Texas prairie dawn-flower
(Hymenoxys texana)

5-Year Review:
Summary and Evaluation

Photo credit: USFWS

U.S. Fish and Wildlife Service
Texas Coastal Ecological Services Field Office
Houston, Texas

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ABBREVIATIONS

Act	Endangered Species Act
ABNC	Armand Bayou Nature Center
Corps	United States Army Corps of Engineers
CPC	Center for Plant Conservation
DPS	Distinct Population Segment
EO	Element of Occurrence
Ge and Gs	Gessner soil complex
GIS	Geographic Information Systems
HCFCD	Harris County Flood Control District
H. texana	*Hymenoxys texana*
IPCC	International Panel on Climate Change
Ka	Katy fine sandy loam soil
KPC	Katie Prairie Conservancy
MABG	Mercer Arboretum and Botanic Gardens
Section 7	Section 7 of the Endangered Species Act
TPWD	Texas Parks and Wildlife Department
TxNDD	Texas Natural Diversity Database
USGS	United States Geological Society
USFWS	United States Fish and Wildlife Service

5-YEAR REVIEW
Texas prairie dawn-flower/*Hymenoxys texana*

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional Office: Southwest Region Office Region 2, Albuquerque, NM
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1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (USFWS) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4 (c)(2)(A) of the Endangered Species Act (Act) (16 U.S.C. 1531 et seq.) once every five 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:

We provided notice of this status review via the Federal Register (75 FR 15454) requesting information on the status of the Texas prairie dawn-flower *Hymenoxys texana*. No comments from the public were received. This 5-year review document was prepared by staff of the Texas Coastal Ecological Services Field Office, without peer review.

Information contained herein is derived from published reports in peer-reviewed literature, USFWS files including the *H. texana* Recovery Plan (USFWS 1990), section 7 consultations, the Texas Parks and Wildlife Department's (TPWD) Texas Natural Diversity Database (TxNDD), monitoring reports, scientific publications, unpublished documents, and data received through personal communications involving electronic mail from various individuals representing non-

governmental organizations, universities, and State and Federal agencies involved in *H. texana* monitoring, research and management.

Presentations and summaries derived from a workshop on the status of *H. texana*, held in Houston, Texas, September 30, 2014, were also utilized in this report. Local *H. texana* landowners, managers, and professionals discussed current species trends, land management practices, threats, future species needs, research opportunities, and monitoring techniques. As a result, many of the recommendations from the meeting are captured throughout the document.

The TxNDD was established by TPWD in in 1983 and is a member program of the larger NatureServe network. Comprised of over 8,500 records, the TxNDD stores rare plant and animal spatial and tabular data submitted by Federal, State, academic, non-governmental organizations, researchers, and consultants. TxNDD tracks over 700 natural resource "Elements" including all federally listed plant species known to occur in Texas. These data are presented as Element Occurrences (EO). "An EO is an area of land or water where an element is or was present and has practical conservation value" (TPWD 2015). Since 2004, there are only a few EO updates to the TxNDD. The TxNDD files are incomplete but TPWD expects to have all EOs entered for *H. texana* in Fiscal Year 2016.

1.4 Background:

H. texana, a member of the Helenieae tribe of the Asteraceae family, is a single-stemmed or branching annual reaching a height up to six inches. Its leaves are spoon-shaped, basal, alternate, and narrow. The species was first collected in 1889 near Hockley, Texas, and was considered extinct until rediscovery in 1981 (W. F. Mahler 1982, USFWS 1990, Brown et al. 2007, Poole et al. 2007, Singhurst et al. 2014). *H. texana* is found in small, conspicuous, sparsely vegetated areas of fine, sandy, and compact soils. These bare spots are often located on the lower sloping portions of pimple mounds (USFWS 1990). Pimple mounds are low, roughly circular or elliptical domes or shield-like mounds, often with flat tops, composed of unstratified sandy loam soils coarser than, and distinct from, the surrounding less coarse, often clayey soil. Pimple mounds range from 1 to 30 meters (m) in diameter, and attain heights from about 10 centimeters (cm) to over 2 m (Johnson and Horwath Burnham 2012). Common soil series associated with *H. texana* consist of primarily Gessner Complex (Ge) and Katy Find Sandy Loam (Ka or Kf). *H. texana* flowers from early March through mid to late April and produces yellow, cone-shaped seed heads. The early flowering period is a result of specific wet conditions available on the bare and saline slick spots where the plant is found. These spots tend to dry out to almost desert like conditions during the hot summer months. Cool and wet winters tend to produce conditions favorable for increased and more robust flowers. However, drought conditions (as seen during the winters from 2009 to 2011) may impede growth of the plant resulting in fewer individuals. Alternatively, excessively prolonged wet winters can reduce the number of plants present, as was evident during the 2015 growing season.

Originally described under the name *Actinella texana* by Coulter and Rose (1891), Cockrell proposed the new combination *H. texana* in 1904 (Cockrell 1904). Initially thought to occur in only two counties, this species is now confirmed in five counties in Texas: Fort Bend, Gregg, Harris, Trinity, and Waller.

Throughout this document we refer to sites to indicate a general area of presence, but sites do not necessarily correspond to individual populations (i.e. there can be multiple populations at a site). There are no rigorous definitions to delineate populations of this species at this time, but we refer to populations throughout this document in a more general sense to indicate a localized area of species presence.

Up until about 1992, *H. texana* was known only from the northwest portion of Houston with only one population located in Fort Bend County (Barker Reservoir), with subsequent populations located in Addicks Reservoir in Harris County. In 1993, researchers located several populations in the Pineywoods area west of Lake Houston. In 1999, two populations were located on the south east side of Houston near S. Post Oak Road. Then in 2002, several populations were identified on a prairie adjacent to the Ellington Field Joint Reserve Base. In 2003, researchers located a population in Trinity County (Brown et al. 2007); one most recent discovery (2011) occurred in Gregg County on private lands. The Gregg County site has almost 187 acres (ac) (75.7 hectares [ha]) of prime *H. texana* habitat and may have populations over 50,000 individuals. The Waller County site is a small privately owned site (< 1 ac [0.4 ha]) with a few hundred individual plants.

Identified as a crucial recovery action for *H. texana* in 1986, Mercer Arboretum and Botanic Gardens (MABG), located in Houston, began seed collection from all known locations to maintain a seed bank (USFWS 1990). While the number of counties where *H. texana* is known to be present has increased since the publication of the Recovery Plan (USFWS 1990), additional work is needed to further define the distribution range and additional suitable habitat for potentially undiscovered populations and promising areas for reintroduction.

1.4.1 Notice citation announcing initiation of this review:

75 Federal Register 15454-15456, March 29, 2010.

1.4.2 Listing history:

Original Listing
FR notice: 51 CFR 8681
Date listed: March 13, 1986
Entity listed: *H. texana* (Texas prairie dawn-flower)
Classification: Endangered without Critical Habitat

1.4.3 Associated rulemakings: None

1.4.4 Review History:

No previous 5-year review has been conducted for this species. Other review documents include:

- ❖ Proposal to determine *Hymenoxys texana* to be an endangered species, 1985, (50 FR 9095)
- ❖ Determination of endangered status for *H. texana*, 1986, (51 FR 8681)
- ❖ Final Recovery Plan, (USFWS 1990)
- ❖ Habitat Conservation Plan for Private Lands in the Gulf Coast Prairies of Texas, (USFWS 1995)

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

The species' recovery Priority Number is 5C, meaning there is a high degree of threat, the recovery potential remains low and the C indicates there is potential for conflict with development activities.

