

Texas Poppy-Mallow Five-Year Review

**Texas Poppy-Mallow**  
***Callirhoe scabriuscula* B.L. Robinson**

**5-Year Review:**  
**Summary and Evaluation**



**U.S. Fish and Wildlife Service**  
**Austin Ecological Services Field Office**  
**Austin, Texas**

## 5-YEAR REVIEW

### Texas Poppy-Mallow / *Callirhoe scabriuscula* B.L. Robinson

#### 1.0 GENERAL INFORMATION

##### 1.1 Reviewers.

Lead Regional Office: Southwest (Region 2)  
Jennifer Smith-Castro, Regional Recovery Biologist, (281) 212-1509.

Lead Field Office: Austin Ecological Services Field Office  
Chris Best, Texas State Botanist, Austin Ecological Services Field Office. (512) 490-0057 x 225.

Cooperating Field Office: n/a

##### 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Department (TPWD) Natural Diversity Database (TXNDD), monitoring reports, scientific publications, Master's theses, unpublished documents, personal communications from botanists familiar with the species, and Internet web sites.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 Texas poppy-mallow as endangered without critical habitat on January 13, 1981. The State of Texas listed it as endangered on April 29, 1983.

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 30-34. For convenience, the first uses of scientific units are spelled out, and are also summarized on page 29. Photographic credits are on page 29. This is the first status review since the species was listed (1981) and the recovery plan was prepared (1985). For convenience, we include brief summaries under each topic of the information known at those times.

Recommended citation:

U.S. Fish and Wildlife Service. 2019. Texas poppy-mallow (*Callirhoe scabriuscula* B.L. Robinson) five-year review: Summary and evaluation. Austin Ecological Services Field Office, Austin, Texas. 34 pp.

##### 1.3.1 FR Notice citation announcing initiation of this review.

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February 11, 2009 (74 FR 6917) and May 31, 2018 (83 FR 25034).

### **1.3.2 Listing history.**

Original Listing

Federal Register notice: 46 FR 3184.

Date listed: January 13, 1981.

Entities listed: *Callirhoë scabriuscula* (Texas poppy-mallow).

Classification: Endangered; Critical Habitat was not designated.

Critical Habitat Designation: n/a.

### **1.3.3 Associated rulemakings. n/a**

### **1.3.4. Review History.**

No previous 5-year review has been conducted for Texas poppy-mallow. Other review documents include:

Amos, B. 1979. Status report on *Callirhoë scabriuscula* Robins.

### **1.3.5 Species' Recovery Priority Number at start of 5-year review.**

Prior to this review, the Recovery Priority Number for Texas poppy-mallow was 5C. This indicates that the degree of threat was high, the recovery potential was low, the taxon was a species, and the species is, or may be, in conflict with construction or other development projects or other forms of economic activity.

### **1.3.6 Recovery Plan or Outline.**

Name of plan or outline: Texas poppy-mallow (*Callirhoe scabriuscula* Robins.) Recovery Plan.

Date issued: March 21, 1985.

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 (U.S. Fish and Wildlife Service 1985).

##### **2.2.1.1 Does the recovery plan contain objective, measurable criteria?**

No.

#### **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 plan does not include any recovery criteria. We are—concurrently with this five-year review—developing objective, measurable criteria in accordance with the revised recovery planning guidance (U.S. Fish and Wildlife Service 2017).**

#### **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

Executive Summary (p. iii): “The criteria for downlisting and/or delisting Texas poppy-mallow have not yet been determined. The implementation of studies in this recovery plan will provide the necessary data from which quantified downlisting and/or delisting criteria can be established.”

Part II. (p. 11): “However, limited data makes it impossible to quantify habitat and abundance in a manner needed to establish downlisting and delisting criteria at this time.”

## 2.3 Updated Information and Current Species Status.

### 2.3.1 Biology and Habitat.

#### 2.3.1.1 Description, taxonomic classification, and phylogenetics.

Summary of prior information (Robinson 1895–1897, p. 302; Amos 1979, pp. 1–3; 46 FR 3184; USFWS 1985, pp. 2–3).

Texas poppy-mallow is a perennial herbaceous plant found in deep, loose, sandy soils near the Colorado River in west Texas. The fleshy taproots extend about 45 centimeters (cm) (18 inches (in)) deep before branching (figure 1.b). During the winter, the plants form rosettes of 3 to 8 basal leaves that have 3 to 5 palmately-arranged lobes (figure 1.a). Flower stalks emerge in the spring, reaching up to 45 cm (18 in) tall. The stems and leaves have a rough texture due to a covering of stellate pubescence (star-shaped hairs). Flowers have 5 reddish-purple petals, about 3.8 cm (1.5 in) long, arranged in the form of a cup, with dark maroon centers (figures 1.d, e).

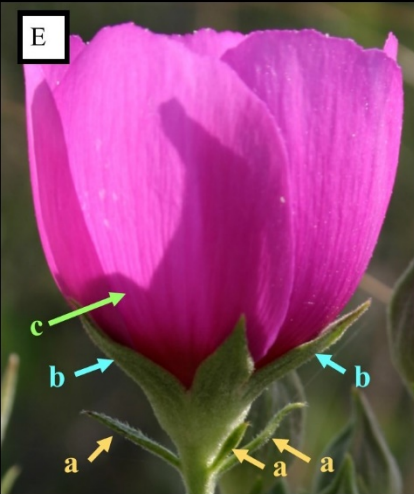
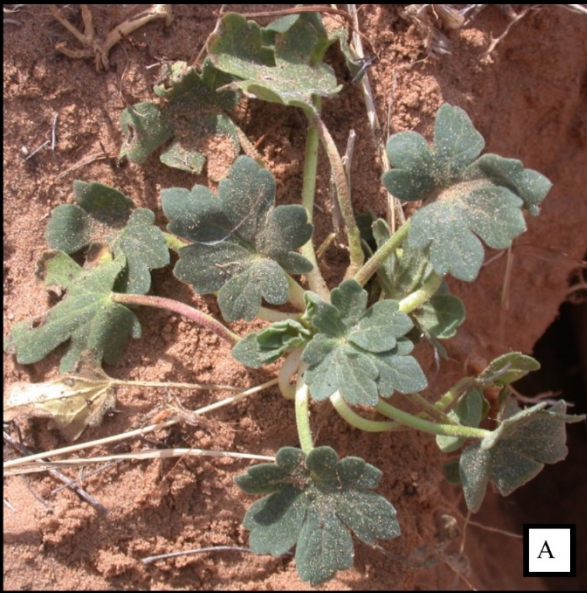
Robinson (1895–1897, p. 302) described *Callirhoe scabriuscula* as a new species in the Malvaceae (Mallow Family), based on a single specimen collected by Dr. Sutton Hayes. Robinson distinguished this from other species in the genus by its densely pubescent carpels with short beaks and involucl of 3 linear bractlets (figure 1.e.a). *Callirhoe leiocarpa* (tall poppy-mallow) and *C. involucrata* (winecup) occur near *C. scabriuscula*. These are distinguished by smaller flowers with white petal bases and the absence of stellate pubescence; additionally, *C. leiocarpa* is an annual species and lacks an involucl, and *C. involucrata* has a prostrate rather than erect habit.

#### New information.

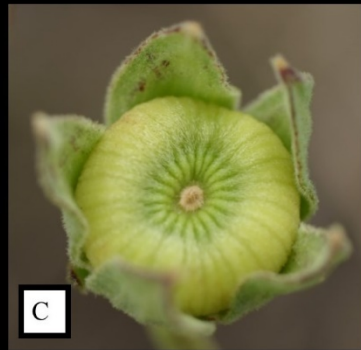
Nine species have now been described in the genus *Callirhoe* (Dorr 2015a, p. 1). Note that most authors now spell the genus *Callirhoe* without an umlaut (ë). *C. scabriuscula* is distinguished by its linear involucellar bractlets (figure 1.e.a), valvate calyx lobes that form an apiculate or acuminate point in bud (cover photograph), indehiscent mericarps (figure 1.c), stiffly erect stems, and 6- to 8-rayed stellate hairs (Poole et al. 2007, p. 130; Dorr 2015b, p. 1). *C. scabriuscula* is recognized as a valid species by the Flora of North America (Dorr 2015a, b), the Integrated Taxonomic Information Service (2019), Natural Resources Conservation Service (NRCS) (2019a), and Tropicos (2019).

We are not aware of investigations, either published or ongoing, of DNA-based phylogenetics of the genus *Callirhoe*. However, an investigation of isozyme variation (Giles 1991, p. 31) reported genetic identities of 0.997 and 0.966–0.997 for *C. scabriuscula* and *C. involucrata*, respectively; these values indicate very high genetic similarity among each species' populations. The genetic identity between these two species was 0.677; this value indicates that *C. involucrata* is not the progenitor of *C. scabriuscula*.

Figure 1. Images of Texas poppy-mallow.



A. Basal rosette.  
B. Taproot exposed during salvage near Ballinger, February 22, 2007.  
C. Fruit with 21 mericarps.  
D. Flower with mature stamens.  
E. Flower: a) bracts of involucre; b) sepals; c) petals.



