can be composed of smaller subpopulations so that the units function as one large meta-population if habitat availability is limited or fragmented and life history information support a meta-population structure. Distance between (meta) populations should be determined as information on genetics, seed dispersal and pollination is gathered throughout the recovery process. For populations to count toward the reclassification criteria, the number of plants, number of reproductive individuals, and age class structure must be verified through monitoring, including an assessment of the general habitat condition. Reintroductions, if necessary, can occur on Federal or State land, and/or private land that have been voluntarily entered into a stewardship agreement for the Zapata bladderpod by its owners. Threats to the species must be managed and controlled at each site.*
>
> **(2)** *Establish agreements for the protection and management of the 12 self-sustaining populations:*
>
> *Although binding agreements such as an approved management plan (e.g., National Wildlife Refuge Comprehensive Conservation Plan), or formal stewardship agreement with private landowners are preferable due to the commitment of long-term management continuity, non-binding verbal agreements can contribute in the interim to the objectives of this Recovery Plan. Protection and management measures for any populations on public land should be fully incorporated into Federal and State management plans.*
>
> *The justification for twelve Zapata bladderpod populations is based upon the following: (a) the understanding that this number reflects sufficient population repetition such that extinction is not likely in the foreseeable future; (b) it represents a significant increase in the number of known populations from the time of listing (4 known sites) to reclassification; and (c) it is a feasible*

target considering the amount of unsurveyed range and the opportunity for reintroduction on Federal, State, and participating private land sites.

The recommendation for population size of 2,000 individuals of Zapata bladderpod is based on the concept that a minimum viable population (MVP) should maintain enough individuals that there is a 95 percent probability that the population will remain viable over a period of one-hundred years (Mace and Lande 1991). MVP size for the Zapata bladderpod should take into account the life characteristics of the plant, the extent of appropriate habitat, and threats to the species. Characteristics of the plant that should be examined include the life habit, breeding system, growth form, fecundity, ramet production (if any), survivorship, seed duration, environmental variation, and successional status (Pavlik 1996). According to these population characterizations, and available information on Zapata bladderpod, MVP for the plant requires a population size of approximately 2,000 reproductive individuals.

Discussion

The recovery plan defines criteria for de-listing only (not down-listing to threatened). The measurable attributes of recovery criterion 1 are: a) 12 self-sustaining populations; b) 2,000 or more individuals per population. Criterion 2 requires establishment of agreements for the protection and management of these populations. Four populations of undetermined size were known when the species was listed in 1999. The recovery plan (2004) lists 11 occurrences, of which 7 populations ("sites") were extant. The most recent complete surveys, in 2007, documented 8 extant populations, while 2 populations had unknown status (discussed in detail in section 2.3.1.2, listed in table 2, and mapped in Figure 3). Of the extant populations, 4 have had maximum populations of at least 2,000 individuals. Four populations are protected, including two with maximum populations of at least 2,000 individuals. Therefore, 2 populations meet all requirements of both criteria.

2.3 Updated Information and Current Species Status

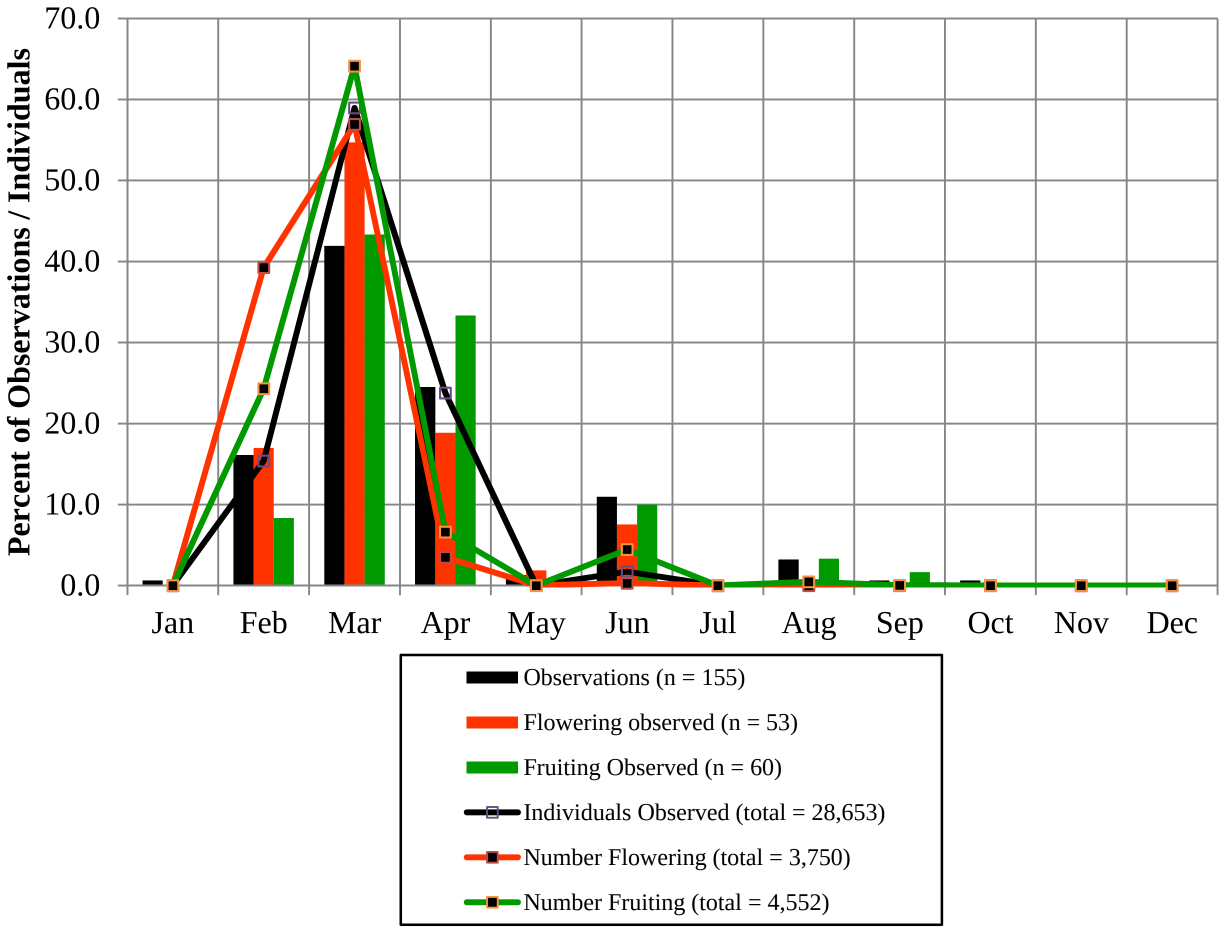
2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology, life history, habitat, and ecosystem:

Zapata bladderpod has been described as a perennial (O'Kane 2015; Poole 1989; Poole et al. 2007; Rollins and Shaw 1973; Sternberg 2005; 64 FR 63745, U.S. Fish and Wildlife Service 2004) and as a short-lived perennial (Fowler et al. 2011; Price et al. 2012). The presence of old leaf-scars at the apex of the woody caudex indicates that the species is perennial. However, we have seen no documentation of the actual lifespans of individual plants. This information would be useful for predicting demographic trends and estimating the size of viable populations.

Texas Natural Diversity Database (2015; TXNDD) provided Element Occurrence (EO; see discussion in 2.3.1.2.) records that include 155 observations of Zapata bladderpod plants at specific times and locations. Many of the EO records include counts of individuals as well as their phenological states, such as juvenile or seedling, mature vegetative (non-reproductive), flowering, or fruiting. Figure 1 summarizes our analysis of these records. Flowering occurs mainly from February to April, with a peak in March; flowering has occasionally been observed as late as October. Most fruiting has been observed in March and April. Since surveys are usually scheduled to coincide with flowering and fruiting, the plant itself has been observed primarily from February to April. However, surveys of known populations following extended periods of hot, dry weather have detected few or no Zapata bladderpod plants. We believe that leafless caudices are able to remain in a dormant state for extended periods, during which they are very difficult to detect. Rainfall in this hot, semi-arid region occurs most reliably from September through November. Seed germination and the emergence of basal rosettes from dormant caudices probably occur in the fall and early winter in response to rain, cooler weather, and shorter day lengths.

Figure 1. Phenology of Zapata Bladderpod.
Based on Texas Natural Diversity Database (2015) Element Occurrence Records.



Following completion of the Zapata bladderpod recovery plan in 2004, two investigations have contributed greatly to our knowledge of the species' ecology. Sternberg (2005) examined the population size and associated vegetation from 1997 to 2003 at EO 7, located on the 18.2-hectare (ha) (44.9-acre [ac]) Cuellar tract of Lower Rio Grande Valley National Wildlife Refuge (LRGV NWR). By extrapolating plot data to the entire population, he estimated that the observed population ranged from a low of 826 Zapata bladderpod individuals, in March 2001, to a high of 8,351 in July 1997; this variation in population size was strongly related to rainfall during the previous 6 and 12 months. Zapata bladderpods had a significantly clumped distribution, suggesting positive or negative associations with other plant species. By comparing Zapata bladderpod distribution to the vegetation composition at that site, he determined that it had a non-random association with canopy species, occurring beneath a canopy more often than expected. Table 1 lists the observed and expected frequencies of plant species Sternberg observed at EO 7.

A team of investigators from TPWD, University of Texas at Austin, Texas A&M University – Kingsville, and LRGV NWR also determined population sizes and associated plant frequencies, from 2002 to 2007, at the four most secure and accessible Zapata bladderpod populations (Fowler et al. 2011; Price et al. 2012). In addition to Cuellar tract, the study included Arroyo Ramírez (EO 12) and Arroyo Morteros (EO 14) tracts of LRGV NWR, and Santa Margarita (EO 6), a privately-owned ranch. A unique opportunity arose in December 2000 when vegetation was cut along a pre-existing powerline right-of-way (ROW) that bisected the Cuellar population. The implement used, called a Woodgator, shreds woody plants without disturbing the soil and scatters the debris over the soil surface. This allowed a comparison of the response of Zapata bladderpod and associated plants in adjacent cut and intact shrubland.

Price et al. (2012) described the geology of these study sites as Eocene calcareous sandstones of the Jackson (EOs 6, 12) and Yegua (EOs 7, 14) formations (see figure 4). All known populations have yellowish, calcareous, highly erodable soil derived from sandstone; rapid sheet and gully erosion are evident at all study sites. Soils at these sites are shallow, well-drained, sandy loams of the Zapata, Maverick, Catarina, and Copita series (NRCS 2009). Although the recovery plan states that Zapata bladderpod populations also occur on Jimenez-Quemado soils underlaid by caliche (precipitated calcium carbonate), Price et al. (2012) determined that this is incorrect. Gypsum (hydrated calcium sulfate) crystals occur at the soil surface of most Zapata bladderpod sites; Catarina and Maverick soils contain up to 15 percent gypsum, and Copita soils have about 2 percent gypsum (NRCS 2009). Wu and Smeins (1999, cited in Price et al. 2012) detected very high soil levels of calcium, high sulfur, and low nitrogen at Zapata bladderpod sites. Although clearly associated with gypseous soils, Zapata bladderpod may tolerate rather than require gypsum. Many Zapata bladderpod populations are also immediately down-slope from fossil oyster shell strata (see figure 5). The porous shell strata perched above impermeable sandstone may create seepage zones that concentrate gypsum through evaporation from the soil surface.

