Texas Prairie Dawn-Flower
(Hymenoxys texana)
5-Year Review:
Summary and Evaluation



U.S. Fish and Wildlife Service

Texas Coastal Ecological Service
Houston, Texas
August 31, 2022

5-YEAR REVIEW
Texas Prairie Dawn-Flower (*Hymenoxys texana*)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional or Headquarters Office: Southwest Regional Office, Region 2
Janess Vartanian, Recovery Biologist, Recovery and Restoration, Ecological Services (505) 248-6657

Lead Field Office: Texas Coastal Ecological Services Field Office- Clear Lake
Jan Culbertson, Fish and Wildlife Biologist, (281) 286-8282
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1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review:

This review was conducted through a public review notification in the Federal Register, review and field verification of most recent element of occurrence (EO) records in the Texas Parks and Wildlife Department's Texas Natural Diversity Database (TXNDD 2021), review and Geographical Information System (GIS) analysis of saline soils in the U.S Department of Agriculture Natural Resources Conservation Services' Soil Survey Geographic Database (SSURGO), communication with private landowners, state natural resource agencies, federal agencies, and a comprehensive review of all documents regarding the Texas prairie dawn-flower that were available to the Service's Texas Coastal Ecological Services Field Office in Houston, Texas. We solicited new information about the species biology, reproductive breeding mechanisms, seed dispersal mechanisms, habitat conditions, potential pollinators, conservation measures, threats, genetic information, and population trends from other agencies, such as Federal, non-governmental organizations, non-profit organizations,

academic institutions, and the general public. Private landowners, Harris County, Harris County Flood Control and U.S. Army Corps of Engineers (USACE) provided their monitoring data collected over the past five years and in some cases more than 20 years. This review considers both new and previously existing information from Federal and State agencies, non-governmental organizations, academia, and the general public. The current 5-year review was prepared without peer review by Jan Culbertson of the Texas Coastal Ecological Services Field Office in Clear Lake.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review:

87 FR 5834 Endangered and Threatened Species: Initiation of 5-Year Status Reviews of 35 Species in the Southwest. February 2, 2022

1.4.2 Listing history:

Original Listing
FR notice: 51 FR 8681
Date listed: March 13, 1986
Entity listed: Species
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.4.3 Associated Rulemakings:

None

1.4.4 Review History:

August 26, 2015. Texas prairie dawn-flower 5-year review: No status change recommended.

Habitat Conservation Plan for Private Lands in the Gulf Coast Prairies of Texas (USFWS 1995).

U.S. Fish and Wildlife Service. 1986. Determination of endangered status for *Hymenoxys texana*. Fed. Reg. 51(49): 8631–8633.

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

2C, meaning there is a high degree of threat, the recovery potential is high for the species. C indicates that there is conflict with development activities.

1.4.6 Recovery Plan or Outline

Name of plan or outline: *Hymenoxys texana* Recovery Plan
Date issued: April 13, 1990
Dates of previous plans or outline, if applicable: N/A

2.0 REVIEW ANALYSIS

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of "endangered species" or "threatened species" based on the five factors in Section 4(a) of the Act: Factor (A) continues to be present or threatened destruction, modification, or curtailment of its habitat or range; Factor (B) overutilization for commercial, recreational, scientific, or educational purposes; Factor (C) with the effects of disease or predation; Factor (D) threat from inadequacy of existing regulatory mechanisms; and Factor (E) there are other natural or manmade factors affecting its continued existence.

The identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an "endangered species" or a "threatened species." In assessing whether a species meets either definition, we must evaluate all identified threats by considering the expected response of the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, then analyze the cumulative effects of all of the threats on the species as a whole. We also consider the cumulative effects of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Service recommends whether the species meets the definition of an "endangered species" or a "threatened species" only after conducting this cumulative analysis and describing the expected effect on the species now and in the foreseeable future.

2.1 Distinct Population Segment (DPS) policy (1996):

N/A

2.2 Updated Information and Current Species Status

2.2.1 Biology and Habitat

2.2.1.1 New information on the species' biology and life history:

Texas prairie dawn-flower is endemic to Texas and previously thought to only occur in the eastern portion of the state, in Fort Bend, Gregg, Harris, Trinity and Waller Counties (USFWS 2015). Although new information on this species' biology is not available for this review, the Service recently awarded Section 6 funding from the U.S. Fish and Wildlife Service's Division of Wildlife and Sport Fish Restoration (WSFR) to Texas Parks and Wildlife Department (TPWD) to study Texas prairie dawn-flower reproductive biology, genetics, pollinators, and seed dispersal mechanisms over a two-year period on July 26, 2022 (WSFR Grant F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702). This study will evaluate at least 10 known populations in Fort Bend, Harris, Gregg, Trinity, Waller, and Madison Counties, Texas. Through this study we hope to understand more about the biological requirements of this species, so that appropriate conservation measures and land management strategies may be developed and implemented that lead to sustainable populations where suitable habitat is already established or discovered on private and public lands.

Seeds

The section 6 grant (WSFR Grant F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702) will fund seed collection and seed ecology research. Seeds will be collected from flower heads utilizing the Center for Plant Conservation (CPC) guidelines for seed collection from rare plants, limiting the seed collection to no more than 10% of seeds collected from the annual production of a population. This study will be conducting seed dispersal and germination research during the next two flowering seasons. Prior to this study, seed banking and management of Texas prairie dawn-flower has been an on-going recovery action conducted by the Mercer Botanic Gardens, Harris County. Seed banking is a critical component of the recovery plan for Texas prairie dawn-flower (USFWS 1989). As a member institution of the CPC, Mercer Botanic Gardens maintains a frozen bank of seeds of rare Texas flora. On March 1, 2004, seeds were collected from the Space Center Prairie Preserve near Ellington Field in Harris County (Tiller, unpublished research 2004; Electronic mail dated May 17, 2022). From this initial seed collection, 34.7 seeds per head were counted from 142 flower heads, with a range of 30 to 43.4 seeds per flower head. Flower heads from Texas prairie dawn-flower were also collected from one population on a saline barren prior to construction of West Green Road in north Harris County on May 3, 2012 (Tiller, unpublished research 2015). Although most Texas prairie dawn-flowers have single or double flower heads, the 2012 collection consisted of 1,006 plants with 5,819 fruiting flower heads, that could potentially yield 201,919.3 seeds, based on the previous 2004 estimate of 34.7 seeds per flower head. In this case, multiple plants were fused together as they germinated from one or more heads resting together in the soil. In the nursery, these seeds were observed to germinate directly out of the flower heads still attached to the mother plant, while the flower heads rested on the soil surface (Anita Tiller, Electronic mail dated May

17, 2022). These seeds were used to augment populations at the Harris County Precinct 4 Prairie Dawn Preserve (recently changed to Harris County Precinct 3 Prairie Dawn Preserve) and for *ex-situ* seed banking. Seeds are refrigerated until planting the following year in January through February, germinated in 13 days, and matured by May. Subsets of the seeds are transferred to seed banks maintained by Lady Bird Johnson Wildflower Center and the National Center for Genetic Resource Preservation in Fort Collins, Colorado, which serve as back-ups for these collections. Additional seed collections from Harris and Gregg County populations were completed on May 18, 2013 (Tiller, unpublished research 2015); and 164 flower heads were collected from the Trinity County population on May 16, 2022, for the Mercer Botanic Gardens' bank of rare Texas seeds (Anita Tiller, Mercer Botanic Gardens Harris County, Electronic mail dated May 17, 2022).

Pollinators

Although a potential pollinator of the Texas prairie dawn-flower was identified as composite thrips *Microcephalothrips abdominalis* from specimens collected north of Cypress (Young 1987), new potential pollinators were identified and photographed during the 2022 flowering season. Harvester ants in the genus *Pogonomyrmex*, which builds characteristic mounds more than 50 cm in diameter in large cleared flat areas with small pebbles, were observed and recorded within many of the saline barrens supporting populations at the Warren Ranch and the Jack Roads Prairies managed by the Coastal Prairie Conservancy. The harvester ants observed on the Warren Prairies during the 2022 flowering season was identified as *Pogonomyrmex barbatus* (Dr. Ulrich Mueller at University of Texas, Personal mail communication dated July 21, 2022). Additional pollinators were also identified as miner bees in the genus *Andrena* on the Warren Prairie, and the green miner bee in the genus *Lasioglosusm* on the Gregg County private lands (Dr. Dan Bennett at Stephen F. Austin University, personal mail communication dated July 28 and 29, 2022, respectively). Future research conducted under the section 6 grant (WSFR Grant F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702) will also identify potential pollinators over the next two years.

Habitat

Texas prairie dawn-flower habitat has previously been described as sparsely vegetated areas of fine, sandy to loamy, compact saline soils at the base of mima mounds (USFWS 1989; Bierner 2006; Mink et al 2010). This saline barren habitat contains cryptogamic soils that are often covered with the blue-green algae *Nostoc sp*., which appears as a "slick" surface during wet winters and early spring, or crusty dry patches during summer (Singhurst et al. 2014). Although historic records for this species show they only occurred on this type of coastal prairie habitat in the Gulf Prairies and Marshes Ecoregion, two isolated populations in Trinity and Gregg Counties were discovered on a

different type of saline barren habitat in frequently flooded sandy-loamy alluvial soils (Sawlit, Kullit, Wrightsville-Raino, and Udorthents Series) in the Piney Woods Ecoregion (SSURGO 2022; Table 1; Figure 1). These exceptions to the species historic range led the Service to investigate the potential for more populations occurring on similar soils in saline barrens habitat outside of this species' current range. We collaborated with TPWD, who had discovered a new population in Madison County, (Dr. Jason Singhurst at TPWD, Electronic mail communication dated March 29, 2022). Through our review of specific soil types, potential saline barren habitat in aerial imagery, and field investigations, we confirmed and photographed the new population in Madison County, which is located in a pasture adjacent to a major highway within the Post Oak Savannah Ecoregion (Figure 1; Photograph 1). This new population was observed to span multiple saline barrens associated with a rare soil type (Gowker Series, a fine-loamy siliceous thermic Cumulic Hapludolls), which is only found on frequently flooded stream terraces in east Texas (SSURGO 2022; Table 1). Our review of similar habitat with sparsely vegetated barrens on this same soil type indicates additional suitable habitat may be present on other private pastures and the state prison lands in Madison County and adjacent counties. The discovery of the new populations thriving in other ecoregions also indicates this species may have biological mechanisms that allow it to adapt or recruit to prairie habitats outside of it known range. Future recovery efforts will be focused on working with local private landowners to gain access to areas with this same soil and habitat type to determine if other populations may occur in the Post Oak and Savannah Ecoregions. We will also work with these landowners to conserve and manage these populations.

