Species Status Assessment Report for

Prostrate Milkweed (*Asclepias prostrata* W.H. Blackwell)

Version 1
February 2020
U.S. Fish and Wildlife Service
Region 2
Albuquerque, NM

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The following provided assistance and important information in the preparation of the SSA report:
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Version history:
v. 1.0 – preliminary draft distributed to peer and partner reviewers (February 2020)
v. 1.1 – final draft revised after peer review; for internal use only (March 2020)
Suggested reference:
U.S. Fish and Wildlife Service. 2020. Species status assessment report for the prostrate milkweed (*Asclepias prostrata*). Version 1.x. February 2020. Albuquerque, NM.

Executive Summary

Prostrate milkweed (*Asclepias prostrata*) is an herbaceous perennial plant restricted to Starr and Zapata counties in the U.S. and isolated pockets in Tamaulipas and eastern Nuevo León, Mexico. Prostrate milkweed is one of the most poorly known species of the milkweed genus. This species needs an open canopy with little or no herbaceous cover and therefore often occurs in areas that mimic historic levels of disturbance, such as along maintained roads. Prostrate milkweed has an energy-storing taproot that allows the plant to survive underground in a dormant state for months or even years. Stressors include conversion of native vegetation to non-native grass (primarily buffelgrass, *Pennisetum ciliare*), right-of-way maintenance (including mowing during flowering or fruiting periods and herbicide treatment), land conversion, such as development from road expansion, and border security activities. Because prostrate milkweed can persist underground in a dormant life stage, it can survive extended periods of drought and respond quickly to rainfall events. Therefore, while climate change is a potential threat, effects on prostrate milkweed are difficult to project.

The species has never been abundant in available survey data. Since 1995, only one population has had more than 50 individuals, and most others have fewer than 10 individuals. Of the 24 extant populations of prostrate milkweed that remain in Texas and Mexico, 19 (79%) are estimated to be in low current conditions. Future scenarios predict all populations in either low condition or extirpated, except for a conservation scenario in which two populations would remain in moderate condition while all others would be projected as low condition.

Using minimum viable population estimates for species with similar life history traits, no prostrate milkweed population has ever been in a high condition for abundance (i.e., containing at least 1,600 individuals). The Dolores population in Zapata County was estimated to have up to 200 individuals between 1988 and 1993 until a fiber optic cable was installed in the highway right-of-way location. By 2017, only 1 plant was found. Another population, Mission Mier a Visita, had 137 individuals in 1986; however, buffelgrass invaded the site in 1988 and only one or two individuals have been observed since. The expansion of buffelgrass and effects of climate change are expected to become more severe over time, as will road expansion and maintenance projects due to increased wind energy development in this area and ongoing border security activities.

Our analysis of the viability of prostrate milkweed is based upon concepts of population resilience, species redundancy, and species representation. Although some individuals within a prostrate milkweed population may be surviving as underground taproots not visible during surveys, numbers are still far below minimum viable population targets; therefore, the resilience of all populations is low. Likewise, although it is likely that there are more populations on private lands that are unknown to us, we believe that the numbers of known populations are low, especially for a species that occurs in road right-of-ways. Based upon this assumption, we determine that redundancy is low for this species due to low numbers of resilient populations. We also consider prostrate milkweed to have low representation in the form of genetic diversity due to the species occurring in small disjunct populations. In summary, prostrate milkweed has

low resilience, redundancy, and representation while threats such as climate change, buffelgrass encroachment, and ongoing development are increasing. Therefore, we determine that the overall species viability of prostrate milkweed is low.

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Chapter 1 Introduction

1.1.Introduction

The Species Status Assessment (SSA) framework (USFWS 2016, entire) is an analytical approach used by the United States Fish and Wildlife Service (USFWS) to assess the needs, current status, and projected future status of a species using the best available information. The SSA Framework uses the conservation biology principles of resilience, redundancy, and representation as a lens to evaluate the species' current condition and to project its future condition. The result is an SSA Report that characterizes a species' ability to sustain populations in the wild over time (viability) based on the best scientific understanding of current and future abundance and distribution within the species' range. The SSA report can be easily updated as new information becomes available, and supports all functions of the USFWS' Endangered Species Program, from Listing to Section 7 Consultations to Recovery. As such, the SSA Report will be a living document upon which other documents, such as listing rules, recovery plans, and 5-year reviews, would be based if the species warrants listing under the Endangered Species Act (ESA).

Prostrate milkweed (*Asclepias prostrata*) is one of the most poorly known species of the milkweed genus (Fishbein In prep., unpaginated). This herbaceous perennial is named for the sprawling habit of the stems and leaves. The historic distribution of prostrate milkweed is unknown. In the U.S., prostrate milkweed was documented to occur at a location along the Rio Grande between Laredo (Webb County, Texas) and Ringgold Barracks near Rio Grande City (Starr County, Texas). Currently, in the U.S. it is restricted to Zapata and Starr counties, in southern Texas, with all known populations located within 8 miles of the Rio Grande (Strong and Williamson 2015, pp. 34-35). In Mexico, known locations for this species occur in isolated pockets widely scattered in northern Tamaulipas and eastern Nuevo León, many over 160 kilometers (km) (100 miles (mi)) from the Rio Grande (Figure 11; Strong and Williamson 2015, p. 35). The historical range of prostrate milkweed is unknown; therefore it is presumed to be approximately the same as the current range in southern Texas and northern Mexico. However, the distribution of populations throughout this range may have been more abundant.

Prostrate milkweed was petitioned for listing under the ESA in 2007 (USFWS 2009a, p. 66867). This SSA Report is intended to provide the biological support for the decision on whether or not to propose to list the species as threatened or endangered, and if so, where to propose designating critical habitat. Importantly, the SSA Report does not convey a decision by the USFWS on whether this species should be proposed for listing as a threatened or endangered species under the ESA. Instead, this SSA Report provides a review of the available information strictly related to the biological status of prostrate milkweed. The listing decision will be made by the USFWS after reviewing this document and all relevant laws, regulations, and policies. The results of a proposed decision will be announced in the Federal Register, with appropriate opportunities for public input.

For the purpose of this assessment, we define viability as the ability of prostrate milkweed to sustain populations in natural systems over time. Using the SSA framework (Figure 1.1), we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resilience, redundancy, and representation (i.e., the **3Rs**, Smith *et al.* 2018, entire). The 3Rs are defined as:

- Resilience describes the ability of populations to withstand stochastic events (arising from random factors). Populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of disturbance. We can measure resilience based on metrics of population health; for example, recruitment, mortality, and population size. Highly resilient populations are better able to withstand disturbances such as random fluctuations in germination rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

- Representation describes the ability of a species to adapt to changing environmental conditions over time. Representation can be measured by the breadth of genetic and ecological diversity within and among populations, and gauges the probability that a species is able to adapt to environmental changes. The more representation, or diversity, a species has, the more able it is to adapt to changes (natural or human caused) in its environment. In the absence of species-specific information about its genetic and ecological diversity, we evaluate representation based on the extent and variability of habitat characteristics across its geographical range.

- Redundancy describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resilience, and their distribution and connectivity, redundancy gauges the probability that the species has a margin of safety to withstand and recover from catastrophic events (such as a rare destructive natural event or episode involving many populations).

To evaluate the current and future biological status of prostrate milkweed, we assessed a range of conditions to allow us to consider the species' resilience, redundancy, and representation. This SSA Report provides a thorough assessment of biology and natural history and assesses demographic risks, stressors, and limiting factors in the context of determining the viability and risks of extinction for the species.

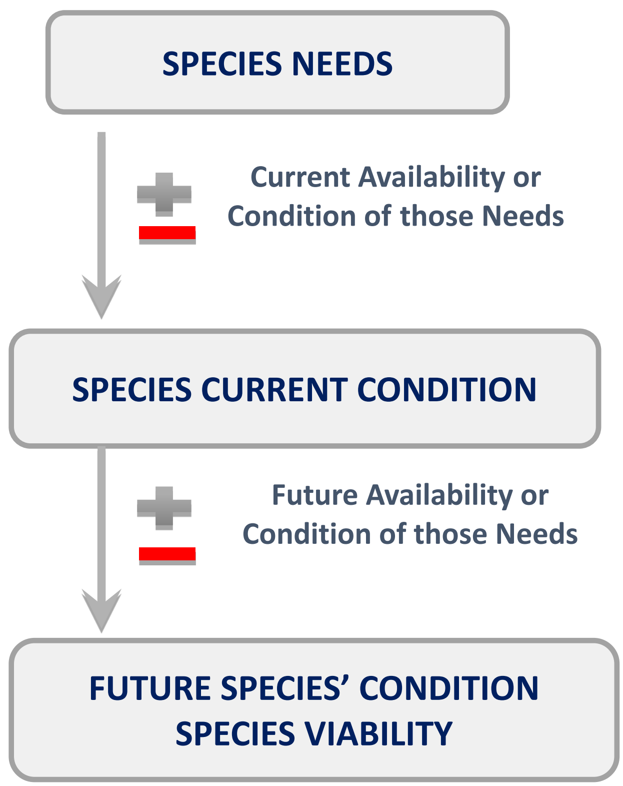


Figure 1. Species Status Assessment Framework

Chapter 2 - Taxonomy and Phylogenetics, Description, and Life History Needs

2.1. Species Information

2.1.1. Taxonomy and Phylogenetics

The taxonomic status of prostrate milkweed, *Asclepias prostrata* W.H. Blackwell, is well accepted. The species was first described by Blackwell in 1964 from a type specimen collected in 1960 in Tamaulipas (Blackwell 1964, p. 178; University of Texas Herbarium, #TEX00372529). The Genus *Asclepias* was formerly classified within its own family, the Asclepiadaceae (milkweed family); more recent phylogenetic analyses revealed that the genus is nested within Apocynaceae, the dogbane family (Sennblad and Bemer 1996, entire) (Table 1). No other synonyms have been proposed for this species (Poole *et al.* 2007, p. 98).

Prostrate milkweed is a member of the Podostemma clade (Fishbein *et al.* 2011, p. 1018; Worcester 2015, p. v), which includes six species of milkweeds sharing a common ancestor (Fishbein *et al.* 2011, p. 1018; Worcester 2015, p. v). Most species in this clade have distributions that straddle the U. S.-Mexico border, with ranges of some extending to Central America or the U. S. Midwest (Figure 2 below). This clade contains Emory's milkweed (*A. emoryi*), Zizotes milkweed (*A. oenotheroides*), Mojave milkweed (*A. nyctaginifolia*), hierba de la mula (*A. standleyi*; Woodson 1954, p. 160), sand milkweed (*A. arenaria*), and prostrate milkweed (Fishbein *et al.* 2011, p. 1015). Prostrate milkweed is also morphologically similar to the species of subgenus *Podostemma* (Fishbein *et al.* 2011, p. 1018).

About 130 species of Asclepias have been described in North and South America (Fishbein *et al.* 2018, p. 515). The Flora of North America recognizes *Asclepias prostrata* as a unique species (Fishbein In prep., unpaginated). Consequently, the USFWS considers this a valid taxonomic species.

Table 1. Taxonomic Chart for prostrate milkweed (*Asclepias prostrata*) (NCBI 2020).

Kingdom	Phylum	Class	Order	Family	Genus	Species
Viridiplantae	Streptophyta	Magnoliopsida	Gentianales	Apocynaceae	Asclepias	prostrata

2.1.2. Population Genetics

No studies on the genetic diversity of prostrate milkweed have been conducted; however, a sample from a single prostrate milkweed individual had polymorphism levels that were on the high side of average for the genus (Weitemier 2019, pers. comm.). The genetic diversity was not quantified *per se*, but the amount of sequence divergence among prostrate milkweed samples was comparable to that of related species Zizotes milkweed and Emory's milkweed (Worcester 2015 p. 28; Weitemier 2016, p. 38; 2019, pers. comm.; Fishbein 2019c pers. comm.).

Although several phylogenetic studies have included prostrate milkweed (discussed above), there have been no investigations of the species' genetic diversity within or among populations. Prostrate milkweed probably has an outcrossing breeding system (Damude and Poole 1990, p 23) and has wind-dispersed seeds. Outcrossing, wind-dispersed plants tend to have relatively high levels of genetic diversity (Hamrick and Godt 1996, pp. 1293–1294); conversely, among long-lived perennial plants, endemic species have lower levels of genetic diversity than more widely distributed species (Hamrick and Godt 1996, p. 1296).

In plants, gene flow occurs via seeds and pollen: therefore pollen dispersal can have a substantial influence on the genetic makeup of plant populations (see Section 2.1.5. for reproductive biology and pollinator information). Gene flow can occur within and among populations that are clustered within the forage range of its pollinators. Urban expansion or other development that occurs between populations could isolate populations from pollen transfer (Janssen *et al.* 2010, p. 97-98).

Hybridizations between prostrate milkweed and co-occurring milkweeds have not been documented even though two other species of *Asclepias* have been found with prostrate milkweed (Damude and Poole 1990 p. 28). Zizotes milkweed is known to co-occur with prostrate milkweed and Emory's milkweed has been reported within the same counties (Strong and Williamson 2015 p. 40).

The range of prostrate milkweed extends about 200 miles, from northwest Zapata County to east-central Tamaulipas, México. It is unknown if there are populations between these areas. If there are, it is possible that genetic exchange still occurs. However, if this area no longer contains prostrate milkweed there could be a loss of genetic exchange and the genetics of the Texas and Mexico populations could be diverging. A loss of genetic exchange and resulting divergence 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.

2.1.3. Similar Species

The closest relatives of prostrate milkweed are Emory's milkweed, Zizotes milkweed, Mojave milkweed, and hierba de la mula (Fishbein *et al.* 2011, p. 1015; Fishbein 2019a, pers. comm.); however, it is not clear which of those four is the most closely related as they all appear to be equally close (Fishbein 2019a, pers. comm.). The life history of prostrate milkweed differs enough from other milkweeds that the use of surrogates may not be appropriate (Fishbein 2018, pers. comm.). However, in the absence of appropriate surrogates and because so little is known about prostrate milkweed, we use the best available information from the milkweed species listed below.

The prostrate milkweed clade is fairly homogeneous morphologically (sessile inflorescences, spatulate corona lobes) and contains all species of subgenus *Podostemma*, except *A. subulata* (rush milkweed) (Fishbein *et al.* 2011, p. 1019). Prostrate milkweed exhibits similarity in all vegetative traits, including habit, to two co-occurring asclepiads, *Matelea brevicoronata* (shortcrown milkvine) and *M. parviflora* (mesquite plains milkvine); however, no information was found to allow use of these milkvines as surrogates for prostrate milkweed. Instead, we use demographic information as necessary from *A. tuberosa* (butterflyweed), *A. meadii* (Mead's milkweed), Zizotes milkweed, and *A. syriaca* (common milkweed). *A. verticillata* (whorled milkweed) and rush milkweed do not have similar life histories to prostrate milkweed; however some information for these milkweeds is presented but only as representatives of the *Asclepias* genus and not as surrogate species.

2.1.3. Species Description

Prostrate milkweed is an herbaceous, flowering, perennial species with cream, yellow, greenish, or pinkish flowers (see Figures 4a and 4b). The plant has a distinctive odor, similar to the tree tobacco (*Nicotiana glauca*) (Santore 2019a, unpaginated). This species is distinctive in its prostrate habit; the leaves and stems hug the ground and sprawl outward from a woody crown (Figure 2). No other *Asclepias* species within the range has a prostrate habit; however, shortcrown milkvine and mesquite plains milkvine occur within the range of prostrate milkweed and are similar in appearance

Prostrate milkweed life stages and forms include seed, seedbank, seedling, vegetative adult, flower, seed follicle/fruit, and below-ground structure. Descriptions of each are provided below in Table 2.

Figure 2. Prostrate milkweed (photograph courtesy Anna Strong).

Table 2. Description of Life Stages of Prostrate Milkweed. Alphabetic superscripts for each descriptive element correspond to references within the same life stage row. All information refers to prostrate milkweed except information in italics, which refers to other species as noted or to milkweeds in general.

