Recovery Plan for Texas Golden Gladecress

(*Leavenworthia texana*)

U.S. Fish and Wildlife Service
Southwest Region
Albuquerque, New Mexico
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Approved: AMY LUEDERS Digitally signed by AMY LUEDERS Date: 2024.12.30 12:58:47 -07'00'

Regional Director, Southwest Region
U.S. Fish and Wildlife Service

Disclaimer

The Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.), requires the development of recovery plans for listed species, unless such a plan would not promote the conservation of a particular species. In accordance with section 4(f)(1) of the ESA and to the maximum extent practicable, recovery plans delineate such reasonable actions as may be necessary, based upon the best scientific and commercial data available, for the conservation and survival of listed species. Plans are published by the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS), and sometimes prepared with the assistance of recovery teams, contractors, State agencies, or others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan development, other than the USFWS or NMFS. They represent the official position of the USFWS or NMFS only after they have been signed by the Regional Director (USFWS) or Assistant Administrator (NMFS). Recovery plans are guidance and planning documents only; identification of an action to be implemented by a public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans may be revised to include new information, change in species status, or the completion of recovery actions.

Literature citation should read as follows:

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Copies of the document can be requested from:
U.S. Fish and Wildlife Service
Texas Coastal and Central Plains Ecological Services Field Office – Clear Lake
17629 El Camino Real, Suite 211
Houston, TX 77058
281-286-8282
An electronic copy of this draft Recovery Plan can be downloaded from the USFWS website:
https://ecos.fws.gov/ecp/species/8339.

Table of Contents

This Draft Recovery Plan describes criteria for determining when the Texas golden gladecress (*Leavenworthia texana*) should be considered recovered and eligible for removal from the *List of Endangered and Threatened Plants* (50 CFR 17.12). It also lists site-specific actions that will be necessary to meet those criteria and estimates the time and cost for implementing recovery actions. Brief descriptions of the species' status, habitat requirements, and limiting factors are included. The species status assessment also analyzed the species' requirements, factors affecting its survival, and current conditions, to assess the current and future viability in terms of resiliency, redundancy, and representation (the '3R's'). A detailed discussion of these and other topics pertinent to the recovery of Texas golden gladecress can be found in the Species Status Assessment (SSA; USFWS 2022, entire) and the Draft Recovery Implementation Strategy (RIS) available at *https://ecos.fws.gov/*. The RIS and SSA are finalized separately from the Recovery Plan and will be updated as necessary.

This Draft Recovery Plan is a streamlined document, based on the USFWS 2022 SSA, including the required elements:

- A description of site-specific management actions necessary for conservation and survival of the species;
- Objective, measurable criteria that, when met, would support a determination under section 4(a)(1) that the species should be removed from the List of Endangered and Threatened Species; and,
- Estimates of the time and costs required to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

In cooperation with our partners, we are also preparing a Recovery Implementation Strategy (RIS) for the Texas golden gladecress, which serves as an operational plan for stepping down the higher-level recovery actions into specific tasks, or activities. The RIS is separate from the recovery plan and can be modified as needed if, for example, monitoring reveals that expected results are not being achieved, thereby maximizing flexibility of recovery implementation. The SSA can also be updated as needed to incorporate the latest scientific information.

Current Species Status: Texas golden gladecress was listed as endangered with critical habitat under the ESA on September 11, 2013 (78 Federal Register (FR) 56026-56069; 78 FR 56071-56120). Critical habitat included four occupied units in San Augustine and Sabine counties, Texas, totaling 1,353 acres (ac) (547 hectares (ha)) of land. All critical habitat units were considered occupied at the time of listing.