Loss of the saline barren habitat from urban development and agricultural use in the Gulf Prairies and Marshes Ecoregion continues to be a high threat to this species (USFWS 1989; 2015). However, there are seven populations in Harris and two populations in Waller County that continue to reproduce and recruit new plants annually because appropriate grazing practices, routine mowing, or invasive species management is implemented to prevent shading and competition with this species. Six of these self-sustaining populations in western Harris County are conserved on private lands managed by Coastal Prairie Conservancy (former Katy Prairie Conservancy). Although previous reports of the primary soils associated with these six populations were thought to be Gessner Series, the soils have been reclassified as Clodine-Warrenlake complex and Snakecreek fine sandy loam (SSURGO 2022; Table 1; Figure 2).

Coastal Prairie Conservancy also holds the conservation easement for one small population with less than 100 plants in Waller County on Tomball loam (Table 1; Figure 2). However, there is a much larger self-sustaining Waller County population of over 5,200 plants that spans 12 saline barrens conserved by a private landowner, which are located on Tomball loam and Wockley fine sandy loam soils (SSURGO 2022; Table 1; Figure 2).

Mercer Botanical Gardens and Harris County manages one self-sustaining population on three saline barrens in North Houston on an Addicks loam soil (SSURGO 2022; Table 1; Figure 2). This same soil is found further west in the Addicks Reservoir. However, implementation of mowing and invasive species control measures may not always possible when soil moisture levels are high, resulting in competing herbaceous and woody vegetation encroachments and degradation of existing suitable habitat.

Insufficient land management practices appear to be a greater threat to the smaller populations with less than 1,000 plants on saline barrens conserved in Harris County. Armand Bayou Nature Center and Harris County have attempted to mow and control invasive species woody encroachments for one population on 10 saline barrens on the Space Center Prairie near Ellington Field in southeast Harris County. This population is located the furthest south of this species range on a rare Mocarey soil type (SSURGO 2022; Table 1, Figure 2). However, wet soil conditions that have prevented implementation of routine mowing, and feral hog damages to the rare saline soils on this site have had negative effects on this population resulting in fewer and smaller plants.

Harris County Flood Control District also manages two saline barrens on Bernard Edna soils at the Willow Waterhole Prairie in Central Houston (SSURGO 2022; Table 1; Figure 2), by using manual removal methods for controlling encroaching vegetation because the saline barrens are enclosed in fenced areas where mowing is not possible. Alternative methods such as grazing or aerial spraying is prohibited within city limits, which restricts management of this species in an urban environment.

Although there are six saline barrens in the historic EO records on Clodine Complex soils (SSURGO 2022; Table 1; Figure 2) in Bear Creek Park in USACE's Addicks Reservoir, only two saline barrens produced flowers from this one population in 2022 (TXNDD 2021). Five of these saline barrens are located on Clodine Complex soils, and one is located on Katy fine sandy loam soils (SSURGO 2022; Table 1, Figure 2). Although the USACE annually marks these individual barrens with spray paint and prohibits mowing during the flowering season, there is no signage posted to inform mowers or recreational users to not disturb this endangered plant. The reasons for only a few barrens producing flowers from the same soil type under the same management conditions are unclear. A second population in Addicks Reservoir is located outside of the park where seven historic EO records are located north of Groeschke Road (TXNDD 2021). These saline barrens are located on a Cyfair find sandy loam soil (SSURGO 2022; Table 1; Figure 2). Only one of these saline barrens produced flowers in 2022 where a pipeline right of way is mowed.

However, there are an additional 117 EO records within Addicks and Barker Reservoirs that occur on Cyfair, Addicks, Clodine, Katy, and Waller soils

(SSURGO 2022; Table 1; Figure 2). Fifty of these saline barrens were surveyed in 2022, and no flowers were found where herbaceous or woody vegetation covered the barren. The USACE has monitored many of these populations on an annual basis since 1998, but many have not produced flowers for several consecutive years because routine mowing, or invasive species control measures have not been implemented. In some cases, the saline barrens cannot be surveyed, or invasive species control measures be implemented because there are no public roads or restricted public access because gated residential communities were allowed to be constructed on the periphery of the reservoir.

Table 1. Soil Types and Ecoregion associations identified with Texas prairie dawn-flower populations surveyed during the 2022 flowering season.

County	**Soil Code**	**Soil Type**	**Ecoregion**
Ft Bend	CduA	Clodine-Urban land complex	Gulf Prairies and Marshes
Ft Bend	Wb	Waller slightly saline, occasionally ponded-Katy complex	Gulf Prairies and Marshes
Gregg	KtB	Kullit very fine sandy loam	Piney Woods
Gregg	Ud	Udorthents, Loamy and Clayey	Piney Woods
Gregg	WrA	Wrightsville-Raino complex	Piney Woods
Harris	Ad	Addicks loam	Gulf Prairies and Marshes
Harris	Ak	Addicks-Urban land complex	Gulf Prairies and Marshes
Harris	Be	Bernard-Edna complex	Gulf Prairies and Marshes
Harris	Cd	Clodine fine sandy loam	Gulf Prairies and Marshes
Harris	Gs	Clodine-Warrenlake complex	Gulf Prairies and Marshes
Harris	Ap/Cd/Ca	Cyfair fine sandy loam	Gulf Prairies and Marshes
Harris	GesA/Wa	Gessner loam	Gulf Prairies and Marshes
Harris	Kat/Kf	Katy fine sandy loam	Gulf Prairies and Marshes
Harris	ModA	Mocarey-Urban land complex	Gulf Prairies and Marshes
Harris	SnlA	Snakecreek fine sandy loam	Gulf Prairies and Marshes
Madison	Go	Gowker clay loam	Post Oak Savannah
Trinity	SsA	Sawlit-Sawtown complex	Piney Woods
Waller	WoA	Wockley fine sandy loam	Gulf Prairies and Marshes
Waller	Wa	Tomball loam	Gulf Prairies and Marshes

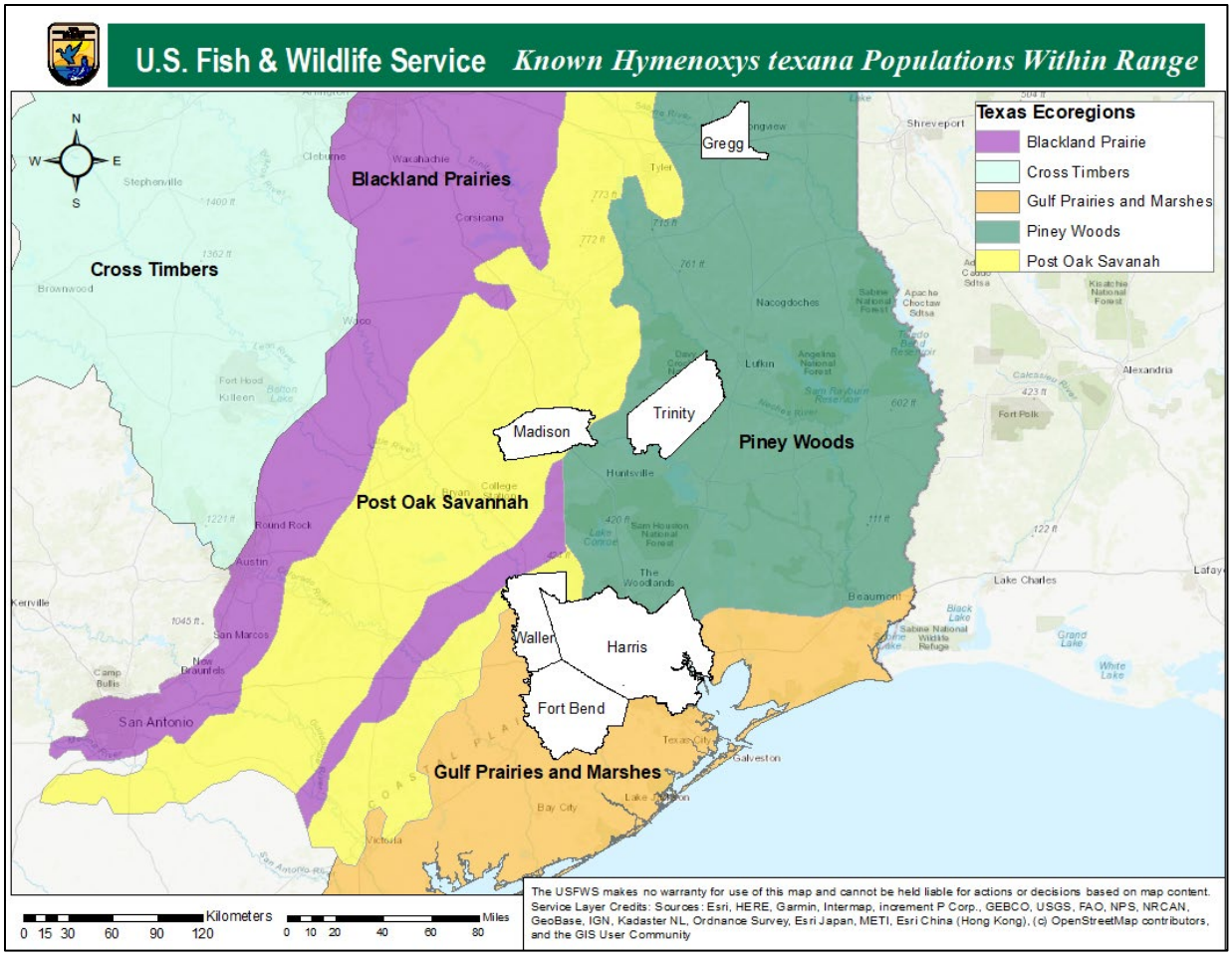


Figure 1. Texas prairie dawn-flower with known populations occur within the Gulf Prairies and Marshes ecoregion (orange), Piney Woods ecoregion (green), and Post Oak Savannah ecoregion (yellow). Fort Bend, Gregg, Harris, Madison, Trinity, and Waller counties are outlined on this ecoregion map where known populations occur. Populations may occur outside of these geopolitical boundaries in the same habitat as found within these ecoregions.