Zapata bladderpod populations fluctuated greatly with year and site. In 2007, Arroyo Morteros and the sampled portion of Santa Margarita had 78,000 and 1,800 reproductive plants, respectively, while in 2006, no plants reproduced at any site (Fowler et al. 2011). Although Zapata bladderpod density tended to be greater when the previous 12-month precipitation was greater, precipitation accounted for only 13 percent of density variation; however, the relatively few years of data did not allow testing of complex relationships between rainfall and precipitation (Fowler et al. 2011). The authors also state, “The wide fluctuations in the sizes of populations among years indicate that success or failure of any management practice should not be judged on results of 1-2 years. A 10-year evaluation period would be more appropriate.” These fluctuations also make it very difficult to detect population trends over short periods of time.

These investigators detected 152 plant species, listed in Price et al. (2012), on 182 plots within the five populations (in this case, Cuellar cut and un-cut areas were treated as separate populations). Twenty-four species were woody plants capable of reaching 1 to 3 meters (m) (3.3 to 9.8 feet [ft]) in height (Fowler et al. 2012). Table 1 lists these associated plants and their occurrences and average frequencies. The plant species found on at least 4 sites that had the highest percent frequency (in parentheses) are: *Acacia rigidula* (blackbrush, 35.7); *Thymophila pentachaeta* (parralena, 30.0); *Aristida purpurea* (purple three-awn, 29.5); *Leucophyllum frutescens* (cenizo, 29.2); *Polygala lindheimeri* (shrubby milkwort, 23.5); *Physaria thamnophila* (Zapata bladderpod, 18.4); *Melampodium cinereum* (blackfoot daisy, 15.6); *Thamnosma texana* (ruda del monte, 15.6); *Nama hispidum* (bristly nama, 13.5); *Lippia graveolens* (oregano cimarrón, 11.9); and *Mimosa texana* (Wherry mimosa, 10.9). Locally common, visually dominant upland plants that were absent or rare at all populations include *Acacia berlandieri* (guajillo), *Prosopis glandulosa* (honey mesquite), *Celtis ehrenbergiana* (granjeno), *Yucca treculeana* (palma pita), *Ziziphus obtusifolia* (lotebush), *Guaiacum angustifolium* (guayacán), *Zanthoxylum fagara* (colima), *Cordia boissieri* (anacahuita), and *Lycium berlandieri* (Berlandier's wolfberry). *Pennisetum ciliare* (buffelgrass), a highly invasive, introduced grass, was noticeably uncommon within these populations, and members of the introduced, invasive *Dichanthium annulatum – Bothriochloa ischaemum* complex (Old World bluestems) were entirely absent. The absence or rarity of these species within Zapata bladderpod populations is notable, especially since the first six as well as buffelgrass and Kleberg bluestem were included as characteristic species of Zapata bladderpod habitat in the federal listing (64 FR 63745).

In the comparison of cut and uncut vegetation at Cuellar (Fowler et al. 2011; Price et al. 2012), cut plots had significantly more herbaceous species diversity, more grass cover, and (of course) lower canopy <u>cover index</u>. In 2002, 2003, and 2006, a significantly greater proportion of cut plots were occupied by Zapata bladderpod; by 2007, after 6 years of shrub re-growth, this difference persisted but was no longer significant. However, occupied plots in cut and uncut vegetation did not differ in Zapata bladderpod density.

The analyses of vegetation associations at these four populations, described in Fowler et al. (2011) and Price et al. (2012), reveal that Zapata bladderpod has a complex relationship with shrub canopies. Canopy cover index was positively correlated with Zapata bladderpod density in occupied plots in some years but not others; in some years canopy cover was <u>correlated</u> with seedling density only. Herbaceous <u>species richness</u> was positively correlated with grass abundance, but neither grass abundance nor herbaceous species richness had an effect on Zapata bladderpod density or its proportion of reproductive plants. The significant correlation of shrub canopy cover with the density of seedlings but not adult plants suggests that shrub canopies facilitate Zapata bladderpod seed germination, but that once established, competition with shrubs for resources outweighs facilitation. The authors attribute facilitated germination to the accumulations of leaf litter beneath shrubs that trap soil, seeds, and moisture; where litter is sparse, rapid sheet erosion impedes seedling establishment. This hypothesis is also supported by the higher proportion of plots occupied by Zapata bladderpod in the cut right-of-way, where the soil had an ample cover of shredded plant debris. Fowler et al. (2012) conclude, "...optimal habitat of *P. thamnophila* may require temporal variation in densities of shrub-canopy. Native grasses may have been substantially more abundant before 1880 and may have supported fires that would have thinned shrub-canopies. The mechanical clearing of part of Cuellar, so beneficial to *P. thamnophila*, may have simply mimicked effects of fires. Thus, our results suggest serious consideration should be given to the possibility that fire once played a significant role in shrublands, as well as in savannas, in this region...The positive response of *P. thamnophila* and other herbaceous species to non-soil-disturbing removal of brush suggests that thinning brush may be a useful management tool. Because removal of brush may be mimicking pre-settlement fire, use of prescribed fire also should be considered." Noting the severity of soil erosion in Zapata bladderpod populations, these authors recommend managing sites to minimize erosion, such as excluding foot and vehicular traffic, controlling erosion during construction, practicing good rangeland management, and controlling brush with non-soil disturbing methods.

Table 1. Plant species associated with Zapata bladderpod.

				Sternberg 2005	**Price et al. 2012**	
Family	**Genus**	**Species**	**Common Name**	**Frequency[a] Observed (Expected)**	**No. Sites[b]**	**Average Frequency[c]**
Acanthaceae	*Justicia*	*pilosella*	Gregg's Tube Tongue		2	0.30
Acanthaceae	*Ruellia*	*nudiflora* v. *runyonii*	Wild Petunia	3(5)	0	0.00
Agavaceae	*Manfreda*	*longiflora*	Runyon's Huaco		1	0.12
Agavaceae	*Yucca*	*treculiana*	Spanish Dagger		2	0.14
Apiaceae	*Spermolepis*	*echinata*	Bristly Scaleseed		1	0.41
Apocynaceae	*Cynanchum*	*barbigerum*	Climbing Milkweed		4	1.38
Apocynaceae	*Mandevilla*	*lanuginosa*	Flor de San Juan		1	0.13
Aristolochiaceae	*Aristolochia*	species	Pipevine		1	0.13
Asteraceae	*Acourtia*	*runcinata*	Featherleaf Desertpeony		1	0.13
Asteraceae	*Aphanostephus*	*skirrhobasis v. kidderi*[d]	Arkansas Dozedaisy		5	8.11
Asteraceae	*Bahia*	*absinthifolia*	Hairyseed Bahia		1	0.14
Asteraceae	*Chaetopappa*	*bellioides*[d]	Manyflower Leastdaisy		5	8.11
Asteraceae	*Fleischmannia*	*incarnata*	Pink Thoroughwort		1	0.07
Asteraceae	*Florestina*	*tripteris*	Sticky Florestina		1	0.07
Asteraceae	*Gamochaeta*	*pensylvanica*	Pennsylvania Everlasting		1	0.21
Asteraceae	*Heterotheca*	species	Camphor Weed		1	0.07
Asteraceae	*Jefea*	*brevifolia*	Shorthorn Zexmenia		2	0.35
Asteraceae	*Melampodium*	*cinereum*	Blackfoot Daisy	13(5)	5	15.63
Asteraceae	*Palafoxia*	*texana*	Texas Palafox		2	1.60
Asteraceae	*Parthenium*	*confertum*	Gray's Feverfew		3	5.86
Asteraceae	*Sonchus*	*oleraceus*	Sowthistle		2	0.22
Asteraceae	*Thymophylla*	*pentachaeta*	Parralena	10(9)	5	29.98

Family	Genus	Species	Common Name	Sternberg 2005	Price et al. 2012	
				Frequency[a] Observed (Expected)	No. Sites[b]	Average Frequency[c]
Asteraceae	*Viguiera*	*stenoloba*	Skeleton-Leaf Goldeneye	2(5)	0	0.00
Asteraceae	*Wedelia*	*texana*	Orange Zexmenia		5	3.39
Boraginaceae	*Heliotropium*	*confertifolium*	Leafy Heliotrope		2	0.87
Boraginaceae	*Heliotropium*	*curassavicum*	Seaside Heliotrope		1	0.07
Boraginaceae	*Tiquilia*	*canescens*	Oreja de Perro	10(29)	4	6.75
Brassicaceae	*Lepidium*	*lasiocarpum* v. *wrightii*	Wright's Pepperweed		1	0.55
Brassicaceae	*Paysonia*	*lasiocarpa*	Roughpod Bladderpod		1	0.34
Brassicaceae	*Physaria*	*thamnophila*	Zapata Bladderpod	46(1)	5	18.41
Brassicaceae	*Synthlipsis*	*greggii*	Gregg's Keelpod		3	3.42
Cactaceae	*Cylindropuntia*	*leptocaulis*	Tasajillo		4	0.75
Cactaceae	*Echinocactus*	*texensis*	Horse Crippler		1	0.12
Cactaceae	*Echinocereus*	*enneacanthus*	Pitaya		3	0.55
Cactaceae	*Echinocereus*	*poselgeri*	Dahlia Cactus		4	0.78
Cactaceae	*Echinocereus*	*reichenbachii* ssp. *fitchii*	Rainbow Cactus		1	0.13
Cactaceae	*Escobaria*	*emskoetteriana*	Runyon's Escobaria		2	0.25
Cactaceae	*Ferocactus*	*hamatacanthus* v. *sinuatus*	Rio Grande Barrel Cactus		2	0.52
Cactaceae	*Grusonia*	*schottii*	Dog Cholla		1	0.08
Cactaceae	*Mammillaria*	*heyderi*	Heyder's Pincushion Cactus		1	0.47
Cactaceae	*Mammillaria*	*sphaerica*	Pale Mammillaria		1	0.12
Cactaceae	*Opuntia*	*engelmannii*	Texas Prickly Pear		4	1.37
Cactaceae	*Opuntia*	species	Nopal		1	0.12
Capparaceae	*Koeberlinia*	*spinosa*	Junco		1	0.08
Celastraceae	*Schaefferia*	*cuneifolia*	Desert Yaupon		3	0.61
Commelinaceae	*Commelina*	*erecta*	Whitemouth Dayflower		4	0.94
Convolvulaceae	*Convolvulus*	*equitans*	Texas Bindweed		3	0.29
Convolvulaceae	*Evolvulus*	*alsinoides*	Slender Dwarf Morning-Glory		3	3.57
Cucurbitaceae	*Ibervillea*	*lindheimeri*	Lindheimer Globeberry		2	0.20
Cyperaceae	*Cyperus*	species	Sedge		5	2.19
Ebenaceae	*Diospyros*	*texana*	Texas Persimmon		4	2.11
Ephedraceae	*Ephedra*	*antisyphilitica*	Clapweed		3	4.60
Euphorbiaceae	*Acalypha*	*monostachya*	Round Copperleaf		2	2.10