The Texas golden gladecress has been assigned a recovery priority number of 5 in a range of 1 to 18, with a species ranking 1 having the highest recovery potential (USFWS 1983, entire). The ranking of 5 indicates that the species has a high degree of threat and faces a low recovery potential. Texas golden gladecress is influenced by the loss, modification, and degradation of habitat through the invasion of native and nonnative plant species. Fire was a natural and prevalent component of the savanna habitats within the Pineywoods ecoregion. A change and/or lack in fire regimes has allowed the encroachment of woody vegetation into glade exposures, blocking out the sun and increasing the canopy cover on the glade and the plants. Texas golden gladecress is also affected by habitat modification through oil and gas exploration; mining of

glauconite; and management strategies that are not compatible with the species and its needs. Effects from climate change also threaten the species. Texas golden gladecress has a low recovery potential due to the endemism on a unique ecosystem found only in three East Texas counties and with only four identified extant populations. These populations only occur on private lands where suitable habitat extends into the state-owned right-of-way on two of the four. Glade exposures are naturally small in size, therefor support smaller population sizes. Conservation efforts of glade ecosystem is challenging since these communities are small and might not meet minimum conservation specifications (i.e., acreage size). None of the populations are under long-term protection and USFWS access to sites historically has been limited. The species, *Leavenworthia texana*, is a distinct and valid species recognized by the Flora of North American (FNA) (Al-Shehbaz and Beck 2010, pp. 486-487), Tropicos (2024), and the Integrated Taxonomic Information Service (ITIS) (2020, p. 1). *Leavenworthia texana* is listed as synonymous with *L. aurea* var. *texana* in the Plants Database (Natural Resource Conservation Service (NRCS) 2022, p. 2); however, neither the USFWS nor the FNA consider this valid.

Habitat and Limiting Factors: The Texas golden gladecress is an annual plant and member of the family Brassicaceae. The best available information suggests that 4 extant populations occur in Texas on private and state-owned lands within San Augustine, Sabine, and Nacogdoches counties, Texas. Three of these populations are natural, and 1 is introduced (Nacogdoches County). These populations are represented by Texas Parks and Wildlife Department's Element Occurrence (EO) IDs from the Texas Natural Diversity Database (TXNDD; 2020, pp. 1-18). These populations are distributed across the Weches geologic formation that loosely parallels Texas State Highway 21 within these counties (Figure 1). Sites are relatively bare (treeless) and host a diverse set of associated species that vary throughout the annual cycle of the Texas golden gladecress. The species depends on cool, wet winter months to aid its growth, promoting a short flowering season in February and March each year. When temperatures warm in summer, Texas golden gladecress withers away, and drought-tolerant species emerge. Glade exposures on the Weches geology are naturally small giving rise to smaller population sizes, and therefore increasing the species' chances of negative effects from stochastic events. Due to its annual nature, plant numbers fluctuate each year. Little is known about the species' seed biology, reproductive strategies (i.e., need of pollinators), and/or genetic relatedness among and within populations. Known threats to the species include habitat loss, modification, degradation; climate change; and ineffective management strategies (USFWS 2022, pp. 38-51).