Photograph 1. New population confirmed in Madison County over multiple barrens within a grazed pasture adjacent to major highway.

2.2.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, birth rate, seed set, germination rate, age at mortality, mortality rate, etc.), or demographic trends:

The first verified record of Texas prairie dawn-flower was collected in 1889 near Hockley, in Harris County Texas (USFWS 1989). Texas prairie dawn-flower was not collected again until 1981 by James Kessler, when he discovered three populations growing in "buffalo wallows" or small depressions in Cypress, in northwest Harris County (Mahler 1982 and 1983). The Cypress populations were surveyed several times between 1981 and 1989 as recorded in the EO population records from the TPWD's Texas Natural Diversity Database (TXNDD 2021). These populations varied in size from 200 to 10,000 plants over the nine years they were monitored. These populations occurred on Cyfair fine sandy loam soils, which is not prime farmland and generally used for grazing (SSURGO 2022). This same soil type is found within other saline barrens within the Addicks and Barker Reservoirs within this species range. However, rapid development of private lands has accelerated over the past 20

years, and aerial imagery shows few saline barrens identified in the EO records remain undisturbed in this part of northwest Harris County (TXNDD 2021).

Although only one population in the Barker Reservoir was known at the time of this species listing, the EO records show 120 populations were located within the 24,500 acres of the Barker and Addicks Reservoirs (TXNDD 2021). This reservoir serves the Houston Community by providing a dry forested flood control basin for absorbing flood events or mowed recreational fields and bike trails for the public during non-flood events. No invasive species control measures have been implemented in the forested areas resulting in a significant decline in available saline barren habitat for this species to inhabit. During the 2022 spring flower blooming season, the Service surveyed 50 of these historic populations to confirm presence or absence on federal lands. The remaining 70 populations in the interior of the reservoir were not accessible. Only three of the 50 saline barrens surveyed in 2022 produce plants because they are routinely mowed for recreational purposes or for pipeline right of ways. Two of the saline barrens are less than 100 meters apart and are considered one population based on each plant EOs having a minimum separation distance of 1,000 meters (Nature Serve 2020, page 13). The third saline barren was located in another part of the reservoir. Plants were counted in each saline barren, using either total counts where the size of the patch was less than 20 square meters, or 20 to 40 representative one half meter square quadrats were used to subsample the entire saline barren, and the aerial extent was mapped using Collector software and ARCGIS Online to determine the population's total distribution over each saline barren. (Table 2). The USACE also provided their 1998-2022 annual monitoring records for these 120 saline barrens that show the majority of these populations have significantly declined since 2005. Although no plants were found on the historic saline barrens surveyed during the 2022 flowering season, the seed bank for these populations may remain in the soils and recovery may still be possible with appropriate management measures implemented.

The Service also surveyed an additional 12 known populations recorded the TXNDD (2021) and one recently discovered population not recorded. This effort was achieved with the assistance and cooperation of multiple partners including TPWD, Harris County, Mercer Botanical Gardens, Coastal Prairie Conservancy (former Katy Prairie Conservancy), T.L.L. Temple Foundation, Armand Bayou Nature Center, and several private landowners (Sand Hill Farms in Waller County and Komatsu Global in Gregg County). Seven of the known populations in western counties (Harris and Waller), and two populations in northern counties (Trinity and Gregg) had high densities of plants on multiple saline barrens conserved on private lands (Table 2). Two Harris County owned lands set aside for recovery including Mercer Botanic Gardens Prairie Preserve and Space Center Prairie Preserve had fewer plants than previous years (Table 2). The encroachment of native and non-native species appears to be the primary reason for competition for space at both sites. Willow Waterhole Detention Basin maintained by Harris County Flood Control in Harris County

had no plants flower this year. This site has had declining numbers for several years despite efforts to repopulate the saline barrens on these public lands.

The Service also investigated a potential population recently discovered by state biologist along a major highway on private lands in Madison County (Dr. Jason Singhurst Electronic email communication on March 29, 2022). Multiple patches of saline barren habitat were observed distributed across the entire landscape over a large tract of land adjacent to a stream. In this case, the plants were counted by binoculars from the fence line and abundance was estimated based on size of the barrens in aerial imagery.

Table 2. Populations Surveyed during 2022 Spring Flowering Season in each Ecoregion.

Populations	**Texas Prairie Dawn Populations Name**	**2022 Population Estimate**	**County**	**Ecoregions**
1	Addicks Reservoir – Bear Creek Park on Federal Lands	6,579	Harris	Western Gulf Prairies and Marshes
2	Addicks Reservoir – North Clay Road & Groeschke Road on Federal Lands	51	Harris	Western Gulf Prairies and Marshes
3	Private Lands held in conservation by Coastal Prairie Conservancy – North Warren Prairie	7,000	Harris	Western Gulf Prairies and Marshes
4	Private Lands held in conservation by Coastal Prairie Conservancy – Mid-Warren Prairie near Stream	33,074	Harris	Western Gulf Prairies and Marshes
5	Private Lands held in conservation by Coastal Prairie Conservancy – South-Warren Prairie near Stream	35,763	Harris	Western Gulf Prairies and Marshes
6	Private Lands held in conservation by Coastal Prairie Conservancy – adjacent to Warren Prairie	77	Waller	Western Gulf Prairies and Marshes
7	Private Lands held in conservation by Coastal Prairie Conservancy– North-Jack Roads Prairie	5,355	Harris	Western Gulf Prairies and Marshes

8	Private Lands held in conservation by Coastal Prairie Conservancy– Mid-Jack Roads Prairie	7,433	Harris	Western Gulf Prairies and Marshes
9	Private Lands held in conservation by Coastal Prairie Conservancy– South-Jack Roads Prairie	5,813	Harris	Western Gulf Prairies and Marshes
10	Private Lands proposed for future conservation	5,274	Waller	Western Gulf Prairies and Marshes
11	Mercer Prairie Dawn Preserve on Harris County Lands	2,583	Harris	Western Gulf Prairies and Marshes
12	Willow Waterhole Prairie Dawn Preserve on Harris County Flood Control Lands	0	Harris	Western Gulf Prairies and Marshes
13	Space Center Prairie Dawn Preserve on Harris County Lands	153	Harris	Western Gulf Prairies and Marshes
14	Private Lands	>30,000*	Madison	Post Oak Savannah
15	Private Lands	7,622	Trinity	Piney Woods
16	Private Lands	50,422	Gregg	Piney Woods

*Note estimates of populations where data could not be collected using actual counts or counts within quadrats interpolated over aerial coverage.

2.2.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

The Recovery plan reported genetic information was available for seven populations with chromosome number 2n = 16 (Strothers and Brown 1988), and one population with chromosome number 2n = 6 (Kessler and Hatch 1984) that occurred in same site north of Cypress. These populations are no longer accessible or have been converted to urban structures and roads. Although no new information on genetics of the 16 existing populations is available, the Service is providing section 6 funding to study reproductive biology, genetics, and seed dispersal mechanism for Texas prairie dawn-flower (WSFR Grant

F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702). This grant, awarded July 26, 2022, will investigate at least 10 populations in Fort Bend, Harris, Gregg, Trinity, Waller, and Madison Counties, Texas. Polyploidy-Flow Cytometry will be used to determine ploidy (chromosome numbers of 2n = 6) in Texas prairie dawn-flower populations. During the period of February to April, at least 10 Texas prairie dawn-flower populations will be visited across the range of the species to collect 50 mg of fresh plant tissue for flow cytometry for genetic analysis. Removing only this small portion of each plant will not result in any mortalities or damage to the population being evaluated. Depending on population size, up to 30 individuals from each population will be sampled and plant tissues will be sent to a Flow Cytometry Lab for ploidy determination.

2.2.1.4 Taxonomic classification or changes in nomenclature:

Texas prairie dawn-flower, *Hymenoxys texana* member of the Helenieae, tribe of the sunflower family (Asteraceae), originally described under the name *Actinella texana* by Coulter and Rose (1891), and later Cockerell (1904) proposed the new combination *Hymenoxys texana*. Texas prairie dawn is a delicate, 3.5-18 cm tall annual with a green to reddish, 4-7+ cm wide rosette of paddle-shaped leaves. These leaves persist on the plant past the blooming period. Although most of the leaves are at the plant's base, a few smaller leaves grow from the thin sprawling floral stalks. Leaves are ≤4 cm long, have three conspicuous veins on their underside, and can be shallowly lobed, saw-toothed, or smooth-edged. Two rows of overlapping green, leaf-like structures closely cup the outside base of the flower head. The inner row usually has a purple dot on each structure. Flower heads are yellow with no obvious "petals" (actually tiny flowers called ray florets) because they are hidden behind the leaf-like structures. The flat-topped flower head is composed of a tight disc of 40-75+ very small, yellow flowers. Each of these is called a disc floret and is only 1.5-2.1 mm long. The fruits that develop from this disc are cylindrical to pyramidal and are 1.5-2 mm long.