1.4.6 Recovery Plan or Outline

Name of plan or outline: Texas prairie dawn-flower (*H. texana)* Recovery Plan
Date issued: April 13, 1990
Dates of previous revisions, if applicable: No revisions completed

2.0 REVIEW ANALYSIS

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

The Distinct Population Segment policy applies only to vertebrate animals.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes

2.2.1.1 Does the recovery plan contain objective, measurable criteria? Yes.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? No.

The single downlisting criterion developed at the time the *H. texana* Recovery Plan (USFWS 1990) was published does not reflect any new available information. In addition, new threats relevant to the species and its habitat have been identified and should be incorporated and addressed in a revised recovery plan.

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

***Downlisting criterion 1*:** *H. texana* can be downlisted to threatened when at least 50 separate populations, each occupying at least 1 ha (2.47 ac) of suitable habitat are

discovered or established, and when these 50 populations remain protected from land use practices or land use changes that could destroy the populations.

***Discussion*:** The coastal prairie region is located along the western Gulf coast of the United States extending from Louisiana and into southeast Texas. Once comprised of almost 9 million ac (3.6 million ha) of prairie, with 6.5 million ac (2.6 million ha) in Texas alone, what remains is one tenth of one percent or about 65,000 ac (26,304 ha) in Texas (USGS 2015). Much of the former prairie has been converted to pasture lands and agricultural fields. In Texas, some of the landscape was transformed to accommodate intense rice farming. Many of the native pimple mounds closely associated with *H. texana* were leveled and levees were constructed to impound water which ultimately changed the hydrology of the landscape. Grazing practices have forever changed the vegetative landscape affecting and depleting many native flora found in the coastal prairies.

Ninety-five percent of Texas's land is privately owned and urban sprawl pressure accounts for land losses (not limited to prairie only) upwards of 200,000 ac (80,937 ha) every year (Texas Land Conservancy 2010). Under the Act, plants are not afforded the same protection as are vertebrate species. It is not prohibited by the Act to destroy, damage, or move protected plants unless such activities involve an endangered species on Federal land or if the action occurs in violation of State laws. If a person wishes to develop private land with no Federal jurisdiction involved, in accordance with State law, then the potential destruction, damage, or movement of endangered or threatened plants does not violate the Act. While there is an Incidental Take Permit process in the Act for animals [in section 10 (a)(1)(B)], there is no such process for plants.

Due to the plant's limited protection on private lands, the USFWS may not be alerted to the presence of *H. texana* populations in many instances, as coordination is not required. Continued coordination with natural resource partners and academia does provide some information on these private sites that may or may not be evaluated as part of the downlisting and delisting criteria.

While there are 63 known occurrences of *H. texana* in the TxNDD (TPWD 2014) this can not be interpreted to mean that 63 distinct populations exist. Many of the occurrences document subsequent visits to known *H. texana* sites by the public, TPWD staff biologists, other botany professionals, and are not all inclusive. Most occurrences note number of plants seen, associated species, and site condition (e.g. developed, overgrown vegetative conditions). However, little has occurred to delineate each of the populations into one hectare size plots for recovery purposes.

Further, a lack of systematic surveying efforts, consistent monitoring, data collection efforts, and a central database housing up-to-date accurate population data, makes it difficult to assess historical and current *H. texana* populations for movement toward downlisting or delisting.

Researchers initially believed *H. texana* occurred in only two Texas counties. However recent surveys revealed populations in three additional counties. In 2012, a Gregg county landowner first identified *H. texana* on 187 ac (75.7 ha) where surveys found the largest *H. texana* population with estimates greater than 50,000 individuals. Trinity County also is home to one 2-3 ac (0.8-1.2 ha) site where an estimated 2,000 to 3,000 plants were identified in 2004. Waller County supports one known population of *H. texana* (currently under a conservation easement) that is managed by a local land trust. Due to these recent findings, it appears that *H. texana* is more widespread than originally thought and the range of this plant warrants further investigation. TPWD assisted in the plant identification and subsequent counts at all of the newly identified sites. As a result of the three additional county findings, spatial analysis using Geographic Information Systems (GIS) followed by ground truth visits are necessary to determine the species' true range. No sites have been delineated sufficiently to assess whether the downlisting recovery criterion of a minimum of 50 separate one hectare (2.47 ac) populations is met. Figure 1 illustrates *H. texana's* current known range.

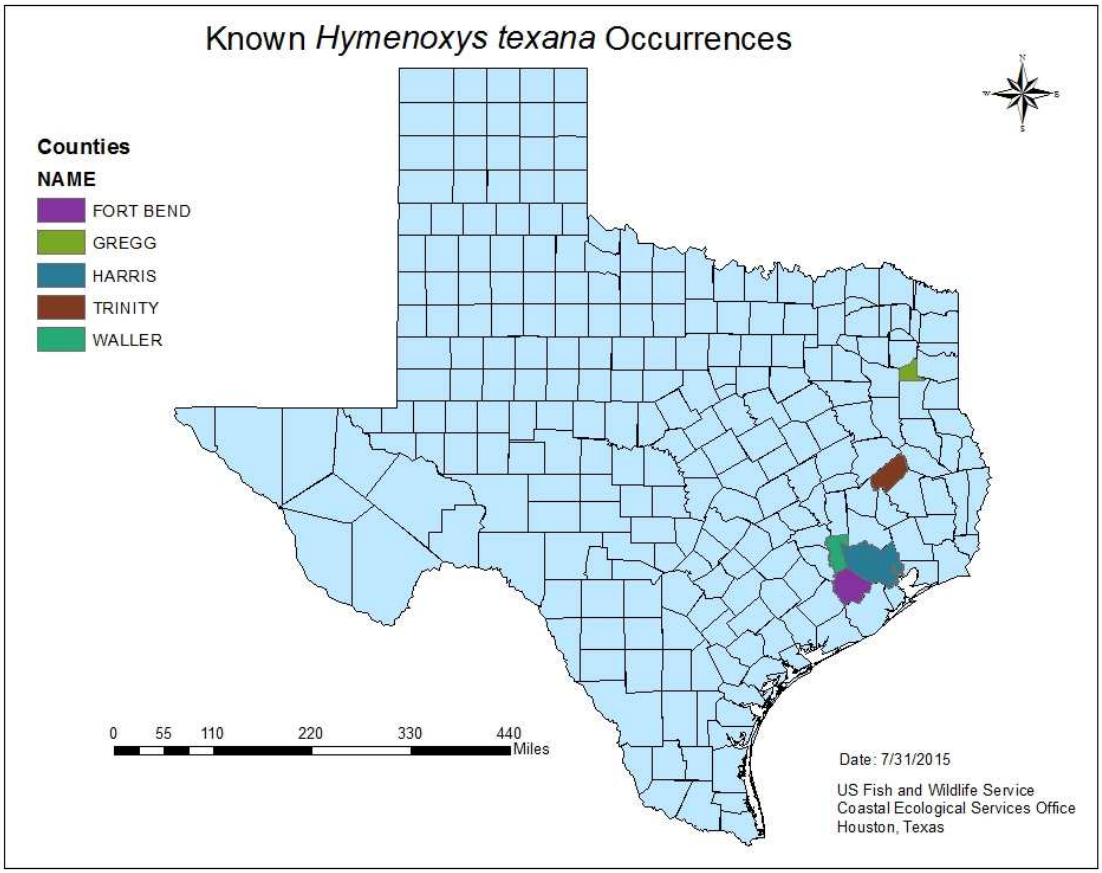

Figure 1 Current *H. texana* county occurrences

***Delisting criterion 1*:** *H. texana* can be delisted when management practices are established that ensure the numbers of plants at protected populations will remain stable. Since many questions about the biology and habitat requirements of *H. texana* remain

unanswered, it may be necessary to modify the downlisting and delisting criteria as additional information is obtained.