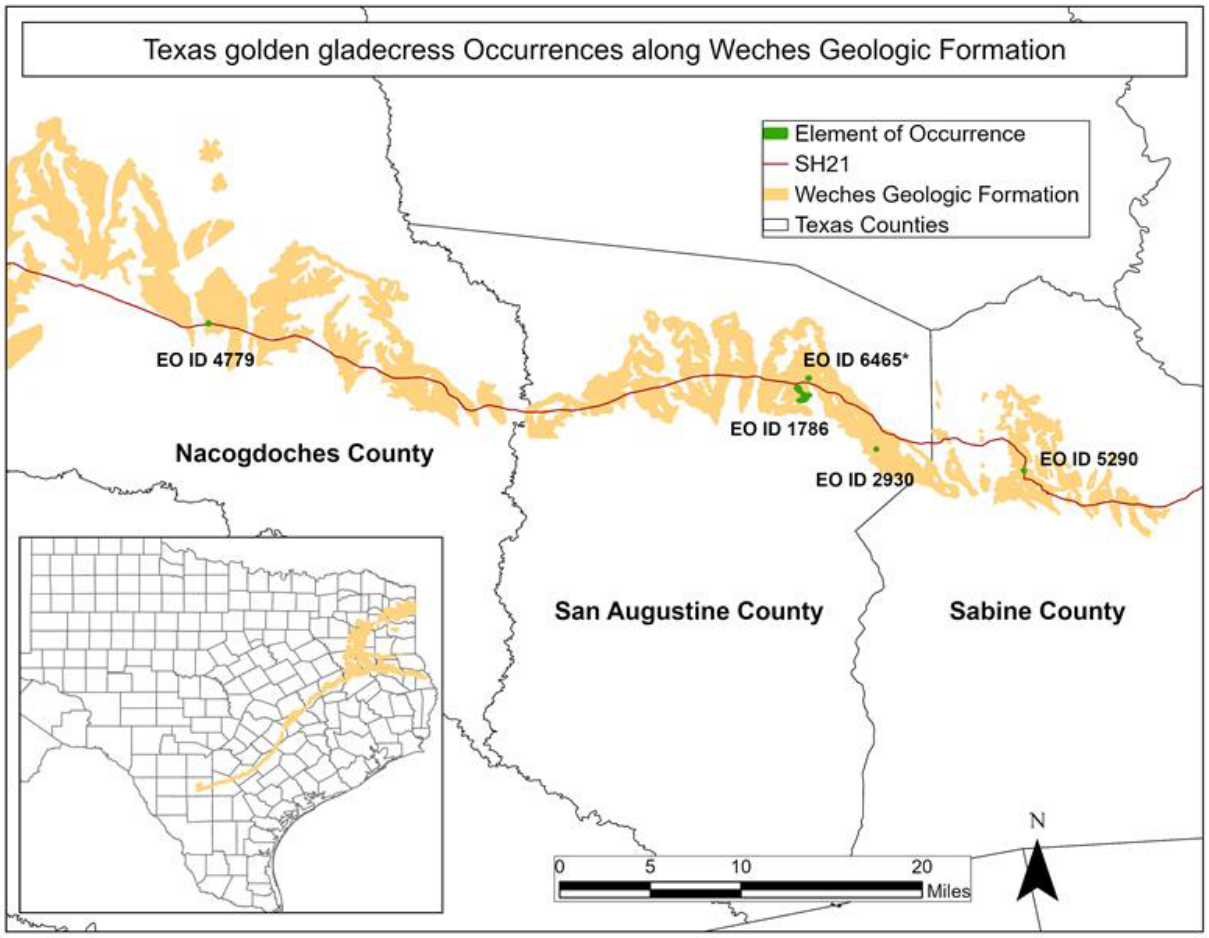

Figure 1. Geographic distribution of Texas golden gladecress populations within San Augustine, Sabine, and Nacogdoches counties, Texas. EO ID 6465 is presumed extirpated and is denoted with an *.

Recovery Strategy: The recovery strategy for the Texas golden gladecress is to ensure the long-term viability of the species through cooperative habitat conservation, restoration, and management where population resiliency is increased, multiple populations are maintained across the full breadth of the species' range, and sufficient connectivity is observed to support genetic diversity. Initial recovery efforts should focus on maintaining the functionality of extant populations before the establishment of new populations.

The steps needed to conserve the species include, but are not limited to:

- Protect and conserve the Texas golden gladecress at known populations for the foreseeable future; continue or increase management at extant sites to abate threats and minimize soil disturbance.
- Ensure collection and long-term preservation of Texas golden gladecress seed.
- Promote and engage in landowner and other partner relations throughout the current and historical range of Texas golden gladecress.
- Monitor the species on an annual basis.

- Conduct studies on Texas golden gladecress biology, ecology, and habitat, including investigation of pollination, breeding system, and dispersal mechanisms.
- Minimize further loss or fragmentation of suitable habitat within mapped areas of the Weches formation in East Texas; survey for additional populations within mapped glade habitats.
- Establish a reintroduction program for the species.

1. Recovery Criteria

"The term 'endangered species' means any species which is in danger of extinction throughout all or a significant portion of its range" (16 USC §1532 (6)). The term 'threatened species' means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 USC §1532 (20)). When we evaluate whether a species warrants downlisting (reclassification from endangered to a threatened status) or delisting (removal from the list of threatened and endangered species), we consider whether the species meets either of these statutory definitions. A recovered species is one that no longer meets the definitions of threatened or endangered due to amelioration of threats under the ESA.