Life Stage	Description	Months	References
Seed	-produces many seeds[a]; -flat, broadly ovate, 0.7-0.8 x 0.5-0.6 cm (0.3 x 0.2 in)[b]; -conspicuous silky white hairs, 1.0–1.8 cm (0.4-0.7 in) [b,c]; -likely dispersed by wind[a]		[a]Damude and Poole 1990, p. 4 and 25; [b]Fishbein In prep.; [c]Richardson and King 2011, p. 76;
Seedbank	-lifespan of seeds is unknown, possibly 1-2 years[a]		Fishbein 2019[a], pers. comm.
Seedling	-emergence may be dependent upon rainfall[a,b]; -assumed to emerge at least 1 week after rainfall[b]; -timing of emergence varies from year to year[a]; *under greenhouse conditions, Zizotes milkweed seedlings may become fully mature in approximately 6 months or more*[c]	Possibly year-round depending upon rainfall; May-June and Sep-Nov are periods of highest rainfall	[a]Eason 2019, pers. comm.; [b]Strong 2019a, pers. comm.; [c]Fishbein 2020, p. 3
Vegetative Adult	-prostrate growth (ground-hugging)[a] forming a mat up to about 30.5 cm (1 ft) in diameter[b]; -herbaceous[c]; -leaves: triangular, curly-margined opposite, 1.8-5 cm (0.7–2 in) long, 0.4-1.8 cm (0.2-0.7 in) broad[c]; -exude milky sap[a]; -stems: 2–7 per plant[b,c], twisted and sprawling from a woody crown[a]; -above-ground structure dies back during winter and drought[d]	Mar-Dec[a,e,f] ; possibly year-round, depending upon year	[a]Damude and Poole 1990, p. 3; [b]Poole and Janssen 1997, p. 14; [c]Fishbein In prep; [d]Hempel 2018, pers. comm.; [e]Strong and Williamson 2015, p. 38; [f]King 2019, pers. comm. see Figure 6

Life Stage	Description	Months	References
Flower	-inflorescences erect[a], some on the ground[b]; -clusters of 3-8 flowers[a,c,d]; -cream, yellow, greenish, or pinkish[a] (see Figure 4b); -reproduces sexually based upon seed production and highly specialized pollinia and intricate flower containing both male and female structures[c]; -emanates a sweet and spicy floral perfume[c]; -in cultivation, blooms for an extended period of time throughout the summer and into September with mature fruit production at the same time[e];	Mar-Oct[f,g]; sporadic and dependent upon rainfall	[a]Fishbein In prep.; [b]Correll 1966, p. 309; [c]Damude and Poole 1990, pp. 3–5 and 23; [d]Poole *et al.* 2007, pp. 98–99; [e]Eason 2019, pers. comm.; [f]Strong and Williamson 2015, p. 38; [g]Santore 2019b, pers. comm.
Follicle/Fruit	-boat-shaped follicle or fruit[a]; -minutely hairy, warty pods[a]; -pendent on pedicels[b]; -3.5-5.5 x 1–1.5 cm (1.4-2 x .4-.6 in)[b] -see Figure 5	Mar-Dec (this is a collective range of overlapping months based upon sources ([a,b,c,d,e]) for observations from multiple years	[a]Damude and Poole 1990, p. 4; [b]Fishbein In prep.; [c]Santore 2019a, unpaginated; [d]King 2019, pers. comm., see Fig. 6; [e]Strong and Williamson 2015, p. 38

Life Stage	Description	Months	References
Below-ground Structure	-sometimes plant is only present in underground form[a,b,f], possibly remaining dormant for several years before sprouting above ground[b] -taproot approximately 6.4 mm (.25 in) in diameter and from 15 cm (6 in) to possibly 61 cm (2 ft) long[c,d]; -woody stem/crown, perennial, underground or near ground level[e]; -does not produce rhizomes[g], but energy-storing tubers are produced[h]; *-Mead's milkweed documented to remain dormant 1–5 years*[i]	Unknown, assumed year-round	[a]Price 2005, pers. comm.; [b]Best 2017, pers. comm.; [c]Strong 2019a, pers. comm.; [d]King 2019, pers. comm.; [e]Best 2018, pers. comm.; [f]Hempel 2018, pers. comm.; [g]Fishbein In prep; [h]King 2020, pers. comm. and see Fig. 7; [i]Alexander *et al.* 2009, p. 267

2.1.4. Life History

The prostrate milkweed is a perennial species that can sprout new stems from a long taproot or tuber and produces numerous seeds dispersed by wind. The life span of prostrate milkweed is unknown. All North American milkweeds are perennials. Some species are long-lived. For example, Mead's milkweed can take 20 to 30 years to reach the flowering stage (Bowles *et al.* 2015, p. 1) and after maturing, can persist indefinitely (USFWS 2005, p. 1).

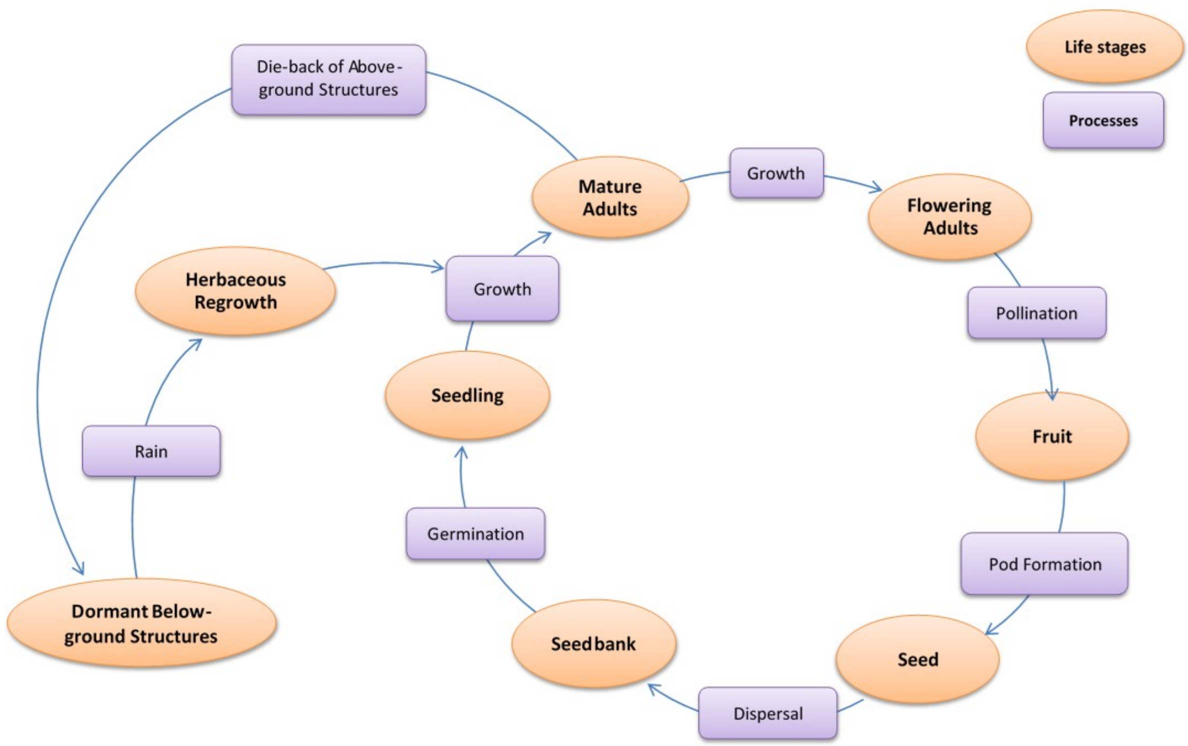


Figure 3. Life cycle diagram of prostrate milkweed

2.1.5. Reproductive Biology

The specific reproductive biology of prostrate milkweed is unknown but may be inferred from similar milkweed species. While many milkweeds are rhizomatous (Fishbein In prep) and form clones via ramets (stems) in adjoining areas, it is not universal and has not been reported for prostrate milkweed. Prostrate milkweed has highly specialized pollinia (pollen sacs) and complex flowers containing both male and female structures (Damude and Poole 1990 p. 23). Further, most milkweed species are self-incompatible and require outcrossing, meaning that in order to produce fruit and seeds, flowers must receive pollen from another unrelated plant (Luna and Dumroese 2013, p. 11; Weitemier 2016, p. 3). Prostrate milkweed plants produce 1 to several tubers that form 30 cm (12 in) or more underground (see Figures 6 and 7). These tubers allow individuals to persist through long droughts, and may provide a limited amount of clonal reproduction. However, the species does not primarily reproduce through asexual means, such as rhizomes (Fishbein, in prep).


Figures 4a and 4b. Prostrate milkweed buds and flowers. Photographs courtesy of Joey Santore (left) and Sam Kieschnick (right).

Milkweeds have remarkably complex flowers with unusual morphology making pollination a multi-step process (Wyatt and Broyles 1994, pp. 424-426). Milkweeds produce waxy masses of pollen in sacs called pollinia. Pollen remains enclosed in the pollinium until inserted into the stigma of another flower by an insect or other pollinator (Holdrege 2010 p. 13). The stigmatic surfaces are also enclosed with just a narrow slit for an opening (Holdrege 2010 p. 15). This specialization means that relatively few pollinia are successfully inserted into a stigmatic chamber (Holdrege 2010 p. 15). However, the design of the milkweed flower is all about attracting pollinators with nectar and ensuring that the pollinators pick up and move pollinia to a different flower to complete pollination (Dellinger 2016, unpaginated).

No formal studies have been conducted regarding pollinators of prostrate milkweed. While all *Asclepias* species have highly specialized flowers, many are effectively pollinated by generalist insect pollinators. South Texas has a high species richness for Hymenoptera, so various species of bees and wasps may be pollinators (Damude and Poole 1990 p. 24). Milkweed pollinia are usually large structures so insects that are relatively large may be better able to function as pollinators (Maclvor *et al.* 2017 p. 8459; Dellinger 2016, unpaginated). Any insect large enough to acquire and transport the pollinia can serve as an effective pollinator of milkweed (Ivey *et al.* 2003, p. 215). Some insects are not robust enough to remove their legs from the anther slits with the attached pollinia and are trapped to die there if they do not lose their appendage first (Dellinger 2016 p. unpaginated). However, among 12 species of milkweed studied, the rare or uncommon species, specifically *A. hirtella* (tall green milkweed), Mead's milkweed, *A. lanuginosa* (woolly milkweed), and *A. viridiflora* (small green milkweed), seemed to have very few insect visitors attracted to them, compared to the common species (common milkweed, whorled milkweed, and *Asclepias incarnata* (swamp milkweed)) (Betz *et al.* 1994, p. 58), indicating a possible link between rare plants and pollinator declines.

In a study of butterflyweed in Arizona, a diverse assemblage of 34 species of insects, representing five orders, were observed transferring or carrying pollinia. Five other *Asclepias* species were also pollinated by a diversity of taxa, with 116 insect species observed carrying pollinia to and from whorled milkweed. However, honey bees (*Aphis* spp.) and bumblebees (*Bombus* spp.) were the most effective pollinators for butterfly weed (Fishbein and Venable 1996, p. 1069). In studies conducted in Michigan, at least 65% of effective pollinator visits to common milkweed and butterflyweed were by honey bees, but 100% of effective pollinator visits to small green milkweed were by bumblebees (La Rosa and Conner 2017 p. 153). In a study conducted in Indiana, bumblebees were the most frequent effective pollinator among three milkweed species (swamp, whorled, and common milkweeds) but all three species appeared to show some specialization for long-tongued Hymenoptera (i.e., bumblebees) and Lepidopterans (i.e., sulphur or swallowtail butterflies) (Kephart and Theiss 2004, pp. 265, 269, and 270).

In 2017 at San Antonio Botanical Garden, observations were made of large ants (possibly *Pogonomyrmex barbatu*s) visiting potted prostrate milkweed plants which produced fruit naturally (i.e., without hand pollination). When the potted prostrate milkweed plants were moved the following year to an area without ants, the same plants produced no fruit or seeds. However, ants are unlikely to be effective milkweed pollinators (Fishbein 2020, pers. comm.) and the second year the plants were also exposed to differing sun exposure, which could also have affected fertilization (Eason 2019, pers. comm.). Since prostrate milkweed flowers are close to the ground, other insects such as flightless bugs and beetles could also be attracted and serve as pollinators (Damude and Poole 1990, p. 24); however, casual observations of insects feeding on a flower's nectar should not be considered proof that they are pollinators for that flower (Fishbein and Venable 1996. p. 1070). In a two-year study on the effectiveness of pollinators in southeastern Arizona, only 43% of the insect species that visited butterflyweed were found to be carrying pollinia (Fishbein and Venable 1996, p. 1070). Furthermore, pollination effectiveness (visitation rates and per-visit pollen removal/deposition rates) and species of insects differed between the two years of study (Fishbein and Venable 1996, p. 1068). Therefore, since not all insect visitors should be considered pollinators, we assume that large bees and wasps are the most effective pollinators for prostrate milkweed, but not necessarily the only pollinators.

The distance that a pollinator will fly affects plant population limits and genetic diversity (see Section 3.1). Pollinator flight distances varied among 10 populations of a wildflower (*Delphinium nuttallianum*) in Colorado; however, recaptures of queen bumblebee pollinators found that they moved distances up to 300 m (0.2 miles) (Schulke and Waser 2001, p. 244). Some pollinators will travel to relatively distant sites (even up to 1,000 m) (0.6 miles) if conditions are correct (Schulke and Waser 2001, p. 244) but isolation of plant populations affects pollinator movements and sufficient isolation may cause a loss of pollination services altogether (Schulke and Waser 2001, p. 243). For rare plant species, it is critical to study the pollinator movements for that species to be able to manage for genetic diversity (Schulke and Waser 2001, p. 244).

Seasonal variation in flowering and fruiting cycles were measured in three species of *Asclepias*; swamp milkweed, common milkweed, and whorled milkweed (Kephart 1987, entire). Each species produced many hundreds of flowers over periods of 2–9 weeks (Kephart 1987, p. 65). The length of time flowers remained open and available to pollinators varied seasonally and among species. Even same-aged plants grown in a single habitat differed in duration, timing, and abundance of flowering (Kephart 1987, p. 65). Intraspecific and interspecific variation in these three species was considerable (Kephart 1987, p. 75). In cultivation prostrate milkweed bloomed for an extended period of time beginning in June and still flowered in September with mature fruit production at the same time. Towards the end of September, the flowers began to fade as fruit production increased (Eason 2019, pers. comm.).

Measures of fruit production in prostrate milkweed are unknown. Fruits (immature or mature) have been observed on plants a few weeks after rainfall (Strong 2019a, pers. comm.). For prostrate milkweed in cultivation at the San Antonio Botanical Garden, most specimens had "ample fruit production" in 2017 yet none the following year (Eason 2019 pers. comm.). Among swamp, whorled, and common milkweed, fruit-set per umbel and the timing of fruit maturation and seed dispersal varies among individual, population, species, and between years (Kephart 1987, p. 70 and 75); however, most members of the *Asclepias* genus are believed to have less than 5% fruit set (Wyatt and Broyles 1994, p. 428; Neyland *et al.* 1999, p. 4). Only 15.2% of hand pollinated rush milkweed flowers set fruit (Wyatt *et al.* 1996, p. 181). For Mead's milkweed, 5.5–25% of flowering stems produced mature fruit and the 25% was considered a very good year (Kettle *et al.* 2000, p. 70). All of the flowering plants in a coastal South Texas backyard population of Zizotes milkweed produced fruit in 2019 but fruit set per flower is unknown (Hardegree 2019, pers. comm.).

Figure 5. Prostrate milkweed with seed follicles. Photograph was taken December 22, 2015 in Starr County, Texas (courtesy Ken King).

Prostrate milkweeds produce fruits, or follicles, that split along one side to release many seeds, each with approximately 2 cm- (0.8 in-) long silky white hairs that parachute the seed away by wind (Damude and Poole 1990, p. 25; Richardson and King 2011, p. 76). The number of seeds produced by a single prostrate milkweed follicle is unknown; however, the common milkweed produces an average of 226 seeds in each follicle (Holdrege 2010, p. 11) and the Zizotes milkweed produces about 100 seeds per follicle (Hardegree 2019, pers. comm.). Seed production of milkweeds is often resource limited (La Rosa and Conner 2017, p. 151); resources for prostrate milkweed include rainfall, pollinators, and open, sparsely vegetated habitat (see Section 2.2).

The duration of seed viability of prostrate milkweed in a seedbank is unknown. Milkweed species with specialized habitat requirements may have low replacement rates, producing seeds for many years or even decades before environmental conditions allow the establishment of a new plant. In butterflyweed, low recruitment is not due to low seed production but rather to low seed survivability and low seed germination. Most butterflyweed seeds died within 12 months due to desiccation, with only 1.7% of seeds producing seedlings (Klemow and Raynal 1986, pp. 379 and 381). Milkweed seeds may not be prolific germinators (Holdrege 2010, p. 11). But those seeds that disperse into appropriate habitat may germinate, grow, and emerge as seedlings if rainfall is received during favorable seasons.

Prostrate milkweed seeds are 7-8 mm in size (Fishbein In prep.) and butterflyweed seeds are 5-7 mm (Woodson 1954, p. 74). A study of butterflyweed demography found low seed survival (only 1.7%) during drought years (Klemow and Raynal 1986, p. 381). Based on the similar sizes of seed of the two species, prostrate milkweed seed viability may be similar to that of butterflyweed. The seed coat of *Asclepias* species is very thin and easily abraded, especially after wetting. Most seeds germinate within 1-2 years, though a few could remain viable longer (Fishbein 2019d, pers. comm.).

During drought and winter, above-ground prostrate milkweed shoots die back, while the root remains dormant but alive underground. Although there has been no systematic work to determine the anatomy and development of underground storage structures in *Asclepias* species (Fishbein 2019b, pers. comm.), mature prostrate milkweeds appear to grow from a central, thickened root or taproot (Poole and Janssen 1997, p. 2; Hempel 2018, pers. comm.; Strong 2019a, pers. comm.; King 2019 pers. comm.). Cultivated plants developed tubers approximately 0.5 meters (1.5 feet) below ground (Figure 6; King 2020 pers. comm.) and a herbarium specimen collected from the wild also had tubers (Figure 7). The taproots and tubers store energy, allowing the plant to survive in a dormant state underground for an unknown period of time until the next rain event restores favorable conditions. Emergence above ground is dependent upon rainfall, and regrowth can occur about a week after a rain event (Strong 2019a pers. comm.). In 2019, an observer familiar with a known prostrate milkweed site noted that plants emerged within two weeks after rainfall from perennial taproots (Santore 2019a, unpaginated). However, the frequency of regrowth is variable, depending upon environmental conditions. Based upon known milkweed life history traits, prostrate milkweed experts believe that not all prostrate milkweed plants within a population will emerge at the same time (Hempel 2018, pers. comm.).

Best (2017) observed prostrate milkweed for over 16 years in tracts of the Lower Rio Grande National Wildlife Refuge, and concluded that individual dormant plants may only emerge a few times per decade, and only a fraction of plants within a population may emerge during each favorable season. Mead's milkweed often goes dormant for 1-5 years (Alexander *et al.* 2009, p. 267).

Figure 6. Tubers from propagated prostrate milkweed plants. The tubers were buried about 0.5 meters (1.5 feet) deep at the bottom of the pot. Other tubers (not shown) were larger (King 2020, pers. comm.; photo courtesy Ken King).