### 2.3.1.2 New information on the species' biology, life history, habitat, and ecosystem.

#### Summary of prior information.

Texas poppy-mallow flowers from late April until mid-June (Amos 1979, pp. 8–10; USFWS 1985, pp. 7–9). Flowers open 2 to 3 hours after sunrise and close before sunset. If pollinated, flowers close within 30 to 90 minutes. Un-pollinated flowers continue to open for 6 to 8 days. Anthers of individual flowers mature prior to stigmas (figure 1.d), releasing their pollen about 36 hours before stigmas emerge. Less than 1 percent of flowers from which insects were excluded produced seeds. Conversely, 85 percent of open-pollinated flowers produced seeds; therefore, Texas poppy-mallow is a predominantly out-crossing species. Plants produced an average of 41.4 fruits per plant per year, and fruits averaged 19 seeds each; thus, individuals produced an average of 878 seeds per year. Three species of bees, *Diadasia afflicta*, *Melissodes intorta*, and *M. tepanica*, forage for nectar and pollen in Texas poppy-mallow flowers and use the staminal column as a landing and take-off platform; the foraging behaviors of these bees indicates that they are likely to be effective pollinators. *D. afflicta* and *M. intorta* are oligolectic species that forage primarily within the genus *Callirhoe*. Seeds mature and dehisce from 10 to 18 days after flowering and fertilization. Flowering ceases by late June, as the weather becomes increasingly hot and dry, and the stems die by late July. New rosettes emerge from the taproots in late August and September.

Texas poppy-mallow occurs in deep, loose sands of the Tivoli and Brownfield Soil Series (USFWS 1985, pp. 3–4). These sands are carried by wind from alluvial formations in the Colorado River flood plain and deposited on the lee (north and east) side of the river (USDA Soil Conservation Service 1970, p. 26). The difference between Tivoli and Brownfield soils is that the former lacks a distinct B horizon, while the latter has a sandy clay subsoil at a depth of about 0.51–1.02 m (20–40 in). Dunes up to 9 m (30 ft) high and 61 m (200 ft) wide form to the lee of cultivated fields. These soils have very rapid rainfall infiltration rates, very little runoff, and low water holding capacity.

#### New information.

##### Life span.

Although Robinson (1895–1897, p. 302) described *C. scabriuscula* as an annual species of *Callirhoe*, we now know that it is a short-lived perennial species (Amos 2001, p. 8).

##### Reproduction.

An ecological study in Runnels County (EO 3; Cruze 1991, pp. 15, 18) found that only 11 percent of individuals flowered during two years of below-average rainfall, and these individuals produced an average of 56.1 seeds each. However, when there is adequate soil moisture in April and May, individuals may produce up to 150 flowers and 20 seeds per capsule (Amos and Delmatier 2003, p. 3).

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Amos (2001, pp. 8–9) reported additional breeding system experiments in a summary of several investigations. Flowers from which insects are excluded produced no fruit. Hand-pollination of insect-excluded flowers with pollen from the same flower yielded 12.5 percent fruit set; when pollen from other flowers of the same individual was used, fruit set increased to 88.5 percent. This difference is probably due to pollen age: Self-pollination of individual flowers is reduced because stigmas mature at least 20 hours after the last anthers release pollen (this pattern is called protandry); stigmas and anthers of different flowers on the same individual may mature concurrently, and are inter-fertile (known as geitonogamy). Hand pollination with pollen from different individuals increased fruit set to 96.7 percent. Open pollinated flowers that were freely accessed by insects had 84.7 percent fruit set. Therefore, Texas poppy-mallow can be self-pollinated, but self-pollination is rare because anthers and stigmas mature at different times, and because pollen viability declines rapidly. Fruit set requires a pollen vector, and out-crossing produces the highest rate of fruit set. This summary affirmed that 3 species of bees, *Diadasia afflicta*, *Melissodes intorta*, and *M. tepanica*, are oligolectic foragers of the genus *Callirhoe* and are effective pollinators of Texas poppy-mallow (p. 9). The introduced European honeybee (*Apis mellifera*) is common in Texas poppy-mallow habitats, but does not visit its flowers (p. 9).

Cruze (1991) investigated the soil seed reserve of the Runnels County population mentioned above (EO3). She recovered 325 seeds from 6,583 soil samples totaling 1.7 m<sup>3</sup> (60.0 ft<sup>3</sup>) of soil (pp. 6, 9). Seed distribution was uneven, with 91 percent of recovered seeds in the uppermost 5 cm of the soil; 85 percent of seeds were found within 1 m (3.28 ft) in horizontal distance of an established individual (pp. 9–11), indicating that seeds have very limited dispersal. Seed viability, tested with tetrazolium chloride, was 16.3 percent (p. 12); on this basis, the author concluded that seed viability declines rapidly in the soil (p. 19).

However, we note that tetrazolium chloride detects only actively respiring tissues, and not all living but dormant cells; specialized methods must be used to distinguish dead seeds from viable, highly dormant seeds and from seeds with impermeable seed coats (Association of Official Seed Analysts 2000, pp. 7, 1–13). The author did not indicate if or how seed coats were scarified and how dormancy was broken, so actual viability and longevity may be higher. Furthermore, the experimental design did not determine the ages of seeds that did or did not germinate; we conclude that the 16.3 percent that germinated could have been of any age, and the data do not support the conclusion that seeds quickly lose viability.

Amos and Gonzales (1990) investigated the seed germination of Texas poppy-mallow. They reported that seeds are covered with 3 layers: The outermost layer is a hard, waxy mericarp; the middle layer is a hard, impervious seed coat; and the inner layer is papery testa that turns brown upon exposure to the air (p. 1). After collection and drying, seeds were stored indoors in paper bags or metal cans for up to 52 months (pp. 1–2). Tetrazolium tests showed viability was 88 to 90 percent for seeds ranging from 2 to 52 months in age. A comparison of 13 treatments and 6 age classes indicated that 3 factors delay germination (pp. 7–8). Upon maturation, seeds undergo an after-ripening period of 4 to 6 weeks, during which they are unable to germinate. This delays germination of newly-matured seeds until autumn, when the chances of precipitation are highest. In addition, seeds that do not germinate during this period develop a hard seed coat that is impervious to water and are thus unable to germinate. How this seed coat is scarified, in nature, or how long this dormancy endures, is unknown. Even when the seed coat is removed,

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germination continues to be physiologically prevented by an inhibitor in the testa in older seeds. Again, how long this physiological dormancy prevails, or what natural conditions break it down, remains unanswered. Seeds either germinate during the first fall, or remain dormant for long periods of time. Some treatments yielded 100 percent germination of 52-month old seeds (Amos and Gonzales 1990, table 1), and old seeds had higher and faster germination rates than young seeds (p. 7), indicating that potential seed viability endures at least that long.

We observe that, currently, we do not know how long seeds can maintain viability in the soil; nevertheless, the probable longevity of the 3-phase dormancy strongly suggests that seeds can remain dormant and viable for multiple years, and perhaps many years. Long dormancy and extended viability occurs among many species of the Malvaceae (Kildisheva *et al.* 2011; Veiga-Barbosa *et al.* 2016); seeds of *Malva rotundifolia* continued to germinate after 120 years in the soil (Telewski and Zeevaart 2002, p. 1286). We conclude that the assertion that Texas poppy-mallow does not form a persistent seed bank is un-proven and also unlikely; the available evidence indicates that the species has long seed dormancy, conferring a greater ability of its populations to recover from prolonged drought or other severe losses.

Since seeds have no specialized dispersal mechanism, and most seeds disperse short distances, gene flow is probably limited to the forage range of the effective pollinators. However, we have no data on the pollination ranges of the known pollinators described above.

### Habitat.

Cruze (1991, pp. 12, 15) found 159 Texas poppy-mallow plants within an area of 225 m<sup>2</sup> (2,422 ft<sup>2</sup>) at the study site at EO3. About 80 percent of Texas poppy-mallow plants occurred on 1-m<sup>2</sup> (10.76 ft<sup>2</sup>) plots that had from 3 to 16 percent cover of forbs and grasses; 79 percent of plots were within this range of vegetative cover (p. 12). This demonstrates that occupied habitats have sparse vegetative cover. Table 1 lists the plant species most frequently associated with Texas poppy-mallow, reported by multiple observers.

Populations depend on spring rainfall to produce seeds and fall rainfall for seed germination and establishment; known populations have declined drastically after extended drought (Amos 2001, pp. 12–14).

Table 1. Plant species associated with Texas poppy-mallow, reported by multiple observers.