Determining whether a species should be downlisted or delisted requires consideration of the same five factors that were considered when the species was listed, specified in section 4(a)(1) of the ESA and at 50 C.F.R. 402.02. These five factors include: A) the present or threatened destruction, modification, or curtailment of its habitat or range; B) overutilization for commercial, recreational, scientific, or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; or E) other natural or manmade factors affecting its continued existence. Recovery criteria are conditions that, when met, indicate that a species may warrant downlisting or delisting. Thus, recovery criteria are mileposts that measure progress toward recovery. Because the appropriateness of delisting is assessed by evaluating the five factors identified in the ESA, the recovery criteria below pertain to these factors. These recovery criteria are our best assessment at this time of what the species needs to be downlisted from endangered to threatened and delisted. Because we cannot envision the exact course that recovery may take, and because our understanding of the vulnerability of a species to threats is likely to change as we learn more about the species and the threats, it is possible that a status review may indicate that downlisting or delisting is warranted even if not all recovery criteria are met. Conversely, it is possible that a status review may indicate that downlisting or delisting is not warranted even if the recovery criteria are met. For example, a new threat may emerge that is not addressed by the current recovery criteria.

Objective and measurable recovery criteria for the Texas golden gladecress are based on the required resiliency, redundancy, and representation as outlined in the SSA (USFWS 2022, entire). The downlisting criteria for Texas golden gladecress consist of a combination of conditions that, when met, indicate the plant may warrant reclassification from endangered to a threatened status. These criteria are described in detail in the "Downlisting Criteria" section below. Full recovery of Texas golden gladecress to the point that protections of the ESA are no longer necessary (delisting) involves similar criteria as that of downlisting, sustained for a longer period, and is described in detail in the "Delisting Criteria" section below. We describe our

justifications for the recovery criteria following the criteria. A table summarizing the criteria and how they relate to each of the "3Rs" is provided here (Table 1).

Table 1. Summary of the key parameters of each of the "3Rs" needed in order to meet both downlisting and delisting of the Texas golden gladecress and the listing factor addressed.

	Listing Factor	Resiliency	Redundancy	Representation
Downlisting Criterion 1: ≥ 1,975 mature individual plants	A	At least 1,975 mature individual plants in each population at least once every 5 years		
Downlisting Criterion 2a: 12 viable populations	A		12 viable populations occur across the Weches formation in East Texas. Of the 12 populations needed for downlisting, 25 percent (3 populations) need to be conserved for the foreseeable future.	
Downlisting Criterion 2b: ≥ 50 percent populations connected to another	E		At least half of the needed populations (6) show connectivity with other Texas golden gladecress sites, demonstrated across the range of the species.	This criterion also corresponds to aspects of geneflow that would impact species representation and be necessary for downlisting to occur.
Downlisting Criterion 3: 12 viable populations dispersed across the range	A			12 viable populations are dispersed across the species' range such that the species may be more able to adapt to changing environmental conditions.
Delisting Criterion 1: 16 viable pops across the range (with 6 populations under long term conservation plans)	A		16 viable populations, with each population maintaining at least 1,975 mature individual plants per site. Of the 16 populations needed for delisting, 40 percent (6 populations) are conserved for the foreseeable future.	

Delisting Criterion 2: ≥ 50 percent of habitat across the range is under long term management for species	E			≥ 50 percent of potential habitat is under active management and occupied habitat is actively maintained to support Texas golden gladecress

1.1 Downlisting Criteria

1.1.1 Downlisting Criterion 1 - Resiliency

Populations meet or exceed the minimum viable population (MVP) standards as adapted and described by Pavlik (1996, pp. 127-155) at least once every 5 years with at least 1,975 mature individual plants (USFWS 2022, pp. 32-34) in each population.

Justification:

Estimating a population size for the Texas golden gladecress sites is extremely difficult. Pavlik outlined MVP guidelines (1996, p. 137) using biological and demographical information known about a species to estimate the MVP size. A conventional MVP was not calculated for the Texas golden gladecress as we do not possess the entirety of the baseline data needed to perform these calculations. Coupling this with the fact that the Texas golden gladecress is an annual plant, the species' populations demonstrate natural fluctuations in plant abundance from year to year. This MVP will serve as the basis for population objectives until more is known.