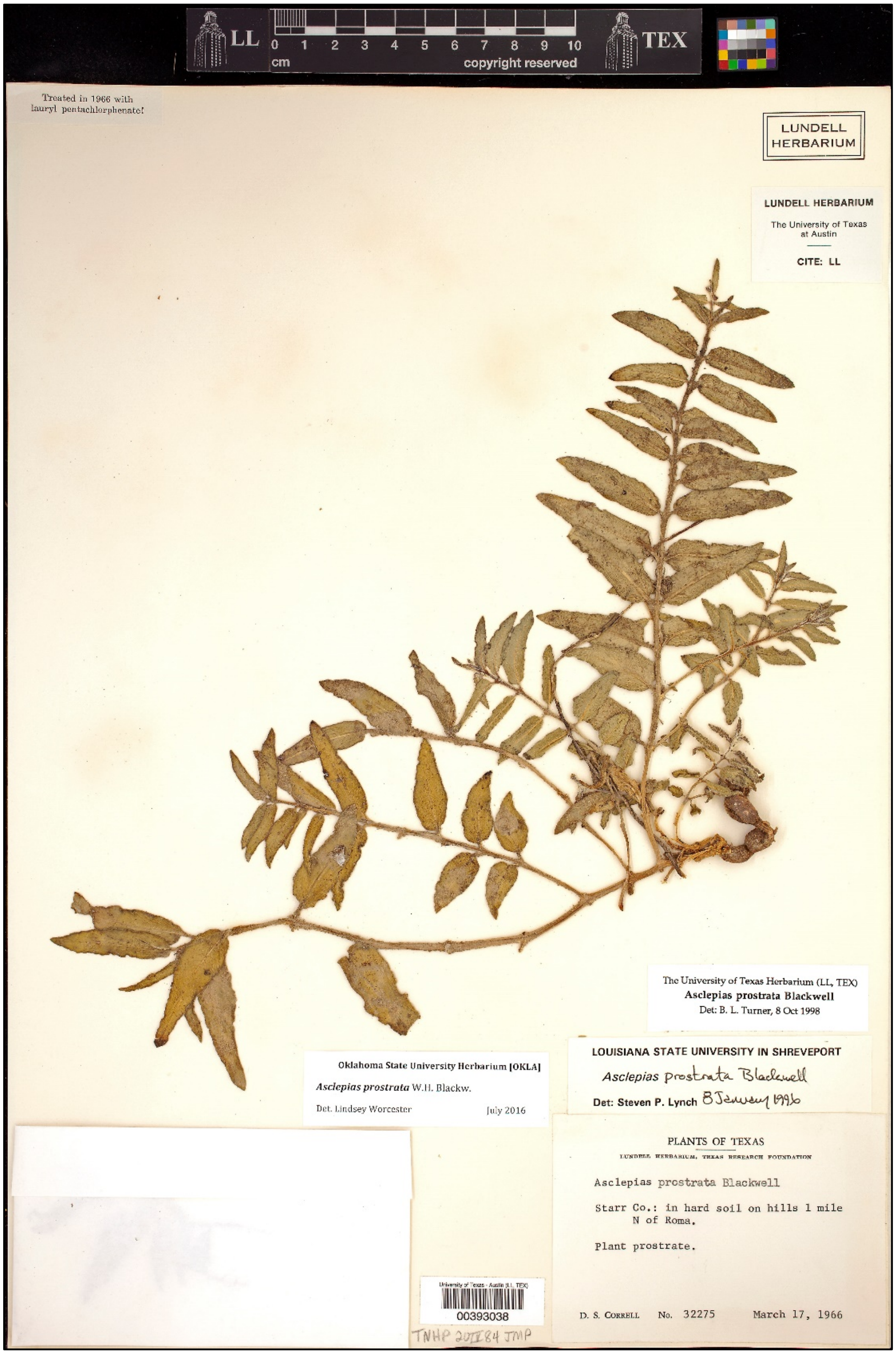


Figure 7. Herbarium specimen (LL00393038) of prostrate milkweed collected from Starr County, Texas, showing underground storage tubers (photo courtesy Billie L. Turner Plant Resources Center, University of Texas at Austin).

2.2. Resource (Habitat) Needs

Prostrate milkweed plants usually occur in open spaces with full sun, and with little to no competition from surrounding plants (Poole and Janssen 1997, p. 117). They require occasional rain and pollinators. Prostrate milkweed occurs in a warm, semiarid climate in sparsely vegetated sites, including disturbed sites, road rights-of-way, openings in shrub-invaded grasslands, open areas of Tamaulipan thornscrub, prairies/grasslands, and areas converted to pasture land on level or gently sloping sites on upland terraces and floodplains of the Rio Grande (Singhurst *et al.* 2015, p. 25; Carr 2004, p 30; Damude and Poole 1990, p. 13; Strong and Williamson 2015, p. 36). Elevations range from near sea level to 200 meters (656 feet) above sea level (Fishbein In prep., unpaginated; Martinez Avalos 2019, pers. comm.). Commonly associated native shrub and grass species include blackbrush (*Acacia rigidula*), honey mesquite (*Prosopis glandulosa*), lotebush (*Ziziphus obtusifolia*), cenizo (*Leucophyllum frutescens*), Texas pricklypear (*Opuntia engelmannii* var. *lindheimeri*), lovegrass (*Eragrostis* sp.), grama (*Bouteloua* sp.), and hooded windmillgrass (*Chloris cucullata*). Vegetation associated by site is listed in Table 3.

Figure 8. Prostrate milkweed habitat at the Arroyo Morteros Tract of the Lower Rio Grande Valley National Wildlife Refuge (photograph courtesy Chris Best, USFWS).

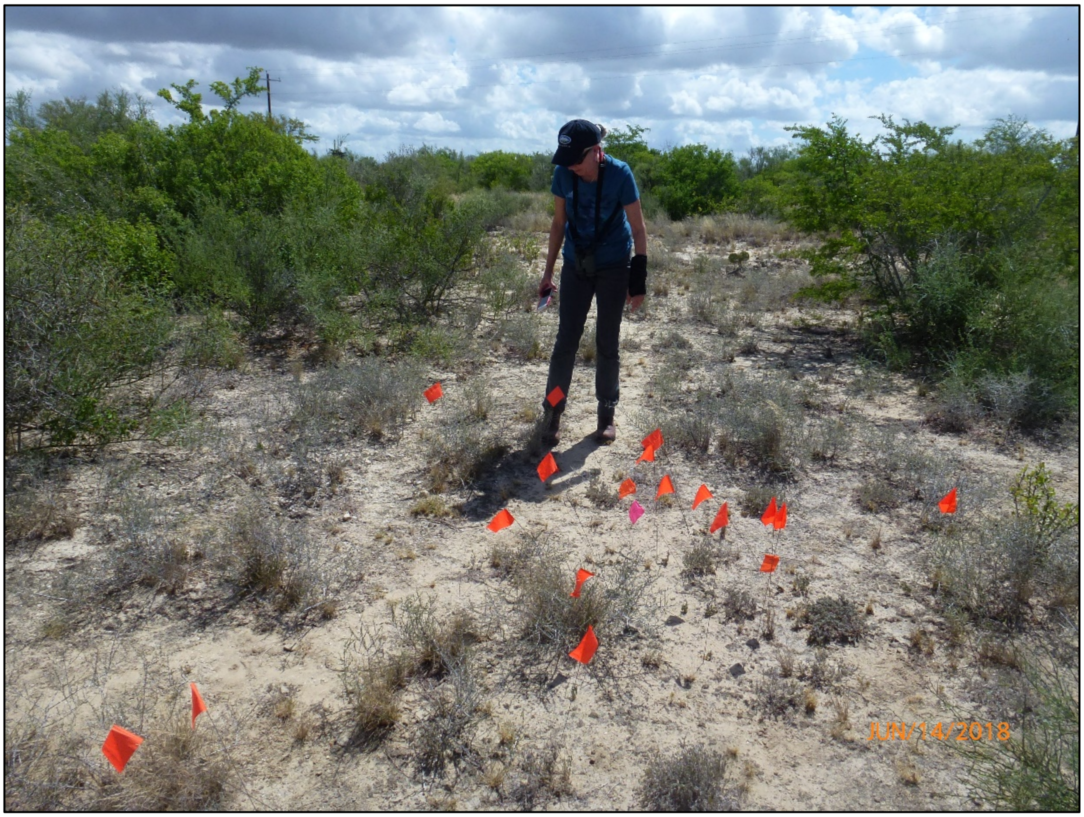


Figure 9. Prostrate milkweed habitat at the San Julian Road population in Starr County. Red flags indicate locations of individual prostrate milkweed plants (photograph courtesy Mary Kay Skoruppa, USFWS).

Soils where prostrate milkweed occur include loamy fine sands, silty soils, or shallow sandy loams (Carr 2004, p 30; Strong and Williamson 2015, p. 36) but also include caliche, gravel, silty, and calcareous, compacted soils (Fishbein In prep., unpaginated). In rights-of-way locations soils are gravelly sandy soils and sandy soils (Poole and Janssen 1997, p. 4). Specific soil series where prostrate milkweed is found include: Eocene sandstones and clays in Laredo, Yegua, and Jackson Group geological formations and in Zapata-Maverick, Hebbronville, and Copita soil series (Singhurst *et al.* 2015. p. 25; Damude and Poole 1990, p. 11-15).

In Texas, prostrate milkweed has been recorded in the understory of shrubs, such as emerging Texas ebony (*Pithecellobium ebano*) or mesquite (*Prosopis* spp.), but also in the dappled shade of a full-grown huisache (*Acacia farnesiana*) (Strong 2014, p. 4). Prostrate milkweed prefers sparsely vegetated areas (less than 30% cover) (Damude and Poole 1990 p. 16). In right-of-way locations, grass is the dominant vegetation but vegetation is sparse due to periodic mowing and sometimes vehicular traffic (Poole and Janssen 1997 p. 4). Associated species in highly disturbed roadside sites with compacted gypseus sand in thornscrub include *Parkinsonia texana* var. *texana* (palo verde), *Croton* sp. (croton), Texas pricklypear, *Acleisanthes* sp. (trumpets), *Cenchrus* sp. (grass), *Condalia* sp. (brasil), *Tiquilia* sp. (oreja de perro), *Yucca* sp. (Spanish dagger), and *Dalea* (dalea) (Fishbein 1995, unpaginated). In Mexico, prostrate milkweed was also found in an actively-cultivated cornfield where it was growing among the corn stalks. The field had been a sand prairie, recently cleared, and had never received herbicide or fertilizer (Best 2005a, unpaginated).

At Ejido Morales, in the Loreto sand plain of Tamaulipas, Mexico, prostrate milkweed occurred sporadically in shallow red sand around outcrops of indurated caliche, in association with native grasses and subshrubs, such as *Calliandra conferta* (false mesquite calliandra) and *Chamaecrista greggii* (sensitive pea) (Blackwell 1964, p. 178; Best 2005a, pp. 5, 7). Nearby, at Rancho Loreto, prostrate milkweed occurred in loose sandy soil shallowly overlying indurated caliche, in association with native grasses and subshrubs (Best 2005a, pp. 5, 7; Contreras-Arquieta 2005, p. 47). In Texas, prostrate milkweed has not been observed in naturally occurring caliche-associated soils except along roadsides where caliche is presumably brought in for use as a road surface material.

2.4. Ecology

Damude and Poole (1990, p. 15) categorized prostrate milkweed as an early seral stage species that may depend upon periodic or cyclic natural disturbances of climate, such as floods, fires, droughts, or temperature extremes. Periodic disturbance facilitates open areas that may be necessary for colonization. It is likely that prostrate milkweed is an arid grassland species that is fire adapted, and also that it is fire-following (specifically stimulated by fire). Fire-following plants are often stimulated by other (non-natural) disturbances. This could be why prostrate milkweed is often found in grazed pastures, in or near unpaved ranch roads, or along highway rights-of-way (Best 2019, pers. comm.) and could benefit from prescribed burning (Contreras Arquieta 2007, unpaginated). Currently, right-of-way maintenance or brush clearing may serve as a facilitator for colonization (Damude and Poole 1990, p. 15-16). However, such disturbance may not be beneficial if seeded to invasive grass because prostrate milkweed likes sparsely vegetated (less than 30%) areas (Damude and Poole 1990 p. 16). Regular and extreme land use practices like root-plowing, discing, and herbicide treatment are threats (Damude and Poole 1990, p. 35) and facilitate another threat, the spread of invasive grasses.

Cattle ranching occurs within the range of prostrate milkweed and many landowners in Texas have seeded their lands with non-native invasive grass, such as buffelgrass (*Pennisetum ciliare*; see Section 5.2) and King Ranch bluestem (*Bothriochloa ischaemum* var. *songarica*), for forage. However, milkweeds are highly unpalatable to cattle, so grazing is not likely a threat, but instead may help control non-native grass and facilitate open areas for colonization. Three populations of prostrate milkweed, Element Occurrence (EO) 14493 in Zapata County and Rancho Loreto North and Rancho Loreto South in Tamaulipas, are located in grazed ranchland habitat. Figure 10 shows heavily grazed prostrate milkweed habitat at EO14493. The prostrate milkweed was found growing in the open patches of mostly bare ground shown in the photograph.

Figure 10. Prostrate milkweed habitat in Zapata County on a private ranch used for cattle production (photograph courtesy Eric Garza).

Prior to the turn of the 20th Century, South Texas led the state in sheep production with Webb and Starr counties being among the top three sheep producing counties in the state (Lehman 1969, p. 31); therefore it is likely that shrub savannas were abundant in the prostrate milkweed's Texas range prior to the era of overgrazing that occurred during the 20th Century. The woody vegetation is described as being "low and open, permitting the development of broad, grassy areas among the shrubbery" during the mid-19th Century (Johnston 1963, p. 458). Because shrub savannas depend upon periodic fires, prostrate milkweed is likely fire-adapted and/or fire-following.

Prostrate milkweed is also very drought tolerant, surviving below ground as an energy-storing taproot and tuber while other competing plants die back at the surface. Occasional drought can minimize some types of ground cover thereby reducing competition from other, less drought-tolerant, species. Even during periods of severe drought, prostrate milkweed disappeared from the soil's surface but returned the following year (Damude and Poole 1990, p. 35; Poole and Janssen 1997, unpaginated but see Table 2 of report; Strong and Williamson 2015, p. 45). However, prostrate milkweed needs water for re-emergence, flowering, fruiting, and seed germination. It is likely that multiple, consecutive years of drought will reduce the survivability of prostrate milkweed taproots, leading to eventual mortality.

2.5. Summary of Individual Needs

Individual resource needs for prostrate milkweed to survive and reproduce include full sun, little to no competition from surrounding plants, sandy or calcareous soils, occasional rain, and pollinators.

Chapter 3 – Range and Distribution

3.1. Population Definition

Populations are groups of interbreeding organisms of a particular taxon and are delineated by barriers to gene flow between individuals. For terrestrial plants, the barriers to gene flow are distances greater than the ranges of pollination and seed dispersal, as well as reproductive isolation due to differing phenologies and pollinators, or to genetic incompatibilities. For the purposes of this report, we define a population of prostrate milkweed as an assemblage of individual plants that are within 1 km (0.6 miles) of each another. This is based on NatureServe Habitat-based Plant Element Occurrence Delimitation Guidance (2004) and the average distance that potential pollinators for this species move (Schulke and Waser 2001, p. 244). Based on this delineation, we analyzed 24 known populations in this SSA (see Table 3), all of which are extant based upon observations of plants within the last 40 years (Hammerson *et al.* 2008, unpaginated; Strong 2020a pers. comm.) and not in habitats completely lost to permanent alteration (i.e., converted into a parking lot). Although gene flow is assumed to occur within populations via pollinators and seed dispersal, no population genetic analyses have been conducted on prostrate milkweed, so the population assignments used in this report are based solely upon proximity.

3.2 Range

Historical

In the United States, prostrate milkweed has been recorded from 16 populations in Starr and Zapata counties (Table 3). In Mexico, there are at least 8 known populations for this species occurring in isolated pockets widely scattered in northern Tamaulipas and eastern Nuevo León, many over 100 miles from the Rio Grande and 220 miles southeast of the northernmost population in Zapata County (Figures 11 and 12; Strong and Williamson 2015, p. 35). It is possible that prostrate milkweed was historically more abundant in Texas and Mexico and may once have had a larger range. Specifically, it is likely that there were populations of prostrate milkweed between their current known occurrences in Texas and Mexico; however, by 1990, the species was considered rare in Tamaulipas, Mexico (Barrera 1990, p.4).

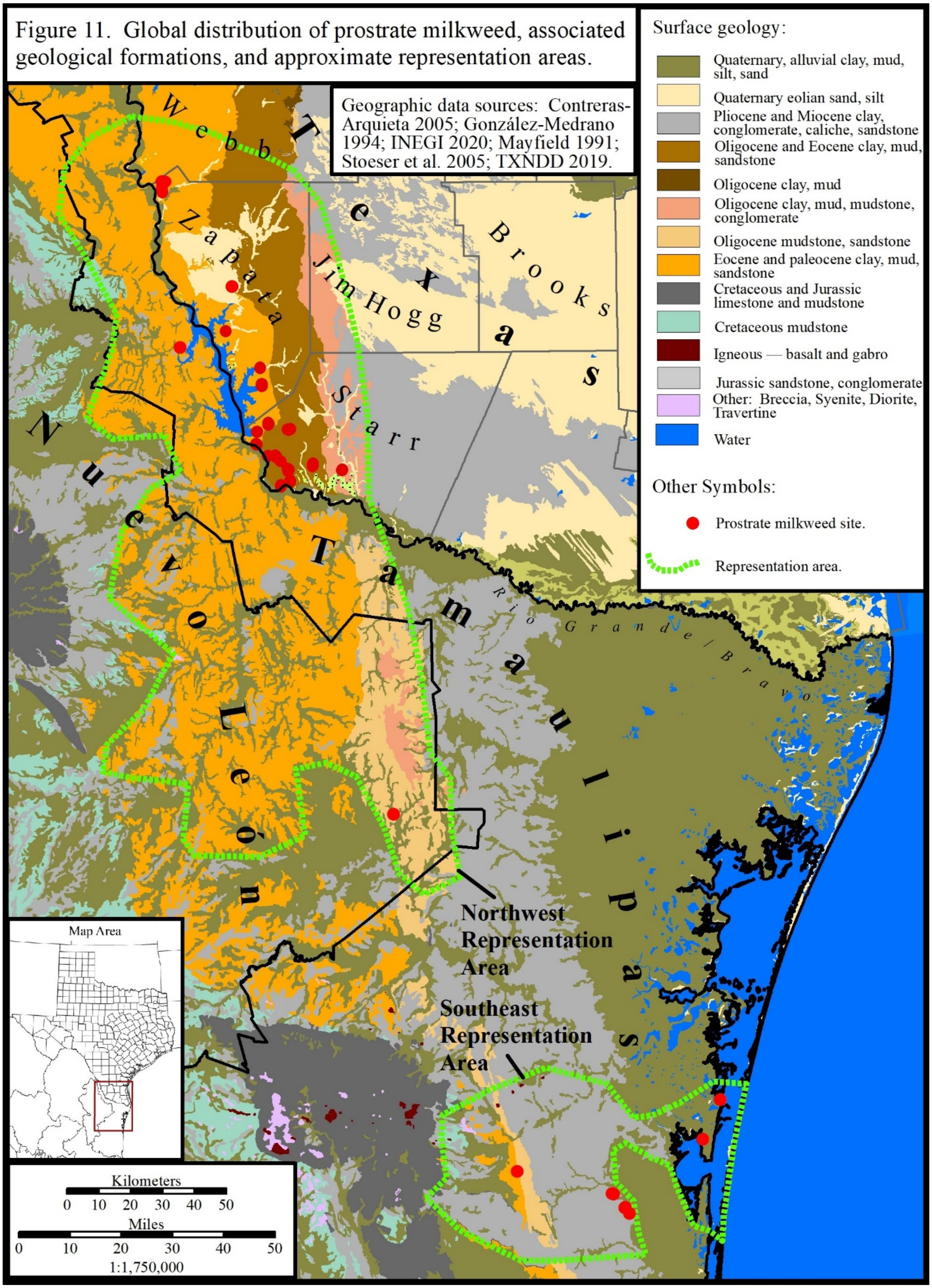


Figure 11. Global distribution of prostrate milkweed, associated geological formations, and approximate representation areas.