Family	Genus <sup>1</sup>	Species <sup>1</sup>	Common Name	TXNDD <sup>2</sup>	Amos 1979	USFWS 1985	Cruze 1991	Poole <i>et al.</i> 2007
Apiaceae	<i>Eurytaenia</i>	<i>texana</i>	Texas Spread Wing					x
Apocynaceae	<i>Asclepias</i>	<i>latifolia</i>	Broad-Leaf Milkweed					x
Apocynaceae	<i>Asclepias</i>	<i>viridiflora</i>	Wand Milkweed				x	
Asteraceae	<i>Ambrosia</i>	<i>artemisiifolia</i>	Short Ragweed		x			
Asteraceae	<i>Aphanostephus</i>	<i>skirrhobasis</i> v. <i>skirrhobasis</i>	Arkansas Lazy Daisy					x

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Family	Genus <sup>1</sup>	Species <sup>1</sup>	Common Name	TXNDD <sup>2</sup>	Amos 1979	USFWS 1985	Cruze 1991	Poole <i>et al.</i> 2007
Asteraceae	<i>Astranthium</i>	<i>sp.</i>	Western Daisy species	2				
Asteraceae	<i>Gaillardia</i>	<i>pulchella</i>	Indian Blanket	2	x	x	x	x
Asteraceae	<i>Heterotheca</i>	<i>subaxillaris</i>	Camphorweed					x
Asteraceae	<i>Hymenopappus</i>	<i>flavescens</i>	Yellow Woolly-White	6	x	x	x	x
Asteraceae	<i>Xanthisma</i>	<i>texanum</i>	Texas Sleepy-Daisy					x
Boraginaceae	<i>Cryptantha</i>	<i>texana</i>	Texas Cat's Eye					x
Cactaceae	<i>Opuntia</i>	<i>macrorhiza</i>	Plains Prickly-Pear		x			
Cactaceae	<i>Opuntia</i>	<i>sp.</i>	Prickly Pear species	1			x	
Cistaceae	<i>Helianthemum</i>	<i>georgianum</i>	Rockrose					x
Commelinaceae	<i>Tradescantia</i>	<i>occidentalis</i>	Prairie Spiderwort	1	x		x	x
Euphorbiaceae	<i>Chamaesyce</i>	<i>missurica</i>	Prairie Sandmat		x			
Euphorbiaceae	<i>Cnidoscolus</i>	<i>texanus</i>	Mala Mujer	1	x	x	x	x
Euphorbiaceae	<i>Croton</i>	<i>texensis</i>	Texas Croton		x		x	
Fabaceae	<i>Galactia</i>	<i>canescens</i>	Hoary Milkpea					x
Fabaceae	<i>Mimosa</i>	<i>rupertiana</i>	Eastern Sensitive-Briar		x	x		x
Fabaceae	<i>Pediomelum</i>	<i>rhombifolium</i>	Gulf Indian Breadroot					x
Fabaceae	<i>Prosopis</i>	<i>glandulosa</i>	Honey Mesquite	4			x	
Fabaceae	<i>Strophostyles</i>	<i>helvola</i>	Trailing Wildbean		x	x		x
Fagaceae	<i>Quercus</i>	<i>havardii</i>	Shinnery Oak	7			x	
Fagaceae	<i>Quercus</i>	<i>sp.</i>	Oak species	1				
Nyctaginaceae	<i>Mirabilis</i>	<i>albida</i>	White Four-O'Clock					x
Onagraceae	<i>Oenothera</i>	<i>engelmannii</i>	Engelmann's Evening Primrose					x
Onagraceae	<i>Oenothera</i>	<i>rhombipetala</i>	Fourpoint Evening Primrose	1				x
Papaveraceae	<i>Argemone</i>	<i>sp.</i>	Prickly Poppy species	1				
Poaceae	<i>Aristida</i>	<i>purpurea</i> v. <i>longiseta</i>	Fendler threeawn				x	
Poaceae	<i>Aristida</i>	<i>spp.</i>	Three-Awn Grass		x	x		
Poaceae	<i>Cenchrus</i>	<i>spinifex</i>	Coastal Sandbur		x		x	x
Poaceae	<i>Chloris</i>	<i>cucullata</i>	Hooded Windmillgrass					x

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Family	Genus <sup>1</sup>	Species <sup>1</sup>	Common Name	TXNDD <sup>2</sup>	Amos 1979	USFWS 1985	Cruze 1991	Poole <i>et al.</i> 2007
Poaceae	<i>Schizachyrium</i>	<i>scoparium</i>	Little Bluestem	1				
Poaceae	<i>Sporobolus</i>	<i>cryptandrus</i>	Sand Dropseed		x	x	x	x
Poaceae	<i>Sporobolus</i>	<i>giganteus</i>	Giant Dropseed		x	x		x
Poaceae	<i>Urochloa</i>	<i>ciliatissima</i>	Fringed Signalgrass		x			x
Polemoniaceae	<i>Phlox</i>	<i>drummondii</i> <i>ssp. mcallisteri</i>	McAllister's Phlox					x
Solanaceae	<i>Solanum</i>	<i>dimidiatum</i>	Western Horse-Nettle		x			

1. Botanical classifications conform to NRCS 2019b.
2. Indicates the number of EOs where species have been observed.

### Population genetics.

Giles (1991) used electrophoresis to compare isozyme polymorphism between *Callirhoe scabriuscula*, a rare endemic species, with winecup (*C. involucrata*), a common and widespread congener. Both species had 13 monomorphic loci, 4 of which had fixed allelic differences between the two species (pp. 13–17). *C. involucrata* had 4 polymorphic loci (23.5 percent polymorphism), 2 of which had fixed allelic differences between the species (pp. 18–20). *C. scabriuscula* had a single polymorphic locus (5.9 percent polymorphism), indicating a very low level of genetic differentiation compared to the average polymorphism of all plant species as well as all endemic plants (pp. 18, 28–30). *C. involucrata* also had less genetic variability than other widespread species (p. 32), but still had a higher percentage of polymorphic loci, higher mean alleles per locus, and higher mean alleles per polymorphic locus, compared to *C. scabriuscula*, as expected for a common, wide-ranging species compared to a narrow endemic (pp. 31–33). *C. scabriuscula* also had lower than expected levels of heterozygosity, which could result from self-fertilization and inbreeding (p. 29). Populations of *C. scabriuscula* are genetically extremely similar, and have less variation within than between populations (pp. 29–30, 36), which may be due to its extreme endemism, mixed mating systems, limited seed dispersal and pollination range (hence, limited gene flow), small, diffuse populations, population size fluctuations, inbreeding, a genetic bottleneck, founder effects (pp. 33, 35–36, 39–41). Interestingly, *C. scabriuscula* had two loci with fixed heterozygosity, which may have been due to a gene duplication (pp. 36–39). Based on this evidence, Texas poppy-mallow may be caught in an extinction vortex (p. 42; Amos 2001, pp. 13–14).

### **2.3.1.3 Trends in abundance, number and spatial distribution of populations, estimate of minimum viable population, population delineation, and demographic trends.**

#### Summary of prior information.

Amos (1979, pp. 8, 12) reported that 16 small populations of Texas poppy-mallow covered 5 ha (12.4 ac) distributed over an area of 162 ha (400 ac). Based on data from sample plots, the total population was estimated to be 48,000 (USFWS 1985, p. 6). However, a large portion of the known range had been altered by the construction of Highway 67, by conversion to row-crop farm fields, or by surface mining of sand. By 1983, much of the population and habitat were destroyed by sand mining (USFWS 1985, p. 6).

#### New Information.

Element Occurrences listed in the TXNDD.

The TXNDD maintains geographic and population data of plant and animal species of conservation concern in Texas. This data is contributed and used by many entities involved in conservation, including TPWD and other state agencies, federal agencies, academic researchers, environmental consultants, non-profit conservation organizations, and private individuals. Data for each species is organized by standard geographical units for populations and habitats called “Element Occurrences” (EOs), which are defined as “areas of land and/or water in which a species or natural community is, or was, present” (NatureServe 2002, p. 10). EOs are displayed as points, lines, and polygons buffered by their estimated geographic precision. The reported populations occur or occurred within, but not necessarily throughout, the buffered EO points, lines, and polygons. We obtained the most recent update of Texas poppy-mallow EOs (TXNDD 2019), summarized in table 2.

The Texas Natural Heritage Program conducted extensive surveys for Texas poppy-mallow from 1987 through 1989 at 143 sites in 37 counties (Poole (1990)). This project documented 9 new populations at 6 sites in Runnels, Coke, and Mitchell counties, totaling 2,817 individuals, and reported an additional population discovered in Coke County in 1990 by an environmental consultant (Poole 1990, pp. 1, 3). All populations were found in areas of intact native vegetation on deep, loose, sandy soils of the Tivoli and Brownfield Series near the Colorado River (note that Likes and Heatly are alternate names for the Tivoli and Brownfield soil map units, respectively). The species has now been documented in four counties—Runnels, Coke, Mitchell, and Scurry (Amos 2008, 2019). The most recent censuses (TXNDD 2019) for all known EOs totals less than 3,000 individuals; however, we have no survey data more recent than 2001 (table 2).

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Table 2. Summary of Element Occurrence records from the Texas Natural Heritage Database (TXNDD 2019, pp. 1–20).