The taxonomic history of this species has not changed since the previous review, and greater detail is included in the Recovery Plan (USFWS 1989). *Hymenoxys texana* remains in same genus as *Hymenoxys sensu stricto* due to it is united outer bract (Bierner and Turner 2003). *Hymenoxys texana* is similar to the pygmy prairie dawn, *Hymenoxys perpygmaea* (Asteraceae, Helenieae, Tetraneuridinae). Pygmy prairie dawn is more erect, have smaller rosettes (1.3-2.4 cm diameter vs. 4-7+cm), shorter -lived basal leaves that wither before flowering, and has fewer disc florets per capitulum (17 and 32 vs. 45 and 75+) (Holmes et al. 2014). Only these two species of the 17 species in this genus are annuals, endemic to Texas (Poole et al. 2007).

2.2.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, pollinator availability, etc.), or

historic range (e.g. corrections to the historical range, change in distribution of the species within its historic range, etc.):

The spatial distribution of this plant has changed significantly since the 2015 review. Although the Recovery Plan (1989) and publications on this species (Singhurst et. al. 2014) provide a description of the saline soil type and barren prairie habitat where this species is found on the periphery of mima mounds in the Gulf Coastal Prairies Ecoregion, the potential for finding this species on similar soil types or suitable habitat has not been fully evaluated. Suitable habitat for this species was thought to be primarily located on Gulf coastal prairies in Harris, Fort Bend and Waller Counties, where urban development and former rice farming/rotational crops has disturbed or fragmented the remaining saline barren habitat needed for survival of this species (USFWS 2015). Specific soils that occur across the Gulf Prairies and Marshes Ecoregion, which may or may not be permanently lost to urban or agricultural development are shown in Figure 2. Only the western saline soils in suitable habitat in the Gulf coastal prairies remain where eight populations in Harris and Waller County have been preserved or protected from development by conservation easements on private lands managed by the Coastal Prairie Conservancy or adjacent private landowners.

The Coastal Prairie Conservancy manages three distinct populations distributed over 50 saline barrens on the Warren Ranch (115 hectares, 285 acres) and three distinct populations on 24 saline barrens on the Jack Roads Prairie (206 hectares, 511 acres) (Figure 2). These distinct populations are found on Clodine-Warrenlake Complex and Snakecreek soils. These large land tracts are specifically managed for protection and conservation of the Texas prairie dawn-flower populations. The Coastal Prairie Conservancy also manages through a conservation easement a smaller population on one saline barren on private lands (0.4 hectares, 1 acre), occurring on Tomball loam soils (Table 1; Figure 2).

In 2021, the Coastal Prairie Conservancy discovered 12 saline barrens supporting one large population on private grazing lands (20.2 hectares, 50 acres), that is located further north of their smaller conserved population in Waller County. This large population is located on both Wockley fine sandy loam and Tomball loam (Figure 2). This Waller population is separated from the small population managed by the Coastal Prairie Conservancy by a distance greater than 1,000 meters, the default distance for determining distinct populations where biological reproduction and seed dispersal mechanisms are unknown (Nature Serve 2020). The Service recommends further investigation of these two populations so we may have a better understanding of whether they are from the same population or separate populations. Specific soils found in Waller County are also found in Fort Bend, Colorado, and Austin Counties, which have not been explored for potential new Texas prairie dawn populations (Figure 2).

Mercer Botanic Gardens and Harris County manage one distinct population distributed over three saline barrens in north Harris County on Addicks soils (1.44 hectares, 3.58 acres) (Figure 2). Armand Bayou Nature Center and Harris County manages one distinct population over ten saline barrens in southeast Harris County on a rare Mocarey soil (9.71 hectares, 24 acres) (Figure 2). Harris County Flood Control District has tried to manage one distinct population on two saline barrens in central Harris County on Bernard Edna soils (6.07 hectares, 15 acres) (Figure 2). This soil type is not typical of saline barren habitat for this species and only one other historic EO record was previously found on this soil type, in the same vicinity as the Willow Waterhole on a local school athletic field (Figure 2). The Willow Waterhole population has declined despite attempts to repopulate the barrens, and hand-pull vegetation to remove encroaching plants. Although the seeds may persist in the soils, no plants were produced this year.

The USACE Addicks and Barker Reservoirs have 120 EO records within federal lands (9,915 hectares, 24,500 acres) on the southwestern side of Harris County and northeast side of Fort Bend County. Only two distinct populations were confirmed to produce flowers on three saline barrens with Addicks loam, Clodine and Cyfair fine sandy loams during the 2022 flowering season (Figure 2). The remaining populations are not managed for this species due to inaccessibility from woody vegetation or residential subdivisions constructed up to the edge of the reservoir. It is unknown if 70 of these populations could be restored through invasive species removal and routine mowing.

There also is an isolated record of this species in Trinity County (Keith 2003; Brown et al. 2007) where three saline barrens are specifically managed and conserved for Texas prairie dawn-flower on private lands (3.2 hectares, 8 acres) (Figure 3). This population is found on a Sawlit-Sawtown soil that is only found in a few locations in Trinity and Rusk Counties (SSURGO, 2022).

Over 15 densely populated saline barrens in Gregg County (Keith 2003; Brown 2011) are managed and conserved on private lands (75.5 hectares,187 acres) (Figure 4). This very distinct and well distributed population represents the most northern range of the Texas prairie dawn-flower populations. This population occurs on three soil types within a 1,000-meter radius with Udothents loamy and clayey soils, Kullit very find sandy loams and Wrightsville Raino Complex soils occurring in close proximity to each other. These soils are alluvial deposits on stream terraces that are frequently flooded which extend into Upshur and Rusk Counties (SSURGO 2022). Future investigation is needed to explored potential suitable habitat for this species in these three counties.

The Service's field observations in 2022 of a new population in Madison County recorded three densely populated saline barrens directly adjacent to the road, but aerial imagery indicates more than 30 barrens may occur on this one

tract of private land (24 hectares, 60 acres). Additional saline barrens with the Gowker soils (SSURGO 2022) appear to exist on the opposite side of the highway and further north and south of the new population. The saline barrens with this same soil type need to be investigated in this and adjacent counties for additional populations that have not been discovered during the next spring flower monitoring season (Figure 3).

Based on the 2022 surveys conducted during this species flowering season, there are over 16 distinct populations occurring on specific soils associated with suitable habitat for Texas prairie dawn-flower over the entire range. Based on our field observations and further review of aerial imagery, the Service created a One Range Map, that is available in ECOSPHERE/IPAC as of August 23, 2022 (Figure 5). This revised range map provides opportunities for further understanding of where undiscovered populations may still exist on Gulf coastal prairies in southern counties as well as alluvial sediments on stream terraces in more northern counties of east Texas. Future exploration of suitable habitat for Texas prairie dawn-flower may provide completion of the recovery goal to find 50 distinct populations that are protected from land use changes:

"The Recovery Criteria for this species to be downlisted to threatened will be possible when at least 50 separate populations, each occupying at least 1 hectare (2.47 acres) of suitable habitat are discovered or established, and when these 50 populations are protected from land use practices or land use changes that could destroy the populations (USFWS 1989). Hymenoxys texana can be delisted when management practices are established that ensure the numbers of plants at protected populations will remain stable."