Figure 12. Prostrate milkweed populations in the southeast representation area (central Tamaulipas, Mexico).

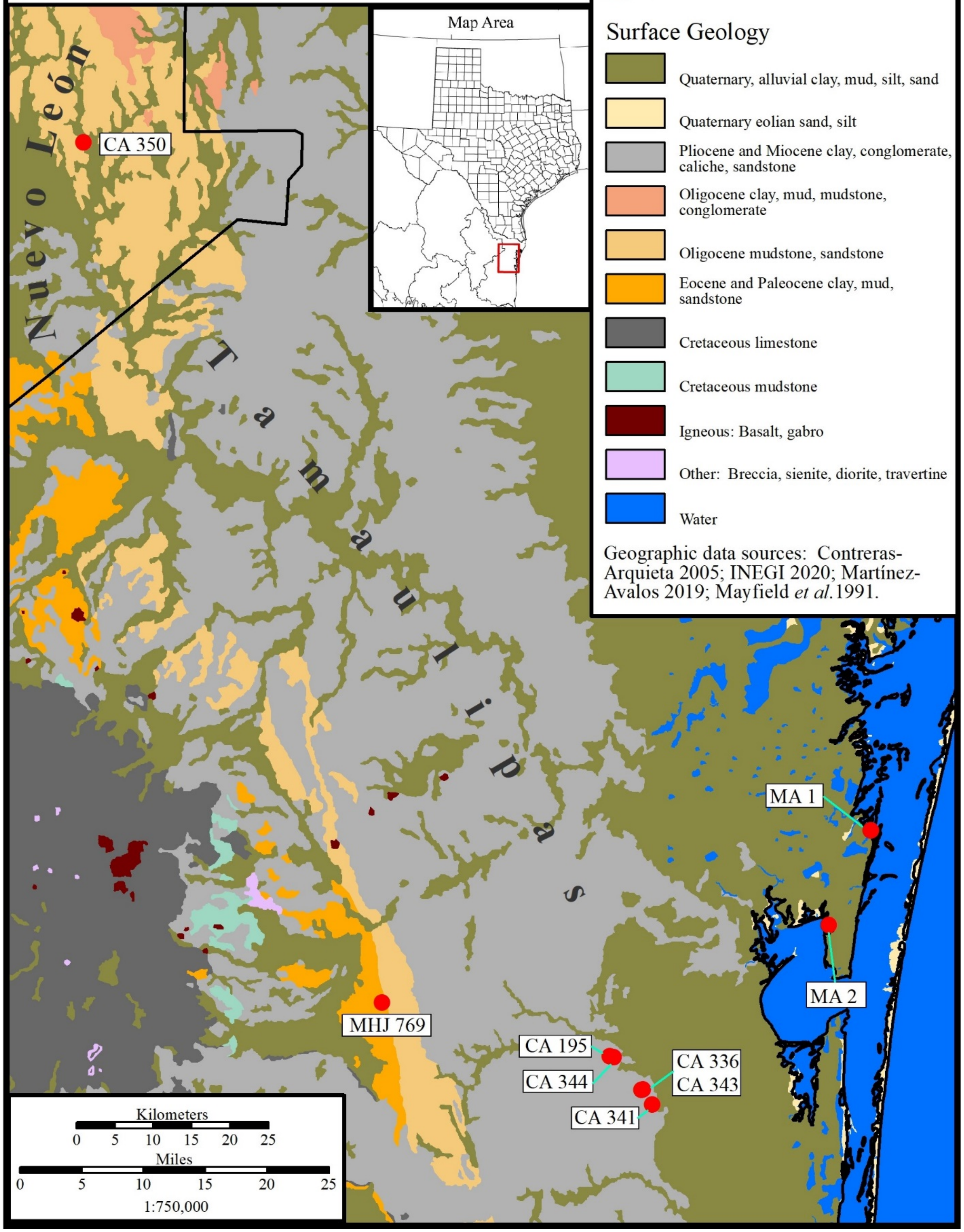


Table 3. Populations and site descriptions of prostrate milkweed. Note: In this table and all succeeding tables, populations are listed from north to south to aid readers in cross-referencing population locations on maps (Figures 11-13).

Population Name	Site Name and/or Location	EO No. (EO ID)[1] or Map ID	Ownership	Surface Geology	Soils	Vegetation
			Texas			
Dolores	Dolores Subdivision – Laredo, Zapata County	3 (3395)	Highway ROW[2] and private	Eocene, Laredo Formation sandstone	Deep eolian soils; Hebbronville series; Copita sandy loam, Brennan fine sandy loam.	Bladed roadside and open shrublands; open soil areas in mesquite-nopal grassland; *Acacia farnesiana*, *Pennisetum ciliare*, *Agave americana*, *Prosopis glandulosa*, *Opuntia engelmannii*, *Bernardia myricifolia*, *Castela erecta*, *Caesalpinia caudata*, *Salvia ballotaeflora*, *Palafoxia* sp., *Eragrostis lehmanniana*, *Celtis pallida*, and *Thymophylla tephroleuca* present.
14493	6 mi NE of Zapata, Zapata Co.	22 (14493)	Private	Quaternary	Eolian sand.	Open canopy near road; *Pennisetum ciliare*, native shrubs.
14491	U.S. 83 5.0 mi S of Zapata, Zapata Co.	20 (14491)	Highway ROW and private	Eocene	Sandy loam.	*Acacia wrightii* and *Ziziphus obtusifolia* shrubland; *Pennisetum ciliare*.
Arroyo del Tigre Grande	Arroyo del Tigre Grande, Zapata County	7 (3803)	Highway ROW	Eocene, Yegua Formation	Sandy, gravelly.	About 25% vegetative cover; *Dalea* sp., *Psilostrophe* sp., *Palafoxia* sp., *Opuntia* sp., *Caesalpinia* sp., *Ziziphus* sp., *Chamaesyce* sp., *Asclepias* sp.
Arroyo del Tigre Chiquito	Arroyo del Tigre Chiquito, Zapata County	6 (7771)	Highway ROW	Eocene	Sandy loam over rock outcrop.	Mowed ROW; bladed area along ditch slope; *Pennisetum ciliare*, *Physaria thamnophila* present.
FM 2098	U.S. 83 near FM 2098, Starr County	14 (12643)	Highway ROW	Eocene	Sandy caliche.	*Pennisetum ciliare*, *Cynodon dactylon*, *Cenhrus spinifex*, *Chloris* sp., *Prosopis glandulosa*, *Karwinskia humboldtiana*, *Helianthus annuus*.

Population Name	Site Name and/or Location	EO No. (EO ID)[1] or Map ID	Ownership	Surface Geology	Soils	Vegetation
Falcon	FM 2098 and Park Road 46, Starr County	5 (1572)	Highway ROW and county park	Eocene, Yegua Formation	Copita fine sandy loam; moderately deep, well drained, calcareous, moderately alkaline Ustochreptic Camborthids; compacted gypseous sand.	Mowed ROW; recently cleared desert shrubland.
Los Alvaros	Los Alvaros Rd, Starr County	17 (14484)	Road ROW	Oligocene and Eocene	Sandy, rocky; Copita fine sandy loam.	Tamaulipan thornscrub with open areas, *Pennisetum ciliare*, *Prosopis glandulosa*, *Thymophylla* sp., *Ziziphus obtusifolia*, *Guaiacum angustifolium*, *Isocoma coronopifolia*, *Parthenium* sp., *Acacia* sp., *Yucca treculeana*.
Arroyo Morteros Tract	Arroyo Morteros tract, LRGV NWR[3], Starr County	15 (12847)	USFWS	Eocene sandstone	Gypseous yellow sandy Copita fine sandy loam overlying calcareous sandstone and gypseous yellow Catarina Clay.	Open grassy areas; *Aristida purpurea*, *Bouteloua trifida*, *Tridens muticus*, *Setaria ramiseta*, *Pappophorum bicolor*, *Krameria ramosissima*, *Pennisetum ciliare*, *Physaria thamnophila*, *Matelia brevicoronata*, *Physaria lasiocarpa*, and *Cardiospermum dissectum*.
Los Arrieros Loop	Los Arrieros Loop Road, Starr County	12 (8798)	Road ROW and private	Oligocene and Eocene, Jackson Formation	Eroded Maverick soils.	Scattered, low Tamaulipan shrubs

Population Name	Site Name and/or Location	EO No. (EO ID)[1] or Map ID	Ownership	Surface Geology	Soils	Vegetation
Arroyo de los Mudos	U.S. 83 3 mi S of FM 2098, Starr County	13 (12636)	Highway ROW	Oligocene and Eocene	Loose sand, loamy clay.	Disturbed roadside; *Pennisetum ciliare*, *Ziziphus obtusifolia*, *Tiquilia canescens*, *Cevallia sinuata*, *Thymophylla* sp., *Prosopis glandulosa*, *Leucophyllum frutescens*, *Melampodium* sp., *Helianthius annuus*, *Acleisanthes longiflora*, *Acacia* sp., *Oenothera patriciae*, *Croton lindheimeri*, *Heterotheca subaxillaris*, *Waltheria indica*, *Convolvulus equitans*, *Matelea brevicoronata*, *Sorghum bicolor*.
Mission Mier a Visita	U.S. 83 and Loma Blanca Rd. (Mission Mier a Visita Historical Marker), Starr County	2 (6223)	Highway ROW and private	Oligocene and Eocene, Jackson Formation	Dry gravelly soil; sandy Zapata soil.	Mowed ROW; *Leucophyllum frutescens* shrubland; *Pennisetum ciliare*, *Helianthus annuus*, *Acleisanthes longiflora*.
San Julián Road	San Julián Rd, Starr County	16 (12876)	Road ROW and private	Oligocene and Eocene	Tight Copita soils; sandy, gravelly.	Minimal shrub cover; *Krameria ramosissima*, *Aristida* sp., *Cercidium texana*, *Forestiera angustifolia*, *Karwinskia humboldtiana*, *Heliotropium confertifolium*, *Ziziphus obtusifolia*, *Eragrostis curtipedicellata*, *Parthenium confertum*, *Thymophylla pentachaeta*, *Physaria thamnophila*, *Bouteloua trifida*, *Chloris cucullata*, *Tiquilia canescens*, *Acleisanthes longiflora*; *Pennisetum ciliare* present, not dominant.

Population Name	Site Name and/or Location	EO No. (EO ID)[1] or Map ID	Ownership	Surface Geology	Soils	Vegetation
FM 3167	Private, Starr County	11 (8325)	Road ROW and private	Oligocene, Catahoula and Frio formations.	Copita fine sandy loam.	Disturbed soils in mixed-stature shrubland, *Acacia rigidula*, *Ebenopsis ebano*, *Prosopis glandulosa*.
Arroyo Roma	U.S. 83 and FM 650, Starr County	1 (6491)	Highway ROW and private	Oligocene and Eocene, Jackson Formation	Sandy loam	Mowed ROW; *Pennisetum ciliare* and *Salsola tragus* present.
Arroyo Ramirez Tract	Arroyo Ramírez tract, LRGV NWR[3], Starr County	10 (5533)	USFWS	Oligocene and Eocene	Sandy, gravelly; Copita fine sandy loam in upland.	Low, open shrubland; in dirt road wheel ruts.
			Mexico			
Rancho La Coma	Rancho La Coma, Nuevo León	CA 350	Private	Oligocene	Sandstone	Unknown
Road to Guerrero Viejo	Road to Guerrero Viejo, Tamaulipas	GM 1	Road ROW	Eocene	Loose red sand overlying sandstone	Open, low shrubland.
Carboneras	3.8 km N of Carboneras, Tamaulipas	MA 1	Unknown	Holocene	Eolian Sand	Unknown
Punta de Alambre	3 km W of Punta de Alambre, Tamaulipas	MA 2	Unknown	Holocene	Eolian Sand	Unknown
Intersection of 101-180	México Carretera 101 0.5 km N of México Carretera 180, Tamaulipas	MHJ 769	Road ROW	Eocene and Oligocene	Calichified conglomerate	Low stiff shrubland.
Rio El Catán	Río El Catán Tamaulipas	CA 195	Ejido[4]	Pliocene	Sand shallowly overlying caliche	Grassland/shrubland mosaic.
	10.5 km de la comunidad America del Norte, Tamaulipas	CA 344	Ejido	Pliocene	Sand shallowly overlying caliche	Grassland/shrubland mosaic.

Population Name	Site Name and/or Location	EO No. (EO ID)[1] or Map ID	Ownership	Surface Geology	Soils	Vegetation
Rancho Loreto North	Rancho Loreto, Tamaulipas	CA 336	Private	Pliocene	Sand shallowly overlying caliche	Grassland/shrubland mosaic.
	Rancho Loreto, Tamaulipas	CA 343	Private	Pliocene	Sand shallowly overlying caliche	Grassland/shrubland mosaic.
Rancho Loreto South	Rancho Loreto, Tamaulipas	CA 341	Private	Pliocene	Sand shallowly overlying caliche	Grassland/shrubland mosaic.

[1]For Texas sites, the EO No. refers to the Texas Natural Diversity Database Element Occurrence number and the EO ID refers to the Texas Natural Diversity Database Element Occurrence identification number. For Mexico sites, Map ID is the observers' initials and the site identification number. See Table 6 for observer sources.
[2]Right-of way
[3]Lower Rio Grande Valley National Wildlife Refuge
[4]An ejido is an area of communal land in Mexico used for agriculture.

Current

As of 2020, in Texas, prostrate milkweed is restricted to 16 assumed extant populations in Starr and Zapata counties with all known populations of prostrate milkweed within 9 miles of the Mexican border (Figure 13). It is likely that prostrate milkweed occurs in other locations on private lands in Starr and Zapata counties that have simply not been surveyed or reported (Strong and Williamson 2015, p. 44). For example, two additional populations in Starr County were reported to us; however, the locations were not provided to us so these populations are not included in the SSA analysis.

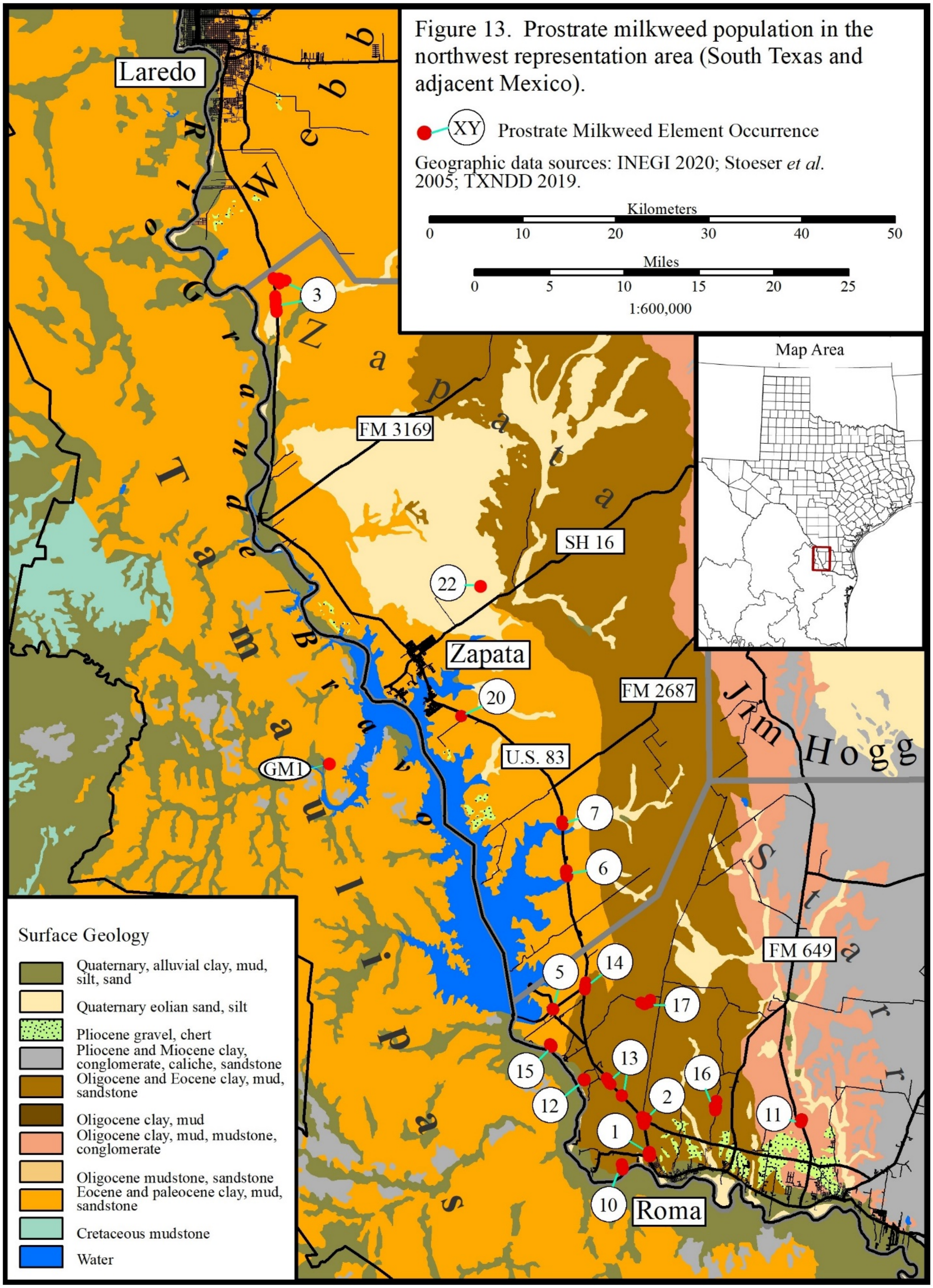


Figure 13. Prostrate milkweed population in the northwest representation area (South Texas and adjacent Mexico).