***Discussion*:** Current land managers (both private and public) are aware of the specific needs of *H. texana*, which require the development of habitat management plans. Funding to carry out necessary activities crucial to the continued existence of *H. texana* may be the limiting factor for both public and private landowners. Such has been the case at US Army Corps of Engineers (Corps) property located in Addicks and Barker Reservoirs where once thriving populations (the largest *H. texana* populations from the late 1990s through 2001were found here) now have only a fraction of the active populations historically surveyed. One Addicks Reservoir site recorded almost 11,000 plants in 2001 and since has not been surveyed. Several additional *H. texana* sites are in imminent danger of being completely decimated due to a failure to maintain suitable habitat conditions. Excessive woody vegetation encroachment, ground debris, and feral hogs have negatively impacted many of the once productive sites by excessive shading and soil disturbance.

Acquiring tracts of native prairie for preservation in the immediate and surrounding areas of Houston has proven to be extremely difficult. Much of the historical *H. texana* sites were lost due to highway, residential, and commercial construction and many times the USFWS was not alerted to their presence due to the lack of federal protection afforded to plants.

Review of current *H. texana* research lacks focus on identifying land management options that may lead to downlisting or delisting the species. While much of the literature mentions *H. texana* as an overall poor competitor that prefers slightly disturbed sites, more research is needed to identify specific management practices compatible with *H. texana* growth and site success. If this research comes to fruition, and additional land management practices are identified and incorporated into new and current land management plans, this may increase opportunities to work with private landowners to protect and conserve preferred *H. texana* habitats.

It is unclear whether 50 separate one ha (2.47 ac) populations currently exist as specified in the downlisting criterion. Although it is possible that the downlisting criterion may have been met, more information is needed to determine both the number of populations and the size of the area that each population occupies. It is apparent that current management practices at many known populations are not sufficient to maintain stable populations. Thus, the delisting criterion has not yet been met.

Recovery team:

H. texana does not have a recovery team. However, the species is included within the East Texas Plant Workgroup. This newly formed group is led by USFWS staff and is composed of researchers, botanists, land managers, and state and federal agencies to promote the continued existence of rare and listed plant species.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

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

Associated Species: Several of the scientific names of the associated species originally listed in the Recovery Plan (USFWS 1990) have changed and are noted in Table 1.

Table 1 Renaming of species historically associated with *H. texana*

Historical Scientific Name	Common Name	New Scientific Name
Guilleminea lanuginose var. tenuiflora	Cottonflower	*Gossypianthus lanuginosus* (Poir.) Moq. Var. *tenuiflorus* (Hook).
Houston machaeronthera	Houston tansyaster	*Rayjacksonia aurea* (A. Gray)
Gutierrezia triflora	Thurovia	*Thurovia triflora* Rose
Tillaea aquatica	Pygmyweed	*Crassula aquatica* (L.) Schoenl.
Talinum parviflorum	Prairie flameflower	*Phemeranthus parviflorus* (Nutt.) Kiger
Centunculus minimus	Chaffweed	*Anagallis minima* (L.) Krause
Hedyotis rosea	Rose bluet	*Houstonia rosea* (Raf.) Terrell
Lepidium ruderale	Common pepperweed	*Lepidium densiflora*

Singhurst (2014) proposes eight new associated species with *H. texana* and are noted in Table 2. A complete list of proposed associated species for *H. texana* can be found in Appendix A.

Table 2 List of new proposed associate species

Scientific name	Common Name
Atriplex texana	Texas saltbrush
Coreopsis basalis	Goldenmane tickseed
Distichlis spicata	Saltgrass
Lechea san-sabeana	San Saba pinweed
Opuntia macrorhiza	Twistpine pricklypear
Schoenolirion wrightii	Texas sunnybell
Spergularia echinosperma	Bristleseed sandspurry
Valerianella florifera	Texas cornsalad

Growing Conditions and Soils

A recent description of *H. texana* describes the species as found in localized patches ranging from 2 to 3 m in size or as large as 100 square meters usually

associated with Gessner and Katy fine sandy loam soils which sometimes are located at the base of pimple mounds (Smeins 2014).

Typical habitat for *H. texana* in Texas. Photo Credit: USFWS

Katy Prairie Conservancy (KPC) (a non-profit land trust) conserves almost 20,000 ac (8,093 ha) of tallgrass prairies adjacent to Houston. KPC manages suitable *H. texana* habitat on both the Warren Ranch and the recently acquired Jack Road South Prairies, in Harris County, Texas. Recent soil surveys at both prairie sites indicate a possible new soil series suitable for *H. texana*. Current soils are classified as Gessner Complex (Gs and Ge) or Katy Fine Sandy Loam (Kf) (Wheeler 1976), both of which are considered suitable for *H. texana*. Singhurst et al. (2014) reports the presence of the Natric horizon found within the Warren prairie soils which separates it from the Gs and Kf series, may not accurately reflect the soils found, and indicating a possible new soils association.

Singhurst et al. (2014) described the Houston Saline Prairie Association. *H. texana* is limited to only one of the two phases of this association. Part of the Houston Coastal Prairie (National Vegetation Classification System 2012), the Houston Saline Priaire is comprised of *Sporobolus pyramidatus, Spergularia echinosperma, Iva angustifolia, Hymenoxys texana* and *Thurovia triflora*. Phase 1 is dominated by *Sporobolus pyramidatus*, *Spergularia echinosperma*, *Iva angustifolia*, and *Nostoc* (Nostocaceae). Phase 2 is dominated by *Sporobolus pyramidatus*, *Hymenoxys texana*, *Thurovia triflora*, and *Willkommia texana*. This association consists of saline prairies primarily dominated by annual plants. Singhurst et al. (2014) further notes the newly described Houston Saline Prairie Association persists on sandy and clay prairie landscapes with salty barren spots adjacent or between pimple mounds.

Further, Singhurst's research revealed the differences in percent cover within KPC saline barrens (Table 3) that are indicitive of the Houston Saline Priaire Association's two phases described above.

Table 3 Percent cover of KPC Saline Barrens

Site	Genus	% Cover
Jack Road	*Sporobolus pyramidatus*	8.4
	Spergularia echinosperma	6.8
	Iva angustifolia	3.6
	Nostoc spp.	3.3
	Bare	50.8
North Warren Ranch	*Sporobolus pyramidatus*	6
	Hymenoxys texana	3.3
	Thurovia triflora	2.9
	Willkommia texana	2.3
	Bare	55.6

Source: Singhurst et al. (2014)

Some researchers suggest *H. texana* may be correlated with the presence of salt domes and fault lines along the eastern portions of the state. Further investigation to include on-the-ground surveys and GIS analysis may be warranted to identify any correlation between these geologic features and the presence or absence of *H. texana*.