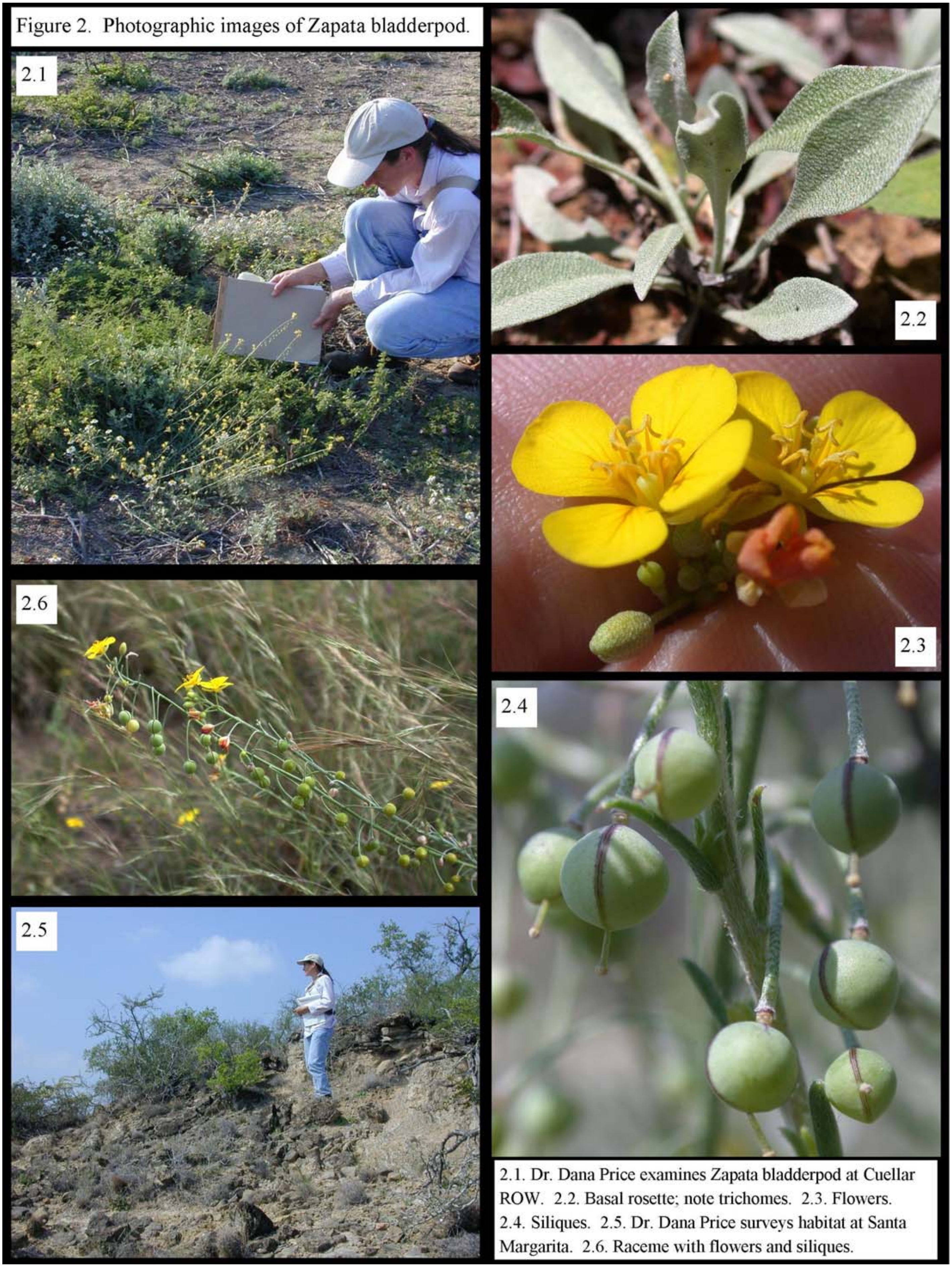
Family	Genus	Species	Common Name	Sternberg 2005	Price et al. 2012	
				Frequency[a] Observed (Expected)	No. Sites[b]	Average Frequency[c]
Euphorbiaceae	*Argythamnia*	*humilis* v. *humilis*	Low Silverbush		5	0.88
Euphorbiaceae	*Chamaesyce*	*cinerascens*[f]	Ashy Sandmat		4	4.07
Euphorbiaceae	*Chamaesyce*	*laredana*[f]	Laredo Sandmat		4	4.07
Euphorbiaceae	*Chamaesyce*	*prostrata*	Prostrate Sandmat	22(47)	0	0.00
Euphorbiaceae	*Croton*	*incanus*	Torrey Croton		1	2.59
Euphorbiaceae	*Jatropha*	*dioica*	Sangre de Drago	0(0)	5	6.26
Euphorbiaceae	*Phyllanthus*	*polygonoides*	Smartweed Leaf-flower		5	7.25
Euphorbiaceae	*Tragia*	*glanduligera*	Brush Noseburn	7(3)	0	0.00
Fabaceae	*Acacia*	*berlandieri*	Guajillo		1	0.13
Fabaceae	*Acacia*	*rigidula*	Blackbrush	25(11)	5	35.67
Fabaceae	*Astragalus*	*nuttallianus*	Smallflowered Milkvetch		2	0.30
Fabaceae	*Astragalus*	species	Milkvetch		1	0.07
Fabaceae	*Dalea*	*nana*	Dwarf Prairie Clover		2	1.41
Fabaceae	*Dalea*	*pogonathera*	Bearded Prairie Clover		1	0.07
Fabaceae	*Eysenhardtia*	*texana*	Texas Kidneywood	0(0)	5	4.08
Fabaceae	*Lupinus*	*texensis*	Texas Bluebonnets		1	0.27
Fabaceae	*Parkinsonia*	*texana* v. *texana*	Texas Palo Verde	0(0)	4	1.96
Fabaceae	*Senna*	*bauhinioides*	Two-Leaved Senna		3	0.58
Hydrophyllaceae	*Nama*	*hispidum*	Bristly Nama		4	13.51
Hydrophyllaceae	*Phacelia*	*congesta*	Caterpillars		1	0.41
Krameriaceae	*Krameria*	*ramosissima*	Calderona	1(5)	5	8.75
Lamiaceae	*Salvia*	*ballotiflora*	Shrubby Blue Sage		1	0.14
Liliaceae	*Cooperia*	species	Rain Lilly		2	0.62
Linaceae	*Linum*	*lundelli*	Sullivan City Flax		5	3.63
Loasaceae	*Cevallia*	*sinuata*	Stick-Leaf Cevallia		1	0.69
Malphigiaceae	*Galphimia*	*angustifolia*	Narrowleaf Goldshower		4	1.53
Malvaceae	*Abutilon*	*fruticosum*	Texas Indian Mallow		1	0.07
Malvaceae	*Herissantia*	*crispa*	Bladdermallow		2	0.37
Malvaceae	*Hibiscus*	*martianus*	Tulipán del Monte	7(3)	3	0.27
Malvaceae	*Sida*	*abutiflora*	Spreading Sida		3	2.30
Nyctaginaceae	*Acleisanthes*	*obtusa*	Berlandier's Trumpets		2	0.69
Nyctaginaceae	*Allionia*	*incarnata*	Trailing Windmills		3	2.50
Oleaceae	*Forestiera*	*angustifolia*	Elbowbush		5	8.69
Onagraceae	*Oenothera*	*laciniata*	Cutleaf Evening Primrose		3	3.70

Family	Genus	Species	Common Name	Sternberg 2005 Frequency[a] Observed (Expected)	Price et al. 2012 No. Sites[b]	Price et al. 2012 Average Frequency[c]
Oxalidaceae	*Oxalis*	*dichondrifolia*	Peonyleaf Woodsorrel		3	1.02
Passifloraceae	*Passiflora*	*tenuiloba*	Slender Lobe Passionflower		2	0.54
Phytolaccaceae	*Rivina*	*humilis*	Pigeonberry		1	0.35
Plantaginaceae	*Plantago*	*hookeriana*	Tallow Weed		3	2.53
Poaceae	*Aristida*	*purpurea*	Purple Three-Awn		5	29.52
Poaceae	*Bothriochloa*	*laguroides* ssp. *torreyana*	Silver Bluestem		1	0.24
Poaceae	*Bouteloua*	*curtipendula*[g]	Side-Oats Grama	0(29)	0	0.00
Poaceae	*Bouteloua*	*repens*	Slender Grama		1	0.13
Poaceae	*Bouteloua*	*trifida*	Red Grama	10(8)	5	6.76
Poaceae	*Cenchrus*	*spinifex*	Coastal Sandbur		2	0.36
Poaceae	*Digitaria*	*cognata*	Fall Witchgrass		4	5.09
Poaceae	*Eragrostis*	*curtipedicellata*	Gummy Lovegrass		3	0.91
Poaceae	*Eragrostis*	*intermedia*	Plains Lovegrass	2(1)	0	0.00
Poaceae	*Erioneuron*	*pilosum*	Hairy Tridens		2	0.96
Poaceae	*Melinis*	*repens*	Natal Grass		1	0.07
Poaceae	*Mimosa*	*texana*	Wherry Mimosa		5	10.85
Poaceae	*Panicum*	*hallii*	Hall's Panicum		1	0.14
Poaceae	*Paspalum*	*setaceum*	Thin Paspalum		1	0.07
Poaceae	*Pennisetum*	*ciliare*	Buffelgrass	4(15)	3	4.23
Poaceae	*Setaria*	*leucopila*	Plains Bristlegrass	3(6)	4	0.77
Poaceae	*Setaria*	*reverchonii* ssp. *ramiseta*	Rio Grande Bristlegrass		2	1.11
Poaceae	*Setaria*	*texana*	Texas Bristlegrass		1	1.59
Poaceae	*Sporobolus*	*cryptandrus*	Sand Dropseed		5	3.49
Poaceae	*Tridens*	*muticus*	Slim Tridens		5	8.75
Poaceae	*Urochloa*	*ciliatissima*	Fringed Signalgrass		1	0.21
Poaceae	*Urochloa*	*Texana*	Texas Panicgrass		1	0.07
Polemoniaceae	*Giliastrum*	*Incisa*	Splitleaf Gilia		1	0.22
Polygalaceae	*Polygala*	*lindheimeri*	Shrubby Milkwort		5	23.46
Polygonaceae	*Eriogonum*	*Greggii*	Gregg's Wild Buckwheat		1	5.33
Portulacaceae	*Phemeranthus*	*aurantiacus*	Flame-Flower		2	0.14
Portulacaceae	*Portulaca*	Species	Purslane		1	0.34
Rhamnaceae	*Condalia*	*spathulata*	Knife-Leaf Condalia		1	0.07
Rhamnaceae	*Karwinskia*	*humboldtiana*	Coyotillo	1(3)	5	9.39