EO_No.	EO_ID	County	Owner <sup>1</sup>	Site Name	Most Recent Census	Population Size
1	3492	Runnels	TxDOT	FM 3115	6-Jun-2001	0
2	3097	Runnels	TxDOT	Hwy 67	12-Jun-2001	25
3	5825	Runnels	Private	Burns Pecan Nursery	27-May-1987	2,500
4	94	Runnels	n/i	Earl Barr Sands	26-May-1987	70
5	7435	Runnels	n/i	Henrick-Barr Sands	27-May-1987	59
6	3509	Coke	Private	Spade Ranch	29-May-1987	10
7	7030	Coke	Private	Spade Ranch	29-May-1987	80
8	4703	Mitchell	n/i	Low Shinnery	29-May-1987	24
9	1534	Mitchell	n/i	County Rd	29-May-1987	74
10	1535	Coke	n/i	Sand Creek		Unk.
Total:						2,842

1. n/i = not indicated, but presumed private.

Geographic distribution of populations and provisional recovery units.

All known populations of Texas poppy-mallow occur in Tivoli (Likes) and Brownfield (Heatly) fine sands (NRCS 2019c) in Runnels, Coke, Mitchells, and Scurry counties, indicated in figure 2. Although we do not have geographic data for populations in Scurry County, Amos (2008, 2019) confirmed that at least one population extends from northern Mitchell County into southern Scurry County. The known populations span a linear distance of about 155 km (96 mi) from northwest to southeast. Within the counties mentioned, NRCS (2019c) classifies 16,987 ha (41,975 ac) as Tivoli (Likes) or Brownfield (Heatly) fine sands.

To conserve the full range of the species’ genetic diversity and ecological adaptation, it must be conserved throughout its geographic range. We have provisionally identified 3 recovery units in the southeast, middle, and northwest portions of the geographic range (figure 2) that will contribute to recovery planning and the development of recovery criteria. These recovery units may be revised if data on the species’ population genetics or ecological adaptation indicate more logical delineations.

Estimate of Minimum Viable Population size.

Minimum viable population (MVP) refers to the smallest population size that has a high probability of surviving a prescribed period of time. For example, Mace and Lande (1991, p. 151) propose that species or populations be classified as vulnerable when the probability of persisting 100 years is less than 90 percent. Determinations of MVP usually take into account the effective population size ( $n_e$ ), rather than total number of individuals ( $n$ ); 10 genetically identical individuals (for example, clones) would have an effective population size of 1.

MVP or Population Viability Analysis have not been calculated for Texas poppy-mallow, nor do we possess all the baseline demographic and life history data needed to perform these

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calculations. Table 3 is an adaptation of a method for estimating plant MVPs published in Pavlik (1996, p. 137). 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, corresponding to an MVP of 1,000 individuals, to account for species with intermediate or unknown traits. The bold letters in the table indicate values, if known, for Texas poppy-mallow. Two factors require fewer individuals (perennial lifespan and climax successional status); although the loose sand substrate is unstable and subject to dune formation, we interpret the plant community as a climax successional state. Two factors are intermediate (mixed mating system and moderate fecundity); compared to plant species in general, the range of seed production described in section 2.3.1.2 constitutes moderate fecundity. Two factors are unknown (survivorship and longevity of seed viability). Three factors require more individuals (herbaceous growth form, no ramet production, and high environmental variation); the latter value is due to the wide variation in annual precipitation. The estimated MVP for Texas poppy-mallow is:

$((2 \times 50) + (4 \times 1,000) + (3 \times 2,500)) / 9 =$  approximately 1,300 individuals. We have adopted this provisional estimate of MVP for Texas poppy-mallow.

Table 3. Minimum viable population guidelines applied to Texas poppy-mallow (adapted from Pavlik 1996, p. 137).

Factor	A. MVP of 50 individuals for species with these traits.	B. Intermediate MVP of 1,000 individuals for species with intermediate or unknown traits.	C. MVP of 2,500 individuals for species with these traits.
Longevity	<b>Perennial</b>		Annual
Breeding System	Selfing	<b>Mixed</b>	Outcrossing
Growth Form	Woody		<b>Herbaceous</b>
Fecundity	High	<b>Moderate</b>	Low
Ramet Production	Common		<b>Rare or None</b>
Survivorship	High	<b>Unknown</b>	Low
Longevity of Seed Viability	Long	<b>Unknown</b>	Short
Environmental Variation	Low		<b>High</b>
Successional Status	<b>Climax</b>		<u>Seral</u> or <u>Ruderal</u>

This estimate of MVP is based only on numbers of mature individuals (those that have flowered at least once or are judged capable of flowering) because juveniles that die before they reproduce do not contribute to the effective population size or future genetic diversity. Furthermore, population surveys that do not distinguish mature plants from seedlings would appear to fluctuate wildly, depending on how recently seeds had germinated and the proportion of surviving seedlings; thus, basing MVP on mature individuals will also make it easier to judge when the level has been attained. Since the proportion of plants that flower is much greater during years when rainfall in April and May are above average than in years of below-average

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April–May rainfall (Cruze 1991, pp. 4, 20), population sizes are best judged during years of above-average April–May rainfall.

### Delineation of populations.

In order to determine the sizes, numbers, and distribution of populations, it is necessary to delineate populations. As used here, a population consists of groups of individuals within which gene flow, by means of seed dispersal or pollination, occurs often. Metapopulations refer to two or more populations between which gene flow is infrequent. Separate groups of individuals between which gene flow does not occur constitute separate populations. Viable populations of rare plants often consist of metapopulations of numerous small colonies that migrate (by means of mortality in one area and recruitment in another) through areas of contiguous habitat, or between patches of suitable habitat within mosaics of different habitat types, periodically merging or dividing over spans of many years. We hypothesize that Texas poppy-mallow may also follow this pattern.

Since seed dispersal has a very limited range, gene flow of Texas poppy-mallow is limited by the forage range of its pollinators (described in section 2.3.1.2). However, we do not currently know the forage ranges of these specialist solitary bee species. In cases where specific data on gene flow is not available, TXNDD employs the default minimum separation distances between EOs developed by NatureServe: 1 km (0.6 mi) for gaps of unsuitable habitat or unoccupied suitable habitat and 0.5 km (0.3 mi) for gaps of cultural vegetation (i.e., planted by humans; NatureServe 2002, p. 26). We are provisionally adopting this estimate for delineating populations of Texas poppy-mallow to maintain standards that are consistent with our state partner agency.

### Demographic trends.

The known populations of Texas poppy-mallow declined between 1981 and 1991, but whether this represented a trend or stochastic variation was not known (Giles 1991, pp. 39, 41). More recently, Amos (2008, 2019) stated that the Coke County population has not been seen for 10 years and may be extirpated, and the Runnels County populations have declined or are extirpated. Nevertheless, a new population (discussed in section 2.3.1.4) was discovered in Mitchell County in 2002. Although the anecdotal reports suggest that the species' status has declined, very few quantitative surveys have been conducted, and there are no recent surveys. Since the species occurs almost entirely on private land, surveys can only be conducted where landowners have granted permission. While some landowners have enthusiastically supported conservation and population monitoring, it is time consuming to determine who the landowners are and to obtain permission, and access may be denied. Furthermore, since observed population sizes fluctuate greatly (Cruze 1991, pp. 15, 18), depending on recent rainfall patterns, surveys conducted at any one time may not reflect the potential population size. For all of these reasons, we cannot currently project demographic trends for this species. This lack of data underscores the need for more consistent population monitoring of Texas poppy-mallow as well as public outreach to landowners.

### 2.3.1.4 Conservation.

Amos and Delmatier (2003) described a Texas poppy-mallow reintroduction project conducted in 2002 and 2003 on 0.4 ha (1.0 ac) of the Mitchell County Sports Complex, in Colorado City (p. 7). This project was a collaboration between the Mitchell County Board of Economic Development, the TPWD Outdoor Recreation matching grants program, Angelo State University, and the USFWS Partners for Fish and Wildlife program. The seed source for this reintroduction was a new population discovered on several private properties whose owners enthusiastically supported the project. This report states that the new population is about 16 miles southwest of Colorado City (p. 8), which would appear to be a new EO in a different soil type than other known EOs. However, other documents indicate that this site is very near EOs 8 and 9, about 15 miles south of Colorado City (Fuller 2002), and may actually pertain to either of these EOs. In May and June, 2002, participants placed protective cages around 30 individual plants; due to prevailing drought, they watered the plants to stimulate flowering and seed production. They collected 1,400 seeds (about 20 percent of the available total); 384 seeds were pre-treated, according to the methods of Amos and Gonzales (1990), to stimulate germination, 500 seeds were donated to the Lady Bird Johnson Wildflower Center for seed banking, and the remaining seeds were used for subsequent greenhouse propagation (pp. 8–9). In October, 2002, they planted the 384 treated seeds on 24 1-m<sup>2</sup> plots; 25 seeds germinated in these plots during the fall, but all died by February 2003. Although additional seeds were collected in 2003, we have no further documentation of the results of this project.