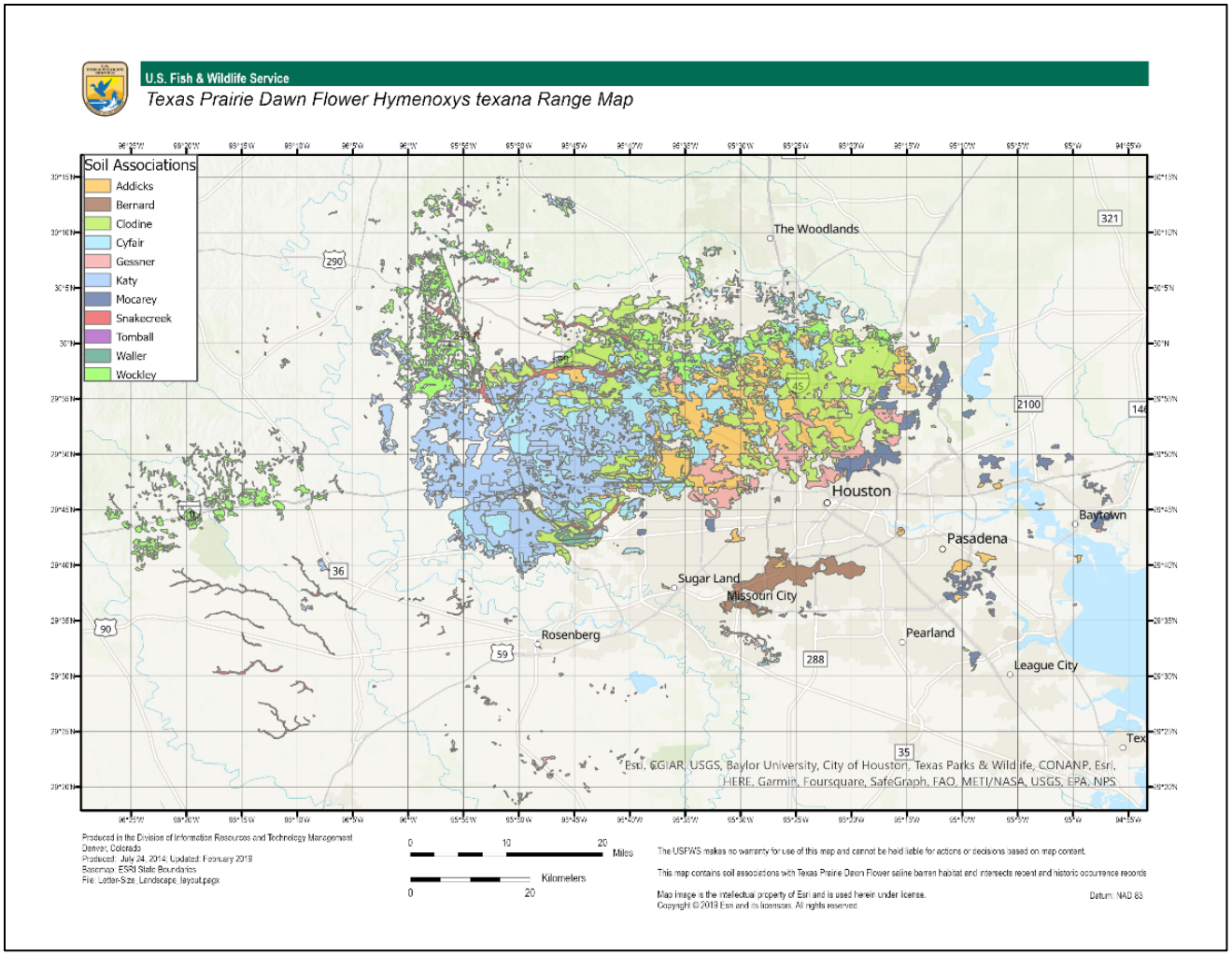


Figure 2. Saline barren habitat associated with specific soils found in the Gulf coastal prairies are color coded to show where potential suitable habitat for Texas prairie dawn-flower may occur (SSURGO 2022). Many of these soils are no longer available due to urban and agricultural development. Only the western soils in Harris and Waller County have been preserved or protected from development. Specific soils in Fort Bend, Colorado and Austin Counties have not been explored for potential Texas prairie dawn populations.

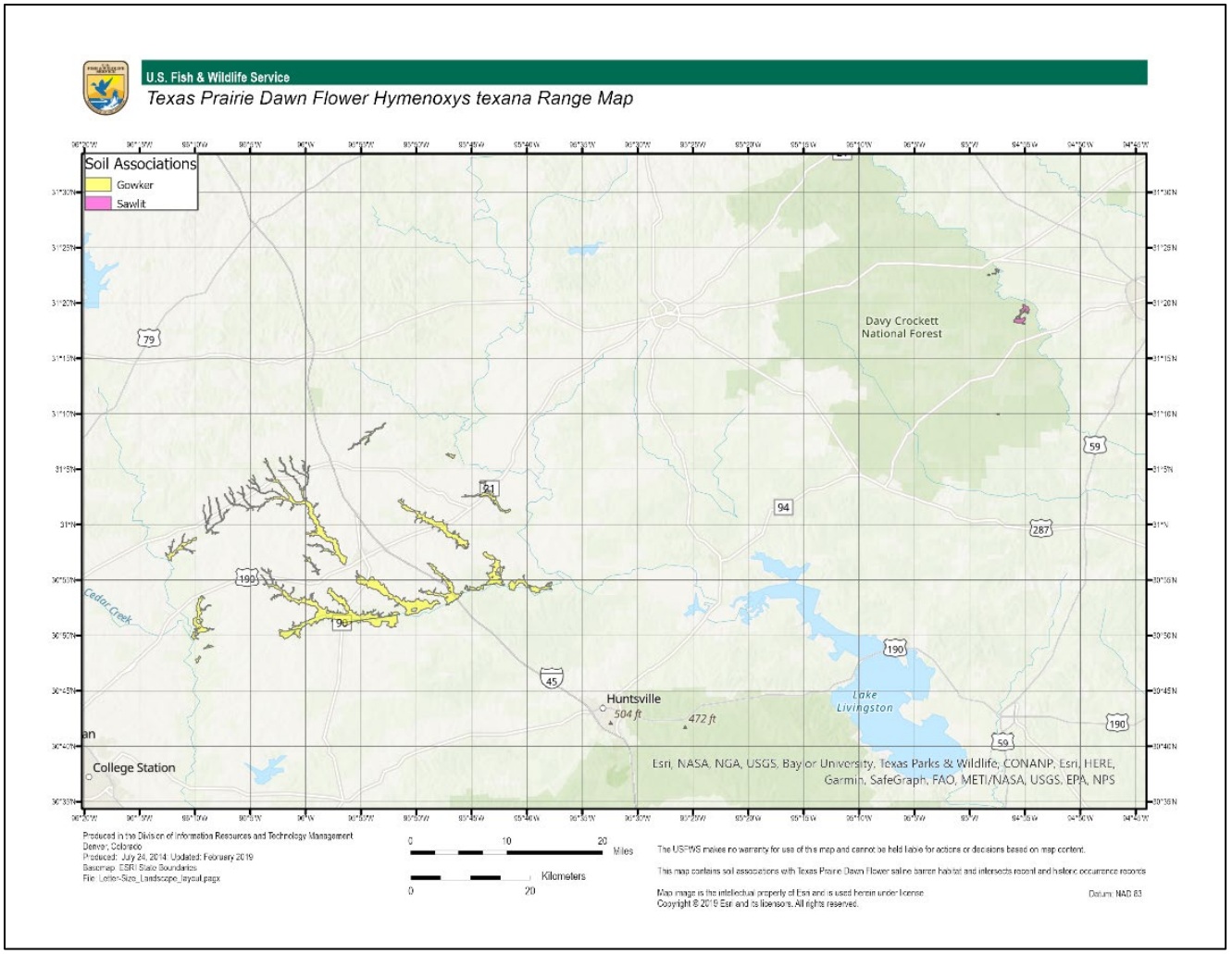


Figure 3. Saline barren habitat associated with specific alluvial soils (Gowker and Sawlit Series) found on stream terraces in the Post Oak Savannah and Piney Woods grasslands that provide suitable habitat for Texas prairie dawn-flower.

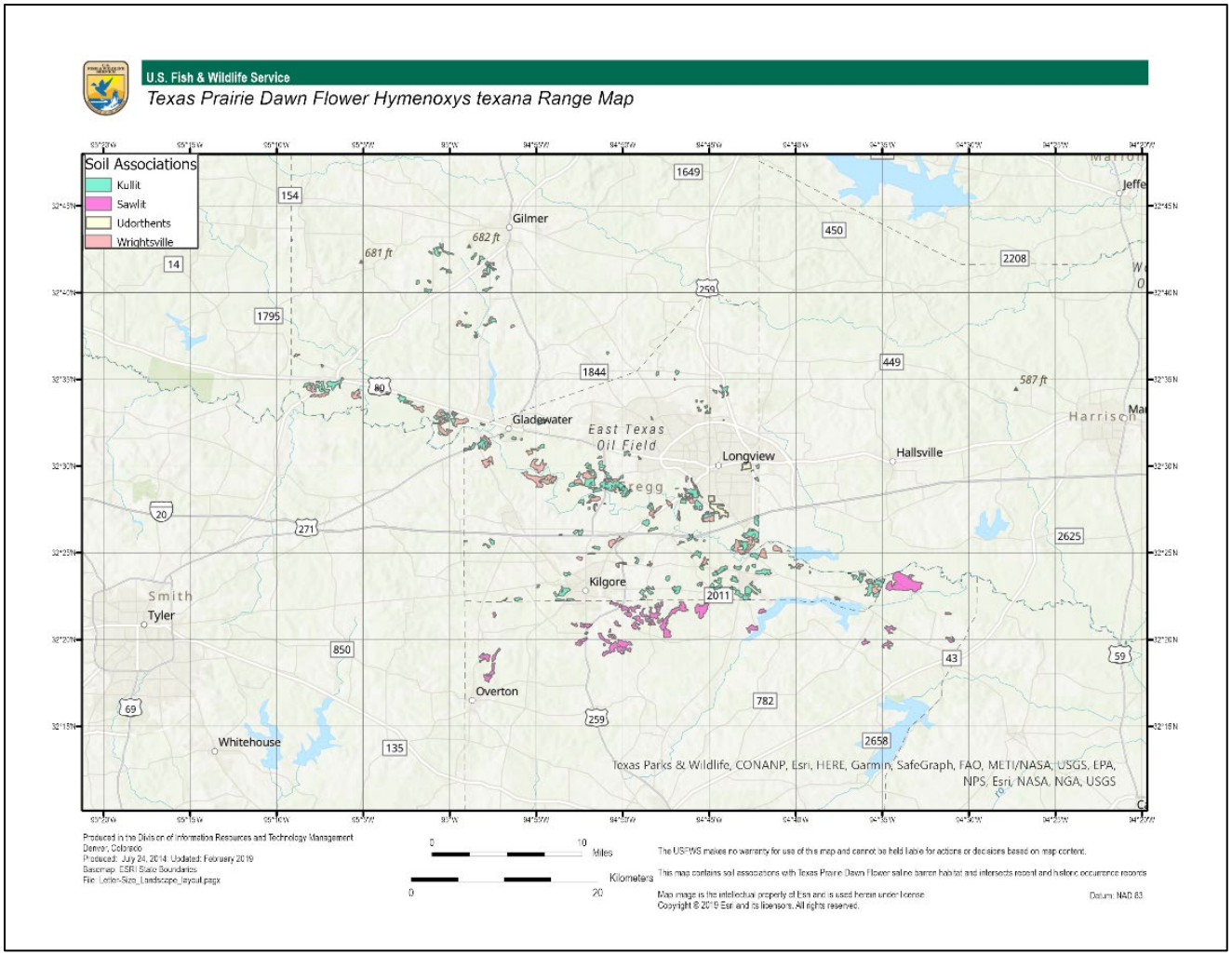


Figure 4. Saline barren habitat associated with specific alluvial soils (Kullit, Sawlit, Udothents, and Wrightsville Series) found on stream terraces in the Piney Woods grasslands in the northern extent of the range that provide suitable habitat for Texas prairie dawn-flower.

