

**Recovery Outline for the Swale Paintbrush**  
***(Castilleja ornata)***



Swale Paintbrush (*Castilleja ornata*) in Hidalgo County, New Mexico. Photo Credit: USFWS.

**Species Common Name:** Swale Paintbrush

**Species Scientific Name:** *Castilleja ornata*

**ESA Listing Status:** Endangered, December 5, 2024 (89 FR 96602)

**Lead Region:** Southwest Region

**Cooperating Region(s):** N/A

**Lead Office:** New Mexico Ecological Services Field Office; 2105 Osuna Rd NE, Albuquerque, NM 87113; (505) 346-2525

**Cooperating Office(s):** N/A

**Lead Contact:** Katie Sandbom, Fish and Wildlife Biologist

**Species Range:** New Mexico, USA; Chihuahua and Durango, Mexico

## **PURPOSE AND DISCLAIMER**

The recovery outline is a succinct document that presents a preliminary recovery strategy and actions to direct the recovery efforts of a species newly listed under the Endangered Species Act (ESA) until a recovery plan is completed. Recommendations in the recovery outline are non-binding and are intended to guide (not require) regulatory (e.g., section 7 consultations and section 10 permitting) and conservation actions to be implemented by the U.S. Fish and Wildlife Service (USFWS) and our external partners.

This document lays out a preliminary course of action for the survival and recovery of the Swale Paintbrush. Formal public participation for recovery planning will be invited upon the release of the draft recovery plan. However, we will consider any new information or comments that members of the public offer in response to this outline during the recovery planning process. For more information on Federal recovery efforts for Swale Paintbrush, or to provide additional comments, interested parties may contact the lead field office for this species at the above address and telephone number.

## **BACKGROUND**

The following sections include a summary of the biology, life history, and ecology of the species. A complete discussion of the species' morphology, taxonomy, distribution, phenology, reproduction, life span, demographic trends, and habitat needs can be found in Species Status Assessment for the Swale Paintbrush (USFWS 2023, entire). An electronic copy of the assessment report is available on the [ECOS species webpage for Swale Paintbrush](#).

## **Important Information Gaps and Treatment of Uncertainties**

Due to limited data, there is some uncertainty associated with our analyses in the Swale Paintbrush SSA. We therefore make assumptions, which are explicitly defined in the SSA, based on the best available information. Key uncertainties to resolve to support recovery planning and implementation include the species' self-compatibility, effective pollinators, seed dormancy, seed longevity, germination requirements, germination timing, range-wide habitat diversity, essential habitat features and habitat maintenance requirements, drought tolerance, and response to disturbance.

Data limitations include limited survey effort across the species' range, limited observation record details, a lack of research about Swale Paintbrush, and a lack of long-term monitoring of Swale Paintbrush populations. Limited survey effort hinders our understanding of the status of Swale Paintbrush range-wide. Limited observation details hinder our understanding of the distribution and abundance of Swale Paintbrush as well as the variety of habitats that support Swale Paintbrush occurrences. A lack of research studies hinders our understanding about Swale Paintbrush's lifecycle (especially the timing of critical life cycle events range-wide), reproductive biology, and habitat needs. A lack of long-term population monitoring hinders our understanding of the species' response to influential factors over time and, therefore, how threats—such as surface disturbance, nonnative plant competition, altered fire regimes, climate change, and herbivory and trampling—may be directly or indirectly affecting Swale Paintbrush population trends.

## **Limiting Ecological Traits**

The Swale Paintbrush has several limiting traits that make it vulnerable to extinction: short life span, reliance on a short-lived seedbank, a winter seed chilling requirement (to overcome seed dormancy), dependence on host species (*Castilleja* taxa are hemiparasites that exploit the roots of host plants for nutrients), specific habitat requirements (seasonally inundated areas within semi-arid, relatively high-elevation native grasslands), and specific habitat and grassland canopy gap maintenance requirements (such as seasonally appropriate fire, grazing or herbivory, drought, and/or inundation). These limitations are described in detail in the SSA (USFWS 2023, chapters 2 and 3).

## **Threats**

The Swale Paintbrush SSA provides a thorough discussion of multiple stressors to the species, with the following three posing the largest risk to its future viability: 1) natural and artificial drought, 2) altered disturbance regimes and subsequent changes in the species composition of habitats, and 3) the effects of small population size. Risks from these stressors are exacerbated by climate change, which can reduce germination and establishment (hastening seedbank depletion), stress plant growth and flowering (reducing seedbank replenishment), increase nonnative species competition, and change the frequency, intensity, duration, and seasonality of disturbances, among other things. Further, synergistic interactions between these stressors—amplifying adverse effects—are also possible.

Swale Paintbrush inhabits seasonally moist, loamy soils and appears to be primarily documented from grassland and savannah habitats fringing high elevation (at least 1,500 m (5,000 ft)) basins and valleys. Stressors on these habitats include habitat loss and fragmentation, hydrological alteration, altered fire regimes, effects from intensive grazing pressure, exotic plant invasion, and climate change (NatureServe 2021a, unpaginated; NatureServe 2021b, unpaginated).

Swale Paintbrush relies on cool season precipitation, monsoon precipitation, and a suitable surface/subsurface hydrology to complete its life cycle and maintain its seedbank. Thus, this species is sensitive to natural or artificial drought. Artificial drought may occur when upslope obstacles to, or diversions of, surface and near-surface flows starve downslope areas that would have otherwise received those flows (Raiter et al. 2018, pp. 445–446; Roth 2020, p. 5; Nichols and Degginger 2021, entire).