Chapter 4 – Summary of Individual, Population and Species Requirements

This summary is based on the supporting information described in Chapters 2 and 3.

4.1. Summary of individual requirements

Prostrate milkweed plants establish and persist in sparsely vegetated uplands with loose sands, sandy loams, or fine gravelly soils. Moisture drains quickly from these xeric soils, so seeds probably germinate and establish during rare periods of extended rainfall; this occurs most often during summer and fall, when tropical storms develop in the Gulf of Mexico. Seed germination may be stimulated by wildfire or by a reduction of competition from grasses and forbs following mowing, grazing, or extended drought. Individuals need full sun exposure in sparsely vegetated sites with less than 30% vegetative cover. Like other *Asclepias* species, seedlings quickly develop thickened taproots that allow individuals to endure extended droughts in a state of dormancy. This species has not been found in areas of higher rainfall, or in soils with higher clay content that retain moisture longer, where it would not survive competition from more robust grasses and forbs. Hence, prostrate milkweed is a habitat specialist that escapes competition by growing in sites that are too dry for many plants.

Flowering and fruiting can occur sporadically from February through December, but occurs primarily from April through October. The species does not appear to have a strict phenology, but reproduces in response to rainfall throughout the warm seasons. We assume that prostrate milkweed is an obligate outcrosser, like most other *Asclepias* species, so fertilization and seed production require the clustering of genetically diverse individuals within the forage range of its pollinators. The unique, highly specialized floral structures of milkweeds are most effectively pollinated by large bees and wasps; for example, the closely related Zizotes milkweed is effectively pollinated by tarantula hawks (*Pepsis* and *Hemipepsis* species), which are among the largest wasps in North America (see Figure 14). The pollination range of bees is proportional to body size (Greenleaf *et al.* 2007, all), and we assume that large wasps also have correspondingly large forage ranges. The ample nectar reward that many milkweed flowers provide to potential pollinators would justify foraging over a relatively extensive range. In synthesis, the high nectar reward and potentially large forage range of its pollinators may allow prostrate milkweed to reproduce and survive even at very low densities. Persistence at low density might also hinder the dissemination of pathogens, parasites, and insect herbivores.

Figure 14. A tarantula hawk wasp on a Zizotes milkweed with pollinia attached to both fore limbs. This wasp was one of many observed nectaring on Zizotes milkweed in Wilson County, Texas. These observations indicate that tarantula hawks are likely effective milkweed pollinators (Best 2020, pers. comm.; photograph courtesy Chris Best, USFWS).

4.2 Summary of population requirements

Populations that are genetically diverse are more likely to adapt and survive when threatened by new pathogens, competitors, and changing environmental conditions. Prostrate milkweed is likely to have a predominantly outcrossing breeding system. Fertilization and seed production declines when mating of outcrossing plants is restricted to close relatives. Populations that are separated beyond the pollinator forage range, which we estimate to be 1 km (.6 mi), are likely to be reproductively isolated. Inbreeding usually increases among small, reproductively isolated populations, and can lead to genetic drift and the loss of genetic diversity. Prostrate milkweed may also be affected by inbreeding depression (see discussion in section 5.8, genetic consequences of small population sizes). In synthesis, a lack of gene flow and loss of genetic diversity among small, isolated populations may engender a downward spiral toward extirpation.

Populations of prostrate milkweed must be large enough to have a high probability of enduring random demographic and environmental variation. 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. This metric of population resilience, called minimum viable population (MVP), refers to the smallest population size that has a high probability of surviving over a specified period of time.

Determinations of MVP usually take into account the effective population size, rather than total number of individuals; 10 genetically identical individuals (for example, clones) would have an effective population size of 1. Since prostrate milkweed is probably self-incompatible and does not appear to form clonal colonies, the effective population size is likely to be nearly the same as the total population size. However, future genetic analyses might prove otherwise.

Unfortunately, the calculations of MVP require data that are not currently available for prostrate milkweed. As a practical alternative, the likely MVP range of prostrate milkweed can be estimated by comparison to species with similar life history traits for which MVPs have been calculated, using the following guidelines (Table 4) adapted from Pavlik (1996, p. 137).

Table 4. Minimum viable population guidelines applied to prostrate milkweed (adapted from Pavlik 1996, p. 137). Factors applicable to prostrate milkweed are in bold text.

Factor	MVP of 50 individuals for species with these traits.	Intermediate MVP of 1,000 individuals for species with intermediate or unknown traits.	MVP of 2,500 individuals for species with these traits.
Longevity	**Perennial**		Annual
Breeding System	Selfing		**Outcrossing**
Growth Form	Woody		**Herbaceous**
Fecundity	High		**Low**
Ramet Production	Common		**Rare or None**
Survivorship	**High**		Low
Seed Duration	Long	**Unknown**	Short
Environmental Variation	Low		**High**
Successional Status	Climax	**Intermediate**	Ruderal

Some life history traits for prostrate milkweed are unknown; however, we make assumptions based upon best available information for *Asclepias* species. We assume that, like most other *Asclepias* species, prostrate milkweed is an obligate outcrosser with low fecundity. We assume high survivorship based upon the presence of perennial taproots and tubers, and high environmental variation based upon climatic extremes in South Texas. Five factors in Table 4 (outcrossing, herbaceous growth form, low fecundity, rare or no ramet production, and high environmental variation) indicate a requirement for more individuals (2,500) to maintain a viable population. Two factors are intermediate or unknown (seed duration and intermediate successional status). Two factors (perennial lifespan and high survivorship) require fewer (50) individuals. This suggests an estimated MVP for prostrate milkweed of about 1,600 individuals, calculated as follows:

$$\frac{(2 \times 50) + (2 \times 1{,}000) + (5 \times 2{,}500)}{9} = 1{,}622$$

Only mature individuals contribute to the MVP estimate because for most plant species, the majority of seedlings die before they are able to reproduce and therefore do not contribute to the effective population size.

Based on the information above, a highly resilient population of prostrate milkweed has 1,600 or more adult individuals. From this, we estimate that moderately resilient populations have from 800 to 1,600 mature individuals, and populations with low resilience have less than 800 mature individuals.

Population persistence, meaning a stable or increasing demographic trend, requires recruitment rates that equal or exceed mortality rates. All stages of recruitment, from flowering and seed production to germination and establishment, occur when the soil has available moisture. The porous soils of prostrate milkweed habitat dry quickly after a single heavy thunderstorm. Based on observations of other perennial forbs in this ecosystem, recruitment probably occurs during periods of extended rainfall, meaning multiple rain events over a period of several weeks. These are rare events in this semiarid region. Consequently, we expect that successful recruitment may occur only once or a few times per decade. Similarly, most mortality probably occurs during years of extended drought. Hence, both recruitment and mortality would have strong pulses and observed population sizes would vary widely from year to year, leading to potentially spurious interpretations of demographic trends. Therefore, assessments of population sizes should be based on the average or maximum numbers observed over at least 5 consecutive years. Demographic trends should be determined by comparing population sizes over multiple 5-year spans.

Populations of prostrate milkweed require habitats that also support healthy populations of large native bees and wasps, if these prove to be effective pollinators of prostrate milkweed. Native bees in turn require a diversity and abundance of native forb and shrub species that provide pollen and nectar. Tarantula hawks may also be important pollinators of prostrate milkweed; tarantula hawks require healthy populations of their prey species, tarantulas.

Prostrate milkweed populations persist where competition from grasses and forbs is periodically reduced. This response, which has been observed in other milkweed species, may be an adaptation to wildfire (Baum and Sharber 2012, p. 968-971). Although mowing or livestock grazing can reduce competition, it is likely that prostrate milkweed is adapted to grasslands that were sustained by periodic wildfires.

4.3. Summary of species requirements

We assessed the viability of prostrate milkweed in terms of its resilience, redundancy, and representation (Shaffer and Stein 2000, pp. 307-310).

Resilience, discussed in section 4.2, refers to population sizes; larger populations are more likely to endure than small ones. We provisionally estimate that viable prostrate milkweed populations have at least 1,600 mature individuals. Highly resilient populations also have good quality habitat. Good prostrate milkweed habitat includes full sun exposure, sparsely vegetated with less than 30 percent cover, and open space with little to no competition from surrounding plants to survive, expand, and colonize.

Redundancy indicates the number of populations and their distribution over the species' range. Species that have more populations distributed over a broader geographic range have a greater chance of surviving catastrophic events.

Representation refers to the breadth of genetic diversity and environmental adaptation necessary to conserve long-term adaptive capability. Viable species typically possess both intra- and inter-population genetic diversity; inter-population differentiation reflects adaptation to a range of ecological factors, and increases the likelihood that at least some portion of a species will be able to adapt to changing climates and other future threats.

The known populations of prostrate milkweed are geographically clustered in two representation areas: Deep South Texas and adjacent northern Tamaulipas and Nuevo León, México; and the Loreto Sand Plain and adjacent coast of east-central Tamaulipas. The Rancho La Coma (CA 350) population, which is located in central Nuevo Leon and isolated from the nearest other populations by about 112 km (70 miles), was included in the northwest representation area (but not shown in Figure 13) because it is geologically most similar to that area. Representation areas are sectors of a species' geographic range where important constituents of its genetic and ecological diversity occur. The species' overall viability requires the conservation of populations and genetic diversity in both of these representation areas. These representation areas may be revised if new populations are discovered outside the areas, or if new genetic evidence indicates more logical groupings.

Chapter 5 - Factors affecting the species

The following list describes factors that either positively or negatively affect the continued survival of prostrate milkweed.

5.1 Nonnative Invasive Grass

Introduced invasive grass species displace native plants by competing for water, nutrients, and light, and their dense root systems prevent germination of native plant seeds (Texas Invasives 2019, unpaginated). Buffelgrass is a perennial bunchgrass introduced from Africa that is now one of the most abundant nonnative grasses in South Texas, and the most prevalent invasive grass within the range of prostrate milkweed. During the 1950's, federal and state land management agencies promoted buffelgrass as a forage grass in South Texas (Smith 2010, p. 113). Buffelgrass is very well adapted to the hot, semi-arid climate of South Texas due to its drought resistance and ability to aggressively establish in heavily grazed landscapes (Smith 2010, p. 113). Despite increasing awareness of the ecological damage caused by nonnative grasses, buffelgrass is still planted in areas affected by drought and overgrazing to stabilize soils and to increase rangeland productivity. Prescribed burning used for brush control typically promotes buffelgrass forage production in South Texas (Hamilton and Scifres 1982, p. 11). Buffelgrass often creates homogeneous monocultures by out-competing native plants for essential resources (Lyons *et al.* 2013, p. 8). Furthermore, buffelgrass produces phytotoxins in the soil that inhibit the growth of neighboring native plants (Vo 2013, unpaginated).

The majority of prostrate milkweed plants have been observed in disturbed soils where buffelgrass is absent or at low densities (Eason 2019, pers. comm.; Strong 2019b, pers. comm.). Private lands in South Texas are increasingly bisected with a proliferation of oil and gas wells, wind farms, service roads, and pipeline and powerline rights-of-way (ROWs). The mostly unpaved ROWs could benefit prostrate milkweed through the periodic soil disturbance and mowing of road margins. Unfortunately, disturbed soils can rapidly be colonized by buffelgrass. On National Wildlife Refuge lands, prostrate milkweed was found in areas where native grass was still dominant, but not where buffelgrass or woody vegetation was present in dense stands (Best 2005b, p. 3). In 1999, prostrate milkweed was observed beneath a thick cover of buffelgrass (Clary 2014, pers. comm.); however, this population has not persisted. The Texas Natural Diversity Database (TXNDD) lists invasive species, primarily buffelgrass, as a pervasive threat of extreme severity to prostrate milkweed. The TXNDD defines a pervasive threat as one that affects all or most (71-100%) of a species' populations, occurrences, or extent. An extreme level of severity is one that is likely to destroy or eliminate occurrences or habitat, or reduce population sizes by 71-100% (TXNDD 2016). Abundance data and observer comments (TXNDD 2019-2020, entire; Eason 2019, pers. comm.; Kieschnick 2019, pers. comm.; Santore 2019a, unpaginated) indicate that it is likely that buffelgrass has negatively impacted all of the Texas populations. Consequently, competition from buffelgrass is the greatest threat to prostrate milkweed. Since nonnative grasses are a primary stressor for all prostrate milkweed populations, we include this in our analysis of population resiliency.

5.2 Root-plowing and conversion of native Tamaulipan shrubland to buffelgrass pasture

Root-plowing is a brush control method that uses powerful tracked vehicles to excavate the roots of woody plants with heavy steel subsoil rippers that dig several feet into the ground. As practiced in South Texas and northeast Mexico, the dead trees and shrubs are typically burned, and the root-plowed soils are planted with buffelgrass for livestock grazing. Root-plowing and conversion to buffelgrass pasture has been conducted very widely in South Texas and northeast Mexico, including much of the potential habitat of prostrate milkweed. In aerial photographs of Starr and Zapata counties and adjacent Mexico, extensive areas of root-plowed lands are clearly identified by the linear striations left by heavy equipment, and by the uniform appearance of the buffelgrass dominated vegetation. These practices have been promoted and subsidized by the USDA Natural Resources Conservation Service and its precursor, the USDA Soil Conservation Service, for many years.

Evaluating the effect of root-plowing and buffelgrass conversion on prostrate milkweed is complex. Reducing shrub density reverses the encroachment of woody plants into the grassland component of former savannas, which by itself might benefit prostrate milkweed and other herbaceous plants. Because prostrate milkweed can survive underground as tubers, it is often seen as new growth in areas where soils have been disturbed. Conversely, the establishment of dense buffelgrass is detrimental to this species, but this may be partially alleviated if the pastures are intensively grazed. We have no direct evidence of the ability of prostrate milkweed to persist in lands that have been root-plowed, converted to buffelgrass, and grazed. Nevertheless, the conversion of native habitats to pastures dominated by buffelgrass or other exotic grasses greatly reduces the abundance and diversity of most native grass and forb species (Woodin et al. 2010, p. 1), including prostrate milkweed. Consequently, we conclude that the net effect on prostrate milkweed is likely to be detrimental.

Alternative methods of brush control and rangeland improvement may be very beneficial to the survival of prostrate milkweed. Woody plants can be cut at ground level using roller-choppers or similar implements that do not excavate the soil. Subsequently, woody plants are periodically suppressed through prescribed burning. Additionally, since about 2005, South Texas ecotypes of useful native grasses and forbs have become commercially available through the efforts of the NRCS Plant Materials Center (Kingsville) and the South Texas Natives program at TAMU-Kingsville. Restoring native grasslands is more expensive and difficult than conversion to buffelgrass, but is far more beneficial for wildlife conservation. Considering that many South Texas landowners could potentially earn more money from hunting leases than from cattle ranching, native grassland restoration may prove to be more economically viable than buffelgrass, and would restore excellent habitat conditions for prostrate milkweed conservation.

5.3 Livestock grazing

Livestock grazing is the primary economic use of privately owned land throughout the range of prostrate milkweed in Texas and northeast Mexico. Although many of the prostrate milkweed populations in Texas are along road and highway ROWs that are not grazed, this is largely because plant surveyors can readily access publicly owned roadways, not because prostrate milkweed is absent from grazed areas. Prostrate milkweed does appear to benefit from periodic disturbances, such as mowing and blading of roadsides. Nevertheless, we conclude that the vast majority of the species' potential habitats are on private lands that are used for livestock grazing. We base our evaluation of the potential effect of grazing on prostrate milkweed on the species' palatability to cattle and on the effect of grazing on competition from buffelgrass and other grasses and forbs. When injured or browsed, almost all *Asclepias* species produce an extremely bitter, milky latex that contains toxic levels of cardiac glycosides. Milkweeds are unpalatable to cattle, and often increase in abundance where there is grazing. Livestock, including cattle, sheep, and horses, graze preferentially on grasses, including buffelgrass, and non-toxic herbaceous plants, and therefore reduce competition with prostrate milkweed from these plants. In addition to grazing, livestock may also reduce competition with prostrate milkweed by trampling herbaceous plants. Since prostrate milkweed has often been observed in the wheel ruts of dirt roads, it appears to be unusually tolerant of trampling; thus, the effect of livestock trampling is minimal. Consequently, we conclude that livestock grazing is compatible with management of prostrate milkweed habitat, and may actually benefit this species.

5.4 Energy development, road and utility construction, and ROW maintenance

Oil and gas exploration and wind energy development are occurring at a very rapid pace in Starr and Zapata Counties. Seismic exploration and the construction of roads and caliche pads for oil and gas wells and for wind turbines can destroy rare plants and their habitats within the construction footprint (Reemts *et al.* 2014, pp. 123 and 125; Leslie 2016, p. 49). Additionally, elevated service roads and other permanent structures may indirectly affect the hydrology of surrounding habitats by diverting and channeling water through drainage culverts. As previously described, invasive buffelgrass quickly colonizes disturbed roadsides, then invades adjacent habitats. Heavy vehicle traffic during oil and gas well drilling and wind farm construction may increase the frequency of road maintenance, such as grading or widening (Peña 2019, pers. comm.) (Figure 14). Grading or blading a caliche road involves scraping the road's surface with a large heavy blade to remove ruts and roadside vegetation. Increased frequency of road maintenance that removes above-ground portions of prostrate milkweed plants could reduce or eliminate flower and fruit production. Conversely, grading or blading of caliche roads during the milkweed's dormant periods may benefit the species by temporarily reducing competition from grasses and forbs (TXNDD 2019, p. 11, EO ID 3395).

Figure 14. A freshly-graded caliche road in Starr County where a prostrate milkweed population has been documented to exist since 2004. Counties use heavy tractor equipment attached with a large blade to periodically remove ruts and roadside vegetation (photograph courtesy Joey Santore).