Propagation

As part of the recovery tasks, Mercer Arboretum has maintained endangered species and native garden displays since 1994. The display garden pots require little maintenance aside from weeding other plant seedlings and fire ant control. All *H. texana* pots are mixed with an equal blend of sand and prepared garden mix. Because *H. texana* is a facultative halophyte, no additional salt is necessary. Once the seed heads mature, they are "pushed" into next year's display pots. However, duplicating the hydrological regime or maintaining barren "slick" spots for this species to survive is extremely difficult. Mercer was successful with greenhouse propagation for seed bank purposes and salinity tolerance experiments; however, results are not publically available.

MABG staff was encouraged when seeds from a 1993 in–house propagation experiment were germinated during the winter of 2001 under greenhouse conditions at almost 70% with 50% survivorship (Center for Plant Conservation 2015). However, further germination studies are needed to optimize frozen storage of seeds. Some positive preliminary results have shown seeds to remain viable for approximately 30 years; however protocols are needed to standardize frozen storage methods.

While germination efforts have been successful, reintroduction efforts of *H. texana* by MABG and Harris County Flood Control District (HCFCD) have resulted in poor results and warrant further testing to determine reintroduction parameters.
MABG was awarded a grant by the Lady Bird Johnson Wildflower Center Conservation Grant Program to conduct seed accessions, germination tests, and create and update a seed accessions database. These germination tests include not only *H. texana*, but two rare associates *Rayjacksonia aurea* and *Chloris texensis*. Seed collection of the rare associate *Thurovia triflora*, were completed in Harris County in December 2013. Updates for these seed accessions are being prepared for the TxNDD and Center for Plant Conservation database (Tiller 2015).

Monitoring
Smeins (2014) suggests a relatively rapid assessment procedure to provide sufficient quantitative data to track *H. texana* over time. Dr. Smeins selected 24 permanent sites for long term monitoring within the Jack Roads complex that had relatively large populations of *H. texana* the previous year. Within each site a sampling scheme consisting of 20 quarter-meter quadrats was developed to capture the abundance and distribution (Smeins 2014). A summary of the 2015 data is found in Table 4.

Dr. Smeins' monitoring protocol (2014) is specific to *H. texana* and marks the first attempt at a standardized count method for this species. Monitoring at most other sites with large patch populations involves estimating and sometimes counting individual plants while other sites count seed heads. Adopting a standard method for defining and monitoring populations would provide consistent results and allow for better analyses of *H. texana* populations.

Sister Species
A new and similar species, *Hymenoxys perpygmaea*, was identified and cataloged in May 2009 (Mink 2012). This species is similar in appearance to *H texana*, exists as an annual plant, flowers from April to May, is endemic to alfisol prairies containing pimple mounds in Lamar County, and consists of only one population with approximately 300 individuals. Its distribution is not known to overlap geographically with that of *H. texana*.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

The earliest reports of *H. texana* identitfied a total of 21 sites in 2 counties; 11 located on public and 10 on private lands (USFWS 1990). There is limited historical data avalable for many of the private landowner sites in Harris County. The TxNDD reports that many of the historical sites have disappeared due to development. While early efforts to preserve some of the historical populations

may have been unsuccessful, new sites and expanded ranges recently were identified for *H. texana*.

U.S. Army Corps of Engineers

The largest *H. texana* populations were located on public lands held by the Corps at Addicks and Barker Reservoirs. The Recovery Plan (USFWS 1990) reports 11 total sites (8 sites at Addicks and 3 sites at Barker Reservoirs) with the largest site occupying almost 40 ac (16.2 ha) (USFWS 1990). Today, many of these sites have either dissappeared or have been significally reduced in size due to a lack of management, woody encroachment, and poor grazing practices. Survey data was not completed for years 2002-2004 and 2008-2009; for the years where surveys were conducted, many of the sites were not visited. Overall population trends for Addicks and Barker Reservoirs show a dramatic decrease at all sites. Surveys were diligently completed between 1997 and 2001 with 17 sites reporting over 1,000 plants each. One site reports 10,775 plants in 2001 but then only 37 plants since the last survey in 2006.

The USFWS continues to work with the Corps to provide recommendations for *H. texana* management, site restoration prioroties and opportunities, and monitoring support.

Harris County Flood Control Distric and Harris County

Harris County Flood Control District (HCFCD) continues to intensively manage two *H. texana* sites in Harris County. Both sites are located within the Willow Waterhole Detention Basin in southeast Houston. The Basin was constructed to mitigate flood events from Brays Bayou and subsequently *H. texana* was identified at two locations within the remnant prairie. HCFCD created a Coastal Prairie Management Area for the remnant prairie adjacent to the *H. texana* sites. Both *H. texana* sites are fenced. The sites receive annual removal of woody vegetation and plant debris, planting of native grasses to control the spread of Bermuda grass, scheduled mowings, and cleaning of all mowing equipment prior to use to reduce spread of invasive species within buffered areas (HCFCD 2013). An improvement from previous years, a total of 100, 122, and 887 individuals were counted during the respective 2013, 2014, and 2015 growing seasons (Benigno pers. comm. 2015). A Coastal Prairie Management Plan was recently completed for both populations at this site and future research efforts are a critical component.

Two other HCFCD *H. texana* sites exist at the Hollister Road Detention Basin Complex. Both sites were identified as potential habitat (Brown 2011); however, the USFWS is not aware of any additional *H. texana* surveys being conducted at either site in recent years. One of the sites lies adjacent to a road, is partially fenced, mowed regularly, and receives no management. The other site is fenced on one side, exhibits excessive tree canopy, has continuous leaf litter, and no active habitat management.

In 2004, Harris County Precinct 2 (HC) acquired a 24 ac (9.7 ha) tract along Space Center Blvd, Houston, Harris County, Texas, where *H. texana* was discovered. The property remained fallow for many years resulting in significant growth of woody invasive species creating a closed canopy layer over much of the property. The USFWS (2008) provided specific immediate and long-term management recommendations for this site and identified this tract as one "of the highest conservation priority and its permanent protection and active management would play a critical role in the conservation of regional biodiversity." However, the lack of habitat management resulted in the total loss of five *H. texana* sites, and severely reduced the number of individuals at many of the remaining eight sites. USFWS files (Stevens 2009) cite approximately 2,300 plants identified at 13 sites across the tract in 2009. Through a recent grant, Harris County plans to restore the site back to a natural coastal prairie habitat (2015) by strategic tree removal and improved fencing aimed at excluding cattle and feral hogs. Armand Bayou Nature Center (ABNC), a department within Harris County, agreed to maintain the site once restoration is complete. *H. texana* can benefit from mowing, fire, and other treatments that limit woody encroachment (Poole et al. 2007) and will be outlined with other management recommendations in the site management plan due out in late 2015.

Harris County Precinct 4 Prairie Dawn Preserve, Harris County
As part of mitigation action for road construction from 2013-2014, a 3.6 ac (1.5 ha) *H. texana* site on Cutten Road and the extension of West Greens Road, Harris County, Houston, Texas, was security fenced and surrounded by a berm and swale system aimed at repelling contaminated runoff and protecting site hydrology. Additionally, in 2013 and 2015, the site was cleared of approximately 47 trees that threatened the *H. texana* habitat. MABG agreed to actively manage the site where it receives intensive habitat enhancement (tree removal, timed mowings, and invasive species removal). As a result of the intensive management, the site rebounded with an estimated 10,700 plants in 2014 and approximately 18,800 in 2015 (Tiller 2015) on three saline slicks. Plants of the rare associate species, *Chloris texensis* and *Rayjacksonia aurea*, have spread beyond the preserve fence within the bounds of the sidewalk servicing West Greens Road. Mercer plans to conduct various *H. texana* relocation experiments during the winter of 2016 at this site.