Family	Genus	Species	Common Name	Sternberg 2005	Price et al. 2012	
				Frequency[a] Observed (Expected)	No. Sites[b]	Average Frequency[c]
Rhamnaceae	*Zizyphus*	*obtusifolia*	Lotebush		4	0.46
Rubiaceae	*Galium*	Species	Bedstraw		4	3.18
Rutaceae	*Thamnosma*	*Texana*	Ruda del Monte	28(11)	5	15.60
Rutaceae	*Zanthoxylum*	*Fagara*	Colima		1	0.21
Sapindaceae	*Cardiospermum*	*dissectum*	Chihuahuan BalloonVine		1	3.29
Sapotaceae	*Sideroxylon*	*celastrinum*	Coma		3	3.35
Scrophulariaceae	*Leucophyllum*	*frutescens*	Cenizo	1(1)	5	29.21
Scrophulariaceae	*Maurandella*	*antirrhiniflora*	Roving Sailor		1	1.31
Solanaceae	*Chamaesaracha*	*sordida*[e]	Hairy Five Eyes		3	3.74
Solanaceae	*Lycium*	*berlandieri*	Berlandier's Wolfberry		2	0.19
Solanaceae	*Physalis*	*cinerascens*[e]	Smallflower Groundcherry		3	3.74
Sterculiaceae	*Ayenia*	*Pilosa*	Hairy Ayenia		5	1.94
Turneraceae	*Turnera*	*Diffusa*	Damiana		1	11.76
Ulmaceae	*Celtis*	*ehrenbergiana*	Granjeno		2	0.28
Ulmaceae	Celtis	*laevigata*	Sugar Hackberry		1	0.12
Urticaceae	*Parietaria*	*pensylvanica*	Pennsylvania Pellitory		4	2.72
Verbenaceae	*Aloysia*	*macrostachya*	Rio Grande Beebrush		3	2.36
Verbenaceae	*Citharexylum*	*brachyanthum*	Mexican Fiddlewood		4	1.14
Verbenaceae	*Lantana*	*achyranthifolia*	Desert Lantana		1	1.38
Verbenaceae	*Lantana*	*urticoides*	Texas Lantana		2	0.49
Verbenaceae	*Lippia*	*graveolens*	Oregano Cimarrón	0(3)	5	11.92
Verbenaceae	*Tetraclea*	*coulteri*	Coulter's Wrinklefruit		3	0.85
Verbenaceae	*Verbena*	species 1	Verbena		2	0.77
Verbenaceae	*Verbena*	species 2	Verbena		3	0.64
Vitaceae	*Cissus*	*Trifoliata*	Ivy Treebine		2	0.21
Zygophyllaceae	*Guaiacum*	*angustifolium*	Guayacán		4	1.98
Bare Ground				1(24)	5	2.36

a. Percent frequencies of associated species (present within 10 cm of Zapata bladderpod plants).
b. Number of Zapata bladderpod populations (out of 5) where species was present.
c. Average percent frequencies of species at 5 Zapata bladderpod populations.
d, e, f. Species pairs with same suffix could not be distinguished in the field, but both were confirmed present. The average frequencies are divided between the two.
g. Although reported as *B. curtipendula* in Sternberg (2005), subsequent floristic surveys indicate the species is not present at Cuellar tract; may have been *B. repens*.

Figure 2. Photographic images of Zapata bladderpod.



2.1. Dr. Dana Price examines Zapata bladderpod at Cuellar ROW. 2.2. Basal rosette; note trichomes. 2.3. Flowers. 2.4. Siliques. 2.5. Dr. Dana Price surveys habitat at Santa Margarita. 2.6. Raceme with flowers and siliques.

2.3.1.2 Trends in populations, demography, and spatial distribution.

Population, site, location, and other terms are often used interchangeably or ambiguously to describe the geographic distributions of rare plants. NatureServe (2002) defines Element Occurrences (EOs) as “area(s) of land and/or water in which a species or natural community is, or was, present.” TXNDD has adopted the EO standard for tracking records of plants, animals, and habitats of conservation concern. Table 2 lists 10 EOs for Zapata bladderpod that TXNDD provided to USFWS on July 10, 2015.

The “Largest Population” column in table 2 includes total counts of individuals, rough estimates, and estimates based on sampled populations. The figures do not distinguish between recently germinated seedlings and established, mature plants. For example, the very large population reported for EO 14 in 2007 consisted of 29.9 percent seedlings, 26.9 percent mature vegetative plants, and 43.1 percent reproductive plants. The previous year, only 361 plants were observed in sample plots (corresponding to a total estimated population of 13,216), of which none were fruiting or flowering. Not surprisingly, precipitation was far below average from fall 2005 through spring 2006 and far above average in the winter and spring of 2007.

The recovery plan stated that there are 7 extant populations, while the TXNDD now lists 8 extant populations and two of unknown status. Of the latter, EO 2 is a historic record north of Roma for which the precise location is unknown. EO17 was detected during a survey of private land in 1994, also north of Roma, and the site has not since been re-visited. The recovery plan also states that there are 11 documented occurrences, but this figure confounds known populations and designated areas of critical habitat. We believe the EOs reported by TXNDD correctly represent our current knowledge of the populations and distribution of Zapata bladderpod.

Recovery criterion 2 specifies that populations meeting criterion 1 must be protected through an established management agreement, such as a Comprehensive Conservation Plan (CCP) of a National Wildlife Refuge, or through a formal stewardship agreement with a private landowner. Non-binding verbal agreements may also contribute to interim objectives of the Recovery Plan. Currently, three EOs occur on tracts of LRGV NWR and are protected under the refuge’s CCP. Winton (2012) and Wahl (2013, 2015) attest to the refuge’s active involvement in protection of those populations. Most of EO 13 is located on a privately owned ranch and is effectively protected through a Voluntary Conservation Agreement with the landowner. EO 3 and part of EO 1 are on highway rights-of-way managed by TXDOT. Although TXDOT cooperates fully in conservation measures to protect these populations, they are publicly-accessible and vulnerable to vehicle traffic and other impacts. We list them as protected but vulnerable.

Table 2. Global populations of Zapata bladderpod (Texas Natural Diversity Database 2015).

EO No.	EO_ID	Place Name	County	Documentation First	Documentation Most Recent	Largest Population[a]	Current Status
1	7751	Siesta Shores	Zapata	1959	2007	487[b]	Partially Intact, partially protected but vulnerable
2	5996	4 mi N Roma	Starr	1889	1986	n/a	Unknown
3	2477	Arroyo Tigre Chiquito	Zapata	1941	2006	5000[c]	Intact, protected but vulnerable
6	7965	Santa Margarita Ranch	Starr	1975	2007	6649[d]	Intact, not protected
7	2223	Cuellar Tract	Starr	1994	2007	8351[d]	Intact, protected
12	7381	Arroyo Ramirez Tract	Starr	2002	2007	1706[d]	Intact, protected
13	8926	San Julian Rd - Martinez Ranch	Starr	2007	2007	370[b]	Intact, protected
14	8927	Arroyo Morteros Tract	Starr	2004	2007	181,838[d]	Intact, protected
15	8929	E Zapata	Zapata	2007	2007	200[c]	Intact, not protected
17	8930	4 mi N Roma	Starr	1994	1994	n/a	Unknown
Totals:	10 Populations					204,601	Individuals

a. Includes all life stages.
b. Actual count of individuals.
c. Rough estimates.
d. Estimates based on samples.

Recovery criterion 1 establishes an MVP target of at least 2,000 reproductive individuals per population. As used here, “reproductive” means established, mature plants that are capable of reproducing, not necessarily reproducing at the time of a survey. The total number of individuals observed at any one time is not an appropriate measure of recovery. The surveys reported in the EOs, as well as Sternberg (2005), Fowler et al. (2011), and Price et al. (2012), all indicate that very large numbers of “juvenile” or “seedling” plants are often observed following periods of weather favorable for seed germination, but that relatively few of these survive long enough to establish a perennating caudex or to reproduce, and thus do not contribute to the surviving gene pool.

An MVP or Population Viability Analysis has not actually been calculated for Zapata bladderpod, as we do not possess the baseline demographic and life history data needed to perform these calculations. The justification for this population size was estimated according to guidelines published in Pavlik (1996). Table 3 is an adaptation of Pavlik's guidelines. Species with traits that all fall under column A would have MVPs of about 50 individuals. Those with traits that all ascribe to column C would have MVPs around 2,500 individuals. We added an intermediate column (B) to Pavlik's table to account for species with intermediate or unknown traits. The bold letters in the table indicate values, if known, for Zapata bladderpod. Three factors require fewer individuals (perennial lifespan, low environmental variation, and climax successional status), two are intermediate or unknown (moderate ramet production, unknown survivorship, and seed duration), and three require more individuals (outcrossing, herbaceous growth, and low fecundity), suggesting an estimated MVP for Zapata bladderpod in the intermediate range (roughly 500 to 1,500 individuals). Hence, the criterion of 2,000 reproductive individuals might err on the high side, but is still reasonable, since this method is just a first approximation.

Table 3. Minimum viable population guidelines applied to Zapata bladderpod (adapted from Pavlik 1996, p. 137).