In south-central Starr County, Duke Energy operates the 22,666 ha (56,008 ac) Los Vientos Windpower Project (Weaver and Jones 2018, p. 1; Hoen *et al.* 2019, unpaginated). In 2018, Bordas Renewable Energy LLC constructed Las Lomas Wind Project in western Starr and eastern Zapata counties (Bordas Renewable Energy, LLC 2019, unpaginated; Hoen *et al.* 2019, unpaginated). Bordas is currently planning the Vaquero Wind Project, which will be one of the largest wind projects ever constructed in South Texas, spanning Starr, Zapata, and two other South Texas counties (Bordas Renewable Energy, LLC 2019, unpaginated). As of November 2019, no wind turbines, oil or gas well pads, pipelines, or energy service roads have been constructed directly within known prostrate milkweed populations. However, some Starr County prostrate milkweed populations are less than 2.0 km (1.2 mi) from existing wind turbines. Since wind energy development does not have a federal nexus, wind energy companies are not required to conduct surveys for rare or listed species. Therefore, existing wind energy farms may have impacted undiscovered populations, and future development could destroy populations before they can be discovered.

Prostrate milkweed grows in disturbed areas such as dirt roads and road ROWs. Figure 15 shows a prostrate milkweed plant (near the small white ruler) growing in a ROW. TXNDD (2019) ranks road expansion as a pervasive threat of extreme severity to prostrate milkweed. From 2010 to 2012, Texas Department of Transportation (TxDOT) widened segments of U.S. Highway 83, causing extensive disturbance to at least three known prostrate milkweed sites: Arroyo del Tigre Grande, Mission Mier a Visita, and Arroyo Roma (Strong and Williamson 2015, p. 51; Paradise 2019, pers. comm.). TxDOT has also scheduled road widening or construction at five known prostrate milkweed populations: Arroyo del Tigre Grande, Arroyo del Tigre Chiquito, Arroyos de los Mudos, Mission Mier a Visita, and Arroyo Roma (TxDOT 2019, unpaginated). U.S. Customs and Border Protection (CBP) has scheduled road improvements at the prostrate milkweed population site located in the Arroyo Morteros tract of the Lower Rio Grande Valley (LRGV) National Wildlife Refuge (NWR) (Vallejo 2019, pers. comm.).

Figure 15. Typical roadside habitat of prostrate milkweed. Prostrate milkweed plants growing in ROWs are vulnerable to road construction, road maintenance, drag stripping, and buffelgrass invasion (photograph courtesy Anna Strong).

The installation of natural gas pipelines and fiber-optic cables has destroyed prostrate milkweed plants in the Dolores and Arroyo del Tigre Chiquito populations in the past (Damunde and Poole 1990, p. 32; Boydston 1993, unpaginated; Campos 1993, unpaginated). In 1995, Southwestern Bell installed a fiber-optic cable in the Hwy 83 ROW, 2.6 miles south of the Webb/Zapata county line, which destroyed at least 100 individuals at the Dolores population (USFWS 1995, p. 1). In 1993, prior to the fiber-optic cable installation, this population was estimated to have 100 to 200 individuals (TXNDD 2019), and may have been the largest known population of prostrate milkweed.

Mowing along highway ROWs may benefit prostrate milkweed by reducing competition from grasses and forbs. However, mowing at low height while individuals are flowering or fruiting will damage reproductive structures and interfere with recruitment. TxDOT may also apply herbicides to maintain highway ROWs. Some milkweed species are resistant to some types of herbicides (Moore 2006, unpaginated; Smith 2015, pers. comm.), but we do not know what herbicides would be used or what effect they would have on prostrate milkweed. TxDOT has established restricted mowing areas at two ROW populations where Zapata bladderpod (*Physaria thamnophila*) also occurs (Dolores and Arroyo del Tigre Chiquito). Of the 16 Texas populations, 13 occur along roads.

In summary, prostrate milkweed is currently threatened by oil and gas well construction, wind energy development, road construction, utility and pipeline corridor construction, and maintenance of ROWs associated with these projects. However, mowing and ROW maintenance may also benefit prostrate milkweed if they avoid the active growing and flowering period of prostrate milkweed. We include all of these factors in our analysis of population resiliency.

5.5 Quarrying/Mining

The Spanish word “caliche” can refer to many types of light-colored mineral deposits. However, in South Texas, caliche refers specifically to soil strata of calcium carbonate that resemble limestone, but have a different geological origin (Spearing 1998, pp. 258, 398). In South Texas, caliche is often excavated in surface mines (pit mines) and used for roadbeds and surfacing of unpaved roads, parking lots, and well pads. Caliche surface mining along the Goliad geological formation threatens the endangered Walker’s manioc (*Manihot walkerae*) in eastern Starr and western Hidalgo Counties (USFWS 2009b, p. 16). However, in South Texas and northern Tamaulipas and Nuevo León, prostrate milkweed is associated with sandstones of the Laredo, Yegua, and Jackson geological formations, but not the Goliad caliche outcrops. Prostrate milkweed does occur in sandy soils shallowly overlying caliche of the Goliad formation at Rancho Loreto and Ejido Morales, in the Loreto sand plain of Tamaulipas (Johnston 1963, pp. 462–464; Blackwell 1964, p. 178; Contreras-Arquieta 2005, pp. 50, 84). Historically, sandstone was quarried for buildings in Guerrero Viejo and Mier, Tamualipas, and San Ignacio, Texas (George 2008, pp. 2 and 30). Nevertheless, we are not aware of any active sandstone quarrying or caliche mining in the vicinity of prostrate milkweed populations in Texas or Tamaulipas. Consequently, surface mining and quarrying is a low-probability potential threat to prostrate milkweed.

5.6 Hybridization

Hybridization between common plant species and rare, closely-related species can overwhelm the genome of the latter to the point that it no longer exists as a distinct taxonomic entity. Therefore, hybridization is a potential threat to the survival of rare species. Zizotes milkweed and Emory's milkweed are closely-related species of subgenus Podostemma of *Asclepias* that overlap in range and habitat with prostrate milkweed (Worcester 2012, p. 38; Richardson and King 2011, p. 74-76). Woodson (1954, pp. 158–159) noted that frequent morphological intergradation between Zizotes and Emory's milkweed may be due to occasional hybridization. Woodson's 1954 monograph did not include *A. prostrata*, which had not yet been described (Blackwell, Jr. 1964, p. 178). However, Fishbein *et al.* (2011, p. 1018) state that prostrate milkweed is morphologically similar to the species of subgenus Podostemma; nevertheless, there is no evidence of hybridization between prostrate milkweed and other species of *Asclepias* (Strong and Williamson 2015, p. 39-40). In fact, Fishbein (2020, pers. comm.) found no evidence of hybridization among the large number of herbarium specimens he studied. We conclude that hybridization is a low-probability potential threat to prostrate milkweed.

5.7 Border security development and enforcement activities

All known Texas populations of prostrate milkweed are within 14.5 km (9 miles) of the Texas-Mexico border (Figure 13). Starr and Zapata counties are within the Rio Grande Valley Sector of the CBP. As of 2019, CBP apprehended more undocumented aliens and seized more narcotics in the Rio Grande Valley than in any other border sector in the U.S. (U.S. Customs and Border Protection 2019, p. 1-2).

To address border security concerns, additional border barrier construction has been proposed in the Rio Grande Valley. Depending on the alignment, construction would obliterate prostrate milkweed plants that occur within the construction footprint. The prostrate milkweed population at the Arroyo Morteros tract of the LRGV NWR could be directly impacted by barrier construction, or indirectly impacted by channeling of runoff along the barrier during heavy rainfall. Additionally, CBP plans to improve roads across this tract (Vallejo 2019, pers. comm.), and may also install new drag strips along existing roads. Drag strips are 4- to 5-m (13- to 16-ft) wide swaths cleared of all vegetation and regularly scraped to keep the soil surface loose, in order to detect recent foot traffic (Figure 16). Due to the high gypsum content, soils in this area are extremely vulnerable to gully erosion. Hence, the un-vegetated, continually disturbed drag strips may exacerbate soil erosion and impact a much wider area. TXNDD ranks drag strip construction within prostrate milkweed populations as a small threat (defined as a threat that affects 1-10% of the total population or occurrences or extent) with an extreme level of severity (likely to destroy or eliminate occurrences or habitat, or reduce population 71-100%) (TXNDD 2016). Consequently, the construction of border barriers, roads, and drag strips are potential threats of high magnitude to prostrate milkweed populations, depending on their alignment, design, and proximity to populations and local topography.

Figure 16. Dragging operations to clear vegetation in ROWs. In some areas, dragging operations extend outside of TxDOT ROWs and into firebreak roads along property fence lines (photograph courtesy CBP, Rio Grande Sector).

Native plant populations are legally protected on National Wildlife Refuges, and if listed under the ESA, have additional legal protections from federally funded or regulated actions. However, 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, border barrier construction on private and public lands is exempt from consultation with USFWS under section 7 of the ESA. During the previous phase of border barrier construction, beginning in 2007, DHS and USFWS coordinated to establish best management practices (BMPs) for the federally listed plants and animals in the project impact area (U.S. Department of Homeland Security 2008); nevertheless, these BMPs did not address prostrate milkweed.

5.8 Pollinator decline

Milkweeds are pollinated by insects that are strong enough to extract pollinia from the complex flowers. Some milkweed species are effectively pollinated by large Hymenoptera (bees and wasps) and Lepidoptera (butterflies and moths), while other milkweed species are pollinated by a large range of sizes and insect orders (Fishbein and Venable 1996, p. 1069; Holdrege 2010, p. 13; MacIvor *et al.* 2017, p. 8459). Insect biodiversity is threatened worldwide; in particular, terrestrial Lepidoptera, Hymenoptera, and dung beetles (Coleoptera) are declining dramatically (Sánchez-Bayo and Wyckhuys 2019, p. 8). Stokstad (2007, p. 970; Cameron *et al.* 2011, p. 662) documented a widespread decline in bee populations. Currently, we do not know what insect species are effective pollinators of prostrate milkweed, nor can we judge the status of its pollinators. Nevertheless, we conclude that pollinator decline is a potential threat of unknown magnitude and immediacy to prostrate milkweed.

5.9 Climate changes

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) 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 events will increase in mid-latitude land masses; and
- it is likely that the intensity and/or duration of droughts will increase on a regional to global scale.

Similarly, the U.S. Global Climate Research Program (USGCRP) Fourth National Climate Assessment (USGCRP 2017) reports that average annual temperatures from 1986—2016 have increased in the Southern Great Plains (including the range of prostrate milkweed) by 0.42° C (0.76° F), compared to 1901—1960 (USGCRP 2017, Chapter 6, table 6.1). Average annual temperatures in the Southern Great Plains are projected to increase by 2.65° to 4.69° C (4.78° to 8.44° F), under moderate and high emission scenarios, respectively, by the late 21st century (USGCRP 2017 Chapter 6, table 6.4). Projected summer and fall precipitation changes under the highest emissions scenario, by the end of the 21st century, will be smaller than natural variations over the range of prostrate milkweed, while a projected decrease of 10 to 20 percent in winter and spring precipitation will be greater than natural variation (USGCRP 2017 Chapter 7 pp. 15–16 and figure 7.5). Additionally, the frequency of heavy precipitation events has increased from 1901 to 2016 and 1948 to 2016 (USGCRP 2017 Chapter 7 pp. 5–9 and figures 7.2–7.4) and is projected to continue to increase under moderate and high emission scenarios (USGCRP 2017 Chapter 7 pp. 18–24 and figures 7.6–7.8).

The magnitude of projected changes varies widely, depending on which scenario of future greenhouse gas emissions is used. These scenarios are called Representative Concentration Pathways (RCPs). Under the best-case scenario of RCP2.6, the combined emissions of carbon dioxide, methane, and nitrous oxide, expressed as the carbon dioxide equivalent, will stabilize at 475 parts per million (ppm) by the year 2100. This figure rises to 630, 800, and 1,313 ppm under the RCP4.5, RCP6.0, and RCP8.5 scenarios, respectively (IPCC 2013, p.22).

To evaluate how the climate of prostrate milkweed habitats may change, we used the National Climate Change Viewer (U.S. Geological Survey 2020) to compare past and projected future climate conditions for Zapata County, Texas. The baseline for comparison was the observed mean values from 1981 through 2010, and 30 climate models were used to project future conditions for 2050 through 2074. We selected the climate parameters of April maximum temperature and annual precipitation for these reasons: 1) Prostrate milkweed emerges from dormant tubers, grows, and flowers quickly in response to sporadic periods of rainfall; 2) the species is able to grow and reproduce between about March through October, but is most often observed in the spring, when botanists typically conduct plant surveys; 3) changes in annual precipitation may affect the species' reproductive output; and 4) higher temperatures in the spring could shorten the period of growth and flowering, and therefore reduce reproductive output, when the species has most often been observed. We used both the RCP4.5 and RCP8.5 scenarios to provide a range of projected values. The results are summarized in Table 5 and in Figures 17 and 18. To interpret these results, it is important to consider the means as well as the dispersion of the 30 climate models (Table 5); wide dispersion indicates greater uncertainty. The baseline average annual precipitation is 42.4 mm/month (20.0 in/year). Although the model means for RCP4.5 and RCP8.5 project little change in annual precipitation (-0.1 mm/month to -0.9 mm/month (-0.05 in/year to -0.43 in/year), respectively), these models do not simulate well the projected patterns of regional precipitation (IPCC 2013, p. 11). Hence, the projection reflects a lack of precision, rather than a likelihood that there will be little change in precipitation. On the other hand, the models more consistently project an increase in April maximum temperatures. The baseline April average maximum temperature for Zapata County is 31.4° C (88.5° F), and is projected to increase by 2.2° to 3.5° C (4.0° to 6.3° F) in the model means of RCP4.5 and RCP8.5, respectively.

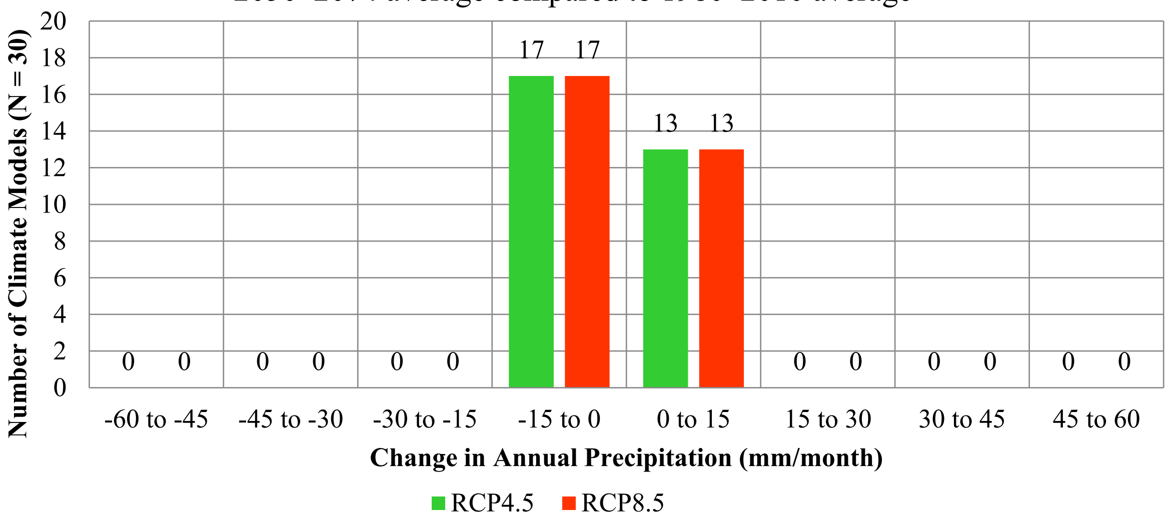
Table 5. Means and dispersion of projected changes of 30 climate projection models for Zapata County, Texas: 2050 to 2074 compared to 1980 to 2010 (U.S. Geological Survey 2020).

Climate Parameter	RCP	Projected changes, means of 30 models	Ranges of individual models
Annual Precipitation Changes. 1980 to 2010 baseline: 42.4 mm/mo (20.0 in/yr)	4.5	-0.1 mm/mo (0.05 in/yr)	-11.7 to +9.7 mm/mo (-5.5 to +4.6 in/yr)
	8.5	-0.9 mm/mo (-0.43 in/yr)	-12.1 to +14.2 mm/mo (-5.7 to +6.7 in/yr)
April Maximum Temperature. 1980 to 2010 baseline: 31.4° C (88.5° F)	4.5	+2.2° C (+4.0° F)	+0.6° to +3.9° C (1.1° to 7.0° F)
	8.5	+3.5° C (+6.3° F)	+2.0° to +4.7° C (+3.6° to +8.5° F)

Nevertheless, we do not know how prostrate milkweed responded to prior climate changes, nor can we determine how these projected climate changes, forecast by the range of models and emissions scenarios, will affect the interactions of this species with its habitat and associated plant and animal community. The virtual certainty of higher summer and winter temperatures and the likelihood of increased drought intensity and duration might reduce the species' reproductive output during its currently observed seasons of growth; alternatively, the species might adapt to these changes by emerging later in the fall or earlier in the spring. Many plant species, perhaps including prostrate milkweed, will decline when exposed to higher temperatures and longer, more intense droughts. Conversely, prostrate milkweed is well adapted to xeric environments, but does not compete well with grasses, including the invasive buffelgrass. Prolonged, intense droughts will reduce competition from grasses and herbaceous plants. Since prostrate milkweed emerges and reproduces quickly after rainfall, this species may benefit from the combination of increased droughts that reduce competition and an increased frequency of heavy rainfall events. Thus, although it is likely that the projected climate changes will affect the survival of prostrate milkweed in infinitely complex ways, we cannot confidently project what the net result of beneficial and detrimental effects will be. We conclude that climate changes represent a potential threat of unknown magnitude.