While Swale Paintbrush relies on seasonally appropriate inundation (for adequate soil moisture) and fire or grazing/herbivory (for adequate canopy gaps and associated solar exposure), it is sensitive to the timing of these events. If inundation, fire, grazing, or trampling incidental to grazing interrupt this species' annual life cycle, existing seedbanks may become depleted and seedbank replenishment may be thwarted, depending on the timing, intensity, and duration of events (Insausti et al. 1999, p. 272).

Swale Paintbrush relies heavily on canopy gaps and mineralized soil nutrient inputs for establishment and growth. Fire fosters these conditions and reduces the cover of woody vegetation. It stimulates the growth of grasses, including blue grama (*Bouteloua gracilis*; which is one of Swale Paintbrush's host plants), and forbs (which support a host of pollinators and, hence, Swale Paintbrush pollination) (Bestelmeyer et al. 2021, p. 181; Sam 2020, p. 69; Johnson 2000, unpaginated; Anderson 2003, unpaginated; Lybbert et al. 2017, p. 1030). Prehistoric fire return intervals in Madrean ecosystems range from 2.5 to 10 years. Historically, Madrean ecosystems most commonly experienced fire during late winter and early spring (early season, outside of the growing season) (Poulos et al. 2013, pp. 3–4, 8). Grasslands, a key ecosystem for Swale Paintbrush, are more likely to convert to shrublands or woodlands when fire return intervals exceed 10 years.

While spring grazing helps to create the canopy gaps that this species needs for establishment, excessive grazing pressure that results in significant canopy loss increases the potential for evaporation, erosion, and nutrient loss (Li et al. 2007, pp. 318, 329–331). Further, growing season grazing or herbivory can result in excessive trampling (Oostermeijer 2003, p. 7 and references therein).

Exotic plants can become introduced to, and dispersed within, grassland habitats by the travel of both humans and animals. Invasive exotic plants could reduce the availability of canopy gaps and outcompete Swale Paintbrush for available gaps, soil moisture, and soil nutrients, potentially both depleting the existing seedbank and reducing seedbank replenishment.

Climate change has the potential to affect all the following factors: drought (and associated increases in grazing/herbivory pressure), flood, fire, and vulnerability to exotic plant invasion.

Climate change could also alter the timing, frequency, or intensity of grazing, fire, and flood, potentially interrupting the species' annual life cycle.

A potential emerging stressor to the species is collection pressure. Given the species' small population sizes, reliance on a short-lived seedbank, and its exposure to existing stressors with compounding effects, populations of this species would be extremely vulnerable to seedbank depletion and extirpation as a result of collection pressure.

## **Current Biological Status**

### *Overview*

The Swale Paintbrush was historically documented from 13 sites in the United States and Mexico, spanning a range extent of approximately 587 kilometers (km) (365 miles (mi)): 2 sites in the Animas Valley of Hidalgo County, New Mexico, and 11 sites in the eastern Sierra Madre Occidental of Chihuahua and northern Durango in Mexico. Currently, only one site—the Gray Ranch site in the Animas Valley of Hidalgo County, New Mexico—is known extant; the species was last observed at this site in 2021. The status of historically collected sites at the Cowan Ranch in New Mexico and in the eastern Sierra Madre Occidental of Mexico is unknown. The last observations of these historical sites were 1993 in New Mexico and 1985 in Mexico.

Since the persistence, size, and condition of populations in Mexico is unknown, SSA team members each ranked the possibility that Swale Paintbrush could persist at a given site based on disturbance in the vicinity of each site. The team assumed that the possibility of persistence decreased with increasing extent, intensity, and/or trend in disturbance. The rank categories are defined as follows.

***Known Extant*** – Swale Paintbrush has been observed in the vicinity of the herbarium record location within the last decade.

***Possibly Extant*** – Swale Paintbrush is known only from the herbarium record location, but there is a reasonable potential for future rediscovery based on the evaluation of remaining potential habitat. Evidence of habitat loss or degradation is present in the vicinity of historical location; however, current disturbance is not substantial enough to presume complete loss of habitat since the time of collection.

***Possibly Extirpated*** – Swale Paintbrush is known only from the herbarium record location, and there remains a low potential for future rediscovery based on the evaluation of remaining potential habitat. Evidence of major habitat loss or degradation is present at all spatial scales in the vicinity of the historical location.

***Presumed Extirpated*** – Disturbance within the vicinity of the herbarium record location over the last decade indicates significant loss or alteration of the habitat that resulted in very likely loss of Swale Paintbrush habitat and a very low potential for future rediscovery.

## New Mexico

1. Cowan Ranch Site: ***Possibly extant***. Swale Paintbrush was initially collected from, and last documented at, this site in 1993. Abundance of the species at this site was not noted.
2. Gray Ranch Site: ***Known extant***. Swale Paintbrush was initially collected from this site in 1993, and last documented at this site in 2021. In 2021, abundance of the species at this site was estimated as greater than 6,028 plants.