Factor	A. MVP of 50 individuals for species with these traits.	B. Intermediate MVP Range for species with intermediate or unknown traits.	C. MVP of 2,500 individuals for species with these traits.
Longevity	**Perennial**		Annual
Breeding System	Selfing		**Probably Outcrossing**
Growth Form	Woody		**Herbaceous**
Fecundity	High		**Low**
Ramet Production	Common	**Moderate**	Rare or None
Survivorship	High	**Unknown**	Low
Seed Duration	Long	**Unknown**	Short
Environmental Variation	**Low**		High
Successional Status	**Climax**		Seral or Ruderal

Recovery criterion 1 also requires "a size class structure reflecting that plants are reproducing and becoming naturally established within the population." The criterion requires signs of demographic stability or growth. In practice, it would be challenging to define what that size class structure should be for Zapata bladderpod, and even more difficult to quantify that structure in the field, for these reasons: First, the observable population, consisting of plants that are actively growing, is often a very small subset of the total live, dormant population; it is extremely unlikely that surveyors could detect or positively identify dormant caudices in the field. Second, the observable size of populations that have been tracked over time, such as EO 7 and 14, may vary by a factor of 10 or more from one year to the next, apparently in response to rainfall amounts or patterns (Sternberg 2005); these dramatic fluctuations in the observed population size do not reflect the true population size of the perennating caudices and viable seed bank. Third, it is clear from the sources mentioned above that most recruitment of Zapata bladderpod, like many plants of arid regions, occurs during those few years when rainfall patterns coincide with requirements for flowering, seed development, germination, and establishment – perhaps only once or twice per decade. Therefore, even among stable and increasing populations, the ratio of seedlings, juveniles, and reproductive plants fluctuates widely from year to year. Size class structure may be a useful theoretical statistic for the cadre of species that populate demography textbooks, but would be burdensome, and worse, meaningless, to attempt to apply to ephemeral species like Zapata bladderpod that reproduce in sporadic pulses. A more appropriate criterion would track the frequency of successful recruitment over a specified period of time, such as a decade.

We are not aware of a scientific method to determine the minimum number of populations needed to assure long-term survival of a species; in general, more populations are better. The recovery criterion of 12 populations was based on a perceived need for feasibility as well as greater redundancy than current levels. Although greater population redundancy reduces extinction risk, the degree of separation between populations is also important; there are both advantages and disadvantages to population independence (White 1996). Considering the narrow geologic endemism and limited geographic range of Zapata bladderpod, its populations cannot be completely independent. For example, variation in climate, such as extended drought or catastrophic rainfall, would likely affect all populations similarly. Due to these uncertainties, we asked the South Texas Plant Recovery Team for guidance on setting population recovery criteria for the 9 listed plant species included under the team's Terms of Reference (USFWS 2010) (including Zapata bladderpod). Their general recommendation is that more populations of moderate size are more secure than fewer large populations, but that at least some populations should be large. We conclude that 12 protected populations consisting of 2,000 reproductive-age plants is a realistic, attainable, and appropriate recovery objective for the interim. However, in combination with a more appropriate method for tracking demographic trends (discussed above), the criterion could be finessed to make it more adaptable to the real world and more effective at tracking the recovery of this species.

Johnston (1963) documented specimens of Zapata bladderpod in the Loreto sand plain of Tamaulipas, Mexico. Johnston's collection was from a sandy prairie near a windmill called Papalote de la Mirandena (CONABIO 2015), on Rancho Loreto in eastern Tamaulipas, about 240 kilometers (km) (150 miles [mi]) southeast of the Texas Zapata bladderpod populations. This is the southernmost terrestrial extent of the Goliad geological formation. Botanists from South Texas College, Pronatura Noreste, TPWD, and USFWS visited the collection site in 2005 (Best 2005; Contreras-Arquieta 2005). They found intact sand prairies at Papalote de la Mirandena and collected specimens there of a *Physaria* species that morphologically resembles *P. thamnophila*. However, genetic analyses of the specimens indicated that these plants are genetically distinct from the *P. thamnophila* of Starr and Zapata counties, and are most closely related to a central Mexican species of *Physaria* (Pepper 2006, 2008). This is not surprising, since the Loreto sand prairies are formed on loose, calcareous sand shallowly overlying indurated caliche; this substrate is geologically and edaphically distinct from the Texas sites. A search of the CONABIO REMIB herbarium database found no other records of *P. thamnophila* in Mexico. Contreras-Arquieta (2005) did not find *P. thamnophila* in surveys of several ranches in Tamaulipas and Nuevo León, within 50 km of the Texas sites, in areas of Eocene sandstone outcrops. However, it would not be surprising to find Zapata bladderpod in such areas.

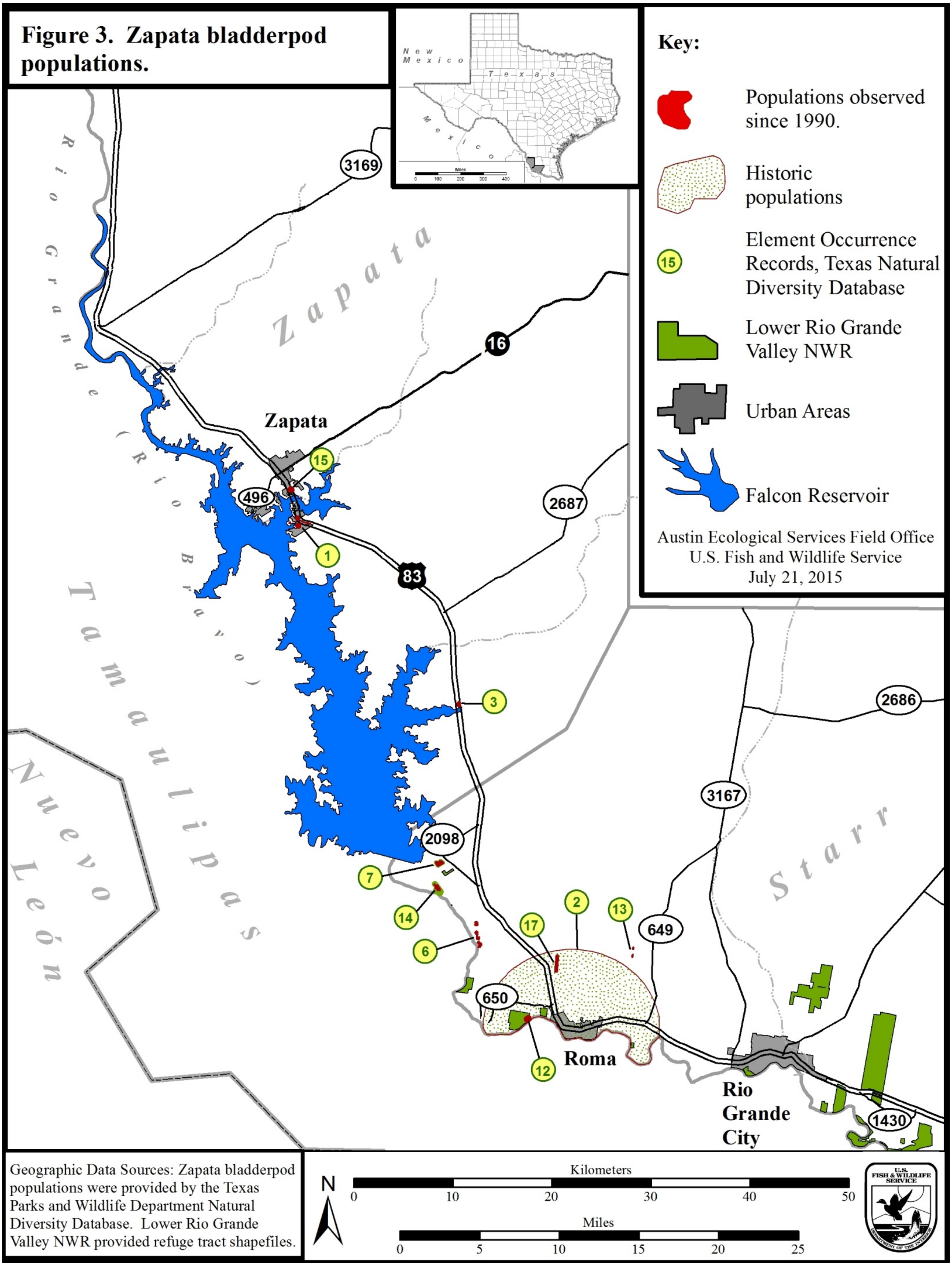


Figure 3. Zapata bladderpod populations.