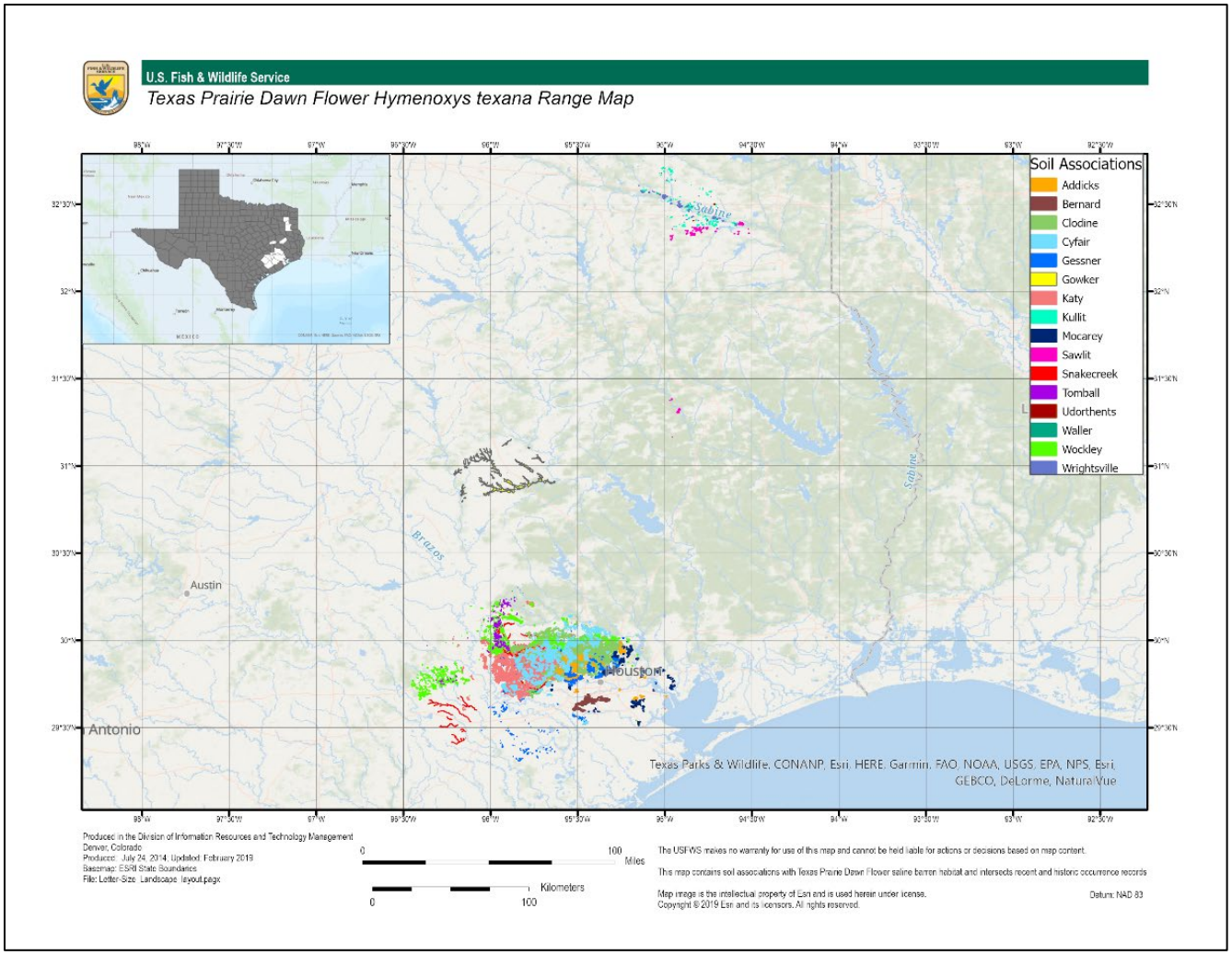


Figure 5. One Range Map (ECOSPHERE, 2022) for Texas prairie dawn-flower showing the full extent of saline barrens and the specific soils that provide suitable habitat for this species.

2.2.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

This review has documented the occurrence of Texas prairie dawn flower on saline barrens under different types of prairie habitats in East Texas. Based on our investigation the Texas prairie dawn requires specific soil types on sparsely vegetated saline barrens in the presence of specific microhabitats in order to compete with other annual plants. Much of the prairie habitat in the species southern range has been converted to urban developments or impacted by invasive woody encroachment, whereas prairie habitat in the species northern range has been converted to pasture lands and agricultural fields. Much of these agricultural lands have been leveled and levees constructed to impound water, which changes the hydrology of the landscape (USFWS 2015).

Although some grazing practices have affected and depleted many native flora on coastal prairies, cows do not forage on the Texas prairie dawn flower because it has a bitter taste. The positive benefit of cows removing competing less bitter tasting annuals allows them grow and flower in denser stands as observed during the 2022 surveys at Warren Ranch in Harris County, on private lands in Waller and Madison County. An additional positive benefit to this species appears to be from harvester ants clearing the area surrounding saline barrens which also removes competition for nutrients and space. However, a negative disturbance on saline barren habitat has been attributed to the rooting activity of feral hogs on both private and public lands (USFWS 2015). During the 2022 field survey, the Service recorded feral hog activity, which damaged soils at the Warren Prairie, Jack Roads Prairie, Space Center Prairie and on USACE lands.

Annual plants such as Texas prairie dawn-flower senesce and die within 4 to 6 weeks after flowers have produced seeds. Important factors in this species' short life cycle requires natural disturbances, in open areas with barren slicks made up of specific and sometimes rare soils, where specific hydrological requirements can be met. Although the exact role of natural disturbance (droughts, fires, and floods) has on these populations is unclear, these disturbances appear necessary to the continued recruitment and recovery of these populations. During the 2022 field surveys, the highest density of plants occurred where specific management practices such as invasive species control, grazing, mowing or prescribed burns had been implemented to deter other species from competing for space on the saline barrens within this species range. Insufficient management of competing species through natural or artificial disturbances or lack of pollinators may result in less effective seed dispersal mechanisms, and recruitment of future generations of plants. Future research in this area is needed and is funded through the section 6 grant that was awarded in July 2022 (WSFR Grant F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702).

2.2.1.7 Other:

Partnerships with other natural resource agencies, academic institutions, and local botanists have led to the identification of Texas prairie dawn in at least six counties, and conservation protection mechanisms are in place for 14 out of 16 populations distributed over 10,300 hectares (25,500 acres) (USFWS 2015).

2.2.1.8 Conservation Measures:

To ensure that appropriate conservation measures are considered when planning construction, excavation of soils or vegetation clearing in areas where there are known saline soils and potential populations of Texas prairie dawn flower as indicated in ECOSPHERE One Range Map, the Service recommends the following general conservation measures be implemented:

1. Consult with the Service to determine the species life history needs; and document the soils from the SSURGO database, the existing vegetation, hydrology, specific EO Records from the TXNDD, Information for Planning and Consultation (IPaC) database, site assessments, and field surveys for the species during its peak flowering season (March through April).
2. Complete training within one year from the Service or experts approved by the Service to be able to identify the species in the field and understand its life history needs and the conservation measures to be implemented to minimize or avoid effects to this species.
3. Conduct two years of surveys during flowering seasons (February through April) after coordination with the Service on standard monitoring methods and survey time frames.
4. Host a pre-construction/pre-activity conversation with contractors and/or producer to discuss the conservation measures applicable to the site.
5. Apply species specific conservation measures as deemed suitable by the Service where specific saline soils are present, that were identified in IPaC and are indicative of suitable habitat for Texas prairie dawn flower; or where EO records from TXNDD has identified that a population may be present. However, site specific locations may be difficult to identify because this species is wide ranging across three ecoregions and/or may occur on private lands that have not been surveyed.
6. Where a more restrictive species-specific conservation measure is identified, the more restrictive measure will govern the management and design for the project site.

To ensure that appropriate habitat loss or degradation of habitat conservation measures are implemented, the Service recommends the following specific conservation measures to avoid impacts to Texas prairie dawn suitable habitat:

1. Avoid earth moving actions or placement of structures involving a disturbance footprint of 20 square feet (~1.9 square meters) or larger where listed plant species occur.
2. Avoid construction during Texas prairie dawn flowering season (March through April).
3. Establish a 50-foot no-earth moving/vegetative management zone and mark known EOs with temporary biodegradable fencing/other suitable materials to avoid entry of equipment.
4. Where Mima mounds bearing or adjacent to known populations are to be cleared of invasive species, only hand tool methods may be used during flowering season between late February through April.
5. Access points and tracks within occupied, suitable, or critical habitats for covered plant species must be limited and clearly marked to avoid soil compaction and damage to covered plant species from vehicles and/or foot traffic.
6. Minimize soil and vegetation disturbance during project construction or installation in or adjacent to suitable habitat for Texas prairie dawn flower; avoid total removal of top layer of soil and only remove targeted species leaving the native species and soils as undisturbed as possible.
7. For linear disturbances, keep vegetative disturbances to less than 8 feet and use existing Right of Ways and access points to the extent possible.
8. Use Windows Pesticide Screening Tool (WIN-PST) (http://go.usa.gov/Kok) to determine pesticide use requirements.
9. Use existing travel routes through covered species habitat.
10. Establish scouting and routine treatment procedures for control of invasive species (e.g. *Triadica sebifera* (Chinese tallow); *Rosa bracteate* (McCartney rose); *Ilex vomitoria* (yaupon); *Diospyros virginiana* (Eastern persimmon); *Paspalum notatum* (Bahia grass), and *Cyperus entrerianus* (deep rooted sedge)).