## Chihuahua, Mexico

3. Nelson 6073: ***Possibly extant***. Swale Paintbrush was initially collected from, and last documented at, this site in 1903. Abundance of the species at this site was not noted.
4. Jones s.n.a. (9/16/1903) Site: ***Possibly extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1993. Abundance of the species at this site was not noted.
5. Keil 13388 Site: ***Possibly extant***. Swale Paintbrush was initially collected from, and last documented at, this site in 1979. Abundance of the species at this site was noted as “occasional.”
6. Jones s.n.b (9/18/1903) Site: ***Possibly extant***. Swale Paintbrush was initially collected from, and last documented at, this site in 1903. Abundance of the species at this site was not noted.
7. LeSueur 899 Site: ***Possibly extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1936. Abundance of the species at this site was not noted.
8. Duek and Martin s.n. Site: ***Possibly extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1985. Abundance of the species at this site was not noted.
9. Palmer 320 Site: ***Possibly extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1908. Abundance of the species at this site was noted as “few plants.”
10. Straw and Forman 1846 Site: ***Possibly extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1960. Abundance of the species at this site was not noted.
11. Pringle 1545 Site: ***Presumed extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1887. Abundance of the species at this site was not noted.
12. Ellis, LeDoux, and Watkins 967 Site: ***Presumed extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1975. Abundance of the species at this site was not noted.

Durango, Mexico

13. Reveal, Hess, and Kiger 2752 Site: ***Possibly extirpated***. Swale Paintbrush was initially collected from, and last documented at, this site in 1971. Abundance of the species at this site was not noted.

In the United States, Swale Paintbrush has been documented only on private lands. Land ownership of historical collections sites in Mexico is unknown, but none of those sites are in administratively protected areas (USFWS 2023, pp. 42, 53–82). In addition to historical collection sites, there could be additional undiscovered sites in suitable habitat throughout the eastern Sierra Madre Occidental and adjacent mountain ranges. Botanical collection efforts in these areas are sparse, and additional suitable habitat exists between and around historically collected sites. See the “Conservation Actions to Date” section, below, for details about survey and outreach efforts.

3 Rs

We characterized the 3 Rs as:

***Resiliency*** (*populations able to withstand stochastic events*): Self-sustaining populations are demographically, genetically, and physiologically robust, have a sufficient quantity of high-quality habitat, and are free of, or have manageable, threats.

***Redundancy*** (*number and distribution of populations able to withstand catastrophic events*): Species has sufficient distribution to guard against catastrophic events wiping out portions of the species’ adaptive diversity; populations are spread out geographically but also ecologically (different ecological settings).

***Representation*** (*genetic and ecological diversity to maintain adaptive potential*): Populations are maintained across spatial and environmental gradients to maintain the ecological and genetic diversity; evolutionary drivers (e.g., gene flow, natural selection, mutation, genetic drift) mimic historical patterns.

Our methodology and evaluations of the 3 Rs are described in more detail in the Swale Paintbrush SSA report (USFWS 2023, chapter 4). The following provides a summary of the current condition of Swale Paintbrush in terms of the 3 Rs.

Based on our assessment of Swale Paintbrush’s current conditions across all sites, one site, the Gray Ranch site, is known extant, four sites ranked as possibly extant, six sites ranked as possibly extirpated, and two sites ranked as presumed extirpated. Of the four possibly extant sites, Swale Paintbrush plants were last observed in 1899, 1903, 1979, and 1993. Although potentially suitable habitat may remain at some of the historical sites in Mexico (particularly the four possibly extant sites), the size and abundance (i.e., resiliency) of populations at the historical sites are unknown, and we cannot reasonably assume anything about the status of the species at these sites. Thus, the Swale Paintbrush has no verifiable redundancy and very limited representation throughout its known range.

Based on our detailed assessment of current condition, Swale Paintbrush has moderate to high resiliency at the Gray Ranch site. The most recent survey in September 2021 documented a minimum abundance of 6,000 plants—higher than our range of provisional minimum viable population sizes (1,500–5,000 plants)—distributed across two patches and 11.3 hectares (27.9 acres) of habitat in the Animas Valley. Generally, the site has moderate amounts of surface disturbance that would have limited influence on pollinator visitation rates. There has been no recent herbicide exposure within 300 meters (984 feet) of Swale Paintbrush patches within the last 15 years. Grazing during the species’ active season within recent years has been avoided, and the disturbance pattern (fire return intervals, inundation seasonality, grazing regime), combined with the recent precipitation history, have maintained favorable canopy cover that allows for Swale Paintbrush growth, establishment, and recent seedbank replenishment within the core of the population area.

Although the Gray Ranch site is currently considered to have moderate to high resiliency, this site is restricted to a specialized and climatically vulnerable habitat that is only approximately one kilometer (0.6 mile) in linear extent and 11.3 ha (27.9 ac) in area. Further, Swale Paintbrush is an annual species with a provisional seedbank viability of two years in the wild, and frequent replenishment of the seedbank is essential to population persistence. Therefore, Swale Paintbrush is extremely vulnerable to adverse stochastic events and the cumulative impacts of multiple stressors.