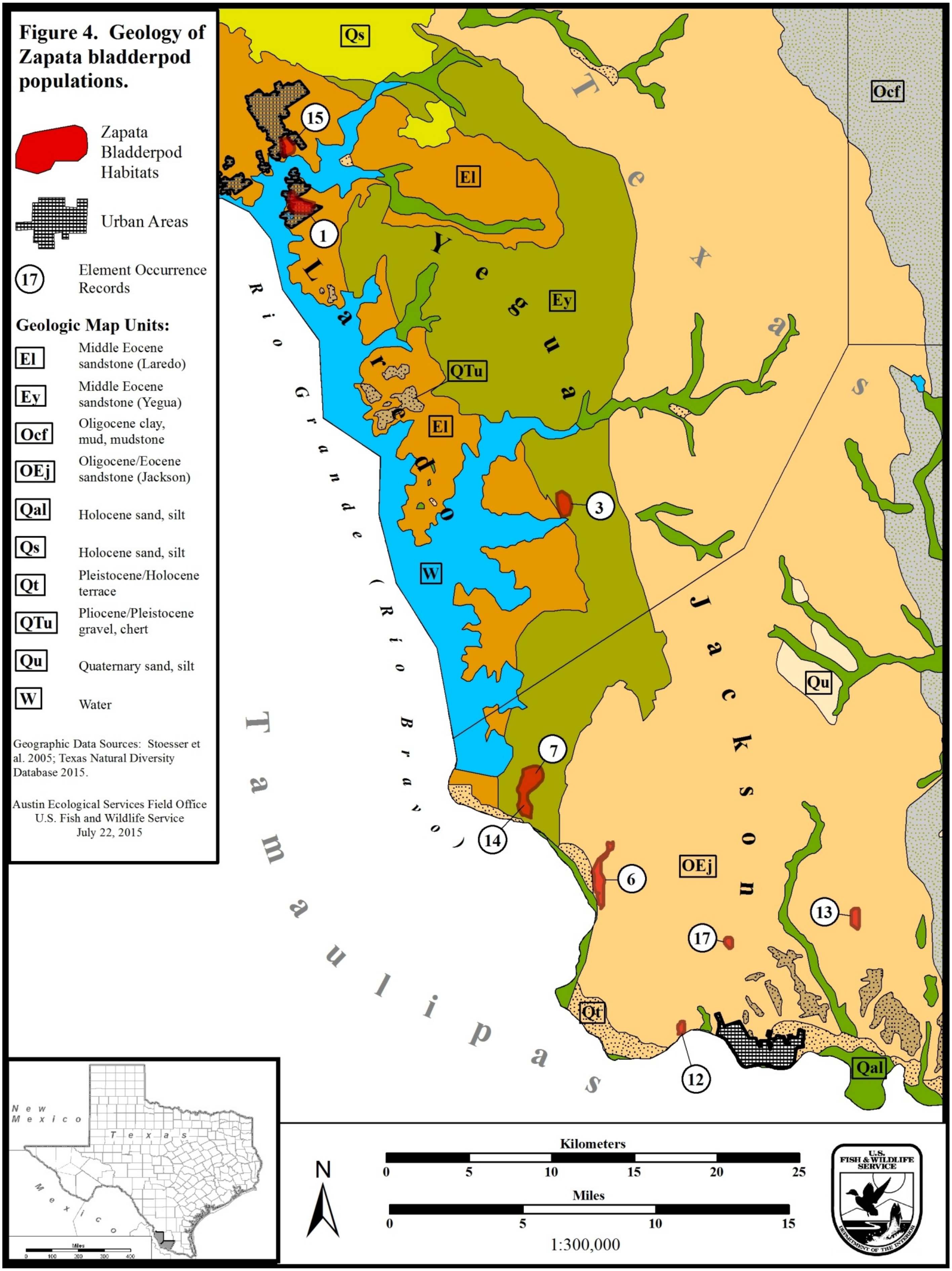


Figure 4. Geology of Zapata bladderpod populations.
Zapata Bladderpod Habitats
Urban Areas
17
Element Occurrence Records
Geologic Map Units:
El
Middle Eocene sandstone (Laredo)
Ey
Middle Eocene sandstone (Yegua)
Ocf
Oligocene clay, mud, mudstone
OEj
Oligocene/Eocene sandstone (Jackson)
Qal
Holocene sand, silt
Qs
Holocene sand, silt
Qt
Pleistocene/Holocene terrace
QTu
Pliocene/Pleistocene gravel, chert
Qu
Quaternary sand, silt
W
Water
Geographic Data Sources: Stoesser et al. 2005; Texas Natural Diversity Database 2015.
Austin Ecological Services Field Office
U.S. Fish and Wildlife Service
July 22, 2015
Laredo
Yegua
Texas
Jackson
Rio Grande (Rio Bravo)
Tamaulipas
New Mexico
Texas
Mexico
Kilometers
0 5 10 15 20 25
Miles
0 5 10 15
1:300,000
N
U.S. FISH & WILDLIFE SERVICE

Figure 5. Association of Zapata bladderpod with sandstone and fossil oyster shell strata.

Zapata bladderpod populations often occur in narrow bands along elevation contours where fossil oyster shell overlays sandstone beds (see photographs). This map shows GPS of groups of Zapata bladderpod plants at Santa Margarita Ranch overlaid on a topographic map.

230 ft Contour

240 ft Contour

250 ft Contour

Zapata bladderpod colonies.

Gegraphic data sources: TNRIS 1999; Zapata bladderpod GPS shapefiles produced by Chris Best and Dana Price.

Meters

0 25 50 75 100 125 150

Feet

0 100 200 300 400 500

Austin Ecological Services Field Office
U.S. Fish and Wildlife Service
July 22, 2015

4.1 Zapata bladderpod in sandstone below about 240-ft elevation contour, Santa Margarita Ranch.

4.2 *Bouteloua curtipendula* in fossil oyster shell above about 240-ft elevation contour, Santa Margarita Ranch.

2.3.1.3 Genetics and taxonomic classification:

Zapata bladderpod was first described as *Lesquerella thamnophila* Rollins and Shaw, based on specimens collected in Starr and Zapata counties (now EOs 1, 2, and 3) (Rollins and Shaw 1973). Al-Shehbaz and O'Kane (2002), citing molecular, morphological, cytological, biogeographic, and ecological data, transferred 91 taxa of *Lesquerella* to *Physaria*, including *P. thamnophila*. Genetic analyses, based on DNA sequences of the internal transcribed spacer of nuclear ribosomal DNA and length variation of inter-simple sequence repeat regions, revealed that *Physaria*, as previously recognized, was nested within and evolved more than once from *Lesquerella*. The former genus was polyphyletic, and the latter was paraphyletic. These authors united the two into a single monophyletic genus, conserving the earlier-published name of *Physaria*. This taxonomic revision is supported by the Flora of North America (O'Kane 2015), the Integrated Taxonomic Information Service (2015), Poole et al. (2007), and the Tropicos database (Tropicos 2015). Interestingly, the PLANTS database (Natural Resources Conservation Service 2015) conserves 104 taxa (species and varieties) of *Lesquerella*, including *L. thamnophila*, but adopts *Physaria* for 44 taxa.

2.3.1.4 Conservation measures:

Recovery team.

USFWS appointed a South Texas Plant Recovery Team in July, 2010. The team periodically reviews new information and advises USFWS on the 9 federally listed plant species in south Texas, including Zapata bladderpod.

Section 7 consultations.

Two formal section 7 consultations with USFWS have affected or may affect Zapata bladderpod populations or habitats. Consultation No. 2-11-04-F-0356, initiated April 25, 2006 with U.S. Federal Highway Administration and Texas Department of Transportation, involved the widening and upgrade of U.S. Highway 83 (US 83) from Farm-to-Market (FM) 3169 in Zapata County, Texas, south to Loma Blanca Road in Starr County, Texas. The Final Biological Opinion, dated October 19, 2006, indicates that two populations, totaling 72 individual Zapata bladderpod plants, would be destroyed, but the alignment chosen would avoid impacts to 96 individuals. Surveyors also found 463 individuals on private property immediately adjacent to the project area. All of these plants are north of Arroyo Tigre Chiquito and pertain to EO 3. Another modification at the communities of Salineño and Los Arrieros avoided impacts to 1,250 individuals; these appear to be previously undocumented populations. USFWS determined that the project is not likely to jeopardize the continued existence of the Zapata bladderpod.

Consultation 02ETTXX0-2015-F-0026, dated July 7, 2015, involves the U.S. Department of Agriculture plan to extend a Cattle Fever Tick Eradication Program (CFTEP) game fence in Starr, Zapata, Webb, and Maverick Counties, Texas. This project may affect Zapata bladderpod populations, depending on the participation of private landowners in the project (Reyes 2015).

Section 6-funded grants.

"The Cooperative Endangered Species Conservation Fund (section 6 of the ESA) provides grants to States and Territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species. The program provides funding to States and Territories for species and habitat conservation actions on non-Federal lands" (USFWS 2009). TPWD and USFWS have supported three section 6 grants in Texas and northeast Mexico that directly addressed *Zapata bladderpod,* summarized in Table 4 (below).

Table 4. Section 6 grants involving Zapata bladderpod.

Job/Project/ Grant no.	Final Report Date	Principal investigator (citation)	Project title
Grant E-17, Project no. 51	December 18, 1995	Carr 1995	Plant Surveys on the Lower Rio Grande Valley National Wildlife Refuge
Grant E-1-6, Project 35	1997	Poole and Janssen 1997	Managing and monitoring rare and endangered plants on highway right-of-ways in Texas.
Grant E-34-R, Project WER 89	July 31, 2005	Contreras-Arquieta 2005	Estatus, distribución y conservación de tres especies de plantas raras en el Bajo Río Grande en Mexico.

These projects resulted in improved knowledge and conservation of Zapata bladderpod. Carr (1995) documented his discovery of Zapata bladderpod on Cuellar tract on March 30, 1994. Poole and Janssen (2007) monitored EO 3, on the Texas Department of Transportation ROW, and developed management recommendations for the site. Contreras-Arquieta (2005) obtained permission to access Rancho Loreto, the only reported population of *P. thamnophila* in Mexico; subsequent genetic analysis of specimens collected there indicated that this is another species (Pepper 2006, 2008).

Additionally, section 6 grant no. E-1 (Project WER71) contributed to the creation of Rare Plants of Texas (Poole et al. 2007), an invaluable compilation of data on 232 rare, threatened and endangered plants of Texas, including Zapata bladderpod.

Contracts, Grants, and Cooperative Agreements.

USFWS has not supported any contracts, grants, or cooperative agreements that involved Zapata bladderpod.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms).

Table 5 summarizes and compares threats to Zapata bladderpod described in the federal listing and recovery plan, and our current understanding of threats.

Table 5. Factors affecting the survival of Zapata bladderpod.

64 FR 63745-63752 and Recovery Plan	This review
A. The present or threatened destruction, modification, or curtailment of its habitat or range.	
Primary threats are habitat destruction and modification through: • Non-native grass competition, particularly buffelgrass and Kleberg bluestem. • Conversion of native vegetation to improved pasture. • Overgrazing. • Urban development. • Construction of highway and utility ROWs. • Oil and gas exploration and production.	• Buffelgrass is more prevalent in disturbed soils; not highly competitive in Zapata bladderpod habitat. • Soils are extremely prone to erosion. Root-plowing and other forms of soil disturbance exacerbate erosion. • Overgrazing increases soil erosion. • Foot and ATV traffic associated with border security destroys plants by trampling and leads to soil erosion. • Rapid local population growth, highway construction between Laredo and Rio Grande City. • Petroleum development and pipeline construction continues at rapid pace.
B. Overutilization for commercial, recreational, scientific, or educational purposes.	
No known uses.	Concur.
C. Disease or predation.	
No known diseases. Browsing by cattle and native herbivores.	Zapata bladderpod conservation may be compatible with well-managed cattle grazing and deer herd management.
D. The inadequacy of existing regulatory mechanisms.	
Not protected (prior to listing) by any federal or state laws or regulations.	Endangered Species Act provisions can be waived by DHS for construction of border barriers.
E. Other natural or man-made factors affecting its continued existence.	
• Exposure to herbicides and impacts of maintenance activities along transportation infrastructure. • Genetic drift induced by low population sizes during drought years.	• Some EOs within developed areas or along highway ROWs are vulnerable. • Periodic vegetation shredding along utility ROWs may have beneficial effect, provided that soil is not disturbed. • Small isolated populations subject to genetic drift and inbreeding. • Historic conversion of shrub savanna to dense shrubs and cessation of wildfire may have affected populations. • Potential impacts of climate changes.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Introduced invasive grasses, principally buffelgrass, guineagrass (*Megathrysus maximus*), and Kleberg bluestem, are super-abundant in many Tamaulipan shrubland habitats in south Texas. Guineagrass and Kleberg bluestem occur mainly in alluvial soils of bottomlands and deltas, but buffelgrass is well adapted to upland sites. Nevertheless, buffelgrass does not appear to be as highly competitive in Zapata bladderpod habitat as it is elsewhere in the region. Vegetation sampled within Zapata bladderpod populations had 4 percent (Sternberg 2005) and 3 percent (Price et al. 2012) buffelgrass cover; in other upland soils, such as McAllen fine sandy loam, percent cover may exceed 80%. However, when soils in Zapata bladderpod sites are disturbed, buffelgrass may be the first species to colonize sites. Hence, buffelgrass competition is primarily a secondary threat to Zapata bladderpod that arises as a result of soil disturbance.