A small population size could affect the genetic variation among individuals in a population or even exchange between populations. Genetic stochasticity (inbreeding and genetic drift in small populations) results in loss of genetic variation and thus could cause decrease population viability (i.e., resiliency) (Newman and Pilson 1997, p. 354). Small populations are vulnerable to extinction by random demographic processes as well as environmental stochasticity. A decrease in effective population size (i.e. the number of individuals that actively contribute to the next generation within a population) increases the rate of both inbreeding and genetic drift, or the random loss of alleles from small populations (Newman and Pilson 1997, p. 354).

Additional demographic factors that may affect the viability of the Texas golden gladecress at the population level (see Figure 3.1, *In* USFWS 2022, p. 26) include germination rates, timing of plant mortality, and seed set. However, none of these parameters have been studied for the Texas golden gladecress, and therefore need further consideration in the future.

Highly resilient and viable populations that meet or exceed the MVP value of at least 1,975 mature individual plants at least once every 5 years should have suitable habitat parameters essential to the Texas golden gladecress. Suitable habitat includes soils, substrate, and slope from the Weches geologic formation where the species occurs. Soils of the Weches formation, which range from shallow and rocky (which naturally limits growth of woody vegetation) (George 1987, p. 3) on the steeper slopes to deeper on the flatter slopes, have a basic pH and have a layer of glauconite clay (Diggs *et al*. 2006, p. 56). Soils are very friable (crumbly) with a low resistance to weathering and are classified within the Nacogdoches, Trawick, or Bub soil series

(Griffith 2009, entire). Water will typically pond during the spring and summer months and slowly percolate off the glade (Diggs *et al.* 2006, p. 56). Habitat may include down-slope seepages across the Weches glade terraces, helping to maintain the hydrology required by the species (J. Singhurst, pers. comm. 2003, *in* 78 FR, p. 56028). Characteristic flora of the Weches formation should be present (see Table 1.5.3.4, *In* USFWS 2022, page 23), and areas of exposed glades occupied by the Texas golden gladecress should have an open canopy and not be densely covered by herbaceous vegetation and/or shaded out by trees on the outskirts of the glades.

Historically, there has been a lack of consistent counts that have occurred across the species' range, mostly attributed to the lack of access to survey private lands and the limited number of known populations. Continuing to engage existing landowners will be critical to meeting this criterion and implies that more routine monitoring efforts are needed.

1.1.2 Downlisting Criterion 2a - Redundancy

Twelve viable populations occur across the Weches formation in East Texas. Downlisting may be possible if each of these populations is stable or increasing ($\lambda \geq 1$) over the next 20 years. Of the 12 populations needed for downlisting, 25 percent (3 populations) are conserved into the foreseeable future.

Justification

Currently 4 extant sites are known across the geographic range of the Texas golden gladecress, with two natural populations occurring in San Augustine County and one natural population in Sabine County, Texas. One introduced site was established in Nacogdoches County, where the Weches formation extends, and is still presumed extant. Due to the annual nature of these plants and the naturally small sites, ensuring that a sufficient number of populations exist across the landscape is vital for the recovery of this species. With all known sites located partially, or entirely, on private lands, where protections and management are not certain, ensuring more populations occur across the known range of the habitat for the Texas golden gladecress is important. The species' future viability requires that at least 25 percent (or 3 populations) of the species' known populations is protected under long-term conservation.

To ensure a resilient species in the face of drought and other stochastic events, the Texas golden gladecress would need to maintain a stable or increasing growth rate over at least 2 drought cycles, or 20 years. This time step will also demonstrate the species' success outcompeting invasive species for an extended period of time.

1.1.3 Downlisting Criterion 2b - Redundancy

At least half of the needed populations (6) show connectivity with other Texas golden gladecress sites and are distributed across the full range of the species. Connectivity means an existing population has ≥ 1 adjacent Texas golden gladecress site in proximity (≤ 1.0 kilometer (km)) (i.e., is a metapopulation).