At the species level, Swale Paintbrush has low resiliency, no redundancy, and limited representation. Swale Paintbrush has moderate to high resiliency within the single known extant site and unknown resiliency across the other 12 historical sites. Although our analyses reflect our best assessment of disturbance at or in the vicinity of the historical site locations, the status of the species at the historically collected sites at Cowan Ranch in the Animas Valley and in the eastern Sierra Madre Occidental of Mexico is unknown. Range-wide, specimens were collected from 1887–2021, and the last observations of historical sites were in 1993 at the Cowan Ranch site and 1985 in Mexico. Additionally, outside of the known extant New Mexico site, there have been no reported estimates of abundance with the exception of qualitative reports of “occasional” for the distribution at the Keil 13388 site and “few plants” for Palmer 320 (Palmer 1906, unpaginated; Keil 1978, unpaginated; USFWS 2023, p. 19). Thus, we cannot reasonably conclude anything about the health or resiliency of any site except for the Gray Ranch site.

Accordingly, Swale Paintbrush has limited to no redundancy, depending on the currently unknown status of the species at the historical sites in Mexico. Even if Swale Paintbrush remains extant at sites outside of Gray Ranch, the majority of sites are isolated and there is limited potential for interpopulation rescue in the event of local extirpations. Finally, the Swale Paintbrush has limited representation. Although the most recent survey of the Gray Ranch site found sufficient population sizes to avoid adverse effects associated with small population sizes and associated inbreeding, all of the plants occurred primarily within a single patch at the northern periphery of the species’ range, reflecting only a small portion of the historical ecological diversity of the species.



## Conservation Actions to Date

Swale Paintbrush is considered a sensitive species by the Bureau of Land Management and is listed as an endangered plant species by the state of New Mexico. The New Mexico endangered plants rule (NMAC 19.21.2) was recently revised to expand protections for state listed plants.

Swale Paintbrush is not managed for conservation in Mexico (NOM-059-SEMARNAT-2010). However, Colectivo Sonora Silvestre (a student collective within Universidad de Sonora (University of Sonora)) has initiated an “Extraordinary Species Monitoring Network” (Red de Monitoreo de Especies Extraordinarias, or REDMEE) that includes outreach for citizen science observations of Swale Paintbrush (Bojórquez 2021, unpaginated). These social media outreach efforts raise awareness about the rarity of this species and the potential for it to exist in Mexico. However, this effort is based in the state of Sonora and may not be effective in reaching the public in the known historically occupied states of Chihuahua and Durango. While Swale Paintbrush is not managed for conservation in Mexico, there are some areas managed for conservation of wildlife in Mexico that may confer some incidental benefits for this species. These protected areas are also hotspots for citizen science iNaturalist observers (iNaturalist Contributors and iNaturalist 2024).

In New Mexico, Swale Paintbrush exists on lands formerly known as the Gray Ranch, which are now managed for livestock production in an ecologically responsible manner by the Animas Foundation, a private operating foundation. (Brown 1998, p. 248). The Animas Foundation was created in 1993 for the primary purpose of acquiring the Gray Ranch from The Nature Conservancy (TNC) (Brown 1998, p. 248). TNC retains a conservation easement prohibiting development on the lands formerly known as Gray Ranch (TNC 2022, unpaginated; Malpai Borderlands Group 2008, p. 7). While this easement does not require that range improvements will avoid adverse effects to Swale Paintbrush, it ensures that the covered areas will remain open space. In the past, awareness of Swale Paintbrush on Animas Foundation land has waned with changes in personnel and activity, resulting in unintended effects to historically occupied areas (Roth 2017, p. 6). However, current Animas Foundation leadership and management are committed to the conservation of Swale Paintbrush on Animas Foundation lands.

The Nature Conservancy, the Animas Foundation, the New Mexico Energy, Minerals, and Natural Resources Department – Forestry Division, and the USFWS have conducted surveys for Swale Paintbrush in the United States intermittently since 1994. In addition, the Animas Foundation, the New Mexico Energy, Minerals, and Natural Resources Department – Forestry Division, and the USFWS conducted maternal line seed collections for the species in 2020 and 2021. These collections are being maintained in long-term storage by the Albuquerque BioPark. In 2022, the USFWS initiated spatial habitat analyses and searches for undocumented occurrences of—and potential reintroduction sites for—this species on publicly-owned lands in the United States. Now that high-resolution light detection and ranging (LiDAR) digital elevation model (DEM) datasets are available for southwest New Mexico, the USFWS can use a LiDAR-derived Topographic Wetness Index raster, which will identify potentially suitable microhabitats not otherwise detectable from geospatial analysis of other, lower-resolution, remote sensing products.

An informal conservation and recovery working group for Swale Paintbrush—consisting of *Castilleja* expert Mr. Mark Egger, Albuquerque BioPark and New Mexico BioPark Society conservationists, New Mexico state botanists, Bureau of Land Management botanists, New Mexico State Land Office ecologists, Animas Foundation representatives, and USFWS species leads—is currently identifying conservation needs, coordinating conservation efforts, and planning for future Animas Valley reintroduction efforts. In addition, USDA Forest Service botanists are anticipated to participate in future conservation planning efforts. The identification of suitable introduction sites is likely limited by a lack of detailed information about the diversity of habitats and microhabitats occupied by Swale Paintbrush in Mexico. Conservation planning is also challenged by uncertainty about biological timelines (e.g., seed longevity in ex-situ storage) and future climatic conditions (e.g., drought events).