Figure 17. Projected Changes in Annual Precipitation (mm/month), Zapata County, TX

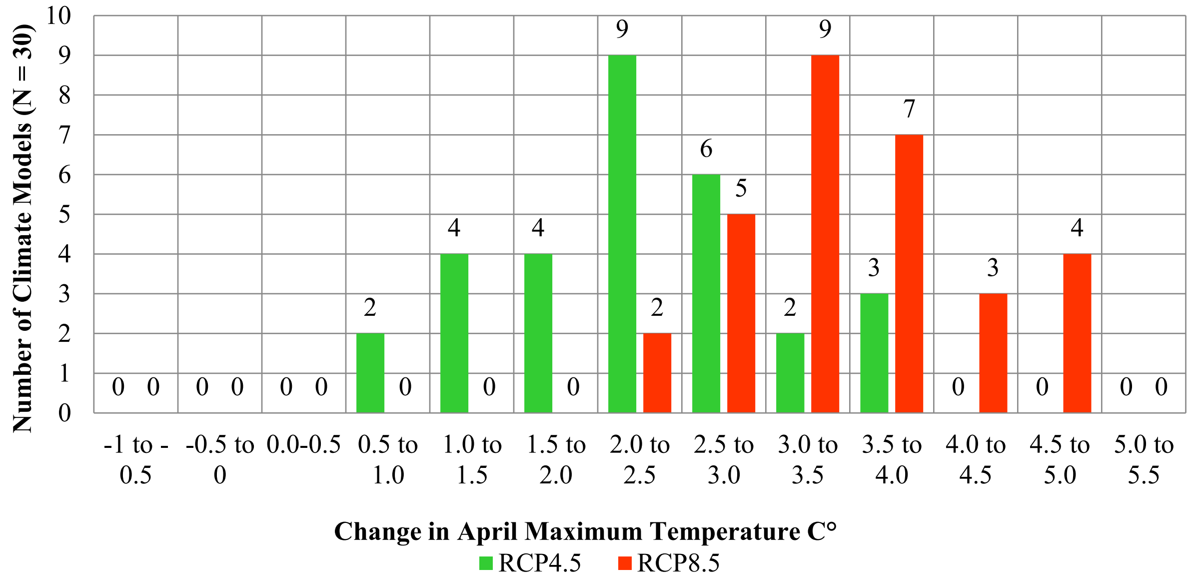
2050–2074 average compared to 1980–2010 average



RCP4.5 Mean: -0.1 mm/month; Range: -11.7 to +9.7 mm/month

Figure 18. Projected Changes in April MaximumTemperature (C°), Zapata County, TX

2050–2074 average compared to 1981–2010 average



RCP4.5 Mean: 2.2°; Range: 0.6° to 3.9°
RCP8.5 Mean: 3.5°; Range: 2.0° to 4.7°

5.10 Small population size and population connectivity

Demographic consequences of small population sizes.

Small, isolated populations are more vulnerable to catastrophic losses caused by random fluctuations in recruitment (demographic stochasticity) or variations in rainfall or other environmental factors (environmental stochasticity) (USFWS 2016, p. 20). Of the 24 documented populations of prostrate milkweed, the maximum observed sizes of 21 populations was less than 30 individuals. The three largest populations had maximum observed sizes of 83, 137, and about 200 individuals. Hence, all known populations are far below the estimated MVP level of 1,600 mature individuals.

Genetic consequences of small population sizes.

Small, reproductively isolated populations are susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding (Barrett and Kohn 1991, pp. 3−30). The loss 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 the random change in the frequencies of alleles in a population over time. Genetic drift is caused by random differences in new populations and the random loss of rare alleles in small, isolated populations. Genetic drift may have a neutral effect on fitness, but most commonly has a negative effect, especially among outcrossing species; this is due to the expression of deleterious recessive genes that have become homozygous. It is also a cause of the loss of genetic diversity in small populations.

Inbreeding depression is the loss of fitness among progeny arising from sexual reproduction between closely related individuals. This loss of fitness may also be due to the expression of deleterious recessive genes that have become homozygous. The probability of sexual reproduction between closely related individuals increases in small, isolated populations. However, plant species differ greatly in response to inbreeding; currently, we do not know if inbreeding of prostrate milkweed leads to inbreeding depression.

Due to the small size and isolation of prostrate milkweed populations, several may already suffer from genetic bottlenecks, genetic drift, inbreeding, and loss of allelic diversity.

In addition to population size, it is likely that population density and connectivity also influence population viability. Prostrate milkweed is very likely to be an obligate outcrosser, as are most other *Asclepias* species. Hence, reproduction requires genetically compatible individuals to be clustered within the forage range of the native pollinators. While the specific pollinator(s) of this species have not been revealed, they are likely to be large bees or wasps, and the forage range could be up to several kilometers. If this is the case, viable populations of prostrate milkweed could be dispersed at very low densities over relatively large areas, provided that they lie within fairly contiguous habitats that are traversed by pollinating insects. Thus, the small, isolated clusters of prostrate milkweed that have been documented, principally along public roads that slice through large expanses of potential habitat on private lands, may represent only tiny fractions of larger, highly dispersed populations. This is not an unreasonable hypothesis. The species was not discovered until 1960, which suggests that it has always been rare and has yet managed to persist.

Based strictly on the available scientific data, the documented populations of prostrate milkweed are all far below the estimated MVP level, and may be threatened by the demographic and genetic consequences of small population sizes. Nevertheless, considering the likelihood that the species is able to persist in highly dispersed populations, and the very small fraction of potential habitat that has been surveyed, it is possible that larger, more viable populations remain on large tracts of privately owned rangeland in South Texas and northeast Mexico. Even so, these populations would also face widespread threats from buffelgrass invasion, root-plowing, energy development, and road and utility corridor construction, and are likely to decline if conservation measures are not promoted throughout the species' range.

5.11 Management

In Texas, prostrate milkweed sometimes co-occurs with other endangered plants, including Zapata bladderpod, star cactus (*Astrophytum asterias*), and ashy dogweed (*Thymophylla tephroleuca*). In the Loreto sand plain of Tamaulipas it is associated with the endangered Walker's manioc. Because of these associations, some prostrate milkweed populations have benefitted from conservation easements, landowner agreements, and agency management actions.

In 1997, TxDOT entered into a management agreement with Texas Parks and Wildlife Department (TPWD) to change mowing and other management actions within road ROWs containing rare or endangered plants. Prostrate milkweed was included in the agreements for Starr County; however, mowing was recommended as often as needed. TPWD also recommended eliminating blading and fire lanes within the management areas and restricting herbicide application in adjacent areas when there is little or no wind (Poole and Janssen 1997, p. 96). Prostrate milkweed and ashy dogweed were found at a ROW near the Dolores population in Zapata County; however, recommendations were geared toward ashy dogweed management and included setting mower height to 6 inches, mowing on a schedule, eliminating disking in some areas, and eliminating stockpiling of road construction materials (Poole and Janssen 1997, p. 117). TxDOT is careful to avoid adverse effects to Zapata bladderpod when controlling buffelgrass with mowing or herbicide applications for buffelgrass control within the Dolores and Tigre Chiquito ROW populations in Zapata County (de la Garza 2019, pers. comm.; Ramirez 2019, pers. comm.).

In 2002 and 2004, botanists discovered populations of prostrate milkweed and Zapata bladderpod at Arroyo Ramirez and Arroyo Morteros tracts of LRGV NWR in Starr County. Figure 8 is a photograph of the Arroyo Morteros tract habitat where Zapata bladderpod and prostrate milkweed co-occur. Although refuge staff do not actively manage for prostrate milkweed (Wahl-Villarreal 2019, pers. comm.), the refuge coordinates with U.S. Customs and Border Protection to avoid impacts from border security activities (Reyes 2019; pers. comm.).

From 2002 to 2006, TPWD coordinated section 6-funded surveys of rare plants on private lands in Willacy, Cameron, Hidalgo, and Starr counties. Nine landowners signed conservation agreements to protect rare plants on their properties. Although prostrate milkweed was found at 8 new sites within the Dolores and FM 3167 populations (EO 3 and EO11), none of the landowners at these sites signed conservation agreements (Price *et al.* 2006, pp. 31-32).

In 2005, the Mexican NGO PRONATURA conducted a section 6-funded survey of rare plants in northeast Mexico (Contreras-Arquieta 2005). Four private and *ejido* landowners in Tamaulipas signed conservation agreements to conserve and manage the rare plant species discovered on their properties (Contreras-Arquieta 2005, pp. 2, 5). One of the agreements, with the privately owned Rancho Loreto, included protection of a population of prostrate milkweed.

Wild-grown milkweeds are difficult to transplant, due to their large taproots and sparse fibrous roots; large amounts of soil around the crown are often lost (Price 2005, pers. comm.). In June 2018, a TPWD botanist transplanted two prostrate milkweed plants that were in the path of impending road maintenance from the Arroyo de los Mudos population (EO 13) in Starr County to private property within the San Julián Road population (EO 16) (Strong 2018, entire). Although the newly transplanted plants were watered well and protected with metal grill covers, three days later only one of the plants was visible above ground and appeared stressed (Strong 2018, entire; Skoruppa 2018, pers. obs.); however, other non-transplanted prostrate milkweed plants in this population were also visibly stressed. It is unknown if the two transplanted prostrate milkweeds survived.

In 2019, a 489-acre conservation easement for a Starr County ranch was approved for purchase under a Recovery Land Acquisition grant (USFWS 2019, entire). The conservation easement will protect several rare, threatened, and endangered plants, including a portion of the San Julián Road population of prostrate milkweed. The transaction was still pending in early 2020 (Strong 2019, pers. comm.).

5.12 Summary of factors affecting the survival of prostrate milkweed

Competition from invasive buffelgrass is a major threat to prostrate milkweed that currently affects most populations and potentially affects all populations. Root-plowing of rangelands is conducted very widely throughout the species' range in South Texas and northeast Mexico; since this is usually combined with buffelgrass planting, it is very likely to adversely affect prostrate milkweed populations. However, alternative methods of brush control that do not involve soil excavation, combined with the restoration of native grass and rangeland plants, is likely to benefit the species' survival. Livestock grazing is very compatible with prostrate milkweed conservation because grazing reduces competition from grasses.

The development of new oil and gas wells, wind energy farms, roads, pipelines, and utility corridors is occurring at a rapid pace and currently threatens prostrate milkweed populations in South Texas and adjacent areas of Mexico. This threat would be exacerbated if newly-disturbed soils are planted with buffelgrass. Conversely, roadsides that are planted with native grass species may provide excellent habitats for prostrate milkweed.

Surface mining of caliche and sandstone is a potential threat of low probability that has not been observed. Similarly, hybridization with other *Asclepias* species is a low probability threat that has not been documented.

The development of new border barriers and drag strips are serious threats to several populations of prostrate milkweed along the U.S. side of the Rio Grande. This includes populations at two National Wildlife Refuge tracts that would otherwise be protected from development. Construction at these sites threatens not only the populations that are within the immediate footprint of construction; due to the extreme susceptibility of soils at these sites to erosion, surrounding habitats are also likely to be damaged.

Pollinator decline is a potential threat of unknown magnitude and immediacy.

It is likely that climate changes will affect prostrate milkweed survival, and may have both beneficial and detrimental effects. We cannot currently project the net result of climate changes to prostrate milkweed, but conclude that it is a potential threat of unknown magnitude.

All documented populations of prostrate milkweed are small and isolated and are threatened by the demographic and genetic consequences of small population sizes. It is possible that the documented populations are only portions of much larger, highly dispersed populations on privately owned rangelands; however, these populations of unknown size and extent are likely affected by the widespread threats of buffelgrass competition, root-plowing, energy development, and road and utility corridor construction, and are likely to decline if conservation measures are not promoted throughout the species' range.

Prostrate milkweed occurs in association with other endangered plants, including Zapata bladderpod, star cactus, ashy dogweed, and Walker's manioc. Consequently, protection of habitats for these species also benefits prostrate milkweed populations.

Prostrate milkweed and the endangered Zapata bladderpod co-occur at two sites within highway ROWs. TxDOT has established management agreements with TPWD to manage these sites for the conservation of Zapata bladderpod, which should also benefit prostrate milkweed.

Two populations of prostrate milkweed occur on tracts of LRGV NWR and may be legally protected from federal actions other than the construction of border security infrastructure.

A conservation agreement was established to protect the prostrate milkweed population at Rancho Loreto, Tamaulipas.

A conservation easement is currently being established to protect 489 acres of native habitat in Starr County. Once finalized, this easement will permanently protect a population of prostrate milkweed and its habitat.

Chapter 6 - Species Current Condition

In 2016, the Texas Parks and Wildlife Department reviewed the state conservation status ranking for prostrate milkweed using NatureServe's Rank Calculator v.3.193 (NatureServe 2019). The resulting status rank for prostrate milkweed remained unchanged as S1: Critically Imperiled, defined as "…especially vulnerable to extirpation from the state/province" (TXNDD 2016).

The available information indicates that there are currently 24 extant populations, 16 in the United States and 8 in Mexico (Tables 6 and 7). All of the populations in Mexico lack current information due to lack of survey effort. Since there is a lack of information on the populations from Mexico, we analyzed the current condition based upon available descriptions of habitat (Best 1996, Contreras-Arquieta 2005, Contreras-Arquieta 2007, and Martinez Avalos 2019, pers. comm.) and assumed that these populations would have a similar number of individuals and resilience as the populations in Texas. Information for Texas populations comes from the Texas Natural Diversity Database (TXNDD 2019 and 2020, entire) and observations from species experts or naturalists familiar with the species. Observational survey data have involved different amounts of surveying effort (surveying is usually opportunistic and can cover different areas) and location information can be imprecise. Based upon our analysis of current condition, there are no populations in high condition. Of the 24 extant populations 5 are in moderate condition and 19 are in low condition (Tables 6 and 7).

Table 6. Current condition ranks of prostrate milkweed populations in the United States. Except where footnoted, numbers observed are from TXNDD 2019 and 2020. Current condition descriptions (habitat and demographic factors) for each population are included Appendix A.

Population Name	EO No. (EO ID)	First Reported	Population Size Range	Most Recent Observation of Plants		Most Recent Search for Plants		Current Condition Rank
				Date	Numbers Observed	Date	Numbers Observed	
Dolores	3 (3395)	1932	0 – ± 200	Apr 2017	1	Apr 2017	1	Low
14493	22 (14493)	2018	3	Oct 2018	3	Oct 2018	3	Low
14491	20 (14491)	2007	0 — ≥ 1	July 2007	≥ 1	May 2019	0	Low
Arroyo del Tigre Grande	7 (3803)	1990	0 – 14	Oct 1990	14	Aug 2014	0	Moderate
Arroyo del Tigre Chiquito	6 (7771)	1992	0 –30	Feb 2006	1	Aug 2014	0	Low
FM 2098	14 (12643)	1990	0 – 1	Aug 1990	≥ 1	Mar 2019	0	Low
Falcon	5 (1572)	1987	0 — 5	Mar 2019	1	Oct 2019	0[1]	Low
Los Alvaros	17 (14484)	2004	0 – 83	Sept 2019	62[2]	Sept 2019	62[2]	Moderate
Arroyo Morteros Tract	15 (12847)	2004	2 – 12	Apr 2016	2	Apr 2016	2	Moderate
Los Arrieros Loop	12 (8798)	1994	5 – 20	Mar 2007	6	Mar 2007	6	Low
Arroyo de los Mudos	13 (12636)	1995	0 – 6	Mar 2019	1	Oct 2019	0[1]	Low
Mission Mier a Visita	2 (6223)	1957	0 – 137	Apr 2017	1	Oct 2019	0[1]	Low
San Julián Road	16 (12876)	2007	0 – 25	June 2018	24	June 2018	24	Moderate
FM 3167	11 (8325)	2004	10	Mar 2004	10	Mar 2004	10	Moderate
Arroyo Roma	1 (6491)	1966	0 – 22	Oct 1999	>1	Oct 2019	0[1]	Low

Population Name	EO No. (EO ID)	First Reported	Population Size Range	Most Recent Observation of Plants		Most Recent Search for Plants		Current Condition Rank
				Date	Numbers Observed	Date	Numbers Observed	
Arroyo Ramirez Tract	10 (5533)	2003	0 – 2	Apr 2004	2	Apr 2017	0	Low

[1]Kieschnick 2019, pers. comm.

[2]Santore 2019b, pers. comm.

Table 7. Current conditions of prostrate milkweed populations in Mexico

Population Name	Map ID	Source	First Reported	Most Recent Observation	Current Conditi on Rank
Rancho La Coma	CA 350	Contreras-Arquieta 2005	2005	2005	Low
Road to Guerrero Viejo	GM 1	Best 1996	1994	1994	Low
Carboneras	MA 1	Martinez Avalos 2019	2017	2018	Low
Punta de Alambre	MA 2	Martinez Avalos 2019	2017	2018	Low
Intersection of 101-180	MHJ 769	Mayfield, Hempel, and Jack 1991	1991	1991	Low
Rio El Catán	CA 195 CA 344	Contreras-Arquieta 2005	2005	2005	Low
Rancho Loreto North	CA 336 CA 343	Contreras-Arquieta 2005	2005	2005	Low
Rancho Loreto South	CA 341	Johnston and Crutchfield 1960; Contreras-Arquieta 2005	1960	2005	Low

6.1. Methodology for Population Resilience Assessment

To describe population resilience, we used abundance, recruitment, canopy cover, and ground cover as the primary factors influencing prostrate milkweed. For each of these four population and habitat factors, we developed condition categories (High, Moderate, Low, and Extirpated) to assess the condition of each population (Table 8) to determine overall population resilience. We assigned a numerical value to the condition categories, High=3, Moderate=2, Low=1, and Extirpated =0, to calculate an overall resilience condition score. Table 9 lists the condition categories for abundance, recruitment, canopy cover, and ground cover factors.

Table 8. Population resilience category definitions for prostrate milkweed.

High (Good)	Moderate	Low	Extirpated
A population with high resilience is one in which abundance is high, seed production is high, recruitment is such that the population remains stable or increases; and the population is able to withstand stochastic events or recover to current or better condition from stochastic events from seed bank; with abundant suitable habitat.	A population with moderate resilience is one in which abundance is moderate; seed production is moderate, recruitment and mortality are equal such that the population does not grow; ability to withstand stochastic events or recover from stochastic events is limited due to low abundance and recruitment and reduced seed bank; with some suitable habitat.	A population with low resilience is one in which abundance is low, seed production is low, mortality exceeds recruitment such that the population is declining; ability to withstand stochastic events or recover from stochastic events is unlikely due to low abundance and recruitment and limited seed bank; with limited suitable habitat.	A population with no resilience is one that has become extirpated completely, either physically or functionally, because no individuals have been observed in the past 40 years or no suitable habitat remains.

Table 9. Condition categories for demographic factors and habitat factors used to estimate population resilience.