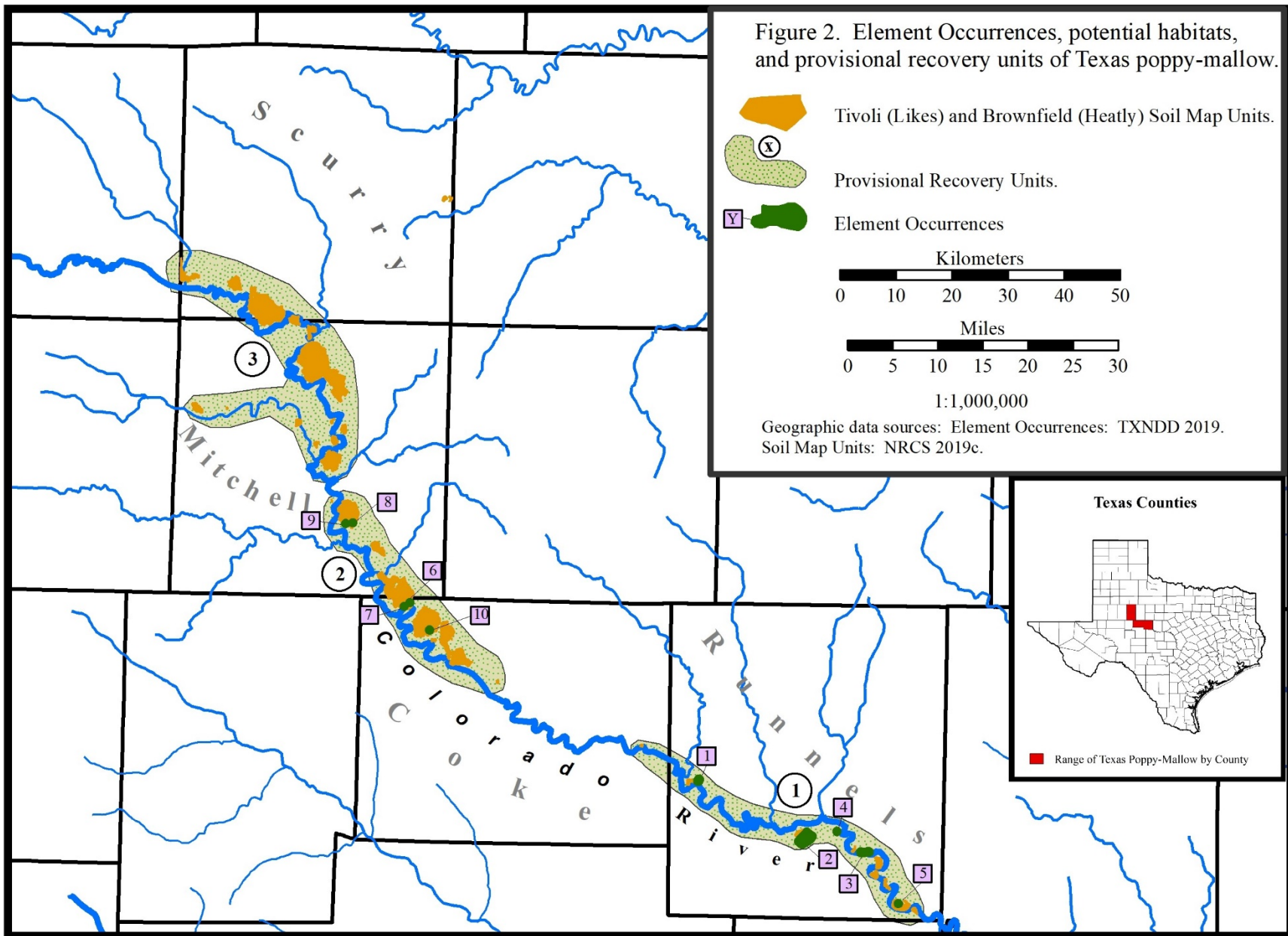
On February 22, 2007, USFWS personnel excavated 28 individual Texas poppy-mallow plants, with permission from the landowners, from the path of a new municipal water line across private land in Ballinger, Texas. The taproots, some exceeding 60 cm (24 in) in length, were brittle and required great care to remove intact (figures 1.a, 1.b). The salvaged plants were donated to the Lady Bird Johnson Wildflower Center, in Austin, where they were used for seed production and experimental purposes.

On June 7–12, 2010, personnel from TPWD and the Lady Bird Johnson Wildflower Center conducted a similar salvage operation in Ballinger (TXNDD 2019). Our records for this project are incomplete, but indicate that at least 27 Texas poppy-mallow individuals and 578 seeds were collected from the site of a construction project. The salvaged plants and seeds were again donated to Lady Bird Johnson Wildflower Center for propagation and seed banking.

### 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” (U.S. Fish and Wildlife Service 2009). However, no section 6 grants have yet been approved to support Texas poppy-mallow conservation.

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

Table 4 (below) summarizes and compares actual and potential threats to Texas poppy-mallow described in the status report (Amos 1979), federal listing (46 FR 3184), and recovery plan (USFWS 1985), and our current understanding of threats.

#### Summary of prior information (Amos 1979; 46 FR 3184; USFWS 1985).

Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range.

The known range of Texas poppy-mallow is restricted to a single county. Most of the original 160 ha (395 ac) of habitat has been disturbed by highway and railroad construction, conversion to cropland, and residential development; sand mining is the most immediate threat. The total amount of occupied habitat is reduced to 16 small colonies (belonging to a single EO) on less than 5 ha (12.4 ac) of land. All known populations occur on private land.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes.

Due to the attractive flowers, the species could be depleted by collection from private land. However, this potential threat had not been observed (Amos 1979, p. 12).

Factor C. Disease or predation.

The species is vulnerable to trampling by livestock, and populations have declined in rangeland grazed by livestock.

Factor D. Inadequacy of existing regulatory mechanisms.

Texas poppy-mallow was not (previously) protected by any state or federal regulations.

Factor E. Other natural or man-made factors affecting its continued existence.

The extreme habitat specialization and limited range intensify other adverse effects. Seedling establishment (recruitment) is very low.

#### New Information.

##### **2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range.**

Currently, we have documented populations along the Colorado River in Runnels, Coke, and Mitchell counties, as well as an anecdotal report of a population in northern Mitchell and southern Scurry County. All known EOs occur on Tivoli (Likes) or Brownfield (Heatly) fine sands. Ten EOs have been documented, but their current statuses are unknown; anecdotal reports suggest that many have declined or are extirpated.

### **2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes.**

Over-collection for any purpose has not been reported.

### **2.3.2.3 Disease or predation.**

We have no specific data on the effect of livestock grazing; effects are probably proportional to grazing intensity.

### **2.3.2.4 Inadequacy of existing regulatory mechanisms.**

The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction; however, the known populations of Texas poppy-mallow occur almost entirely on privately-owned land (as well as a small amount of state highway ROW). Federally-listed plants occurring on private lands have limited protection under the ESA, unless they are protected by state laws; the State of Texas also provides very little protection to listed plant species on private lands. It is reasonable to assume that any undiscovered populations are also likely to be privately owned. Therefore, none of the species' populations and habitats are subject to federal protection unless there is a federal nexus, such as provisions of the Clean Water Act, or a federally-funded project, for example, a new highway or water treatment plant.

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. The State of Texas listed Texas poppy-mallow as endangered on April 29, 1983. 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. Texas Parks and Wildlife Department 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. For example, state law prohibits the destruction or removal of any plant species from state lands without a Texas Parks and Wildlife Department permit.

### **2.3.2.5. Other natural or manmade factors affecting its continued existence.**

Demographic and genetic consequences of small population sizes.

Small populations are less able to recover from losses caused by random fluctuations in recruitment (demographic stochasticity) or variations in rainfall (environmental stochasticity) (Shaffer and Stein 2000, pp. 308-310). In addition to population size, it is likely that population density also influences population viability, since successful sexual outcrossing—necessary to maintain genetic diversity in populations—requires genetically distinct individuals to be in sufficiently close proximity for cross-pollination to occur.

Small, reproductively isolated populations are also susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding depression.

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An investigation of isoenzyme variation (Giles 1991) indicated that Texas poppy-mallow has very little genetic diversity at the population and the species level. The deficiency of genetic diversity may reduce the ability of a species or population to resist pathogens and parasites, to adapt to changing environmental conditions, or to colonize new habitats. Conversely, populations that pass through a “genetic bottleneck” may subsequently benefit through the elimination of harmful alleles. Nevertheless, the net result of the loss of genetic diversity is likely to be a loss of fitness and lower chance of survival of populations and of the species.

Genetic drift is a change in the frequencies of alleles in a population over time (Barrett and Kohn 1991, pp. 3-30). Genetic drift can arise from random differences in founder populations and the random loss of rare alleles in small, isolated populations. Sexual reproduction is the principal mechanism of genetic drift, but mortality within small populations also contributes to changes in allele frequencies. Genetic drift may have a neutral effect on fitness, but is also a cause of the loss of genetic diversity in small populations. Genetic drift may also result in the adaptation of an isolated population to the climates and substrates of specific sites, leading to the development of distinct ecotypes and to speciation.