## **PRELIMINARY RECOVERY PROGRAM**

### **Recovery Priority Number**

**Number:** 5

**Rationale:** Swale Paintbrush is assigned a recovery priority number of 5, indicating a species that faces a high degree of threat, has low recovery potential, and is not in conflict with construction or other development projects or other forms of economic activity (48 FR 43098). Its degree of threat is high due to exposure to risks from stressors. Its recovery potential is low because of low control over, and high uncertainty about, threats. Though risk exposure is high and our capacity to manage threats is low, the species is not currently at immediate risk from construction or other economic activities.

The degree of threat to Swale Paintbrush is high because the species' historical range has been drastically reduced by development, conversion to agriculture, intensive grazing pressure and surface water diversions. These threats have ostensibly limited the known species distribution to a single site of relatively small size. Further, it is an annual species with a provisional seedbank viability of two years in the wild. Therefore, the species is highly vulnerable to catastrophic events, and frequent replenishment of the seedbank is essential to population persistence through natural environmental variation and recovery from periodic disturbances. In New Mexico, Swale Paintbrush's largest threat is disruption of its life cycle, which leads to seedbank depletion. Surface disturbance, drought, fire, grazing, trampling, inundation, or vegetative competition all have potential to disrupt seedbank replenishment when they occur during the Swale Paintbrush's growing season. Further, these influences could affect Swale Paintbrush simultaneously or consecutively and are likely to increase in frequency or severity in response to climate change. Given this plant's small population size and reliance on its short-lived seedbank, it's also especially vulnerable to illegal collection.

Swale Paintbrush has low recovery potential because our capacity to manage stressors is low and the species' capacity to adapt to changing conditions may be low. Our capacity to manage stressors is low because there are no known swale paintbrush occurrences on U.S.

public lands and because the species' environmental stressors (such as growing season drought or flooding and climate change) are not predictable or manageable. Further, the majority of the species' historical range occurs in Mexico, and our capacity to understand the species is limited by challenges of travelling and communicating internationally. Finally, while the species is threatened by habitat alteration and effects from climate change, the species' capacity to adapt to changing conditions may be limited by lost ecological diversity across the species' range.

While historical economic development appears to have resulted in significant species' range reductions, the species is not currently known to conflict with construction or other development projects or other forms of economic activity. Threats from development and horticultural and agricultural production are historical, and threats from range management, forest management, and fire management activities are manageable with discretionary conservation measures, such as timing restrictions.

### **Preliminary Recovery Strategy**

The overall recovery strategy for the Swale Paintbrush is to improve population resiliency, redundancy, and representation, such that the following are met.

- **Resiliency:** There are sufficient numbers of individuals within populations to support rebound from demographic stochasticity (e.g., random fluctuations in germination rates and survivorship) and environmental stochasticity (e.g., normal variation in rainfall and temperature and small-scale fire). Self-sustaining populations are demographically, genetically, and physiologically robust, have a sufficient area of high-quality habitat, and are free of, or have manageable, threats.
- **Redundancy:** Populations occur in sufficient number and distribution to guard against catastrophic events (e.g., catastrophic fire, flooding, prolonged exceptional drought, and disease) which could lead to extirpation of portions of the species' current range or lead to extinction of the species as a whole. The distribution of populations is sufficient to guard against catastrophic events wiping out portions of the species' adaptive diversity and the species as a whole, i.e., to reduce covariance among populations, and populations are spread out ecologically (among different ecological settings) as well as geographically.
- **Representation:** Populations occur across the species' historical range, or beyond it, to maintain genetic and ecological diversity within and among populations, conserving the species' ability to adapt to future changes in its physical (e.g., habitat and climate) and biological (e.g., herbivores, competitors, and diseases) environment. Resilient populations track with shifting climate envelopes across spatial and environmental gradients, conserving ecological and genetic diversity as well as the evolutionary drivers (e.g., gene flow, natural selection, genetic drift) of adaptive capacity.

This strategy will require 1) evaluation of the status of Swale Paintbrush at historically occupied sites, 2) the protection and augmentation of extant populations, 3) reintroduction of genetically appropriate Swale Paintbrush germplasm into ecologically appropriate, historically occupied sites, and 4) the introduction of Swale Paintbrush into (or discovery of Swale Paintbrush in) additional ecologically appropriate sites. Threats to the species must be addressed and reduced or managed to a point such that viable populations of Swale Paintbrush can be maintained in the wild. Implementation of this strategy will involve working with local, County, State, and Federal agencies, Tribes, private landowners, and local communities and businesses in the U.S. and Mexico to address stressors to the species in a way that will restore and protect habitat and enable augmentation, reintroduction, and introduction of the species to increase abundance and the number of resilient populations.

The species' conservation will be promoted among State and Federal conservation agencies, non-profit conservation organizations, and private landowners in Hidalgo County, New Mexico and adjacent communities in Arizona and in the Mexican states of Chihuahua, Durango, and Sonora.

To inform recovery planning, research will be needed on Swale Paintbrush's self-compatibility, effective pollinators and their foraging distances, seed dispersal distance, seed dormancy, the longevity of its seeds in storage and in the soil, its germination requirements, suitable host species, its physiological requirements and thresholds in terms of temperatures, soil moisture, soil texture, and soil composition, and its responses to different types, intensities, and durations of disturbance.