Justification

Most Texas golden gladecress populations are naturally restricted to small areas atop the Weches glade communities (USFWS 2012, p. 55973). The total known area of occupied habitat by plants at the 3 natural sites covers less than 1.2 acres (ac) (4,856 square meters (sq m)) (USFWS 2012,

p. 55973). Since it appears that population sizes may simply be a feature of the size of an exposed glade, connectivity between populations may be essential for seed dispersal, pollinators, and ultimately genetic exchange.

When Texas golden gladecress siliques dehisce, they disperse seeds only a few inches from the parent plant (Singhurst 2011); therefore, the seed dispersal range is expected to be extremely limited, much like most other members of the *Leavenworthia* genus (Lloyd 1965, p. 11). Wet conditions and ponding on the Weches glades may help to facilitate inter-glade movement of seeds, but more far-reaching dispersal is not likely feasible via this mechanism. The tiny seeds may adhere to mud on bird's feet; therefore, birds may be vectors of longer-distance seed dispersal. Population sizes and distance between populations could also dictate how effectively pollinators could connect to each population and carry out pollination. Texas golden gladecress is considered a self-compatible species, but self-fertilization does require pollinators. Pollinators are also needed for outcrossing, which is necessary to maintain genetic diversity. Although pollinating insects have been associated with some *Leavenworthia* species, specific Texas golden gladecress pollinators have not been identified.

Forecasted future precipitation trends will differ across the range of the Texas golden gladecress. San Augustine County is forecasted to have a precipitation increase of 1.83 inches (in) in its' future scenario planning (see Tables 6.1.2 and 6.1.8, *In* USFWS 2022, p. 60), while Nacogdoches County will experience a decrease of 0.41 and 0.48 in. Sabine County will experience smaller increases in temperature and precipitation over the next 50 years. Therefore, redundancy of populations across the range of the Texas golden gladecress is essential to buffer against the loss/decline of any populations across the range due to impacts of drought.

1.1.4 Downlisting Criterion 3 – Representation

The 12 viable populations are dispersed across the species' range such that the species may be better able to adapt to changing environmental conditions. Of these populations, at least 2 viable populations occur in Nacogdoches County, at least 4 in San Augustine County, and at least 2 viable populations in Sabine County to maintain any existing genetic adaptability among populations. Genetic differences are prioritized for long-term conservation.

Justification:

Currently, there are 2 natural sites in San Augustine County; 1 natural site in Sabine County; and 1 introduced site in Nacogdoches County, Texas. To ensure that the species can withstand temperature changes and variations in the timing and amount of precipitation, sites should be spread across the known range of mapped areas of suitable habitat. Multiple populations in a county will help decrease the impacts on any one population from annual fluctuations and maintain species presence in all areas of the range. Maintaining 4 populations in San Augustine County, which has functioned as a stronghold for the species and is centrally located within the range, will increase the overall resiliency of the species by functioning as a potential source population should populations in the eastern and/or western portions of the range be impacted more severely by a catastrophic local event.

1.2 Delisting Criteria

1.2.1 Delisting Criterion 1 – Redundancy and Resiliency
Sixteen viable populations occur across the Weches formation in East Texas, with each population maintaining MVP standards of at least 1,975 mature individual plants at least once every 5 years per site. Delisting may be possible if each of these populations is stable or increasing over the next 40 years. Of the 16 populations needed for delisting, 40 percent (6 populations) are conserved into the foreseeable future.

Justification:

Sixteen viable populations across the Weches formation would indicate sufficient redundancy to buffer against any catastrophic events impacting the species in the future. Each viable population would maintain minimum viable standards of at least 1,975 mature individuals and would thus be buffered against the impacts of annual variation and stochastic events. The species would maintain viability into the future if 40 percent of the populations are conserved into the foreseeable future.

1.2.2 Delisting Criterion 2 - Representation
Greater than 50 percent of potential habitat is under active management, and occupied habitat is actively maintained to support Texas golden gladecress for the foreseeable future. Of the 16 viable populations, at least 2 viable populations occur in Nacogdoches County, 4 in San Augustine County, and 2 in Sabine County. These populations maintain genetic adaptability among populations. Genetic differences are prioritized for long-term conservation.