Trinity County
First identified in 2003, two *H. texana* sites have been located on a 20,000 ac (8,093 ha) privately held tract in Trinity County, south of Lufkin, Texas. Both sites lie adjacent to Boggy and Bayou Sloughs (with hydrological connections to the Neches River) where small openings (8-10 ac [3.2-4 ha] and 2-3 ac [0.8-1.2 ha] sites respectively) in pine-oak bottomland forests (dominated by Loblolly pine *Pinus taeda)* revealed small saline glades. Under the guidance of TPWD botanists, this tract was placed under a conservation easement in 2013 where a management plan guides land managers. TPWD staff report that much of the property has not been surveyed and it is likely that more prairie openings exist

where *H. texana* may be found. This site can remain saturated and at times inundated with water for a period of weeks due to its proximity to the Neches River. Keith (2003) reported several of the glades had some mechanical disturbance while feral hog damage was the most significant disturbance at all of the four glades. Surveys in 2003 indicated 100 plants while a 2004 survey estimated 2,000 to 3,000 individual plants.

MABG has collected, cataloged, and stored seeds from this site. The USFWS does not have consistent and accurate population data for the Trinity County sites nor have these sites been updated in the TxNDD since 2004.

Gregg County

In 2013, large populations of *H. texana* were identified on a privately held 1,225 ac (495.7 ha) property in Gregg County, Texas. The USFWS knows little about this site. However, TPWD and MABG staff have visited and recorded site specifics, collected and cataloged seeds, and are hopeful the landowner will place the property into a conservation easement. Once owned by Laterno Industries, upland portions of the site were used as a major industrial facility while bottomland forests remained undeveloped and used for recreational purposes. Singhurst (pers. comm. 2014) estimated 5,000 to 10,000 individual plants in 2012. There were no complete surveys done in 2013 or 2014; however, landowner representatives now claim approximately 187 ac (75.7 ha) are documented to support *H. texana*. With this large of a site now documented, it will be important to determine how this site contributes to the overall recovery of the species. Of special note, pipelines located through prairie habitat on this property seem to be especially abundant with *H. texana* (Singhurst per. comm. 2014). The USFWS does not have consistent and accurate population data for this site nor has it been added to the TxNDD.

Katie Prairie Conservancy

A local non-profit land trust, Katie Prairie Conservancy (KPC) aims to protect up to 50,000 ac (20,234 ha) of the Katy Prairie while providing public access and outreach and restoring upland and wetland habitats for a variety of fish and wildlife species.

Part of the Warren Prairie, KPC purchased the Warren Ranch property at a 70% buy-in while the Warren family continues to hold the remaining 30%. Two additional parcels of the Warren Prairie, totaling 285 ac (115.3 ha) were purchased specifically to preserve *H. texana* populations. An additional 511 ac (206.8 ha) of the Warren Prairies (still held in private ownership) also known as the Jack Road Prairie, supports *H. texana* and serves as prime habitat for the plant. KPC provides management oversight for this property (Singhurst et al. 2014).

KPC staff survey existing populations of *H. texana* and investigate various management practices aimed at establishing a well-developed management plan.

Prior to 2015, formal delineations of the site were not performed to determine how this site contributes to recovery goals for the species. During the spring of 2015, intensive surveys began utilizing a rigorous new monitoring protocol developed by Dr. Fred Smeins (Texas A&M University) where 24 currently occupied sites will be permanently monitored.

KPC and TPWD staff surveyed at least one of the Warren Ranch sites (both privately owned and KPC ownership) in 2003, 2005, 2006, 2008, 2009, and 2010. However, before 2008, surveys were limited to only locating *H. texana* populations and inventories for associated species (Singhurst 2014). Table 4 depicts the 2015 survey results where over 50,000 plants were counted for the entire location. The USFWS does not have population data for any of the KPC or the Jack Roads site prior to 2015.

Table 4 Jack Roads 2015 survey results

Area	Site	# of Plants	Site average	Total plants for each area
1	1	3,419		
	2	2,169		
	3	2,902		
	4	1,652		
	5	3,615		
	6	4,461		
	7	4,154		
	8	2,314	3,086	24,683
2	9	1,552		
	10	578		
	11	3,406		
	12	2,427		
	13	570		
	14	1,808		
	15	259		
	16	811	1,426	11,411
3	17	4,330		
	18	878		
	19	2,758		
	20	2,570		
	21	1,346		
	22	3,032		
	23	2,243		
	24	2,555	2,464	19,712

Waller County

In Waller County, *H. texana* was recently identified on a privately owned tract of land encompassing 2,000 square feet of saline prairie. KPC recently obtained a conservation easement and will provide management oversight for the property.

2014 surveys estimated a few hundred individual plants on open barren soils. There is no formal delineation to determine how this site contributes to recovery goals for the species.

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

Little else is known outside of genetic information published in the recovery plan and even less is known about how the plant is pollinated. Researchers believe there may be some correlation between the carpenter ant *Camponotus* spp. and the continued existence of *H. texana.* The ant tends to be found within close proximity to many of the *H. texana* populations. While this remains a strong hypothesis, there is no data to support that the ants are pollinators of *H. texana*.

Spring et al. (1994) examined taxa from the genera *Amblyolepis* (one species), *Dugaldia* (three species), *Hymenoxys* (21 species), *Macdougali*a (one species), *Plateilema* (one species), *Plummera* (two species) and *Tetraneuris* (15 taxa in eight species) for chemical composition. Chemical compound patterns of the *Hymenoxys*, *Plummera*, *Dugaldia*, and *Macdougalia* species were very similar to one another, but they differed from those of *H. texana* and all taxa of *Tetraneuris*. These findings reaffirmed the determination that *H. texana* is a species.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No change in nomenclature occurred since the species was listed in 1986.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historical range (e.g. corrections to the historical range, change in distribution of the species' within its historical range, etc.):

The spatial distribution for *H. texana*, once believed to be located in only Harris and Ft. Bend counties, has increased, and is known to occur in Gregg, Trinity, and Waller counties. Table 5 below notes the confirmed presence of *H. texana* (acreage) within each county as well as the number of populations (in parentheses) found within each location. The Gregg County site has not been delineated and only estimates of total number of plants are available.

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

Once thought to only occur on barren slicks at the base of pimple mounds in Harris County, *H. texana* has been identified in a total of five Texas counties with slightly varying habitat conditions. However several factors remain constant: *H. texana* thrives in disturbed, open areas with barren slicks made up of a select few soils, and where specific hydrological requirements can be met. These requirements are specific to the Texas coastal prairie where development and

agricultural practices have denuded, altered, or destroyed much of the available habitat. While good habitat may be a limiting factor for this species, many of the currently populated sites thrive (when the conditions are favorable) with thousands and in some cases tens of thousands of plants recorded each year. As management plans are developed for these sites and technical assistance from the USFWS and TPWD is provided, we expect additional and better quality sites to be available.