2.2.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms):

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

Habitat conversion, fragmentation, and degradation of habitat continue to be a threat to this species (USFWS 2015). Expanding urbanization, construction of paved roads, over-growth of woody and herbaceous invasive species, feral hogs, alteration of watershed hydrology, and agricultural farming contribute to the loss of suitable habitat. Although heavy grazing may be detrimental to this species, light to moderate grazing reduces competition from other annual plant species and allows more open space for annual recruitment. Routine mowing with restrictions during the flowering season has similar positive benefits in removing competitive annual species and allows more open spaces for recruitment.

However, deep soil disturbances such as plowing and feral hog wallowing can be detrimental to this plant's existence. Many of the current saline barrens are not adequately fenced and are subjected to feral hog rooting and excessive cattle grazing. Managed grazing and installing fence panels designed to exclude feral hogs will greatly benefit the species (Service 2015).

Although efforts to restore, create, and effectively manage habitat for the Texas prairie dawn flower are underway, loss or degradation of suitable habitat continues to be a threat within this species range.

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

There is no data to suggest overutilization for commercial, recreational, scientific, or educational purposes is now or will affect Texas prairie dawn flower in the foreseeable future. Therefore, we do not consider this factor to be a threat to this species

2.2.2.3 Disease or predation:

There is no scientific data to indicate that disease or predation is affecting Texas prairie dawn-flowers. Therefore, we do not consider this factor to be a threat to this species. Although this species is often found in grazing pastures, the bitter taste of this plant prohibits it being targeted by herbivores. Harvester ants are often observed on the saline barren habitat of the most densely populated Texas prairie dawn-flower populations at the Warren Ranch and Jack Roads Prairies. These insects are known for clearing their nest areas of all vegetation and carrying seeds produced from the surrounding plants into their nests below the surface. Although harvester ants may prohibit Texas prairie dawn-flower growth near the mound or effect seed dispersal mechanisms, these insects appear to have a positive effect on this species by removing competing vegetation. Crawfish mud stacks were also observed at the Mercer Prairie Preserve, in the same vicinity as Texas prairie dawn-flowers, where the flower heads had recently been removed prior to the plant senescing. Although predation by harvester ants, or other invertebrates such as crayfish may be possible these biological factors should be considered in future research studies to determine what threat if any predation has on this species' recovery.

2.2.2.4 Inadequacy of existing regulatory mechanisms:

Species listed as Endangered or Threatened by the Act are protected by both Federal and State Law. Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed threatened or endangered plants on areas under Federal jurisdiction; the malicious damage of such plants on areas under Federal

jurisdiction; or the destruction of endangered plants on non-Federal areas in violation of any State law or regulation or in the course of any violation of State criminal trespass law.

Texas state laws and regulations pertaining to endangered or threatened plant species are contained in Chapter 88 of the TPWD Code and Sections 69.01 - 69.9 of the Texas Administrative Code (TAC) (TPWD 2022). State-listed plants may be found at 31 TAC §69.8(a) & (b). Texas state law prohibits any take (incidental or otherwise) of state-listed species. State-listed species may only be handled by persons possessing a Scientific Collecting Permit or a Letter of Authorization issued to relocate a species. Section 68.002 of the TPWD Code states that species of fish or wildlife indigenous to Texas are endangered if listed on the United States List of Endangered Native Fish and Wildlife or the list of fish or wildlife threatened with statewide extinction as filed by the director of TPWD.

Based on 2022 field surveys, only two known populations of Texas prairie dawn-flower out of 120 EO population records are producing flowers on federal lands (USACE Addicks and Barker Reservoir) where the Act prohibits removal or destruction of endangered plants. The USACE allows Harris County to mow recreational park areas during non-flowering seasons and prohibits mowing of one population during flowering seasons. No prohibitions have been implemented regarding the second population located in a pipeline right of way. Other EO populations on federal lands occur in areas where no mowing or invasive species control management measures are being implemented so competition from non-native and native species appears to be prohibiting plants from recruiting to the suitable habitat on federal lands.

However, there are not adequate regulatory mechanisms in place for protection or conservation of listed plant species on private lands that are not placed in conservation easements. The known populations that are under protection of conservation agreements on county, drainage districts, or privately owned lands are dependent on voluntary management practices for controlled grazing or non-flowering season specific mowing, and invasive species control measures to protect or maintain sustainable populations. Although regulatory mechanism for protecting endangered plants may not be sufficient to protect all populations on public and private lands from extirpation, proactive educational mechanisms for informing the public of this endangered plant and its habitat requirements would greatly enhance recovery efforts to conserve and protect this species.

2.2.2.5 Other natural or manmade factors affecting its continued existence:

Physical, Biological and Chemical Effects

Although the distribution of Texas prairie dawn flower is naturally restricted to specific habitat and soil requirements, there appear to be biological, chemical, and physical factors that influence population size and health. The exact role natural disturbance (droughts, fires, and floods) has on these populations is unclear, but these natural types of disturbances appear necessary to the continued recruitment and recovery of these populations. The following physical and biological conditions were recorded in each saline barren during the 2022 flowering season: size of the saline barren was determined by the number of patches of plants clustered or distributed across the barren (small – 1 to 3 patches, medium – 4 to10 patches, or large – 11 to 30 patches); the soil surface moisture level (dry or wet); presence of harvester ants or mounds; presence of miner bees or mounds, presence of feral hog activity, presence of rabbit, racoon, armadillo, deer, or other small mammal's feces or tracks; presence of cow hoof prints or manure; presence of blue green algae - *Nostoc* dried or wet on the surface of the soils; presence of hunting stands; proximity to roads, pipelines, recreational areas, or vehicle traffic; mowing or grazing practices; and invasive species presence or control measures. The highest frequency of physical factors that appeared to positively influence successful healthy flowering populations that went to seed before senescing were in large sparsely vegetated saline barrens, with slightly moist soils, the presence of harvester ants or miner bees, the presence of cows in lightly grazed pastures or routinely mowed lands, no disturbances from feral hogs or small mammals, and proximity to roads or pipelines where human foot traffic or animals transiting the area disturbed the soils. Although salinity was not measured in each barren during the 2022 flowering season, the effect of precipitation on salinity levels in the soils may also influence the density of plants present in each barren. The saline barren produced shorter less dense populations where the soils were compact and hardened on the surface. The saline barren produced denser populations where the soil was moist and more friable material. Less densely populated barrens were also observed where grazing or mowing was not implemented to remove competing species or maintain shorter grasses. The Service hopes to learn more about the effects of biological and physical factors on the reproductive biology and seed dispersal mechanism on this species from the section 6 funded research over the next two years (WSFR Grant F22AP03103-00, BO Reference Ecosphere 2022-0024702).

Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2022). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically

decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2022).

Recent climate change predictions indicate there will be more extremes in meteorological conditions observed globally (Bartholomeus et al. 2011; IPAC 2022). More prolonged dry periods will alternate with more intensive rainfall events, both within and between years, which will change soil moisture dynamics (Bartholomeus et al. 2011). The resulting increased occurrence of wet and dry extremes, contribute to plant stresses (e.g., oxygen needs, nutrient needs, acidity requirements, etc.) caused by high or low soil moisture content. High soil moisture contents hamper oxygen transport from the atmosphere through the soil, where part of the oxygen is additionally consumed by soil microorganisms, to the root cells (Bartholomeus et al. 2008). Reduced respiration negatively affects the energy supply to plant metabolism. Drought stress as a result of low soil moisture content inhibits plant transpiration, a process that also responds to increased temperatures and atmospheric carbon dioxide concentrations (Porporato et al. 2004). Species adapted to specific moisture conditions that reduce transpiration water loss or grow in anoxic conditions have traits that allow them to counteract these types of stresses. However, threatened, or endangered plants that have adapted to specific wet or dry conditions in suitable habitat may not have the ability to respond to drastic changes in temperature and precipitation that are not within their physical traits to counteract. Plant life stages such as leaf emergence or flowering period may be altered by these extreme wetting and drying periods, which may hinder survival and reproduction (Loarie et al. 2008; Anacker et al. 2013). However, plant species vary drastically in their response to climate change, based on numerous factors including life history, topographic complexity, geographic range, species rarity, among others (Anacker et al. 2013, p. 207). Negative effects to threatened and endangered species predicted from these extreme conditions include changes in species range, suitable habitat loss, expansion of invasive species, decrease connectivity (IPCC 2022, page 2137).

It is unknown whether climate change that already occurred affected existing Texas prairie dawn-flower populations and/or its distribution. Although there is no new information on reproductive strategies or seed dispersal mechanisms for this species, there are some indications that climate change may be a factor affecting reproduction and possibly distribution of Texas prairie dawn-flower's populations. While future climate projections generally indicate an increase in average annual temperature and decrease in average annual precipitation (Climate Mapper 2022, Table 3), the Service is not able to predict how Texas prairie dawn flower might be affected by the type (i.e., temperature or precipitation) and degree of future climate change under different greenhouse gas emission scenarios (representative concentration pathways (RCPs)).

Field observations of Texas prairie dawn-flower indicate that seasonality, particularly dry winter and spring seasons, result in fewer, less robust

individuals, and fewer seed heads (USFWS 2015). Lower densities of plants were recorded for the 2022 flowering season at Mercer Botanical Gardens Harris County Prairie Preserve, Willow Waterhole Prairie Preserve and Space Center Prairie Preserve after a dry winter in 2021. However, the highest density of plants recorded during the 2022 flowering season occurred on private lands in counties Madison, Trinity, and Gregg Counties, where more precipitation and cooler temperatures prevailed during winter and spring months. Conversely, when annual rainfall exceeds normal levels Texas prairie dawn-flower populations responds with fewer and less robust plants. As an example, the flowering season after Hurricane Harvey in August 2017 where floodwaters covered a major portion of Houston and Addicks Barker Reservoirs resulted in the lowest density and size of plants in known EO populations. Therefore, while it appears reasonable to assume that Texas prairie dawn flower may be affected by the expected changes in climate forecasted, potentially even benefit with decreased or increased precipitation, the Service lacks sufficient certainty to know how climate change specifically will affect this plant.