Justification:

As a narrow endemic, Texas golden gladecress has a limited potential range for distribution compared to more generalist species. With a restrictive range, it is more important for Texas golden gladecress that areas containing the correct suite of environmental variables be available for species occupancy. For these reasons, it is imperative to the species that greater than 50 percent of the potential habitat is under active management and retaining all the conditions necessary for species occupancy. If the potential habitat is not under active management, it may not be suitable for the species even if the abiotic factors such as soil series and precipitation are present.

2. Recovery Actions

Under the ESA, each recovery plan shall incorporate a description of such site-specific management actions as may be necessary to achieve the recovery plan's goal for the conservation and survival of the species. Below (Table 2) we outline the reasonable actions we think necessary to implement to fully recover the species. Recovery actions are accompanied by estimates of the time and cost required to achieve the plan's goal to recover Texas golden gladecress.

We assign priorities to each action. Priority 1 actions must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Priority 2 actions must

be taken to prevent a significant decline in population size or habitat quality, or some other significant negative impact. Priority 3 actions are all other actions that are necessary for the species' full recovery.

Table 2. Recovery Actions for the Texas golden gladecress.

Criteria	Recovery Action	Priority Number	Sites	Estimated Duration	Estimated Cost (in thousands)
Downlisting	1.0 Ensure habitat protection and management of extant populations.	1	All populations	Acquire land or easement in perpetuity; manage every 2-3 years	$1,200
Downlisting	2.0 Monitor population status, trend, and distribution.	2	All populations	Continual	$600
Downlisting	3.0 Conduct scientific studies to improve the understanding of the Texas golden gladecress.	2	All populations and potential new population sites	As needed	$900
Downlisting	4.0 Collect and preserve seeds and the seedbank.	1	From all populations, preserved in multiple seed storage facilities or botanical gardens	Every 10 years, as needed	$12
Downlisting	5.0 Survey for new populations within mapped glade habitats.	2	Potential extant sites	Every 2-3 years	$120
Delisting	6.0 Initiate, develop, and steward partnerships to further the recovery of the species, its habitat, and effective management.	1	Throughout species' range	Continual	$100

Delisting	7.0 Develop and maintain a funding plan in concert with partners to further the recovery of the Texas golden gladecress and rare endemic habitat.	3	N/A	Continual	$50
Downlisting	8.0 Enforce applicable regulations.	2	Throughout species' range	Continual	$50
Delisting	9.0 Establish an introduction program.	2	Potential new population sites	1-5 years	$250
	Total				$3,282

3. Time and Cost Estimate

The estimated cost of recovery (delisting) for Texas golden gladecress is $3,282,000. The estimated cost of downlisting is $2,882,000. We estimate that downlisting could be accomplished by 2044 (20 years), assuming long-term protections are in place at all known populations and populations maintain a stable or increasing growth rate over at least 2 drought cycles, or 20 years. This time step demonstrates the species' success outcompeting invasive species for an extended period of time. We estimate that delisting could be accomplished by 2064 (40 years), assuming sufficient long-term protections and management are in place and effective coordination with necessary partners and stakeholders. The 40-year time step includes 4 drought cycles and allows for observation of the species' response to changing conditions and sufficient rangewide resiliency.

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5. Appendix A. Substantive comments on the Texas golden gladecress draft recovery plan.

Comment 1: What does the term "minimum conservation specifications (i.e. acreage size)" (p. 5 of this document) mean in the context of Texas golden gladecress recovery?

Response: "Minimum conservation specifications" was a phrase used in reference to entities that may target larger acreages for land purchase and/or easement for restoration or recovery efforts. Entities could include those such as The Nature Conservancy or the USFWS's Partners for Fish and Wildlife Program. There are no minimum acreages for project proposals, more conservation benefit may be possible with proposals that target more acres.

Comment 2: Does USFWS define "viable population" for Texas golden gladecress?