Inbreeding depression is the loss of fitness among progeny arising from sexual reproduction between closely related individuals. The probability of sexual reproduction between closely related individuals is increased in small, isolated populations. However, plant species vary greatly in response to inbreeding. We do not know if Texas poppy-mallow is susceptible to inbreeding depression, but if so, this factor could affect the species' viability.

Finally, the combined demographic and genetic consequences of small population sizes may reduce population recruitment, leading to an extinction vortex of even smaller populations, greater isolation, decreasing genetic diversity, and loss of viability. These factors may already have contributed to the restriction of Texas poppy-mallow to its current state of extreme endemism in the Tivoli (Likes) and Brownfield (Heatly) sands along the Colorado River of Texas.

These threats of small population sizes could be mitigated through facilitated population augmentation or reintroduction into secure sites. Unfortunately, an attempted reintroduction at the Mitchell County Sports Complex has not so far produced a self-sustaining population.

Climate change.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013) projects the following changes by the end of the 21<sup>st</sup> 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

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increase of global mean surface temperatures of 0.3° to 1.7° C (0.5° to 3.1° F) by the end of the 21<sup>st</sup> Century. 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, these models do not simulate well the projected patterns of regional precipitation (IPCC 2013, p. 11).

We do not know whether the climate changes that have already occurred have affected the populations or distribution of Texas poppy-mallow, 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, it is unlikely that this species could migrate, due to its extreme endemism to specific soil types and a very restricted range. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species’ fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could benefit rosette growth and stimulate greater recruitment. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, Texas poppy-mallow might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete with it. Conversely, warmer winters could extend the ranges of introduced invasive grasses into its habitats, leading to increased competition and mortality. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of Texas poppy-mallow populations and habitat. Therefore, we will continue to monitor the species’ status and will adapt our recovery and management strategies when necessary to address the changing conditions.

We conclude that Texas poppy-mallow populations continue to face significant, immediate threats from extreme endemism to a very restricted soil type, the limited geographic range, the destruction of a large portion of the potential habitats, and the demographic and genetic consequences of small population sizes. Livestock grazing is a potential threat, but the actual effect of grazing on Texas poppy-mallow populations has not been documented. Climate changes may exacerbate existing threats in the coming decades; however, it is currently not possible to project the extent of those changes or their net effects on Texas poppy-mallow.

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Table 4. Factors affecting the survival of Texas poppy-mallow.

Amos 1979, 56 FR 5784, and USFWS 1985.	This review.
A. The present or threatened destruction, modification, or curtailment of its habitat or range.	
<ul style="list-style-type: none"> <li>• Range is restricted to a single county.</li> <li>• The total amount of occupied habitat is reduced to 16 small populations on less than 5 ha (12.4 ac) of land.</li> <li>• All known populations occur on private land.</li> <li>• Most of the original 160 ha (395 ac) of habitat has been disturbed by highway and railroad construction, conversion to cropland, and residential development; sand mining is the most immediate threat.</li> </ul>	<ul style="list-style-type: none"> <li>• The range extends along the Colorado River in Runnels, Coke, Mitchell, and southern Scurry County.</li> <li>• Ten EOs have been documented, but their current status is unknown; anecdotal reports suggest that many have declined or are extirpated.</li> <li>• All known EOs occur on Tivoli (Likes) or Brownfield (Heatly) fine sands.</li> </ul>
B. Overutilization for commercial, recreational, scientific, or educational purposes.	
<ul style="list-style-type: none"> <li>• Due to the attractive flowers, the species could be depleted by collection from private land.</li> </ul>	<ul style="list-style-type: none"> <li>• Over-collection for any purpose has not been reported.</li> </ul>
C. Disease or predation.	
<ul style="list-style-type: none"> <li>• The species is vulnerable to trampling by livestock, and populations have declined in rangeland grazed by livestock.</li> </ul>	<ul style="list-style-type: none"> <li>• We have no specific data on the effect of livestock grazing; effects are probably proportional to grazing intensity.</li> </ul>
D. The inadequacy of existing regulatory mechanisms.	
<ul style="list-style-type: none"> <li>• Not protected by any state or federal regulations.</li> </ul>	<ul style="list-style-type: none"> <li>• ESA and the State of Texas confer very limited protections to listed plants on private land.</li> </ul>
E. Other natural or man-made factors affecting its continued existence.	
<ul style="list-style-type: none"> <li>• The extreme habitat specialization and limited range intensify other adverse effects.</li> <li>• Seedling establishment (recruitment) is very low.</li> </ul>	<ul style="list-style-type: none"> <li>• A single study of isoenzyme variation indicates that the species has very little genetic diversity.</li> <li>• Threatened by the demographic and genetic consequences of small population sizes.</li> <li>• An attempted reintroduction has not been successful.</li> <li>• Potentially threatened by climate change.</li> </ul>

## 2.4 Summary and Synthesis.

Texas poppy-mallow is a valid, distinct plant species of the Mallow family. This perennial herb reproduces primarily by outcrossing, but it can also self-fertilize through the transfer of pollen between different flowers of the same plant. Fertilization is accomplished in the wild by 3 species of solitary bees that specialize on the genus *Callirhoe*. One investigator determined that, in the soil, its seeds lose most viability within 1 year; this would make its populations very vulnerable to extirpation from extreme weather events, disturbance, or other factors. However, other studies showed that the seeds have a 3-phase dormancy and can remain viable in dry storage for at least 4 years. Although we do not actually know how long seeds remain viable in the soil, or how dormancy is naturally broken, many members of the Mallow family have highly dormant seeds that remain viable in the soil for many years. Therefore, Texas poppy-mallow populations may be less vulnerable than previously considered.

This species is endemic to the Tivoli (Likes) and Brownfield (Heatly) soils, which are very specific types of sandy soils found mostly on the lee side of the Colorado River of Texas. The TXNDD documents 10 EOs in Runnels, Coke, and Mitchell Counties. An additional population was reported in northern Mitchell and southern Scurry Counties. Thus, the known range extends in a narrow band about 155 km (96 mi) from southeast to northwest. The aforementioned soil types in these 4 counties—a total of 16,987 ha (41,975 ac)—serve as a provisional model of the species' potential habitat. However, much of the potential habitat has been excavated by sand mining, row-crop agriculture, or residential and transportation development. The largest known population had an estimated size of 48,000 individuals, but was mostly destroyed by a sand mine. Surveys reported in the TXNDD total less than 3,000 individuals, and anecdotal observations indicate that many EOs have declined or are extirpated. Nevertheless, we have no recent survey data, and many EOs were last surveyed in 1987. Most of the documented EOs and almost all of the potential habitat occur on private land, so access for monitoring and recovery are subject to permissions of numerous landowners.

We estimate that Texas poppy-mallow has an MVP size of 1,300 mature, reproductive individuals. We have provisionally adopted NatureServe's default minimum EO separation distances of 1 km (0.6 mi) for gaps of unsuitable habitat or unoccupied suitable habitat and 0.5 km (0.3 mi) for gaps of cultural vegetation. We provisionally identified 3 recovery units that will contribute to recovery criteria that address the conservation of the species' range of ecological and genetic adaptation.

Texas poppy-mallow populations continue to face significant, immediate threats primarily from the demographic and genetic consequences of small population sizes. This is due to extreme endemism to a very restricted soil type, the limited geographic range, and the destruction or alteration of a large portion of the potential habitats. Livestock grazing is a potential threat, but the actual effect of grazing on Texas poppy-mallow populations has not been documented. Climate changes may exacerbate existing threats in the coming decades; however, it is currently not possible to project the net effects of those changes on Texas poppy-mallow.

A reintroduction project at the Mitchell County Sports Complex was initiated in 2002 and continued at least until 2004. Initial efforts failed to establish a population by early 2003, and we

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have no further documentation of the long-term success of this effort. Two salvage projects were conducted in 2007 and 2010 to remove individual plants from the construction footprint of development projects, and the salvaged plants and seeds were donated to Lady Bird Johnson Wildflower Center, in Austin, for seed banking, propagation, and scientific studies.

In synthesis, the recovery plan did not include recovery criteria. We are currently amending the plan to include criteria that meet updated standards. Recovery tasks that have been addressed include scientific studies that contribute to our knowledge of the species' ecology (Task 21), soil seed reserve (task 212), seed germination (task 213), and genetic diversity (task 211), as well as one attempted reintroduction effort (task 41). Most tasks of the recovery plan have not been accomplished. The survey data we have on Texas poppy-mallow populations is incomplete and out-of-date, although anecdotal reports indicate that many populations have declined or are extirpated. The principal threats remain unchanged, and may be exacerbated by climate changes in the coming decades. Consequently, we have no information that would justify a change in the species' status, and recommend that Texas poppy-mallow continue to be classified as endangered.

### 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*

**No change is needed**

#### 3.2 New Recovery Priority Numbers:

5C (no change).

#### Brief Rationale:

Prior to this review, the Recovery Priority Number for 5C. This indicates that the degree of threat was high, the recovery potential was low, the taxon was a species, and the species is, or may be, in conflict with construction or other development projects or other forms of economic activity. Although several new EOs have been discovered, many populations have apparently declined, and we have no recent monitoring reports. The threat level remains high due to endemism to a very limited habitat, habitat loss, small population sizes, and lack of genetic diversity. Reintroduction efforts have so far failed to establish new populations, so the recovery potential remains low. Texas poppy-mallow is still recognized as a species. The species' recovery may still be in conflict with sand mining or other forms of economic development. Therefore, the Recovery Priority Number should remain 5C.