Table 5 Summary of *H. texana* site acreage and number of known populations

***H. texana* site**	**Harris**	**Fort Bend**	**Gregg**	**Trinity**	**Waller**	**Under Easement**	**Land Manager**
HC Precinct 4	<3 ac (1.2 ha) (2)					Yes	MABG
Warren Ranch	285 ac (115.3 ha) (?)					Yes	KPC
Jack Roads South	511 ac (206.8 ha) (24)					Yes	KPC
Addicks Reservoir	12 sites					Federal property	USACE
Barker Reservoir		0 sites				Federal property	USACE
Willow Waterhole (a)	~ 1 ac (0.4 ha) (1)					Management Area	HCFCD
Willow Waterhole (b)	~ 1 ac (0.4 ha) (1)					Management Area	HCFCD
Space Center Road	24 ac (9.7 ha) (8)					Harris County	ABNC
Private Landowner			~187 ac (75.7 ha)			Not under easement	TPWD oversight
Private landowner (Boggy Slough)				8-10 ac (3.2-4 ha) (1)		No	TPWD oversight
Private Landowner (Bayou Slough)				<3 ac (1.2 ha) (1)		Yes	TPWD oversight
Private Landowner					<1 ac (0.4 ha)	Yes	KPC oversight

2.3.1.7 Conservation Measures:

Section 7 Consultations
USFWS records reveal one formal section 7 consultation for *H. texana*, 139 informal consultations, and 510 project assistance and conservation actions have been completed (USFWS n.d.).

Section 6 Traditional Funds
The Cooperative Endangered Species Conservation Fund (section 6 of the Act) provides grants to States and Territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species. The program provides funding to States and Territories for species and habitat conservation actions on non-Federal lands (USFWS 2015). TPWD and the

USFWS have supported only one section 6 grant in Texas that addresses *H. texana* conservation and recovery.

Project # E-112-3 Contract # 21232, Seedbanking the Rare Plants of Texas (Kennedy 2013), was developed to as a collaborative project (between the Center for Plant Conservation [CPC] and five participating institutions) aimed at securing ex-situ collections of optimal genetic material of Texas priority plant species. Ample collections from prioritized species (federally listed, candidates for listing, critically imperiled, imperiled, or vulnerable to extirpation or extinction) will be cleaned, accessioned, and sent to the National Center for Genetic Resources Preservation where they will be housed at no charge to the CPC under a formal cooperative agreement. If seed numbers permit, each of the respective participating institutions will receive a portion of the seeds for recovery plan tasks.

Mercer continues to review and conduct germination tests from Mercer's seed bank for *H. texana* and two rare associates, *Rayjocksonia aurea* and *Chloris texensis*. Staff at MABG indicate excellent results and seeds are shown to remain viable for approximately 30 years (Tiller 2015). However there seems to be a great need to standardize the germination methods used. In February 2015, Mercer transferred portions of the *H. texana* collection to USDA's National Center for Genetic Resource Preservation at Fort Collins, Colorado. Further, Mercer also plans to revisit all *H. texana* seed collection sites represented in the seed bank to determine whether these sites remain extant.

Partners for Fish and Wildlife Program

In 2009, Harris County applied for and was awarded funding through the USFWS's Partner's Program to enhance *H. texana* habitat at the 24 ac (9.7 ha) site in southeast Harris County. Due to unforeseen legal difficulties, Harris County was not able to start the agreed upon project and elected to return the funding. Realizing the need was still there, in 2013, Harris County applied for and was awarded $145,310.00 through the Coastal Impact Assistance Program grant to complete the project initiated four years earlier. Strategic removal of overgrown woody species and installation of hog exclusion fencing are the focus for the grant and should be completed during 2015.

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

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

Habitat conversion, fragmentation, and degradation continue to be a threat. Expanding urbanization, paved roadways, feral hogs, alteration of watershed drainages, development of natural resources, and agricultural development contribute to the continued loss of suitable habitat. Heavy grazing and in some

cases illegal grazing practices can be detrimental to *H. texana* and may even prevent the species from recruiting.

Private landowner cooperation is critical to implementing habitat management, restoration efforts, and habitat preservation throughout the *H. texana's* range. The USFWS continues to partner with TPWD, local governments, and non-governmental organizations to engage private landowners in *H. texana* conservation, land management, and grant opportunities.

Although efforts to restore, create, and effectively manage habitat for the *H. texana* are currently underway, suitable habitat continues to be degraded or lost within this species range. Considerable increases in overstory vegetation are visible in aerial photography over a majority of the current species' range. This increase in canopy cover results in significant declines in some *H. texana* populations (e.g. Addicks and Barker Reservoirs) where thousands of individual plants once thrived at numerous sites. Due to limited habitat management at Addicks and Barker Reservoir, there is a significant decline in the number of suitable sites with *H. texana* present at this location and as a result, individual plant numbers have declined as well.

H. texana may be present in disturbed areas where soil conditions are favorable. Management practices such as mowing (with certain restrictions) do not seem to harm *H. texana,* and in some instances, promote its existence. However, deep soil disturbances such as plowing and feral hog wallowing can be detrimental to its existence. Many of the current sites are not adequately fenced and are subjected to feral hog and cattle grazing. Managed grazing and installing fence panels aimed at excluding feral hogs will greatly benefit *H. texana*.

Overall, activities that contribute to habitat conversion, fragmentation, and degradation continue to be a significant threat to this species throughout its range and likely contribute to the continued loss of suitable habitat.

2.3.2.2 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 *H. texana* in the foreseeable future. Therefore, we do not consider this factor to be a threat to this species.

2.3.2.3 Disease or predation:

There is no scientific data to indicate that disease or predation is affecting *H. texana* now or in the foreseeable future. Therefore, we do not consider this factor to be a threat to this species. However, due to the limited amount of biological information available on *H. texana*; we do recognize this as a research need.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The Act does provide some legal protection for federally-listed plants on federally owned lands, but federally-listed plants on privately owned lands have limited protection. In this case, *H. texana* is state-listed, but the State of Texas (TPWD 2014) affords very little protection to listed plant species on privately owned land. All but three known populations of *H. texana* (Corps' Addicks and Barker Reservoir and HCFCD) occur on privately owned land; therefore, few regulatory protections currently exist for this species.

Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally-listed as threatened or endangered. The State of Texas listed *H. texana* as endangered on May 18, 1987. TPWD requires permits for the commercial use of listed plants collected from private lands and prohibits taking or possessing plants from public lands for commercial sale. Scientific permits are required for collection from public lands for educational or scientific purposes. The lack of regulatory mechanisms at both the federal and state levels continues to pose a threat *H. texana*.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

The distribution of *H. texana* appears to be naturally restricted as a result of the specific habitat and soil requirements. However, persistent drought conditions can cause the plant to remain dormant and produce smaller, less robust plants with fewer seed heads. The drought of 2011 was especially hard on *H. texana* as evidenced by the reduced number of mature plants. Cool and wet winter weather seems to be conducive to early spring growth and maturation.

Competition from woody vegetation, such as Chinese tallow *Triadica sebifera* (an invasive exotic), yaupon *Ilex vomitoria* (native), and other native trees and grasses (at the ground and canopy layers), remains a large threat to the species. In areas where there is no on-the-ground management, the potential for loss is great as the woody vegetation continues to encroach creating a canopy cover that essentially allows other species to outcompete *H. texana*. The USFWS continues to work with other state and local partners to develop management guidelines to enhancing *H. texana* habitat.

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 2012). 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 2012). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation).

According to the Intergovernmental Panel on Climate Change (IPCC 2007, 2013), "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." It is very likely that average Northern Hemisphere temperatures were higher during the second half of the 20th century than during any other 50-year period in the last 500 years; it is also likely that average temperatures during this period were the highest in at least the last 1,300 years (IPCC 2007, 2013). It is very likely that over the last 50 years, cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007, 2013). It is likely that heat waves have become more frequent over most land areas, and also that the frequency of heavy precipitation events has increased over most areas (IPCC 2007, 2013).