### **Preliminary Recovery Actions**

1. Promote awareness and conservation of Swale Paintbrush throughout its historical range.
  - a. Conduct outreach in Hidalgo County, New Mexico and adjacent communities in Arizona to raise local awareness of Swale Paintbrush.
  - b. Work with land and resource management agencies to prevent illegal collection or vandalism of Swale Paintbrush in the United States.
  - c. Promote conservation of wild populations on private lands with willing landowners through the USFWS's Partners for Fish and Wildlife Program and other USFWS grant programs and through cooperative efforts, such as with Natural Resources Conservation Service (NRCS) or nongovernmental partners.
  - d. Establish a private landowner support group for conservation of Swale Paintbrush (and perhaps other plant species of concern with potential to occur on their properties).
  - e. Communicate with Mexican federal and state conservation agencies to inform them that we have now protected Swale Paintbrush under the ESA and seek to work cooperatively with them to promote the species' conservation in Mexico.
  - f. Communicate with researchers in academic institutions and non-profit conservation organizations in Chihuahua, Durango, and Sonora, Mexico to inform them that we have now protected Swale Paintbrush under the ESA and seek to work cooperatively

with them to promote the species' conservation in Mexico.

- g. Encourage citizen scientists to document and report observations of Swale Paintbrush.
- 2. Conserve existing Swale Paintbrush populations and the areas and natural processes that support those populations as well as ecologically appropriate areas that Swale Paintbrush could occupy in the future.
    - a. Manage and adjust, if necessary, grazing seasonality, intensity, and duration in a manner that is compatible with, or enhances, Swale Paintbrush conservation.
    - b. Coordinate with private and public land managers to incorporate consideration of Swale Paintbrush's needs into relevant land use and management plans, as appropriate.
    - c. Investigate Swale Paintbrush's ranges of tolerances in terms of potentially limiting habitat factors.
    - d. Continue to refine the conceptual model of Swale Paintbrush suitable habitat as more information about occupied habitats and the species' physiological needs and tolerances becomes available.
    - e. Identify areas of potential habitat for Swale Paintbrush. Model potential habitat using geospatial approaches.
    - f. Model areas where future climatic conditions will be suitable for Swale Paintbrush.
  - 3. Improve our understanding of the status, trends, and habitat conditions of Swale Paintbrush populations.
    - a. Monitor Swale Paintbrush to determine the abundance, fecundity, and habitat quality of extant Swale Paintbrush populations, including natural, augmented, (re)introduced, and captive populations.
    - b. Coordinate with partners to revisit and survey historically occupied sites during Swale Paintbrush's bloom season, documenting the species' abundance, distribution, ecological setting, and local influential factors (stressors and conservation mechanisms).
    - c. Coordinate with partners to search for additional populations of, or ecologically appropriate habitat for, Swale Paintbrush.
    - d. Conduct initial genetic research to determine genetic diversity and gene flow patterns within and among natural Swale Paintbrush populations and subpopulations. Monitor genetic diversity and gene flow patterns within and among natural, augmented, (re)introduced, and ex-situ populations over time.
  - 4. Ensure long-term Swale Paintbrush conservation through the establishment of ex-situ plant and seed collections housed at multiple Center for Plant Conservation-approved

botanical institutions and seed banks.

- a. Conserve Swale Paintbrush seed (representing the geographical, morphological, and genetic diversity of the species) in Center for Plant Conservation-approved facilities; periodically test the seed to track the rate of viability loss during seed storage, and estimate seed longevity in ex-situ storage.
  - b. Use seed longevity results to appropriately plan for maintaining viable seeds in ex-situ storage (such as establishing ex-situ seed amplification and in-situ recollection timelines, targets, and protocols). Consider what germplasm may be needed for successful reintroductions when planning grow-out and collections (Maschinski et al. 2012, entire). Conduct grow-outs and recollections, as appropriate. Also consider the need to collect soil from the species' habitat to maintain the strains of mycorrhizal fungi and other beneficial microbial components of the species' rhizosphere. Following Center for Plant Conservation guidelines, collect seeds from each accessible population (representing the geographical, morphological, and genetic diversity of the species) for propagation in ex-situ refugia as well as long-term seed banking. The objective is to create redundant refugium populations that could be used to recover natural populations that suffer catastrophic losses.
  - c. Cryogenically preserve Swale Paintbrush germplasm at the National Laboratory for Genetic Resource Preservation in Fort Collins, Colorado.
  - d. Grow and maintain Swale Paintbrush plants (representing the geographical, morphological, and genetic diversity of the species) in captivity at botanical gardens and other USFWS-approved facilities for educational purposes and seed amplification, as needed.
  - e. Establish multiple ex-situ refugium populations in botanical gardens or other protected locations for the following purposes: a) conserve the genetic diversity of plants that would be destroyed if construction sites overlap Swale Paintbrush populations; b) facilitate genetically appropriate gene flow between plants from different sites to produce genetically diverse seeds for use in reintroduction and augmentation efforts; c) produce live plants and seeds for use in scientific investigation that contributes to the species' conservation and recovery. For these purposes, the maternal lines of all source plants and their progeny should be maintained through permanent labels and record-keeping.
5. Increase the size and number of Swale Paintbrush populations (i.e., improve resiliency, representation, and redundancy).
    - a. Establish new Swale Paintbrush populations at strategic sites using genetically appropriate germplasm.
    - b. Augment natural and newly established Swale Paintbrush populations, as appropriate.
  6. Initiate research needed to inform recovery, and share results among land managers and researchers.
    - a. Research Swale Paintbrush's self-compatibility, effective pollinators and their

foraging distances, seed dispersal distances, seed dormancy, the longevity of its seeds in storage and in the soil, its germination requirements, suitable host species, its physiological requirements in terms of temperatures, soil moisture, soil texture, and soil composition, and its responses to different types, intensities, and durations of disturbance.