#### **4.0 RECOMMENDATIONS FOR FUTURE ACTIONS.**

1. Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria (U.S. Fish and Wildlife Service 2017). Use the MVP level and population delimitation distances described in this review as components of recovery criteria that address resilience and redundancy. Adopt the provisional recovery units discussed in this review to develop recovery criteria that address the species' ecological and genetic representation.
2. Promote awareness and conservation of Texas poppy-mallow in Runnels, Coke, Mitchell, and Scurry counties.
3. Seek permission to survey and monitor populations on private land.
4. Conduct up-to-date censuses of the accessible populations and revise the TXNDD EO records.
5. Work cooperatively with private landowners who are interested in conserving and managing the species on their lands. Consider voluntary measures to confer long-term protection for populations on private lands, such as conservation agreements and conservation easements.
6. Propagate the species, using seeds in the Lady Bird Johnson Wildflower Center seed bank, to establish seed production plots, renew the seed bank, and reintroduce populations in appropriate sites that can be protected.
7. Obtain support for conservation actions from the Cooperative Endangered Species Conservation Fund (Section 6) or other grant sources.

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### 5.0 LITERATURE CITED.

- Amos, B. 1979. Status report on *Callirhoë scabriuscula* Robins. Prepared for U.S. Fish and Wildlife Service. 19 pp.
- Amos, B.B. 2001. The life history and vulnerability of the endangered Texas poppy mallow (*Callirhoë scabriuscula*, Malvaceae). Pp. 8–15 in Texas Rare Plant Conference Proceedings, Lady Bird Johnson Wildflower Center and U.S. Fish and Wildlife Service, September 6–7, 2001, Austin, Texas.
- Amos, B. 2008. The reproductive biology of the endangered Texas poppy mallow and its cost to conservation. Symposium presentation abstract, Botanical Society of America Conference, July 26–30, 2008, Vancouver, British Columbia.
- Amos, B. 2019. Email to Chris Best, U.S. Fish and Wildlife Service, February 12, 2019.
- Amos, B.B. and C.H. Delmatier. 2003. Case study: Texas poppy-mallow (*Callirhoë scabriuscula* Robins., Malvaceae). Presentation at the Saltcedar and Water Resources in the West Symposium, July 16, 2003, San Angelo, Texas. 13 pp.
- Amos, B.B. and C. Gonzales. 1990. An investigation of the seed germination requirements of *Callirhoe scabriuscula*. Final report to U.S. Fish and Wildlife Service. 8 pp. + 3 figures.
- Association of Official Seed Analysts. 2000. Tetrazolium Testing Handbook. Contribution no. 29 to the Handbook on Seed Testing. Ed. Jack Peters. Association of Official Seed Analysts.
- Barrett, S.C.H. and J.R. Kohn. 1991. Genetic and evolutionary consequences of small population size in plants: implications for conservation. Pp. 3-30 in D.A. Falk and K.E. Holsinger (eds.), Genetics and Conservation of Rare Plants. Oxford University Press, New York, New York. 283 pp.
- Cruze, P.B. 1991. Studies of the seed bank and population dynamics of an endangered species, *Callirhoë scabriuscula*. Master of Science thesis. Angelo State University, San Angelo, Texas. 44 pp.
- Dorr, L.J. 2015a. *Callirhoe* Nuttall. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico 6. [http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=105128](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=105128). Accessed June 21, 2019.
- Dorr, L.J. 2015b. *Callirhoe scabriuscula* B.L. Robinson. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico 6. [http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=250101042](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250101042). Accessed June 21, 2019.
- Fuller, W. Memo from Windi Fuller, Mitchell County Board of Economic Development, to Charmaine Delmatier and Bonnie Amos. May 17, 2002. Re: Property Access Permission. 4 pp.

## Texas Poppy-Mallow Five-Year Review

- Giles, S.D. 1991. A comparative investigation of genetic diversity of *Callirhoë scabriuscula* (Malvaceae) and *Callirhoë involucrata*. Master of Science Thesis. Angelo State University, San Angelo, Texas.
- Intergovernmental Panel on Climate Change. 2013. Summary for Policymakers. In T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 29 pp.
- Integrated Taxonomic Information Service. 2019. *Callirhoe scabriuscula* B.L. Rob. Taxonomic Serial No. 21788. <http://www.itis.gov>. Accessed June 21, 2019.
- Kildisheva, O.A., R.K. Dumrose, and A.S. Davis. 2011. Overcoming dormancy and enhancing germination of *Sphaeralcea munroana* seeds. *HortScience* 46: 1672–1676.
- Mace, G.M. and R. Lande. 1991. Assessing extinction threats: Toward re-evaluation of IUCN threatened species categories. *Conservation Biology* 5: 148-157.
- Natural Resources Conservation Service. 2019a. The PLANTS Database. Plants Profile for *Callirhoe scabriuscula* B.L. Rob. Texas Poppymallow. <http://plants.usda.gov/>. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Accessed June 21, 2019.
- Natural Resources Conservation Service. 2019b. The PLANTS Database. Plant profiles for multiple species. <http://plants.usda.gov/>. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Accessed July 18, 2019.
- Natural Resources Conservation Service. 2019c. Web Soil Surveys for Coke, Mitchell, Runnels, and Scurry counties, Texas. <https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx> Accessed February 11–13, 2019.
- NatureServe. 2002. Element Occurrence Data Standard. NatureServe in cooperation with the Network of Natural Heritage Programs and Conservation Data Centers. 201 pp.
- Pavlik B. 1996. Defining and measuring success. In D. Falk, C. Millar, and P. Olwell [eds.], *Restoring diversity: strategies for reintroduction of endangered plants*, 127–155. Island Press, Washington, D.C., USA.
- Poole, J.M. 1990. Habitat delineation and subsequent searches for *Callirhoe scabriuscula*. Texas Natural Heritage Program, Endangered Resources Branch, Texas Parks and Wildlife Department. Austin, Texas. 4 pp. + 2 appendices.
- Poole, J., W. Carr, D. Price, and J. Singhurst. 2007. *The Rare Plants of Texas*. Texas A&M University Press. College Station, Texas. 640 pp.

## Texas Poppy-Mallow Five-Year Review

- Robinson, B.L. 1895–1897. *Callirhoe scabriuscula* in A. Gray *et al.*, Synoptic Flora of North America 1(1,2): 302.
- Shaffer, M.L. and B.A. Stein. 2000. Safeguarding our Precious Heritage. Pages 301-321 in B.A. Stein, L.S. Kutner, and J.S. Adams (eds.), Precious Heritage: The status of biodiversity in the United States. Oxford University Press. 399 pp.
- Telewski, F.W. and J.A.D. Zeevaart. 2002. The 120-yr period for Dr. Beal's seed viability experiment. American Journal of Botany 89: 1285–1288.
- Texas Natural Diversity Database. 2019. Element occurrence report for *Callirhoe scabriuscula*. Wildlife Diversity Program of Texas Parks and Wildlife Department. June 21, 2019. 20 pp. + attachment.
- Tropicos. 2019. *Callirhoe scabriuscula* B.L. Rob. <http://www.tropicos.org/Name/19601217>. Accessed June 21, 2019.
- U.S. Department of Agriculture Soil Conservation Service. 1970. Soil Survey of Runnels County, Texas. U.S. Department of Agriculture Soil Conservation Service in cooperation with the Texas Agricultural Experiment Station. U.S. Government Printing Office, Washington, D.C. 61 pp+75 maps.
- U.S. Fish and Wildlife Service. 1985. Texas poppy-mallow (*Callirhoe scabriuscula* Robins.) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. Iv + 36 pp.
- U.S. Fish and Wildlife Service. 2009. Cooperative Endangered Species Conservation Fund (Section 6 of the ESA). [http://www.fws.gov/endangered/factsheets/Sec6\\_Factsheet\\_2009.pdf](http://www.fws.gov/endangered/factsheets/Sec6_Factsheet_2009.pdf). Accessed June 20, 2009.
- U.S. Fish and Wildlife Service. 2017. Recovery Planning and Implementation User Guide, Version 2.0. U.S. Fish and Wildlife Service, Arlington, VA. 32 pp. + 2 appendices.
- Veiga-Barbosa, L., C. Ruiz, and F. Pérez-García. 2016. Dormancy imposed by tough seed coat in *Malvella sherardiana* (Malvaceae), a highly threatened species of Spain. Botany Letters 163: 321–327.

**PHOTOGRAPHIC CREDITS**

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Figures 1.a and 1.b: Chris Best, U.S. Fish and Wildlife Service.