Predicted changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century. Alarmingly, the next two decades should experience a warming of about 0.2°C (0.4°F) per decade; however temperature projections increasingly depend on specific emission scenarios (IPCC 2007, 2013). The range of emission scenarios suggest that by the end of the 21st century, average global temperatures may increase from 0.6°C to 4.0°C (1.1°F to 7.2°F) with the greatest warming expected over land (IPCC 2007, 2013). Localized projections suggest that the southwestern U.S. may experience the greatest temperature increase of any area in the lower 48 States where it is very likely that hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007, 2013).

Winter and spring field observations indicate in years where drought conditions are prevalent, *H. texana* plants tend to respond with fewer, less robust individuals, and fewer seed heads. Conversely, in years where rainfall exceeds normal levels and plants may be inundated for extended periods of time, *H. texana* respond with fewer and less robust plants with yellowish leaves. Therefore, while it appears reasonable to assume that *H. texana* may be affected by the intense climate swings forecasted, and climate change should be considered a threat, we lack sufficient certainty to know how climate change specifically will affect this plant.

2.4 SYNTHESIS

The spatial distribution for *H. texana* is far greater than originally thought. Documented in only two counties at the time of listing, *H. texana* is now confirmed in a total of five counties (Harris,

Ft. Bend, Trinity, Gregg, and Waller). Harris County alone has five known sites with over 50 documented populations combined, one site in Gregg County claims 187 ac (75.7 ha) of prime *H. texana* habitat with unknown documented populations, and several other sites boast over 50,000 individual plants.

Despite this success, many questions still remain about the biology of the species. Little is known about pollination or transplanting processes. The greatest threat to *H. texana* remains the availability of habitat, as commercial and residential development, transportation construction, and conversion to agriculture production have removed much of the remaining prairies from the landscape.

Since being listed, some landowners and land managers are actively managing for *H. texana*. Unmanaged sites tend to produce fewer individuals, have more invasive flora and fauna species present, and in some cases populations are in danger of being totally eliminated. Four sites receive intense management and all sites have or are in the process of developing management plans. While there have been great strides to recover *H. texana*, we recommend the continued acquisition of prairie habitat or preservation through conservation easement mechanisms to ensure the plant's continued existence.

3.0 RESULTS

Since the Recovery Plan (USFWS 1990) was published, many of the historical *H. texana* sites were destroyed due to residential and commercial development, pipeline right-of-ways, and roadways. Because plants are not afforded the same protection as other fish and wildlife species, the USFWS has not been made aware of *H. texana* presence or subsequent disappearance. However, partnerships with other natural resource agencies, academic institutions, and local botanists have led to the identification of *H. texana* in five counties, and conservation protection mechanisms cover 12 of the 13 confirmed sites on over 1,000 ac (404.7 ha) that support *H. texana*.

Given the limited information that we have about the size of most of the populations located on private lands, we are unable to determine whether the downlisting criterion identified in the Recovery Plan (USFWS 1990) has been met. Although it appears that significant progress has occurred, a range-wide population model should be completed to determine if the species is approaching recovery. Likewise, commitments to maintain management through conservation agreements should be in place to ensure the future viability of the species in the wild.

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X__ No change is needed

3.2 New Recovery Priority Number: 2C

Brief Rationale:
We recommend changing the current Recovery Priority Number from 5C to 2C (high species recovery potential) due to increased species presence in five counties. Increased survey efforts have led to the discovery of several more key sites that significantly contribute to the overall species population. All but one of the newly identified sites is protected by conservation easements and has or is in the process of developing management plans.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The USFWS recommends the following actions be taken for the conservation of *H. texana*:

- Reevaluate the 1990 Recovery Plan to reflect new species information including associated species lists, species range, survey methodologies, and soil findings in partnership with local land managers, botanists, and federal and state resource agency staff.
- Develop protocol to delineate and define "populations" for downlisting or delisting this species.
- Develop a central database to house all pertinent site population information.
- Continue to monitor and survey known populations while searching for additional populations.
- Update associated species list as necessary.
- Implement section 6-funded projects, USFWS Partners for Fish and Wildlife program projects, and cooperative agreements with state and federal agencies.
- Continue to search for additional populations.
- Acquire new landowner conservation agreements with interested parties when appropriate.
- Continue to support conservation and recovery awareness efforts through public and landowner outreach.
- Redefine the range of *H. texana* through strategic GIS mapping efforts. *H. texana* is now more broadly distributed than originally thought, soil characteristics may be different at various locations, and associated species may vary at the different locations across the range.
- Standardize surveying and monitoring protocols to provide consistent population data. If a new site is found, include soils analysis, associated species, genetic analysis, hydrological conditions, location, identify any threats, and note any pollinators present.
- Yearly survey and monitoring data should be deposited with the TxNDD to facilitate accurate and up-to-date species specific information.

Research Needs for the continued existence of *H. texana*

- Assess and quantify predator threats (terrestrial mammals and/or insects).
- Soil analysis at each identified site.

- ❖ Analyze and quantify the role of pollinators at *H. texana* sites.
- ❖ Complete a thorough habitat range assessment using GIS analysis due to the increased range spanning five counties.
- ❖ Conduct further research regarding alternative propagation techniques.
- ❖ Complete additional studies to optimize frozen storage techniques for *H. texana.*
- ❖ Identify propagation and relocation strategies for successful plug and seed transplant to suitable sites within the species range.
- ❖ Identify the mechanism and/or agents of dispersal, dispersal patterns, and the effects of disturbance on dispersal.
- ❖ Include genetic analysis for all sites to determine any genetic variability within sites.

5.0 REFERENCES

Benigno, S. 2015. Personal Communication. June 24, 2015.

Brown, L.E. 2011. Hollister Road Detention Basin. October 2011.

Brown, L.E., Eric L. Keith, David J. Rosen, and Joe Liggio. 2007. Notes on the Flora of Texas with Additions and Other Significant Records. III. Journal of the Botanical Research Institute of Texas. 12-55-1264.

Center for Plant Conservation. 2010. CPC National Collection Plant Profile *Hymenoxys texana*. September 28, 2010. (accessed July 15, 2015).

Cockrell, T.D.A. 1904. The North American species of *Hymenoxys*. Bulletin of the Torrey Botanical Club, Torrey Botanical Club, 31:461-509.

Coulter, J.M., and J. N. Rose. 1891. *Actinella (Hymenoxys) Texana*. Botanical Gazette, no. 16 (1891): 27-28.

HCFCD. 2013. Coastal Prairie Management Plan for Willow Waterhole Detention Basin. Houston: Harris County Flood Control District.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: Synthesis report. Contribution of working groups I, II, and III to the fourth assessment report of the Intergovernmental Panel on climate change. By [Core Writing, 104. Geneva, Switzerland, 2007.

—. 2012. Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to." In A Special Report of Working Groups I and II of the, by C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley [Field, 555-564. Cambridge, UK and New York, NY, USA: Bambridge University Press, 2012.

—. 2013. Climate change 2013: the physical science basis. Contributions of Working Group I to the Fifth Assessment Report of the IPCC. Edited by T.F. Stocker and nine co-editors. Cambridge University Press, New York.

Johnson, D.L., and J. L. Horwath Burnham. 2012. Introduction: Overview of concepts, definitions, and principles of soil mound studies. Special Paper 490, The Geological Society of America.

Katy Prairie Conservancy. 2015. About Us. n.d. http://www.katyprairie.org/about-us/ (accessed June 14, 2015).