We now understand that the specific soils that support Zapata bladderpod populations are extremely prone to sheet and gully erosion. Population sites may be located in areas identified as Zapata, Maverick, Catarina, and Copita series in NRCS maps; regardless, all known populations occur in extremely friable, yellowish, sandy, often gravelly soil overlying sandstone, often just down-slope from overlying strata of fossil oyster shell. Gypsum crystals are often observed at the soil surface, and high gypsum content may contribute to the low soil cohesion (FAO 2015). Root-plowing and other forms of soil disturbance exacerbate erosion to an alarming degree. We have observed erosional channels forming very quickly along foot trails and vehicle tracks. Once soil is lost, it cannot be recovered; damage to habitats is essentially permanent. We conclude that soil erosion is a serious threat to Zapata bladderpod habitats, and recommend prohibiting vehicle traffic from crossing habitats. Foot traffic should be limited to the greatest degree possible, particularly where habitats occur along slopes.

Poor rangeland management includes overgrazing, improper timing of grazing, absence of fire, lack of shrub management, and other practices that reduce the vegetative composition of plants that are palatable to grazing animals. Poor rangeland management probably increases browsing of Zapata bladderpod leaves and flower stalks, which in turn would reduce its growth, survival, and reproductive rates. The depletion of grasses and other palatable herbaceous plants also increases the susceptibility of soil to erosion.

Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south Texas. Sections of border wall were to be constructed upstream from Roma, Texas, that would cross Arroyo Ramirez tract and impact the Zapata bladderpod population. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the Endangered Species Act (ESA), in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (Department of Homeland Security 2008). Ultimately, the border wall was constructed further from the Rio Grande, since the wall would have impeded flood waters along the river and tributary arroyos and would likely be destroyed.

Personnel of LRGV NWR discovered new foot and All Terrain Vehicle (ATV) traffic at Arroyo Ramirez tract that passed directly through Zapata bladderpod habitat; a number of Zapata bladderpod plants were destroyed (Winton 2012). These foot and ATV trails were attributed to border security activity by U.S. Customs and Border Protection agents (and presumably by undocumented immigrants). Increased foot and vehicle traffic through habitats destroys Zapata bladderpod plants by trampling and damages habitats through increased soil erosion.

The economy and human population of south Texas have grown at a rapid pace since the passage of the North American Free Trade Agreement in 1994. This has stimulated residential and commercial land development and highway construction between Laredo and Rio Grande City. Additionally, petroleum extraction and pipeline construction continues at rapid pace. These activities potentially contribute incremental losses of Zapata bladderpod habitat. Fortunately, the human population in most of the species' range is fairly sparse, and development there has been somewhat slower than the region as a whole.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

We are not aware of commercial, recreational, scientific, or education uses of Zapata bladderpod.

2.3.2.3 Disease or predation:

We have not observed pathogens or parasites of Zapata bladderpod. Although poor rangeland management poses a threat to the species, as described above, its populations and habitats will benefit from land uses that sustain healthy populations of grasses and herbaceous plants and minimize soil erosion. Therefore, we believe that Zapata bladderpod conservation is compatible with well-managed cattle grazing and deer herd management.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The Endangered Species Act (ESA) does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the three populations on tracts of Lower Rio Grande Valley NWR. However, as described above, Endangered Species Act provisions, including section 7 consultation, can be waived by DHS to expedite construction of border barriers.

Federally-listed plants occurring on private lands have very limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Therefore, Zapata bladderpod populations and habitats on private land are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project.

Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally-listed with these statuses. Zapata bladderpod was listed as endangered by the State of Texas on July 18, 2001. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands without a TPWD permit.

2.3.2.5. Other natural or manmade factors affecting its continued existence:

Some EOs are located within developed areas or along highway ROWs and are inherently vulnerable. EO 1 is extant, but known from vacant lots within a housing development, a public boat ramp, and adjacent ROWs along U.S. Highway 83. It is likely that houses will eventually be built on the vacant lots and those portions of the population will be lost. EO 3 is also located on the ROW of U.S. Highway 83.

Maintenance activities along highway and utility ROWs do constitute a potential threat to populations within those ROWs. In 2000, Central Power and Light (CPL) contacted LRGV NWR to request access to Cuellar tract to maintain their ROW. They intended to bulldoze the ROW so that machinery could access the towers; this would have destroyed the Zapata bladderpod population within the ROW. Through discussion, we learned that shredding the vegetation with a Woodgator, without disturbing the soil, was perfectly acceptable to CPL. The ROW was shredded in December 2000, and during the following six years the Zapata bladderpod plants occurred at a significantly greater frequency in the ROW than in adjacent un-cut vegetation (see 2.3.1.1). In 2012, a private company contracted by AEP Transmission applied herbicide along the utility ROW that passes through the Chapeño tract of LRGV NWR (near Cuellar tract), impacting federally-listed (but proposed for de-listing) Johnston's Frankenia (*Frankenia johnstonii*) plants. In 2013, the same company had scheduled to apply herbicide to the portion of the ROW that passes through the Zapata bladderpod population at Cuellar tract (Wahl 2013). Fortunately, this time they contacted the refuge prior to spraying, and used a directed application that would avoid impacts to Zapata bladderpod. These experiences demonstrate both the vulnerability of Zapata bladderpod populations that occur on utility ROWs, as well as the benefits of timely communication with ROW owners. Utility companies change ownership and maintenance contractors, and the new personnel may be unaware of previously-established operating procedures on refuge land. Hence, the threats to these populations may be ameliorated through periodic, pre-emptive communication with the utility companies and their contractors.

In general, small isolated plant populations are subject to <u>genetic drift</u>, loss of genetic diversity, and <u>inbreeding depression</u>. The federal listing suggested that genetic drift might result from small population sizes during drought years. However, we now believe the species is well adapted to its arid environment and reproduces in sporadic pulses. Since almost all successful reproduction occurs during the relatively few boom years, we do not believe the intervening drought years will cause genetic drift of otherwise healthy populations. Although we have no information on the <u>breeding system</u> or pollination of Zapata bladderpod, most *Physaria* species are <u>self-incompatible</u> (outcrossing) and are pollinated by flies and bees (Rollins and Shaw 1973). Since we don't know what the pollinators of Zapata bladderpod are, or what their foraging ranges are, we can only guess how far apart populations must be to prevent <u>gene flow</u> between them. Some EOs that appear isolated may in fact benefit from gene flow from undocumented populations on the great majority of private land that has not been surveyed. In summary, genetic drift, loss of genetic diversity, and inbreeding depression are potential threats to small isolated Zapata bladderpod populations, but we have no evidence that this has actually occurred.

In 1750, when Spanish colonists first settled along the Rio Grande (Río Bravo), in what is now south Texas and northeast Mexico, they found abundant forage to support herds of sheep, cattle, and horses; their herds grew rapidly (Lehman 1969). Eighty years later, the lands south of the Rio Grande had filled with trees and shrubs; the residents of Camargo requested that the Mexican army establish forts along the Nueces River to discourage Comanche raiders, who had until then prevented livestock grazing in the lush prairies that remained north of the river (Berlandier 1850, 1980; Mier y Terán 2000). During the 1880s, Starr and Zapata counties led Texas in sheep production (Lehman 1969); sheep are obligate grazers of grasses and herbaceous plants, and without careful management will deplete the palatable plants of arid grasslands. By 1910, sheep production in these counties had declined drastically. Dense Tamaulipan shrubland now occupies most rural areas of Starr and Zapata counties that have not been root-plowed. This historic conversion of what may be called subtropical shrub savanna to dense Tamaulipan shrubland is likely to have affected Zapata bladderpod populations. The depletion of grasses and herbaceous plants would accompany a cessation of wildfire (Johnston 1963); fire is essential to maintaining grasslands, and stimulates the germination of many species of grassland plants, so the absence of fire would compound the impacts to many herbaceous plants. This hypothesis for the current rarity of Zapata bladderpod is somewhat conjectural, but is supported by the beneficial effect of shrub cutting at the Cuellar ROW site (Fowler et al. 2011). We conclude that historical vegetation change, induced by 250 years of poor rangeland management, may have contributed to the decline of Zapata bladderpod populations. Appropriate management of Zapata bladderpod habitats may require restoration of shrub savannas (habitats where multi-stemmed shrubs and herbaceous plants are co-dominant).

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; it is very likely that the frequency, intensity, and/or amount of heavy precipitation will increase in mid-latitude land masses; it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. The magnitude of projected changes varies widely, depending on the assumptions of future greenhouse gas emissions used by different models. For example, the RPC2.6 model projects an increase of global mean surface temperatures of 0.3° to 1.7° C (0.5° to 3.1° F). Under the RPC8.5 model the increase would range from 2.6° to 4.8° C (4.7° to 8.6° F). The report also states, “In many mid-latitude and subtropical dry regions, mean precipitation will likely decrease...”. However, the Fifth Assessment Report does not simulate regional precipitation patterns well. Milly et al. (2005) project a 10–30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models.

We do not know whether the climate changes that have already occurred have affected the populations or distribution of Zapata bladderpod, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, Zapata bladderpod is endemic to a unique geologic formation where there is very little variation in the range of latitude or elevation. Furthermore, it is unlikely that the species could migrate in a time frame to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could alter the species' competitive advantage in the unique micro-habitats it occupies. Regardless of how these changes may affect its autecology, the altered synecology may be far more significant. For example, Zapata bladderpod might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete with it. Conversely, extended drought followed by extreme rainfall could damage habitats through erosion. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of Zapata bladderpod populations and habitat. Therefore, we will adapt our recovery and management strategies when necessary to address the changing conditions; however, our ability to make sound decisions will depend on periodic, verifiable monitoring of the species' status.

We conclude that Zapata bladderpod populations and habitats are currently threatened by: soil erosion; residential, commercial, highway, and border wall construction; poor rangeland management; some border protection activities; oil and gas exploration and production; and buffelgrass competition. Potential threats include highway and utility ROW maintenance, genetic drift, loss of genetic diversity, and inbreeding depression. Historic vegetation changes may have affected Zapata bladderpod; therefore, reversing these changes by periodic shredding of shrubs, and/or through prescribed burning, could become useful tools for managing its habitat. Finally, it is likely that ongoing climate changes will affect the species and its habitat, but we cannot predict the net result of the infinitely complex synecological changes.

2.4 Synthesis.

Ten EOs have been documented for Zapata bladderpod. Eight EOs are extant, and two have unknown status. Two EOs have met the recovery criteria of population size (2,000 or more reproductive individuals) and protection (through the established CCP at LRGV NWR). The de-listing criteria require 12 populations; therefore, we conclude that a change in listing status is not justified. However, we have changed the Recovery Priority Number from 5C to 8C to reflect moderate threats and a higher recovery potential than was previously known.