**ABBREVIATIONS OF SCIENTIFIC UNITS**

<u>Abbreviation</u>	<u>Scientific Unit</u>
ac	acres
cm	centimeters
ft	feet
ha	hectares
in	inches
m	meters

**GLOSSARY OF SCIENTIFIC AND TECHNICAL TERMS.**

Term	Definition
Acuminate	Gradually tapering to a diminishing point and with the margin bowing inward; long-pointed (Correll and Johnston 1979, p. 1745).
Allele	Alternate forms of a gene.
Annual	A plant species that completes its life cycle within the span of a single year.
Anther	The pollen-bearing part of the stamen. (Correll and Johnston 1979).
Apiculate	A shape ending abruptly in a short, protruding point (an apiculation), but not a hard prickly point..." (Powell <i>et al.</i> 2008, p. 357).
Autecology	Ecology of individual species.
B horizon	A well-developed subsoil horizon that is directly beneath and readily distinguished from the topsoil horizon.
Bract	A reduced leaf subtending a flower, usually associated with an inflorescence (Correll and Johnston 1979, p. 1747).
Breeding System	The ability of a plant species to reproduce via outcrossing, self-fertilization, apomixis, or a combination (Wikipedia 2019).
Calyx	The external whorl of a flower (Correll and Johnston 1979, p. 1747); the sepals, collectively.
Carpel	A simple pistil or one unit of a compound pistil; the ovule-bearing female reproductive structure in flowering plants (Poole <i>et al.</i> 2007, p. 528).
Dehiscent	Structure that naturally splits open along lines of mechanical weakness.
Demography	Scientific study of populations.
Ecotype	A genotype that is specifically adapted to a particular ecological area.
Effective population size	The size of an idealized population in which individuals contribute equally to the gamete pool and have the same variation in allele frequencies and levels of inbreeding as the observed population (Barrett and Kohn 1991).
Electrophoresis	A method of separating chemical substances based on the different rates they travel through a gel or other medium when exposed to an electric field.
Endemic	An organism restricted to a specific habitat or geographic range.
Extinction vortex	An accelerating process of small population size, increased inbreeding, and loss of genetic diversity that leads toward extinction.
Founder effects	"The loss of genetic variation and the consequent change in genotype frequencies that occurs when a small number of individuals found a new population. It is equivalent to a burst of random genetic drift." (Evolution-textbook.org 2019).
Geitonogamy	Sexual fertilization between different flowers of the same individual plant.
Gene flow	The transfer of alleles or genes from one population to another (Wikipedia 2019).
Genetic bottleneck	An event that greatly restricts an organism's genetic diversity.

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Term	Definition
Habitat	Ecological or environmental area that is inhabited by a particular species of animal, plant, or other type of organism (Wikipedia 2019).
Herbaceous	Plant tissues, such as leaves and stems, that are not lignified and typically last for a single season or year; as opposed to woody plants and tissues.
Heterozygous	A diploid (or polyploid) organism possessing two (or more) alleles at a specific gene locus on homologous chromosomes.
Inbreeding	Sexual reproduction between closely related individuals.
Inbreeding depression	The reduction of fitness caused by mating between relatives (Edmands 2007, p. 464).
Indehiscent	A fruit that does not naturally split open along lines of weakness.
Involucel	A secondary involucre (Correll and Johnston 1979, p. 1754).
Involucre	A whorl of bracts (phyllaries) subtending a flower cluster (Correll and Johnston 1979, p. 1754).
Isozyme	Enzymes that differ in amino acid sequence but catalyze the same chemical reaction; also known as isoenzymes or more generally as multiple forms of enzymes (Wikipedia 2019).
Locus	The specific position of a gene on a chromosome.
Mericarp	A dehiscent or indehiscent one-seeded segment formed from the division of a compound fruit (Poole <i>et al.</i> 2007, p. 535).
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.
Mixed mating system	A breeding system in which both self-fertilization and outcrossing are possible.
Monomorph	A gene for which there is only one allele.
Nectar	Sugar- or nutrient-rich liquids secreted by flowers of some plants that attract pollinators, or secreted by other plant structures that attract animals whose presence discourages herbivory.
Oligolecty	Bee species that have a narrow, specialized preference for pollen source plants (Wikipedia 2019).
Outcross	In plants, sexual fertilization involving the union of gametes from different individuals.
Palmate	Arrangement of veins, lobes, leaflets, etc., dividing and radiating from a single point.
Perennial	A plant that lives for more than one full year.
Petal	One of the modified leaves of a corolla (Correll and Johnston 1979, p. 1758).
Phylogeny	The study of evolutionary relatedness among various groups of organisms (e.g., species, populations), which is discovered through molecular sequencing data and morphological data matrices (Wikipedia 2019).

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Term	Definition
Pollen	The male fecundating spores found in the anther (Correll and Johnston 1979, p. 1758).
Polymorphism	In genetics, a gene locus for which multiple alleles exist.
Population Viability Analysis	Statistical models used to predict the probability of extinction of a population after a specified period of time.
Protandrous	Flower type in which anthers mature before pistils (Correll and Johnston 1979).
Ramet	An individual, genetically identical plant reproduced as a clone of the parent plant.
Recovery unit	"...a special unit of the listed entity that is geographically or otherwise identifiable and is essential to the recovery of the entire listed entity." (NMFS and USFWS 2010).
Rosette	A radially-symmetrical whorl of leaves formed at the base of a plant stem, usually during a vegetative (non-reproductive) growth phase.
Sepal	A leaf or segment of the calyx (Correll and Johnston 1979).
Soil seed reserve	Dormant and non-dormant seeds present in the soil that are able to germinate; also termed "soil seed bank".
Speciation	The evolutionary process by which new biological species arise (Wikipedia 2019).
Stigma	The receptive part of the pistil on which the pollen germinates. (Correll and Johnston 1979).
Synecology	Ecology of groups of coexisting organisms.
Taproot	Predominantly long or thick central root; may function to access deep soil moisture, storage of water and carbohydrates, or both.
Taxon	(Plural, taxa). A natural group of organisms at any rank in the taxonomic hierarchy (Anderson 2001).
Taxonomy	Scientific classification of living organisms.
Testa	Seed coat.
Valvate	A capsule or legume that separates into segments (Correll and Johnston 1979, p. 1764).

Literature cited in glossary.

Anderson, E.F. 2001. *The Cactus Family*. Timber Press, Portland, OR. 776 pp.

Barrett, S.C.H. and J.R. Kohn. 1991. Genetic and evolutionary consequences of small population size in plants: Implications for conservation. Pp. 3-30 in Falk, D.A. and K.E. Holsinger (eds.), *Genetics and Conservation of Rare Plants*. Oxford University Press, New York, New York.

## Texas Poppy-Mallow Five-Year Review

- Correll, D.S. and M.C. Johnston. 1979. *Manual of the vascular plants of Texas*. University of Texas at Dallas, Richardson, Texas. 1881 pp.
- Edmands, S. 2007. Between a rock and a hard place: evaluating the relative risks of inbreeding and outbreeding for conservation and management. *Molecular Ecology* 16: 463-475.
- Evolution-textbook.org. 2019. Lineage sorting. <http://evolution-textbook.org/content/free/glossary/glossary.html>. April 3, 2019.
- Mace, G.M. and R. Lande. 1991. Assessing extinction threats: Toward re-evaluation of IUCN Threatened Species Categories. *Conservation Biology* 5:148-157.
- National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2010. Interim endangered and threatened species recovery planning guidance. Version 1.3. <http://www.nmfs.noaa.gov/pr/recovery/>. Accessed: January 10, 2011.
- Pavlik, B.M. 1996. Defining and measuring success. Pp 127-155 in Falk, D.A., C.I. Millar, and M. Olwell, (eds.), *Restoring Diversity: Strategies for reintroduction of endangered plants*. Island Press, Washington, D.C. 505 pp.
- Poole, J., W. Carr, D. Price, and J. Singhurst. 2007. *The Rare Plants of Texas*. Texas A&M University Press. College Station, Texas. 640 pp.
- Powell, A.M., J.F. Weedin, and S.A. Powell. 2008. *Cacti of Texas: A field guide*. Texas Tech University Press, Lubbock, Texas. 383 pp.
- Wikipedia.org. 2017. <http://en.wikipedia.org/> Articles on gene flow, habitat, isozyme, mating system, oligolecty, phylogeny, and speciation. Accessed July 26, 2019.

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of**  
*Callirhoe scabriuscula* (Texas Poppy-Mallow)

**Current Classification:** Endangered.

**Recommendation resulting from the 5-Year Review:**

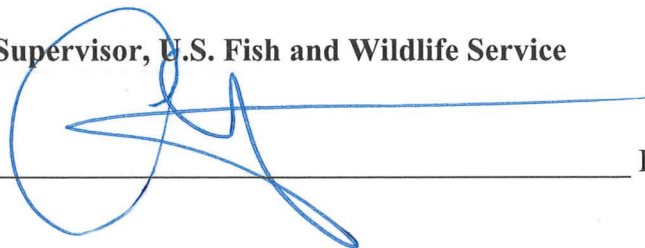
- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed.

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

**FIELD OFFICE APPROVAL:**

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

Approved \_\_\_\_\_



Date \_\_\_\_\_

9/12/19