Keith, E. 2003. Botanical Assessment Report for Compartment 03458 in Trinity County. May 5, 2003.

Kennedy, K. 2013. Seedbanking the Rare Plants of Texas: years 2 and 3. Austin: Texas Parks and Wildlife Department.

Mahler, W. F. 1982. Status report on *Hymenoxys texana* (Coulter & Rose). Albuquerque: USFWS.

Mahler, W.F. 1983. Rediscovery of *Hymenoxys texana* and notes on two other Texas endemics. SIDA, 10(1): 91.

Mink, J.N., J.R. Singhurst, W.C. Holmes. 2012. A New Species of Hymenoxys (Asteraceae, Helenieae, Tetraneuridinae) from Texas. Novon, 2012: 56-59.

Poole, J.M,. W.R. Carr, D.M. Price and J.R. Singhurst. 2007. Rare Plants of Texas: A Field Guide. College Station: Texas A&M University Press.

Singhurst, J. R. 2014. "Per. comm." September 30, 2014.

Singhurst, J.R., N. Shackelford, W. Newman, J. N. Mink, and W. C. Holmes. 2014. Ecology and abundance of *Hymenoxys texana* (Asteraceae). Phytoneuron: 1-19.

Smeins, F.E. 2014. Texas Prairie Dawn (*Hymenoxys texana*) monitoring protocol and management strategies for the Katy Prairie Conservancy Jack Road South Conservation Eastment. College Station.

Spring, O., D. Zitterell-Haid, M. W. Bierner, and T. J. Mabry. 1994. Chemistry of glandular trichomes in *Hymenoxys* and related genera. Biochemical Systematics and Ecology, 1994: 171-195.

Stevens, C. 2009. email. Houston, April 29, 2009.

Texas Land Conservancy. Texas Land Conservancy. 2010. http://www.texaslandconservancy.org/who-we-are-mainmenu-34.html (accessed February 3, 2015).

Tiller, A. 2015. email. Houston, Texas, January 16, 2015.

Tiller, A. 2015. Personal Communication. May 14, 2015.

TPWD. 2014. Texas Natural Diversity Database (TxNDD). Austin, TX: Wildlife Department, May 15, 2014.

—. Texas Natural Diversity Database (TxNDD): Methodology. 2015. https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/txndd/about.phtml (accessed June 24, 2015).

—. Texas Prairie Dawn (*Hymenoxys texana*). n.d. http://www.tpwd.state.tx.us/huntwild/wild/species/txprdawn/ (accessed October 7, 2014).

USFWS. 1985. Proposal to Determine *Hymenoxys texana* to be Enangered Species. In Federal Register, 50:9095-9097.

—. 1985. Review of the plant taxa for listing as endangered or threatened species. In Federal Register, 50:39526-39527.

—. 1986. Determination of endangered status for *Hymenoxys texana*. In Federal Register, 51:8681-8683.

—. 1995. Habitat Conservation Plan in the Gulf Coast Prairies of Texas. Houston: USFWS.

—. 1990. *Hymenoxys texana* Recovery Plan. Albuquerque: U.S. Fish and Wildlife Service.

—. 2008. Space Center site visit. July 2008.

—. 2010. 5 Year Status Reviews of 14 Southwestern Species. In Federal Register, 75:15454-15456.

—. 2015. Endangered Species. August 13, 2015. http://www.fws.gov/endangered/grants/ (accessed August 19, 2015).

—. Section 7 Consultations. n.d. https://ecos.fws.gov/tails/sec/S7SearchResults.do (accessed July 6, 2015).

—. Tracking and Integrated Logging System. n.d. https://ecos.fws.gov/tails/sec/S7SearchResults.do (accessed August 19, 2015).

USGS. Paradise Lost? The Coastal Prairie of Louisiana and Texas. n.d. http://www.nwrc.usgs.gov/prairie/paradise_lost.pdf (accessed July 14, 2015).

Wheeler, F.F. 1976. Soil Survey of Harris County, Texas. Washington, D.C.: USDA-SCS.

Appendix A

Associated species for Texas prairie dawn-flower *Hymenoxys texana*

Monocots	
Grasses	
Agrostis elliottiana	*Annaul bentgrass*
Chloris subdolichostachya	*Shortspike windmillgrass*
Chloris texensis	*Texas windmill grass*
***Distichlis spicata*	*Saltgrass*
Eragrostis secundiflora	*Lovegrass*
Hordeum pusillum	*Little barley*
Panicum hallii var. filipes	*Filly panicum*
Parapholis incurva	*Curved sicklegrass*
Schedonnardus paniculatus	*Tumblegrass*
Spartina spartinae	*Gulf cordgrass*
Sporobolus indicus	*Smutgrass*
*Sporobolus pyra*midatus	Whorled dropseed
Willkommia texana	Willkommia
Vulpia octoflora	Sixweeks fescue
Herbs	
Cyperus aristatus	Bearded flatsedge
Nothoscordum bivalve	False onion
Dicots	
Annuals	
Ammoselinum butleri	Sandparsley
**Anagallis minima*	Chaffweed
***Atriplex texana*	Texas saltbrush

Chaetopappa asteroides	Least daisy
Clemoella angustifolia	Rhombopod
***Coreopsis basalis*	Goldenmane tickseed
Crassula aquatica	Pigmy-weed
Elatine brachysperma	Waterwort
Euphorbia spathulata	Warty spurge
Evax verna	Common evax
Gratiola flava	Golden hedgehyssop
**Thurovia triflora*	Thurovia
Hedeoma hispida	Mock pennyroyal
**Helenium amarum*	Sneezeweed
**Houstonia rosea*	Rose bluet
Iva angustifolia	Narrowlead sumpweed
Krigia occidentalis	Western dwarf-dandelion
**Lepidium densiflorum*	Common pepperweed
Linum imbricatum	Tufted flax
Limnosciadium pumilum	Dog-sunshade
Oenothera linifolia	Threadleaf sundrops
Oenothera spachiana	Evening primrose
Plantago aristata	Bottlebrush plantain
Plantago elongate	Slender plantain
Plantago hybrida	Plantain
**Rayjacksonia aurea*	Houston tansyaster
Rumex hastatulus	Heart-wing sorrel
Sabatia campestris	Meadow pink (Texas star)
Sagina decumbens	Pearlwort

***Schoenolirion wrightii*	Texas sunnybell
***Spergularia echinosperma*	Bristleseed sandspurry
***Valerianella florifera*	Texas cornsalad

Perennials

Succulents

Opuntia compressa	Eastern prickley pear
***Opuntia macrorhiza*	Twistspine pricklypear
**Phemeranthus parviflorus*	Prairie flameflower
Portulaca pilosa	Purslane
Portulaca umbraticola	Purslane

Non-succulents

Callirhoe involucrata	Wine cup
Evolvulus sericeus	Silky evolvulus
**Guilleminea lanuginosus var. tenuiflorus*	Cottonflower
***Lechea san-sabeana*	San Saba pinweed
Sida ciliaris	Bracted sida

*Denotes name change from Recovery Plan (1990) list
**Proposed as new associate species by J. Singhurst (2014)

U.S. FISH AND WILDLIFE USFWS
5-YEAR REVIEW of *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: N/A

Review Conducted By: Donna Anderson, Wildlife Biologist, Texas Coastal Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Texas Coastal Ecological Services Field Office

Approve _____ Acting Field Supervisor Date 8-21-15

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Approve Michelle Shaughnessy Date 8/26/15