Climate change can further impact species phenology, pollination, and response to disease. Multiple studies document the effects of climate change on species that require pollinators. Changes in a species phenology can cause known pollinators to become "out of sync" with the species flowering period, resulting in the reduction in the species overall viability as a result of a reduced reproductive output (Forrest 2014, pp. 5-6; Kudo and Cooper 2019, p. 4; Gerard 2020, pp. 77-78). Further research is needed on the phenology and pollination of a species and associated pollinators to determine the impacts, if any, as a result of climate change. Since little is known about the effects from parasites and pathogens on this species (USFWS 1989; 2015), any effects from this threat and climate change are also unknown.

Table 3. Projected change in annual, winter, and spring temperatures, or annual, winter, and spring precipitation was evaluated through the University of California MERCED Climate Mapper tool within Harris, Waller, Ft. Bend, Madison, Trinity, Gregg counties, Texas.

County	Season	Climate Variable	RCP 4.5 (2010-2039)	RCP 4.5 (2040-2069)	RCP 8.5 (2010-2039)	RCP 8.5 (2040-2069)
Harris	Annual	Temperature	2.1	3.6	2.2	4.7
Harris	Annual	Precipitation	-1.0	-2.1	-1.2	-4.9
Waller	Annual	Temperature	2.2	3.7	2.3	4.9
Waller	Annual	Precipitation	-1.5	-2.1	-1.6	-5.5
Ft. Bend	Annual	Temperature	2.1	3.6	2.2	4.7
Ft. Bend	Annual	Precipitation	-1.0	-2.4	-1.4	-5.3
Madison	Annual	Temperature	2.3	3.9	2.4	5.1
Madison	Annual	Precipitation	-1.3	-0.9	-0.9	-4.1
Trinity	Annual	Temperature	2.3	3.9	2.4	5.1
Trinity	Annual	Precipitation	-1.1	-1.4	-0.7	-4.7

Gregg	Annual	Temperature	2.4	4.1	2.5	5.4
Gregg	Annual	Precipitation	-0.4	-0.5	0.3	-2.6
Harris	Winter	Temperature	1.8	3.2	2.0	4.3
Harris	Winter	Precipitation	-5.0	-3.7	-3.5	-6.2
Waller	Winter	Temperature	1.8	3.3	2.2	4.5
Waller	Winter	Precipitation	-5.0	-4.0	-4.1	-6.7
Ft. Bend	Winter	Temperature	1.8	3.2	2.1	4.4
Ft. Bend	Winter	Precipitation	-5.5	-4.0	-4.1	-6.9
Madison	Winter	Temperature	1.9	3.5	2.3	4.6
Madison	Winter	Precipitation	-2.4	-2.4	-3.3	-3.4
Trinity	Winter	Temperature	1.9	3.4	2.3	4.6
Trinity	Winter	Precipitation	-2.3	-3.0	-3.4	-3.8
Gregg	Winter	Temperature	2.0	3.6	2.3	4.7
Gregg	Winter	Precipitation	0.8	-0.4	-1.7	0.1
Harris	Spring	Temperature	2.1	3.6	2.0	4.7
Harris	Spring	Precipitation	2.0	-0.7	-1.5	-5.7
Waller	Spring	Temperature	2.2	3.7	2.2	4.9
Waller	Spring	Precipitation	0.1	-1.4	-2.5	-6.6
Ft. Bend	Spring	Temperature	2.1	3.6	2.0	4.8
Ft. Bend	Spring	Precipitation	1.4	-2.1	-2.1	-7.4
Madison	Spring	Temperature	2.2	3.8	2.2	5.0
Madison	Spring	Precipitation	-0.5	-0.6	-0.9	-4.2
Trinity	Spring	Temperature	2.2	3.8	2.1	4.9
Trinity	Spring	Precipitation	0.1	-0.1	-1.1	-4.3
Gregg	Spring	Temperature	2.2	3.8	2.2	5.0
Gregg	Spring	Precipitation	0.3	2.1	1.3	-1.2

2.3 Synthesis

A comparison of the current spatial distribution of the Texas prairie dawn flower with historical or previous reviews of this species shows the species has expanded its range westward into Waller County and beyond, and into northern regions of east Texas. Although this plant may have been historically present on prairies which were frequently disturbed by fire, floods, or grazing herbivores that eliminated or reduced plant competition, their diminutive size, short life cycle, and requirements for sparsely vegetated saline prairies makes them difficult to identify, and vulnerable to the current threats of habitat loss and insufficient management of invasive and competitive native species. Additionally, the uncertainty of threats from climate change, predators, diseases and other biological, chemical, or physical factors remain unclear. However, the information provided from research conducted through the recently awarded section 6 grant (WSFR Grant F22AP03103-00; Biological Opinion, Reference Ecosphere 2022-0024702) will provide a better understanding of the reproductive biology, seed dispersal mechanisms, the role of pollinators, and genetics of the populations, and will guide future management strategies to conserve and manage sustainable populations where they exist and where new populations are discovered.

Texas prairie dawn-flower was listed as an endangered species in 1986 because few populations were known, the species distribution had limited range across specific soil types and habitat conditions, and there was imminent destruction of this habitat through urban expansion and agricultural conversion of prairies to rice fields and rotational crops. The term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man. Through our evaluation of Section 4(a) of the Act we determined the Texas prairie dawn flower should remain an endangered species because: Factor (A) continues to be present or threatened destruction, modification, or curtailment of its habitat or range; and Factor (D) continues to be threat from inadequacy of existing regulatory mechanisms; and Factor (E) there are other natural or manmade factors affecting its continued existence. Although there is no defined threat from Factor (B) overutilization for commercial, recreational, scientific, or educational purposes, there is a level of uncertainty for Factor (C) with the effects of disease or predation that are not known, which may affect Texas prairie dawn-flower population's future existence.

3.0 RESULTS

No change in status is recommended because the threat of suitable habitat loss and landscape changes from urban to agricultural conversions continue to remove the remaining saline barrens required by Texas prairie dawn-flower to survive in Gulf coastal prairies despite the discovery of new populations in western and northern prairies with specific soils required by the species to survive. During the 2022 flowering season, the Service gained a greater understanding of population distributions by working with partners to monitor their populations using standardized methods that are not biased and repeatable. Although there are land management plans available to assist landowners with implementing mowing and invasive species control measures, several Texas prairie dawn-flower populations on public lands are surrounded by urban development, which restricts the use of alternative methods for controlling competitive species on suitable habitat (e.g., control burns, grazing, and aerial spraying during non-flowering seasons). However, significant progress has been made in discovering new populations, and funding research to be conducted on existing populations so we will have a better understanding of this species, and its habitat needs in the future.

3.1 Recommended Classification:

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

3.2 New Recovery Priority Number (indicate if no change; see 48 FR 43098):

No Change Recommended.

Brief Rationale:

No change in status is recommended because the threat of suitable habitat loss and landscape changes from urban to agricultural conversions continue to remove the remaining saline barrens required by Texas prairie dawn-flower to survive in Gulf coastal prairies despite the discovery of new populations in western and northern prairies with specific soils required by the species to survive.

3.3 Listing and Reclassification Priority Number, if reclassification is recommended (see 48 FR 43098): N/A

Reclassification (from Threatened to Endangered) Priority Number: N/A
Reclassification (from Endangered to Threatened) Priority Number: N/A
Delisting (Removal from list regardless of current classification) Priority Number: N/A

Brief Rationale:

N/A

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

We recommend that the following actions be taken for the conservation of the Texas prairie dawn flower (*Hymenoxys texana)*:

- Evaluate the recent SSURGO soil information on this species in conjunction with aerial imagery that identifies saline barren habitat on Gulf coastal prairies and Post Oak Savannah prairies that have not been previously surveyed, including the National Wildlife Refuges, where the Act does provide some legal protection for federally listed plants on federally owned lands.
- Evaluate the genetics of at least 10 populations to determine if the species as a whole still possess levels of genetic diversity and heterozygosity that would be found among non-threatened *Hymenoxys* species.
- Continue to work with partners to annually monitor populations on their lands and use consistent standardized methods that were used during the 2022 field season that are comparable across all saline barren habitats.
- Work with partners to acquire new habitat conservation plans for private landowners.
- Investigate climate change effects on the reproductive and seed dispersal mechanisms of the species and its suitable habitat.
- Evaluate and quantify predator effects (terrestrial mammals, invertebrates, and/or insects) on the species.
- Evaluate and quantify the role of pollinators for this species
- Work with partners to implement invasive species management plans and mowing strategies to restore suitable habitat for this species.

- Work with partners to identify propagation and relocation strategies for successful plug and seed transplants to restore suitable habitat where invasive species management practices have been successfully implemented.

Research conducted under the section 6 grant (WSFR Grant F22AP03103-00, BO Reference Ecosphere 2022-0024702) awarded to TPWD on July26, 2022, may provide new information on the reproductive biology, seed dispersal mechanism, genetics and pollinators for the Texas prairie dawn that will be available for the next 5-year review. We recommend once this information is reviewed, if possible given workloads, a Species Status Assessment could be conducted to guide the development of a revised recovery plan.

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U.S. FISH AND WILDLIFE SERVICE

Texas Prairie Dawn Flower (*Hymenoxys texana)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Jan Culbertson, Fish and Wildlife Biologist

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service, Texas Coastal Ecological Services Field Office in Clear Lake

Approve CHARLES ARDIZZONE Digitally signed by CHARLES ARDIZZONE Date: 2022.08.29 13:05:51 -05'00'