Response: We define viability as the ability of the species to sustain populations in the wild over time. Species with greater numbers (redundancy) of healthy populations (resilient), encompassing a broad array of ecological and genetic diversity in a spatial arrangement that maintains adequate gene flow (representation), are more likely to be viable. Using the SSA framework, we describe the species' viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation. The Recovery Plan has been updated with language to reflect this.

Comment 3: Downlisting Criterion 2b ("≥ 50 percent populations connected to another ") may need clarifying language concerning genetic relation of different populations that might be discovered later with more studies on between and within populations genetics regardless of distance.

Response: Currently, connectivity means an existing population with ≥ 1 adjacent Texas golden gladecress site in proximity (≤ 1.0 kilometer (km)) (i.e., is a metapopulation). However, to date there have been no genetic studies specific to this species across the full breadth of the range. Banta and Placyk (2015) examined two populations and how genetically similar, or not, they were to each other. Of the samples, they found that there was relatively high gene flow among the two sampled populations and, therefore were both genetically healthy. These populations are nearly 14 mi (22.5 km) apart (p. 6), with another population (not sampled) only 7 mi (11.3 km) away from either of these sites. Therefore, with more information on the species genetics, distance is the best scientific information to date for the Texas golden gladecress. Therefore, should new information become available regarding the genetics of this species this may need to be incorporated, as appropriate.

Comment 4: When considering Downlisting Criterion 3 ("The 12 viable populations are dispersed across the species' range…"), what if we never find more populations in Nacogdoches County? Can this one introduced population represent the historical range of the species and therefore are more reintroduced populations in Nacogdoches appropriate?

Response: Based on the habitat suitability mapping for the Texas golden gladecress, there is the potential for the suite of needed habitat characteristics to extend into Nacogdoches County, Texas. The one reintroduced site is considered extant and additional areas of habitat could be present in other areas, however the majority of survey efforts have not been focused within this county. Until better information is available that states this county could not be suitable for the Texas golden gladecress, the Service will consider populations within this county necessary for the redundancy and representation of the species. The USFWS and partners should prioritize identifying and surveying for accessible sites within this county to better inform this criterion.

Recovery Plans are guidance documents using the best available scientific information at the time of development. The criteria are not outlined in a way that they must be achieved for delisting to occur. For Downlisting Criterion 3, language was added to further highlight the need for multiple populations to be dispersed across the full breadth of the range; thus, language was added that some subset of populations should occur in Nacogdoches, San Augustine, and Sabine counties. It is possible for downlisting to occur without all criteria being met, however the numbers listed are an attempt at having recovery criteria that are objective and measurable.

Comment 5: Justification for Delisting Criterion 2, are justifications not needed for these delisting criteria?

Response: While justification for down- and delisting criteria are not mandatory, the Recovery Plan has been updated to include the ecological knowledge and scientific information used to determine the recovery criteria.

Comment 6: Recovery Action 1 (“Ensure habitat protection and management of extant populations.”) cost estimate for land purchase seems low.

Response: Ensuring habitat protection and management of extant populations can take many different forms. Land purchase is only one aspect of Recovery Action 1. Other avenues, such as management plans in place through NRCS, TPWD, and USFWS, can also sufficiently ensure the habitat protection and management of extant populations. Land management costs in perpetuity should be considered in this estimate. We have updated the Time and Cost Estimate table to reflect these calculations based on past and/or current project budgets.

Comment 7: Recovery Action 2 (“Monitoring population status, trend, and distribution”) seems low.

Response: Monitoring population status, trend, and distribution can be achieved by multiple means. The estimate offered may be on the high-end of estimates for the work as it would be contracted. It is also possible that State and Federal partners may work together to monitor these populations within their regular conservation duties. Therefore, based on these factors we have updated the Time and Cost Estimate table to reflect these calculations.

Comment 8: Recovery Action 5 (“Survey for new populations within mapped glade habitats”) cost estimate appears inaccurate.

Response: Surveying for new populations within mapped glade habitats can be achieved through multiple means. The estimate offered may be on the high-end of estimates for the work as it

would be contracted. It is also possible that State and Federal partners may work together to survey for new populations within their regular conservation duties. We have updated the Time and Cost Estimate table to reflect these calculations.