- b. Investigate Swale Paintbrush's ranges of tolerances in terms of potentially limiting habitat factors.
- c. Research the optimal frequency and type of disturbance (e.g., fire regimes and intensity levels) to maintain native plant communities, including viable Swale Paintbrush populations, within grasslands.

## **PRELIMINARY STEPS FOR RECOVERY PLANNING**

We will prepare a recovery plan pursuant to section 4(f) of the ESA. The recovery plan will include objective, measurable criteria which, when met, may result in a determination that the Swale Paintbrush be removed from the Federal list of endangered and threatened plants. Recovery criteria will address threats meaningfully impacting the species. The recovery plan will include site-specific management actions as may be necessary for the conservation and survival of the species. Finally, the recovery plan will estimate the time and cost required to carry out those measures needed to achieve the goal of recovery and delisting for the Swale Paintbrush.

Recovery plan preparation will be carried out by the New Mexico Ecological Services Field Office. The USFWS anticipates either writing the recovery plan or appointing a recovery team to help draft a recovery plan for the Swale Paintbrush.

During the recovery planning process, input, comments, and review will be sought from multiple stakeholders across the current and historical species' range. These will include Federal and State agencies, Tribes, and academic and private entities. We will conduct peer review of, and solicit public comments on, a draft recovery plan.

Signed: \_\_\_\_\_  
Assistant Regional Director, Ecological Services,  
U.S. Fish and Wildlife Service, Southwest Region

## LITERATURE CITED

- Anderson, M.D. 2003. *Bouteloua gracilis*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). <https://www.fs.fed.us/database/feis/plants/graminoid/bougra/all.html>, accessed May 8, 2022.
- Bestelmeyer, B.T., L.M. Burkett, and L. Lister. 2021. Effects of managed fire on a swale grassland in the Chihuahuan Desert. *Rangelands* 43(5): 181–184.
- Bojórquez, G. 2021. Colectivo Sonora Silvestre monitoreará plantas “raras” en el desierto de Sonora. *Expreso*. <https://www.expreso.com.mx/seccion/sonora/304280-colectivo-sonora-silvestre-monitoreara-plantas-raras-en-el-desierto-de-sonora.html>, accessed February 22, 2022.
- Brown, B. 1998. Grassland management by the Animas Foundation. In Tallman, B., D.M. Finch, C. Edminster, and R. Hamre (Eds.). 1998. *The Future of Arid Grasslands: Identifying Issues, Seeking Solutions* [Proceedings RMRS-P-3], pp. 248–250. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado. 392 pp.
- Duek and Martin s.n. 1985. *Castilleja ornata*: Collected 7/2/1985 [herbarium specimen(s)]. In SEINet’s Specimen Search. <https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Ellis, LeDoux, and Watkins 967. 1975. *Castilleja ornata*: Collected 7/19/1975 [herbarium specimen(s)]. In C.V. Starr Virtual Herbarium Quick Search. <http://sweetgum.nybg.org/science/vh/specimen-list/?SummaryData=Castilleja%20ornata>, accessed February 18, 2022.
- Federal Register 48 FR 43098. 1983. Endangered and Threatened Species Listing and Recovery Priority Guidelines. [https://archives.federalregister.gov/issue\\_slice/1983/9/21/43096-43105.pdf#page=3](https://archives.federalregister.gov/issue_slice/1983/9/21/43096-43105.pdf#page=3).
- Insausti, P., E.J. Chaneton, and A. Soriano. 1999. Flooding reverted grazing effects on plant community structure in mesocosms of lowland grassland. *Oikos* 84(2): 266–276.
- iNaturalist contributors and iNaturalist (2024). iNaturalist Research-grade Observations. iNaturalist.org. Occurrence dataset <https://doi.org/10.15468/ab3s5x> accessed via GBIF.org on 2024-05-10.
- Johnson, K.A. 2000. *Sporobolus airoides*. In: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). <https://www.fs.fed.us/database/feis/plants/graminoid/spoair/all.html>, accessed May 8, 2022.