	Demographic		**Habitat**	
Condition Categories and Scores	**Abundance**	**Recruitment Rate**	**Canopy Cover* (shade)**	**Ground Cover** (competition)**
High (3)	≥1,600 individuals in population	≥25% of individuals produce viable seeds per year	<30%	All bare ground or sparsely vegetated with mostly native grass/forbs
Moderate (2)	800 to 1,599 individuals in population	15-24% of individuals produce viable seeds per year	30-60%	Sparsely vegetated with a mixture of native grass/forbs and some nonnatives
Low (1)	<800 individuals in population	<15% of individuals produce viable seeds per year	61-100%	Nonnatives are dominant and there is little or no bare ground

*Canopy cover means shade from trees, shrubs, prickly pear cactus, or tall (>1 m) grass.
**Ground cover means vegetation growing at the herbaceous layer (approximately <1 m) that would compete for resources.

Prostrate milkweed abundance is difficult to assess due to its ability to remain dormant for multiple years until the necessary environmental conditions occur. Individual plants may emerge only a few times per decade and not all plants will emerge at the same time (Price 2005, pers. comm.; Best 2017, pers. comm.). For this reason, populations with no observed plants could potentially be persisting below ground. Therefore, we considered populations to be extant if plants have been observed within the past 40 years (Hammerson *et al.* 2008; Strong 2020a, pers. comm.) and with available habitat (i.e., not paved over) or with restorable habitat (i.e. non-native grass could be removed). Available survey data, habitat information, and condition scores for each population are included in Appendix A.

We totaled all the condition category scores for each population to determine the overall resilience score. To provide context for this score we established an overall resilience scale from 0 to 12 to communicate our understanding of the overall condition of each population (Table 10). To determine the overall resilience scale we first determined the highest score attainable (12) and the lowest score attainable (0). Within this range, we established four overall resilience levels based on the number of factors in the condition categories as shown in Table 9. Appendix A provides the ranking of each population and habitat factor for current condition.

Table 10. Overall resilience scale with scoring.

Category	Score
High	$\geq$10
Moderate	7-9.9
Low	4-6.9
Extirpated – Functionally Extirpated	$\leq$3.9

6.2. Representation

Representation refers to the genetic diversity, both within and among populations, necessary to maintain adaptive capacity. However, no studies have been conducted on the genetic diversity of prostrate milkweed.

In plants, gene flow occurs via seeds and pollen: therefore pollen dispersal can have a substantial influence on the genetic makeup of plant populations. Gene flow can occur within and among populations that are clustered within the forage range of pollinators, or within the dispersal range of the wind-born seeds. Urban expansion or other development that occurs between populations could isolate populations from pollen transfer (Janssen *et al.* 2010, p. 97-98). There are over 96 km (60 miles) between the populations in Mexico and Texas and the two representation areas (see Figure 11) stretch over 320 km (200 miles). It is likely that historically populations occurred between these areas, connecting the populations in Texas and Mexico. However, if this area no longer contains prostrate milkweed there could be a loss of genetic exchange and the genetics of the Texas and Mexico populations could be different.

Prostrate milkweed occurs in areas with full sun with little competition and can benefit from disturbance; however, it does not occur across multiple habitat types and is considered a habitat specialist. Prostrate milkweed is thought to be self-incompatible (an obligate outcrosser), meaning the flowers must receive pollen from another non-related plant in order to produce fruit. Outcrossing plants can be pollinated by a wide array of insects. They are more likely to produce new genetic recombinations that may allow for better representation than self-compatible or self-pollinating species (Strong and Williamson 2007, p. 344). However, the restricted range within Texas (all populations occur within an area of less than 500 square miles) and the small disjunct populations in Mexico indicate an overall low species representation.

6.3. Redundancy

Currently, there are 24 extant prostrate milkweed populations spread across Texas and Mexico. Some of the Texas and Mexican populations are more than 200 miles apart. In Texas, one population, Dolores, is somewhat isolated in northern Zapata County, with the next closest population approximately 25 miles (40 km) away. In Mexico, there are 8 known populations occurring in isolated pockets widely scattered in Tamaulipas and eastern Nuevo León. Consequently, catastrophic events could impact some populations and not others. However, natural gene exchange or re-establishment following disturbance is very unlikely between the widely dispersed populations and representation areas. Furthermore, most populations have low resilience and none have high resilience. Therefore, redundancy is low for this species due to low numbers of resilient populations.

6.4. Summary

The stressors listed in Chapter 5, alone or in combination, could result in the extirpation of populations, further reducing the overall redundancy and representation of the species. Historically, the species would likely have had a greater distribution of interconnected populations providing resilience to stochastic events because even if some populations were extirpated by such events, they could be recolonized over time by dispersal from nearby surviving populations. This connectivity would have made for a highly resilient species overall. However, under current conditions, restoring that connectivity on a large scale is not feasible due to the distances between populations. As a consequence of these current conditions, the viability of the prostrate milkweed now primarily depends on maintaining and restoring the remaining isolated populations and potentially reintroducing new populations where feasible.

Chapter 7 - Species Future Condition and Viability Assessment

7.1 Introduction

While we have information about the stressors that are likely to affect prostrate milkweed populations in the future, and we understand how these stressors can impact prostrate milkweed, there is uncertainty regarding the exact risk of the stressors to each population, such as where and when each stressor will occur in the future and exactly which populations will be affected. Therefore, we project what the viability of prostrate milkweed could be under three plausible future scenarios. The continuation scenario represents conditions if current trends continue over the next 10 years. The conservation scenario represents improvements over current conditions for the next 30 years, and the increased stressors scenario represents deteriorating conditions over the next 30 years. We chose 10 years to evaluate continuing current trends because that time frame may cover at least 1 generation span of the species and this is also the projected timeframe of TxDOT projects. We chose 30 years for other scenarios because this is within the range of available climate change model forecasts.

The resilience categories and scale are the same as those used for Current Condition (Tables 8 and 10) with positive or negative scores used for future stressors (see Appendix A). As we did with the current condition assessment, we totaled all of the condition category scores for each population for each scenario at the various time steps to determine the overall projected population resilience score.

Although there is uncertainty on how to accurately define low, moderate, or high resilience in populations, for the purpose of this assessment we quantify these terms, in an effort to minimize ambiguity, as follows. For future scenario projections, populations in healthy condition are expected to have high resilience at that time period; i.e., they occupy habitat of sufficient size to allow for ebbs and flows of density of prostrate milkweed within the population. Populations in healthy condition are expected to persist into the future (> 90 percent chance of persistence beyond 30 years), and have the ability to withstand stochastic events that may occur. Populations in moderately healthy condition have lower resilience than those in healthy condition, but the majority (60–90 percent) are expected to persist beyond 30 years. Populations in moderately healthy condition are smaller and less dense than those in healthy condition. Populations in unhealthy condition have low resilience and are not necessarily able to withstand stochastic events. As a result, they are less likely to persist beyond 30 years (10–60 percent chance). Finally, populations are considered extirpated (lack of individuals) or functionally extirpated (lack of reproduction), and have very low resilience and less than a 10 percent chance of persistence beyond 30 years.

Below we describe the relevant characteristics of these scenarios, and subsequently, their possible effects on the populations that have been documented so far. If additional populations are discovered in the future, these scenarios will likely affect them in similar ways. These projections of varying scenarios should not be interpreted as mutually exclusive. The characteristics of the scenarios will interact independently; future viability will likely result from a combination of scenarios.

7.2. Continuation Scenario

The continuation scenario considers a future where the current levels of existing stressors, as well as existing conservation efforts, continue for the next 10 years. The continuation scenario forecasts all populations will be in low condition (Table 11) with the following summary of risk factors:

a. Nonnative grass: Nonnative grasses continue to spread, especially near roads and into areas with disturbed ground; Highway 83 continues to be heavily infested. Ranchlands are less infested, where grazing keeps nonnative grass somewhat in check. Refuges and lands with conservation easements may increase control efforts.

b. Mowing and Herbicides: Mowing and herbicide treatments can either be a threat or a benefit, depending upon the timing of the action. In this scenario, mowing and herbicide treatments are not scheduled around dormant periods and are therefore usually harmful. Exceptions are in the populations that co-occur with listed plant species.
c. Development: Road projects are planned in several populations; some county roads are graded at least once a year, often during flowering and fruiting periods. The increase in wind energy projects will require more frequent road maintenance by the counties.
d. Border security: A new road is planned on a refuge tract population and other populations could be damaged by drag strip operations.
e. Climate change: Changes in rainfall events, drought severity, soil moisture, and evaporation will have no effect or minimal effects.

Table 11. Future conditions under the Continuation Scenario

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Continuation Scenario
TEXAS			
Dolores	3 (3395)	Low	Low
14493	22 (14493)	Low	Low
14491	20 (14491)	Low	Low
Arroyo del Tigre Grande	7 (3803)	Moderate	Low
Arroyo del Tigre Chiquito	6 (7771)	Low	Low
FM 2098	14 (12643)	Low	Low
Falcon	5 (1572)	Low	Low
Los Alvaros	17 (14484)	Moderate	Low
Arroyo Morteros Tract	15 (12847)	Moderate	Low
Los Arrieros Loop	12 (8798)	Low	Low
Arroyo de los Mudos	13 (12636)	Low	Low
Mission Mier a Visita	2 (6223)	Low	Low
San Julián Road	16 (12876)	Moderate	Low
FM 3167	11 (8325)	Moderate	Low
Arroyo Roma	1 (6491)	Low	Low

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Continuation Scenario
Arroyo Ramirez Tract	10 (5533)	Low	Low
MEXICO			
Rancho La Coma	CA 350	Low	Low
Road to Guerrero Viejo	GM 1	Low	Low
Carboneras	MA 1	Low	Low
Punta de Alambre	MA 2	Low	Low
Intersection of 101-180	MHJ 769	Low	Low
Rio El Catán	CA 195 CA 344	Low	Low
Rancho Loreto North	CA 336 CA 343	Low	Low
Rancho Loreto South	CA 341	Low	Low

7.3. Conservation Scenario

The conservation scenario considers a best possible condition scenario, with reduced stressors, occurring over the next 30 years. The conservation scenario forecasts that two populations will be in moderate condition but all others will be in low condition (Table 12). The following is a summary of risk factors:

a. Nonnative grass: Nonnative grasses will continue to be a problem; however, sites with agency agreements or conservation easements will take aggressive measures to control buffelgrass in order to protect rare plants.
b. Mowing and Herbicides: Mowing and herbicide treatments will be included in the nonnative grass control efforts at some populations. TxDOT expands their fruiting season avoidance program to include some sites with prostrate milkweed.
c. Development: Road projects will continue; however, Starr County will implement a grading schedule that avoids flowering and fruiting periods at county road populations.
d. Border security: Little change is expected, but CBP will continue to coordinate with USFWS to avoid impacting rare plants on refuge tracts as much as possible.
e. Climate change: No effects or possibly some beneficial effects as climate change reduces competition and ground cover.

Table 12. Future conditions under the Conservation Scenario

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Conservation Scenario
TEXAS			
Dolores	3 (3395)	Low	Low
14493	22 (14493)	Low	Low
14491	20 (14491)	Low	Low
Arroyo del Tigre Grande	7 (3803)	Moderate	Low
Arroyo del Tigre Chiquito	6 (7771)	Low	Low
FM 2098	14 (12643)	Low	Low
Falcon	5 (1572)	Low	Low
Los Alvaros	17 (14484)	Moderate	Moderate
Arroyo Morteros Tract	15 (12847)	Moderate	Low
Los Arrieros Loop	12 (8798)	Low	Low
Arroyo de los Mudos	13 (12636)	Low	Low
Mission Mier a Visita	2 (6223)	Low	Low
San Julián Road	16 (12876)	Moderate	Moderate
FM 3167	11 (8325)	Moderate	Low
Arroyo Roma	1 (6491)	Low	Low
Arroyo Ramirez Tract	10 (5533)	Low	Low
MEXICO			
Rancho La Coma	CA 350	Low	Low
Road to Guerrero Viejo	GM 1	Low	Low
Carboneras	MA 1	Low	Low

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Conservation Scenario
Punta de Alambre	MA 2	Low	Low
Intersection of 101-180	MHJ 769	Low	Low
Rio El Catán	CA 195 CA 344	Low	Low
Rancho Loreto North	CA 336 CA 343	Low	Low
Rancho Loreto South	CA 341	Low	Low

7.4. Increased Stressors Scenario

The increased stressors scenario provides an idea of potential increase in negative impacts over the next 30 years. Under the Increased Stressors Scenario, 8 populations are projected to be extirpated with the rest in low condition (Table 13). The following is a summary of the risk factors.

a. Nonnative grass: Nonnative grasses continue to spread, encroaching into lands adjacent to roads. Efforts to control buffelgrass are minimal due to cost and extent of coverage.
b. Mowing and Herbicides: Mowing and herbicide treatments continue without regard to life stages. It is plausible that one or two of the ranches with populations could clear the land and convert the property into hay production with mowing occurring spring and fall.
c. Development: New wind energy projects and population increases require additional roads or higher capacity roads.
d. Border security: CBP activities will always be a consideration in the Texas populations with refuge tracts and other federal lands being especially vulnerable to impacts.
e. Climate change: Changes in rainfall events, drought severity, soil moisture, and evaporation will exacerbate stressors and have detrimental effects throughout the range.

Table 13. Future conditions under the Increased Stressors Scenario

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Increased Stressors Scenario
TEXAS			
Dolores	3 (3395)	Low	Extirpated
14493	22 (14493)	Low	Low
14491	20 (14491)	Low	Low
Arroyo del Tigre Grande	7 (3803)	Moderate	Low

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Increased Stressors Scenario
Arroyo del Tigre Chiquito	6 (7771)	Low	Extirpated
FM 2098	14 (12643)	Low	Extirpated
Falcon	5 (1572)	Low	Extirpated
Los Alvaros	17 (14484)	Moderate	Low
Arroyo Morteros Tract	15 (12847)	Moderate	Low
Los Arrieros Loop	12 (8798)	Low	Low
Arroyo de los Mudos	13 (12636)	Low	Extirpated
Mission Mier a Visita	2 (6223)	Low	Extirpated
San Julián Road	16 (12876)	Moderate	Low
FM 3167	11 (8325)	Moderate	Low
Arroyo Roma	1 (6491)	Low	Extirpated
Arroyo Ramirez Tract	10 (5533)	Low	Extirpated
MEXICO			
Rancho La Coma	CA 350	Low	Low
Road to Guerrero Viejo	GM 1	Low	Low
Carboneras	MA 1	Low	Low
Punta de Alambre	MA 2	Low	Low
Intersection of 101-180	MHJ 769	Low	Low
Rio El Catán	CA 195 CA 344	Low	Low
Rancho Loreto North	CA 336 CA 343	Low	Low
Rancho Loreto South	CA 341	Low	Low

7.5. Summary

We are aware of 24 extant prostrate milkweed populations throughout its range in Texas and Mexico. To evaluate species' viability, we analyzed the known populations of prostrate milkweed for future conditions (Table 14). Results of our current condition analyses (Chapter 6) indicate that none of the populations are in high condition, five are in moderate condition, and the remaining 19 (79%) are in low condition. Assuming that the stressors continue at current levels over the next 10 years (continuation scenario), we predict all 24 (100%) will be in low condition. If stressors increase (increased stressor scenario), eight of the populations (33%) will be extirpated within 30 years and all others (67%) will be in low condition. Even if plausible conservation measures increase (conservation scenario), such as avoidance of populations or protection via conservation easements, none will be in high condition, only two populations will be in moderate condition, and the remaining 22 (92%) will be in low condition within the next 30 years.

Few populations have been observed, and all with very few individuals at low densities. The largest known prostrate milkweed population is in Texas with about 62 individuals as of 2019. The remaining populations have less than 25 individuals. Populations that had 20-30 individuals in 2005 now only have a handful of individuals or appear to be functionally extirpated. Among all 24 populations, fruits have been observed in only one population within the last five years. The effects of buffelgrass and climate change are expected to increase over time as will road expansion and maintenance projects due to increased wind energy development in this area and ongoing border security activities.

Table 14. Summary of current condition and future condition scenarios for prostrate milkweed.

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Continuation Scenario	Future Condition – Conservation Scenario	Future Condition – Increased Stressors Scenario
TEXAS					
Dolores	3 (3395)	Low	Low	Low	Extirpated
14493	22 (14493)	Low	Low	Low	Low
14491	20 (14491)	Low	Low	Low	Low
Arroyo del Tigre Grande	7 (3803)	Moderate	Low	Low	Low
Arroyo del Tigre Chiquito	6 (7771)	Low	Low	Low	Extirpated
FM 2098	14 (12643)	Low	Low	Low	Extirpated
Falcon	5 (1572)	Low	Low	Low	Extirpated
Los Alvaros	17 (14484)	Moderate	Low	Moderate	Low
Arroyo Morteros Tract	15 (12847)	Moderate	Low	Low	Low
Los Arrieros Loop	12 (8798)	Low	Low	Low	Low
Arroyo de los Mudos	13 (12636)	Low	Low	Low	Extirpated

Population Name	EO No. (EO ID) or Map ID	Current Condition	Future Condition – Continuation Scenario	Future Condition – Conservation Scenario	Future Condition – Increased Stressors Scenario
Mission Mier a Visita	2 (6223)	Low	Low	Low	Extirpated
San Julián Road	16 (12876)	Moderate	Low	Moderate	Low
FM 3167	11 (8325)	Moderate	Low	Low	Low
Arroyo Roma	1 (6491)	Low	Low	Low	Extirpated
Arroyo Ramirez Tract	10 (5533)	Low	Low	Low	Extirpated
MEXICO					
Rancho La Coma	CA 350	Low	Low	Low	Low
Road to Guerrero Viejo	GM 1	Low	Low	Low	Low
Carboneras	MA 1	Low	Low	Low	Low
Punta de Alambre	MA 2	Low	Low	Low	Low
Intersection of 101-180	MHJ 769	Low	Low	Low	Low
Rio El Catán	CA 195 CA 344	Low	Low	Low	Low
Rancho Loreto North	CA 336 CA 343	Low	Low	Low	Low
Rancho Loreto South	CA 341	Low	Low	Low	Low

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Appendix A. Population Data, Current Condition, and Future Condition Scenario Analyses

See separate Excel file titled “Appendix A - Prostrate Milkweed Analyses”