We now know that Zapata bladderpod is a geoendemic, found only on friable, gypseous soils overlying sandstone of the Eocene Laredo, Yegua, and Jackson formations. Contrary to statements in the federal listing, critical habitat designation, and recovery plan, the species does not occur on Jimenez-Quemado soils or in association with caliche. Most of the EOs are immediately down-slope from fossil oyster shell strata. These soils are extremely prone to sheet and gully erosion. Historically, these areas had abundant grasses and herbaceous plants, and wildfires may have played an important role in shaping the plant composition. During the last 250 years, trees and shrubs have become more abundant and grasses and forbs less abundant as a consequence of poor rangeland management. Shredding or cutting of shrub vegetation above the ground stimulates increased Zapata bladderpod frequency; this effect decreases as shrubs regrow. However, Zapata bladderpod seed germination appears to be facilitated by leaf litter beneath shrub canopies.

The observable portion of Zapata bladderpod populations fluctuates dramatically from year to year in apparent response to rainfall amounts and patterns. However, the plants are able to survive for an undetermined length of time as dormant caudices. Hence, surveys taken over relatively short time frames cannot accurately estimate the actual size of populations or detect trends in population sizes. Consequently, the frequency of recruitment is a more appropriate measure of demographic trends than changes in observed population size.

Zapata bladderpod was previously reported from the Loreto sand plain of Tamaulipas, about 240 km (150 mi) southeast of the Texas populations. However, more recent genetic analyses indicate that the Loreto plants are distinct from Zapata bladderpod.

Zapata bladderpod continues to be recognized as a valid species. However, phylogenetic analyses indicate that the genus *Lesquerella*, as previously described, was paraphyletic; *Lesquerella* was combined with *Physaria*.

We now understand that soil erosion is a very serious threat to Zapata bladderpod and its habitats, perhaps an unfortunate consequence of its tolerance of high soil gypsum levels. Buffelgrass competition is a less serious threat than once believed due to its reduced competitiveness in gypsum soils. Additional threats include construction for economic development and border barriers, poor rangeland management, some border protection activities, and oil and gas exploration and production. Potential threats include highway and utility ROW maintenance, genetic drift, loss of genetic diversity, inbreeding depression, and climate change effects.

We recommend revision of the recovery plan to define both down-listing and de-listing criteria. The South Texas Plant Recovery Team may be able to assist in the development of revised criteria that more accurately reflect the conservation status of Zapata bladderpod.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
_X_ No change is needed

3.2 New Recovery Priority Numbers:

8C

Brief Rationale:

The Recovery Priority Number for Zapata bladderpod prior to this review was 5C, meaning that it is a distinct species, has a high degree of threat, and a low recovery potential. The letter "C" indicates that the species is, or may be, in conflict with construction or other development projects of other forms of economic activity. We now believe the degree of threat is moderate: the species will not immediately become extinct if recovery actions are delayed. The recovery potential is high, due to improved knowledge of the species habitat, ecology, and threats. Zapata bladderpod continues to be recognized as a valid species. Conflict with construction is evident, considering recent interactions between USFWS and DHS regarding border barrier construction. Therefore, the current Recovery Priority Number is 8C, indicating Zapata bladderpod has a taxonomic classification of species, there is a moderate degree of threat, a high recovery potential, and conflict exists.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS.

The most important recovery actions during the next five years include, but are not limited to, the following:

- Revise the recovery plan and recovery criteria to define both down-listing and de-listing criteria. Consider revising criteria to allow larger numbers of smaller populations to contribute to recovery; use frequency of recruitment as a measure of demographic trends.
- Conduct public outreach in Starr and Zapata counties to raise local awareness of Zapata bladderpod. Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6-funded grants, cooperative efforts with Natural Resources Conservation Service, or non-governmental partners. Establish a private landowner support group for conservation of Zapata bladderpod (and perhaps other plant species of concern known from that region), similar to the group now actively working to conserve Texas snowbells *(Styrax platanifolius* ssp. *texanus*).
- Support scientific investigation of the reproductive biology and pollination, genetic structure of the wild populations, response to shrub cutting and prescribed burning, and degree of tolerance or requirement for gypsum (gypsovagy versus gypsophily).
- Prohibit vehicle traffic, including ATVs, from Zapata bladderpod occupied habitats at LRGV NWR, and limit foot traffic to the greatest extent possible.
- Develop a potential habitat model based on geological and soil factors. Conduct expanded surveys based on this model on private lands (with landowner permission) in Texas as well as Tamaulipas and Nuevo León (pending the resolution of security issues on the Mexican side of the border).
- Collect seeds from the most vulnerable populations, develop propagation methods, and reintroduce the propagated Zapata bladderpod plants into suitable protected habitats to create refugia for the vulnerable populations.

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ABBREVIATIONS OF SCIENTIFIC UNITS

Abbreviation	Scientific Unit
ac	acres
° C	degrees Celsius
° F	degrees Fahrenheit
ft	ft
ha	hectares
km	kilometers
m	meters
mi	miles

<u>GLOSSARY OF TECHNICAL TERMS</u>

Term	**Definition**
Alluvium	Loose, unconsolidated (not cemented together into a solid rock), soil or sediments, eroded, deposited, and reshaped by water in some form in a non-marine setting (Wikipedia 2015).
Autecology	Ecology of individual species.
Biogeography	The study of the distribution of species and ecosystems in geographic space and through geological time (Wikipedia 2015).
Breeding System	The ability of a plant species to reproduce via outcrossing, self-fertilization, apomixis, or a combination (Wikipedia 2015).
Calcareous	Containing relatively high levels of calcium carbonate or other calcium compounds.
Caliche	As used here, a soil stratum that formed through precipitation of calcium carbonate and other minerals from the soil solution.
Caudex	(Pl. caudices). The woody base of an otherwise herbaceous perennial (Correll and Johnston 1996).
Climax Succession	Late, relatively stable stage of ecological succession.
Clumped Distribution	Species distribution in which the distance between neighboring individuals is minimized (Wikipedia 2015).
Cohesion (Soil)	The component of shear strength of a rock or soil that is independent of interparticle friction (Wikipedia 2015).
Correlation	A statistically dependent relationship between two random variables or sets of data (Wikipedia 2015).
Cover Index	A mathematical representation of <u>vegetative cover</u>.
Cytology	The study of cell structure, function, and chemistry (Wikipedia 2015).
DNA Sequence	The sequence of nucleotide bases in a DNA molecule (or portion of a molecule); see gene sequence.
Endemic	An organism restricted to a specific habitat or geographic range.
Eocene	The geological epoch extending from 56 to 34 million years before the present (Wikipedia 2015).
Ephemeral	Of short duration.
Frequency	As used here, the proportion (often expressed as percent) of samples that contain a taxon or type of plant species; compare to vegetative cover.
Friable	Soil that is easily broken into smaller and smaller pieces.
Gene flow	The transfer of alleles or genes from one population to another (Wikipedia 2015).
Gene sequence	The sequence of nucleotide bases in a DNA molecule that constitute a gene.
Genetic drift	A change in allele frequencies within a population over time.
Gully Erosion	Soil erosion caused by the contrated flow of runoff through channels.

Term	Definition
Gypseous	Containing gypsum (calcium sulfate dihydrate, $CaSO_4 \cdot 2H_2O$).
Gypsophile	Plant that is restricted to soils containing high gypsum levels (Moore and Jansen 2007).
Gypsovag	Plant that tolerates but does not require high gypsum soil levels (Moore and Jansen 2007).
Herbarium	A repository for long-term storage and study of preserved plant specimens.
Inbreeding depression	The reduction of fitness caused by mating between relatives (Edmands 2007, p. 464).
Internal Transcribed Spacer	(ITS) Spacer DNA (non-coding DNA) situated between the small-subunit ribosomal RNA (rRNA) and large-subunit rRNA genes (Wikipedia 2015).
Inter-Simple Sequence Repeat	A genome region between microsatellite loci (Wikipedia 2015); see Microsatellite DNA.
Leaf-scar	The mark or cicatrice left by the articulation and fall of a leaf (Correll and Johnston 1996).
Loam	Soil containing moderate amounts of sand, silt, and clay.
Metapopulation	A group of spatially separated populations of the same species that interact at some level (Wikipedia 2015).
Micro-habitat	Very specific or fine-scale portion of a habitat that is occupied by a species.
Minimum viable population	The fewest individuals required for a specified probability of survival over a specified period of time (Pavlik 1996; Mace and Lande 1991); see Population Viability Analysis.
Monophyly	A group of organisms which consists of all the descendants of a single common ancestor.
Morphology	The study of the structure of organisms.
Nuclear DNA	DNA contained within the nucleus of a Eukaryotic organism.
Outcross	In plants, sexual fertilization involving a different individual.
Paraphyly	A group consisting of all the descendants of the group's last common ancestor minus a (small) number—typically just one or two—of monophyletic subgroups (Wikipedia 2015).
Perennial	A plant that lives for more than one full year.
Perennate	To become perennial; to endure more than a single year.
Phenology	Seasonal pattern of plant growth, development and reproduction.
Polyphyly	A group of organisms whose last common ancestor is not a member of the group (Wikipedia 2015).
Ramet	An individual, genetically-identical plant reproduced as a clone of the parent plant.
Redundancy	The number of populations or sites necessary to endure catastrophic losses (Shaffer and Stein 2000, pp. 308-310).

Term	**Definition**
Ribosome	A large and complex molecular machine, found within all living cells, that serves as the site of biological protein synthesis (translation) (Wikipedia 2015).
Root-Plowing	Mechanical vegetation clearing using heavy equipment that severs the roots of woody plants.
Rosette	A radially-symmetrical whorl of leaves formed at the base of a plant stem, usually during a vegetative (non-reproductive) growth phase.
Ruderal	Early stage of succession (colonization).
Savanna	Mosaic of trees or shrubs and grassland; between 40% and 10% cover by trees and shrubs (NatureServe 2010).
Self-incompatible	Incapable of self-fertilization.
Seral	An intermediate developmental stage in ecological succession (Wikipedia 2015).
Sheet Erosion	The transport of loosened soil particles by overland flow (Wikipedia 2015).
Significance	Statistical assessment of whether observations reflect a pattern rather than just chance (Wikipedia 2015).
Species Richness	A simple count of species or taxa within an area of concern; does not account for species abundance.
Subtropical	Climatic region intermediate between tropical and temperate, where freezing temperatures occur infrequently and are of limited duration and intensity.
Synecology	Ecology of groups of coexisting organisms.
Tamaulipan shrubland	The semi-arid, subtropical ecological region of northeast Mexico and south Texas characterized by shrub vegetation.
Vegetative cover	The proportion of an area that is intercepted vertically by tissues of a specified taxon or type of plants; total cover may exceed 1 due to multiple layers.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
PHYSARIA THAMNOPHILA

Current Classification: Endangered.

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed.

Review Conducted By: Chris Best, State Botanist, Austin Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve [signature] Acting Field Supervisor Date 8-27-15

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service

Approve Michelle Shaughnessy Date 8/28/15