- Jones s.n.a. 1903. *Castilleja ornata*: Collected 9/16/1903 [herbarium specimen(s)]. In SEINet's Specimen Search. <https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Jones s.n.b. 1903. *Castilleja ornata*: Collected 9/18/1903 [herbarium specimen(s)]. In SEINet's Specimen Search. <https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Keil 13388. 1978. *Castilleja ornata*: Collected 9/4/1978 [herbarium specimen(s)]. In SEINet's Specimen Search. <https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Keil, D. 1979. 1979 Collection Notes (unpublished data). California Polytechnic State University, San Luis Obispo, California.
- LeSueur 899. 1936. *Castilleja ornata*: Collected 8/29/1936 [herbarium specimen(s)]. In SEINet's Specimen Search. <https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Li, J., G.S. Okin, L. Alvarez, and H. Epstein. 2007. Quantitative effects of vegetation cover on wind erosion and soil nutrient loss in a desert grassland of southern New Mexico, USA. *Biogeochemistry* 85(3): 317–332.
- Lybbert, A.H., J. Taylor, A. DeFranco, and S.B. St Clair. 2017. Reproductive success of wind, generalist, and specialist pollinated plant species following wildfire in desert landscapes. *International Journal of Wildland Fire*, 26(12): 1030–1039.
- Malpai Borderlands Group. 2008. Malpai Borderlands habitat conservation plan for privately owned and state trust lands in the Malpai Borderlands of southern Arizona and New Mexico. Malpai Borderlands Group, Douglas, Arizona. 248 pp.
- Maschinski, J., M.A. Albrecht, L. Monks, and K.E. Haskins. 2012. Center for Plant Conservation Best Reintroduction Practice Guidelines. In *Plant Reintroduction in a Changing Climate: Promises and Perils*, edited by J. Maschinski and K. E. Haskins, 171–88. Washington, DC: Island Press.
- Nelson 6073. 1899. *Castilleja ornata*: Collected 7/1899 [herbarium specimen(s)]. In SEINet's Specimen Search. <https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Nichols, M.H. and T. Degginger. 2021. The landscape impact of unmaintained rangeland water control structures in southern Arizona, USA. *Catena* 201: 105201-1–105201-10.
- NMAC 19.21.2. 2023. New Mexico Administrative Code; New Mexico Energy, Minerals and Natural Resources Department, Forestry Division. Endangered plant species list and

- collection permits. <https://www.srca.nm.gov/parts/title19/19.021.0002.html>, accessed April 10, 2024.
- NOM-059-SEMARNAT-2010.  
<https://www.dof.gob.mx/normasOficiales/4254/semarnat/semarnat.htm>, accessed January 28, 2022.
- Oostermeijer, J.G.B. 2003. Threats to rare plant persistence. In Brigham, C.A. and M.W. Schwartz (Eds.). 2003. Population Viability in Plants: Conservation, Management, and Modeling of Rare Plants [Ecological Studies 165], pp. 17–58. Springer, Heidelberg, Germany. 112 pp.
- Palmer 376. 1906. *Castilleja ornata*: Collected 7/25/1906–8/5/1906. [herbarium specimen(s)]. In SEINet's Specimen Search.  
<https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Palmer 320. 1908. *Castilleja ornata*: Collected 5/27/1908–6/3/1908. [herbarium specimen(s)]. In Smithsonian National Museum of Natural History's Search the Department of Botany Collections. <https://collections.nmnh.si.edu/search/botany/>, accessed February 18, 2022.
- Poulos, H.M., J.V. Díaz, J.C. Paredes, A.E. Camp, and R.G. Gatewood. 2013. Human influences on fire regimes and forest structure in the Chihuahuan Desert Borderlands. *Forest Ecology and Management* 298: 1–11.
- Pringle, C.G. 1887. Collection Book 1887. Cyrus Pringle Collection Notebooks. University of Vermont, Pringle Herbarium, Burlington, Vermont.  
<https://www.biodiversitylibrary.org/creator/4734#/titles>, accessed May 7, 2022.
- Raiter, K.G., S.M. Prober, H.P. Possingham, F. Westcott, and R.J. Hobbs. 2018. Linear infrastructure impacts on landscape hydrology. *Journal of Environmental Management* 206: 446–457.
- Reveal, Hess, and Kiger 2752. 1971. *Castilleja ornata*: Collected 8/12/1971. [herbarium specimen(s)]. In SEINet's Specimen Search.  
<https://swbiodiversity.org/seinet/collections/harvestparams.php>, accessed February 18, 2022.
- Roth, D. 2017. Swale Paintbrush (*Castilleja ornata*) Status Survey Report. Report prepared by the EMNRD–Forestry Division, Santa Fe, New Mexico for the U.S. Fish & Wildlife Service, Region 2, Albuquerque, New Mexico. 9 pp. chrome-extension://efaidnbmninnibpcjpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fwww.emnrd.nm.gov%2Fsf%2Fwp-content%2Fuploads%2Fsites%2F4%2FS6\_CASORN.31.pdf&cflen=927957&chunk=true, accessed February 22, 2022.

- Roth, D. 2020. Swale Paintbrush (*Castilleja ornata*) Status Survey Report. Report prepared by the EMNRD–Forestry Division, Santa Fe, New Mexico for the U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico. 7 pp. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fwww.emnrd.nm.gov%2Fsd%2Fwp-content%2Fuploads%2Fsites%2F4%2FSwalePaintbrushStatusSurveyReport2020\_000.pdf&cld=1686942&chunk=true, accessed February 22, 2022.
- Sam, N.T.V. 2020. Effects of wildfire on plant and insect pollinator communities in the Mojave Desert [doctoral dissertation]. University of Nevada, Las Vegas. 90 pp.
- Straw and Forman 1846. 1960. *Castilleja ornata*: Collected 8/3/1960. [herbarium specimen(s)]. In University of Michigan Herbarium Catalog Collection. <https://quod.lib.umich.edu/h/herb00ic/x-1291025/1>, accessed February 18, 2022.
- The Nature Conservancy [TNC]. 2022. Diamond A Ranch: New Mexico. In Places We Protect. <https://www.nature.org/en-us/get-involved/how-to-help/places-we-protect/diamond-a-ranch/>, accessed February 22, 2022.
- U.S. Fish and Wildlife Service. 2023. Species status assessment report for the swale paintbrush (glowing Indian paintbrush) (*Castilleja ornata*): Version 1.1. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico.