

U.S. Fish & Wildlife Service

**Bartram's stonecrop (*Graptopetalum bartramii*)  
Final Recovery Plan**



Bartram's stonecrop (*Graptopetalum bartramii*) with two inflorescences. Photo by Thomas R. Jones, September 2021, with permission.

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Southwest Region  
U.S. Fish and Wildlife Service  
Albuquerque, NM

Approved: \_\_\_\_\_

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

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Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions. Please check for updates or revisions at the websites below before using or citing.

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An electronic copy of this Final Recovery Plan will be made available at:  
<https://ecos.fws.gov/ecp/species/8382>

## **BARTRAM'S STONECROP (*GRAPTOPETALUM BARTRAMII*) FINAL RECOVERY PLAN**

### **BACKGROUND**

#### Recovery Plan Overview

This document presents the U.S. Fish and Wildlife Service's (USFWS) plan for the conservation and recovery of Bartram's stonecrop (*Graptopetalum bartramii*). On August 31, 2021, Bartram's stonecrop was listed as threatened under the Endangered Species Act of 1973, as amended ("ESA") (16 U.S.C. 1531 et seq.) and no critical habitat was designated due to the threat of illegal collection (U.S. Fish and Wildlife Service 2021 entire). Bartram's stonecrop is assigned a recovery priority number of 8 in a range from 1 to 18, with species ranking 1 having the highest recovery priority (U.S. Fish and Wildlife Service 1983 entire). The 8 indicates that this species faces (1) a moderate degree of threat and (2) has a high recovery potential. First, the degree of threat to the species is moderate due to ongoing sources of habitat loss, degradation, and modification, including nonnative plant invasion, altered fire regime, climate change, mining activity, reduction in groundwater, border related activity, recreation activity, erosion, sedimentation, burial, trampling, illegal collection, severe frost, and cumulative impacts to small populations. Second, Bartram's stonecrop has a high recovery potential due to the extent of the species' distribution in Arizona and Mexico, efforts to preserve native overstory trees that provide shade and microhabitat, and ongoing surveys, monitoring, seed banking, and propagation trials.

Pursuant to section 4(f) of the ESA, a recovery plan must, to the maximum extent practicable, include (1) a description of site-specific management actions as may be necessary to achieve the plan's goals for the conservation and survival of the species; (2) objective, measurable criteria which, when met, would support a determination under section 4(a)(1) that the species be removed from the List of Endangered and Threatened Species; and (3) 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 2016, the USFWS adopted a new recovery planning process called "Recovery Planning and Implementation" (RPI). This is a streamlined approach to recovery planning and is intended to reduce the time needed to develop recovery plans, increase the relevancy of recovery plans over a longer timeframe, and add flexibility to recovery plans so they can be adjusted to new information or circumstances. Under the RPI framework, a recovery plan includes the statutorily required elements pursuant to section 4(f) of the ESA, along with a concise introduction and explanation of our strategy to achieve species recovery. This recovery plan is based on a separate Species Status Assessment Report for Bartram's stonecrop (SSA)(U.S. Fish and Wildlife Service 2020 entire), which describes the life history and biology of the species, the current status of the species, and the threats that impact the species. The Bartram's stonecrop SSA is briefly summarized below with updated information. Additionally, under the RPI process, a separate working document called the Recovery Implementation Strategy (RIS) is developed. The RIS provides a stepped-down schedule of activities from the more general description of the recovery actions described in the recovery plan. The RIS describes in detail specific activities necessary for implementing this plan's recovery actions. The RIS will be

adaptable by incorporating new information as needed without revising the recovery plan unless there is a need to also change statutory elements. Both the SSA and the RIS will be updated as necessary and are available at: <https://ecos.fws.gov/ecp/species/8382>.

### Species Status Assessment Report Overview and Updated Information

The following overview summarizes life history information, habitat needs, distribution and abundance, and threats to Bartram's stonecrop. For a more thorough review of these topics, see the Bartram's stonecrop (*Graptopetalum bartramii*) SSA from which the following information is derived (U.S. Fish and Wildlife Service 2020 entire). We also provide updated information on population status since the SSA was finalized. Bartram's stonecrop is a short-lived succulent of the Crassulaceae or stonecrop family which flowers in the fall after summer rains, from September through November. The species produces one or two inflorescences per plant (up to three or more), each containing few to many white, cream, or pale yellow petaled flowers with red spots (Figure 1).



Figure 1. Bartram's stonecrop (*Graptopetalum bartramii*) flower. Photo credit: Thomas R. Jones, September 2021

Bartram's stonecrop is pollinated by *Sarcophaga* spp. (true flies) and *Musca* spp. (house flies), *Apis mellifera* (honeybee), wasps, butterflies, and Tachinidae and Bombyllidae flies. The species typically occurs on rocky outcrops in deep, narrow canyons in heavy cover of litter and shade; and typically, within 10 meters (m; 32.8 feet (ft)) of streambeds, springs, or seeps.

The deep, narrow canyons and associated overstory species provide shade during a portion of the day, creating a cooler temperature and aiding in maintaining a humid microenvironment. Shade is created by rock outcrops and a variety of overstory tree species, including *Fraxinus velutina* (velvet ash), *Hesperocyparis arizonica* (Arizona cypress), *Juglans major* (Arizona walnut), *Juniperus deppeana* (alligator juniper), *Pinus discolor* (border pinyon pine), *Populus fremontii* (Fremont cottonwood), *Quercus arizonica* (Arizona white oak), *Q. emoryi* (Emory oak), *Q. oblongifolia* (Mexican blue oak), *Q. toumeyii* (Toumey oak), and *Salix gooddingii* (Goodding's willow).

Bartram's stonecrop is known to occur in 54 separate populations within 14 isolated sky island mountain ranges, ten (10) in southern Arizona and four (4) in northern Mexico (the Baboquivari, Chiricahua, Dragoon, Empire, Mule, Pajarito-Atascosa, Patagonia, Rincon, Santa Rita, and Whetstone Mountains in Cochise, Pima, and Santa Cruz counties, Arizona; Sierra Las Avispas in Sonora, and Sierra San Luis, Sierra La Escuadra [including Mesa Tres Rios], and Sierra La Estancia in Chihuahua). We are aware of four populations that have become extirpated in the United States in recent years and are unlikely to return from a seed bank due to drying of the habitat (Carlink Canyon, Cave Canyon, Empire Mountains, and Indian Creek), and other populations that have decreased in abundance (U.S. Fish and Wildlife Service 2020 entire, Drost and Thomas 2023 entire).

The majority of known Bartram's stonecrop in Arizona occur on US Forest Service land, with the remaining populations occurring on National Park Service, Bureau of Land Management (with one population overlapping onto U.S. Fish and Wildlife Service lands), State of Arizona, and private lands. At the time of finalizing Version 2 of the SSA in 2020, we were aware of 4,628 adult individuals across the entire range within the United States and Mexico. This number included an assumed ten (10) plants from two (2) United States populations (Gardner Canyon East and Thomas Canyon), and one (1) Mexico population (Cuarenta Casas). These three (3) populations have had no population counts nor have they been revisited since the initial survey took place. We presume that these populations are extant, but low in abundance.

Since Version 2 of the SSA was finalized, between 2020 and 2021 there was a complete re-count of 12 populations in the United States showing a collective decrease of 640 adults (14 percent decrease since prior to 2020), including the loss of a fourth population (Drost and Thomas 2023). The cause of these declines is most likely due to historically dry monsoon and winter periods (Drost 2023 entire), which likely also impacted other populations that were not surveyed. In addition, since the finalizing of Version 2 of the SSA, in the Rincon Mountains, the National Park Service has continued rare plant surveys and documented a slight increase in the number of individuals within several known populations. Also, in 2024, a population of 20 individuals was discovered in the Sierra San Luis, Chihuahua, Mexico. We assume the current number of Bartram's stonecrop plants is now less than 4,000 individuals. Of the 54 known populations, 4 (7.4 percent) are extirpated, 45 (83.3 percent) contain fewer than 150 individuals, and 31 (57.4 percent) contain fewer than 50 individuals (Figure 2).

Madrean evergreen woodlands of the sky islands have evolved with frequent low severity fire. Surface fires were quite common in nearly all montane forest types, including Madrean woodlands, prior to about 1900 (Swetnam et al. 2010 p. 1). The maximum interval between the relatively widespread fires typically ranged from about 10 to 30 years in the pine-dominant forests (Swetnam et al. 2010 p. 4). Due to a variety of human activities on the landscape (e.g., excessive livestock grazing, fuelwood cutting, nonnative plant invasion and expansion, and fire suppression starting around the turn of the last century through the mid-1900s), today these woodlands have high fuel loads, and fires with large high severity components are becoming increasingly more common (Swetnam et al. 2010 p. 11, AZ Firescape 2016). Swetnam et al. (2010 p. 15) note that there is no evidence that such large stand-replacing fires occurred historically; for example, fire-scar studies have revealed that only low intensity surface fire regimes persisted for the past three to five centuries. Between 1984 and 2021, there were 23

wildfires that burned within 200 meters of known Bartram’s stonecrop populations in Arizona. These fires burned approximately 117,210 ha (289,633 acres).

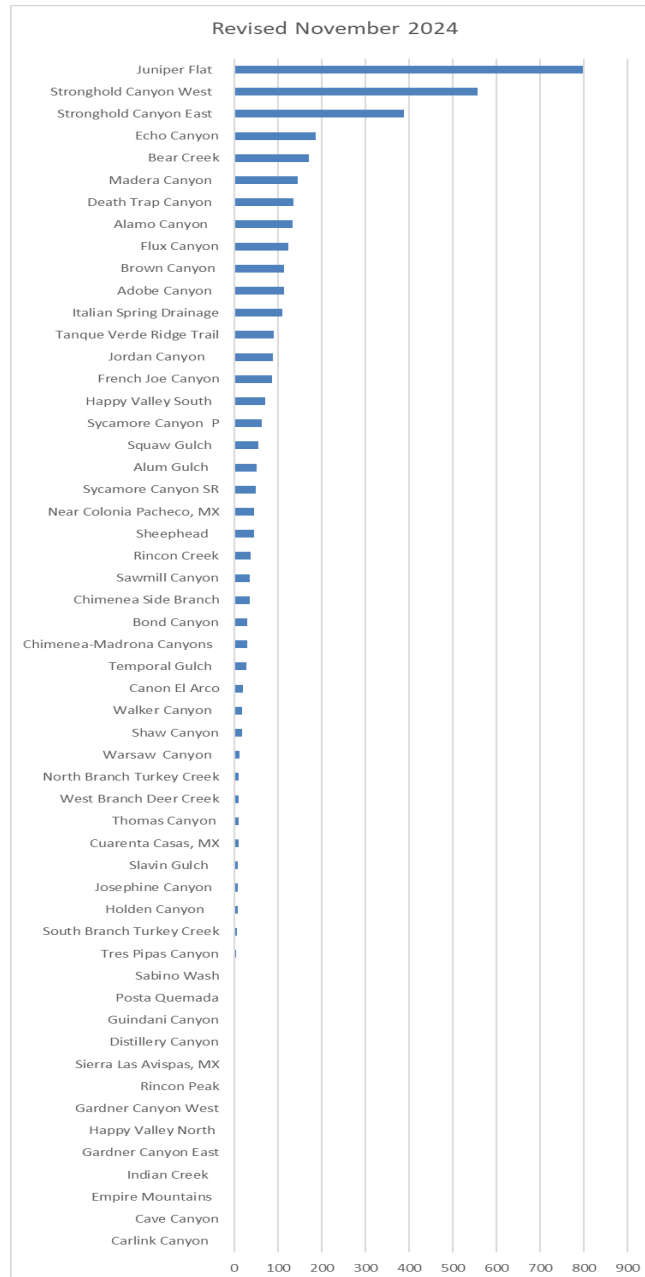


Figure 2. Total number of adult Bartram’s stonecrop (*Graptopetalum bartramii*) individuals known from each of the 54 United States and Mexico populations (U.S. Fish and Wildlife Service 2020 p. 57, Drost and Thomas 2023 entire, Jones 2024 entire).

Madrean woodlands have warm wet summers and mild winters. Precipitation within the sky island mountain ranges is bimodal, with winter snow and rain, and summer monsoon rain. Mean annual precipitation in the Madrean woodland habitat of southern Arizona is 250–450 mm (10–17 in), with more than 50 percent occurring in summer. Climate change has already begun to affect the regions of Arizona where Bartram’s stonecrop occurs, resulting in higher air temperatures,



increased evapotranspiration, and changing precipitation patterns, such that precipitation levels range-wide have already reached historical lows (Climate Assessment for the Southwest 2021 entire). Winter precipitation, in particular, has been shown to have decreased over the past century, as recorded by weather stations within sky island mountain ranges containing Bartram's stonecrop. Winter precipitation is needed for Bartram's stonecrop growth, summer precipitation is responsible for much of the seedling germination, and both summer (July-August) and fall precipitation (captured partially in the October and November "winter" data) is needed for Bartram's stonecrop flower production.

There are multiple threats to Bartram's stonecrop throughout its range, including from mining, wildfire, and climate change; and threats to individuals (e.g., erosion, sedimentation, burial, trampling, illegal collection, and severe frost), the effects of which are exacerbated by small population size. Direct removal of Bartram's stonecrop individuals and substrate due to erosion, or burial of individuals, may occur due to the placement of mineral extraction sites and debris piles. Impacts to Bartram's stonecrop from wildfires include burning of individual Bartram's stonecrop, increased floodwater runoff, erosion, deposition of debris and sediment originating in the burned area, changes in vegetation community composition and structure, increased presence of nonnative plants, alterations in the hydrologic and nutrient cycles, and loss of overstory canopy shade essential for maintaining Bartram's stonecrop microhabitat.

Continued drought, increased temperatures, and increased evapotranspiration may lead to Bartram's stonecrop stress and the loss of shade through the dying of overstory trees stressed from the reduction of in-stream flow (Ferguson 2014 p. 42) or from insect herbivory or wildfire, both of which may increase under these circumstances. Increased flooding from either post wildfire runoff or increased high severity events with projected climate change can remove Bartram's stonecrop individuals occurring near a stream's edge and has the potential to remove entire small populations. With over 57 percent of extant Bartram's stonecrop populations containing fewer than 50 individuals, loss due to erosion, sedimentation, burial, trampling from multiple sources, illegal collection, severe frost, or other threats such as sheet flow or dust from roads, have the potential to seriously damage or completely remove these small populations.

The genetic diversity of the isolated populations within mountain ranges is unknown. However, threats are exacerbated because of the likelihood that small population size, distance between populations, and geographical barriers, coupled with limited dispersal capability, increase isolation and loss of genetic variability. In addition, isolation between populations can increase the chance of random genetic drift, increase inbreeding by reducing gene flow, and increase the chance of local extirpation (Hufford and Mazer 2003 p. 153, Tóth et al. 2019 p. 191). Therefore, we have defined three representation areas based on geographic separation of known populations and assume local adaptation to environmental regimes and selective pressures to local conditions occur, at a minimum, among these three areas (Figure 3)(Linhart and Grant 1996 entire, DeMarche et al. 2016 p. 345). Recovery criteria are based on populations within these three representation areas to ensure conservation of the species across its range and across any local adaptations that may be occurring.

During the listing process, the SSA informed the Service of considerable threats to the Bartram's Stonecrop under Section 4(a) of the ESA. This section described five factors that should be considered when assessing the endangered or threatened status of a species. 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. Bartram's stonecrop faces varying levels of risk into the future from natural and anthropogenic threats, including the following: nonnative plant invasion, alteration of natural fire regime, mining activity; reduction in groundwater, border related activity; recreation activity, erosion, sedimentation, burial; and trampling (Factor A); illegal collection (Factor B); and drought and climate change, intensive storms, and flooding (Factor E). In addition, low numbers and limited distribution, which characterize many Bartram's stonecrop populations, increase susceptibility of populations to all threats and limit recruitment and genetic diversity (Factor E), thus reducing resiliency and representation. Factors C and D are not known to threaten Bartram's stonecrop currently.

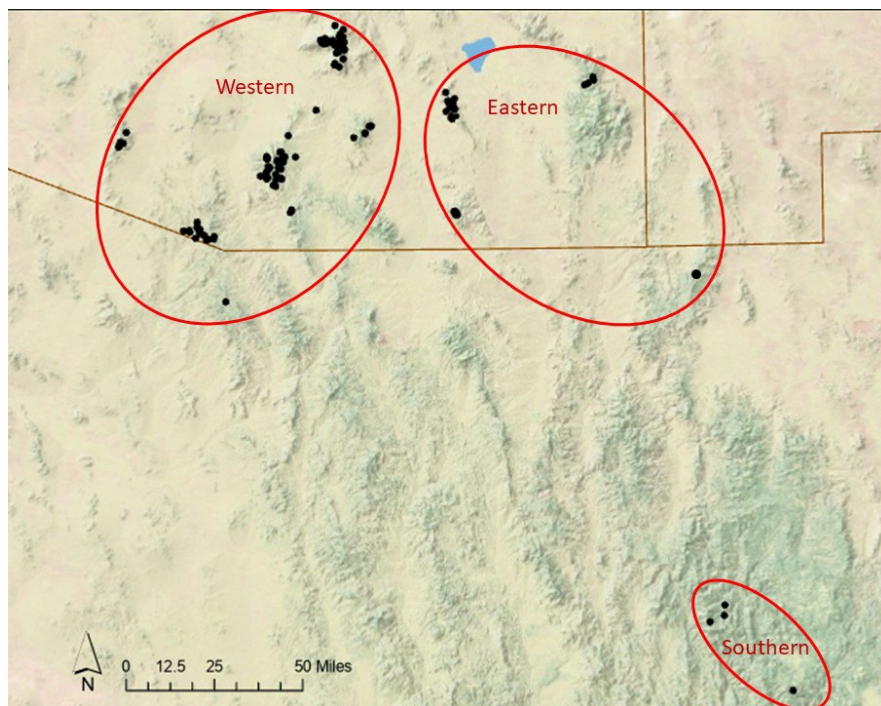


Figure 3. Three Bartram's stonecrop representation areas within red ovals (Western, Eastern, and Southern), chosen based on geographic separation and largely falling within the Santa Cruz and San Pedro watersheds, in southern Arizona and the Rio Yaqui and Rio Casas Grandes watersheds of northern Sonora, Mexico. Black polygons are general population areas.

### RECOVERY STRATEGY, OBJECTIVES, AND CRITERIA

The recovery goal is to ensure (1) the long-term persistence of Bartram's stonecrop in the wild over time (viability) through increasing and maintaining the size and number of populations and subpopulations within the range of the species; (2) restoring and conserving habitat; and (3) reducing threats to the species and its habitat, thus allowing for removal of Bartram's stonecrop from the list of threatened and endangered species (i.e., recovery).

For the species to be recovered, we envision that Bartram's stonecrop will demonstrate: 1) resiliency, by having naturally occurring viable populations; and 2) redundancy and representation, by having genetically and ecologically diverse populations distributed in multiple

locations throughout the species' range. Threats to long-term viability will be reduced and habitat restored and conserved such that there is sufficient habitat quantity and quality to support the long-term survival of the species, its needed native overstory trees that provide shade, and its pollinators.

### **Recovery Strategy**

The USFWS uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3Rs") as a lens to evaluate the current and future condition of the species. Resiliency describes the ability of populations to withstand demographically or environmentally stochastic events (arising from random factors). Representation describes the ability of a species to adapt to changing environmental conditions. Redundancy describes the ability of a species to withstand localized catastrophic events. To ensure viability, Bartram's stonecrop requires multiple resilient populations distributed throughout its geographic range. The recovery strategy includes: 1) increasing resiliency by augmenting, introducing, and maintaining sufficiently large populations to withstand stochastic events, 2) maintaining representation of the genetic and ecological diversity of the species throughout its geographic range, and 3) increasing redundancy by introducing additional populations and subpopulations to provide a safety margin to withstand catastrophic events.

Recovery of the species will require augmentation of some existing populations and subpopulations throughout the geographic range of the species to increase the number of individuals in some populations. This increase in numbers of individuals is essential to protect the species against extinction. Because it is believed that the main cause of the decline of the species is the loss and degradation of its habitat (primarily due to alteration of the fire regime, climate change, and mining activity), the recovery strategy focuses upon reduction and mitigation of these threats. The additional threat of individual effects to small populations due to erosion, sedimentation, burial, trampling, illegal collection, severe frost, or other threats are also addressed in the Recovery Implementation Strategy. It will be challenging to remove or ameliorate all threats to the species (particularly alteration of the fire regime and climate change) as they are widespread and complex to manage; however, in some cases, these threats can be reduced or mitigated.

### **Recovery Objectives**

Recovery objectives identify outcomes that will lead to achieving the goal of recovery and delisting. Recovery objectives for Bartram's stonecrop are:

1. Increase and maintain the size and number of populations and subpopulations, such that they are viable (improve resiliency and redundancy), within the known geographic range of the species through successful Bartram's stonecrop propagation and augmentation of some existing populations and subpopulations, introduction of new populations and subpopulations, and reintroduction of populations and subpopulations, as appropriate.
2. Properly manage, restore, and protect the quantity and quality of Madrean woodland habitat areas supporting all Bartram's stonecrop within the known geographic range of the species through successful Bartram's stonecrop habitat improvement and disturbance regime restoration allowing for maintenance of existing populations, population expansion, or establishment of new populations.

3. Ensure long-term Bartram's stonecrop conservation through the establishment of ex-situ plant and seed collections housed at multiple Center for Plant Conservation-approved botanical institutions and seed banks.
4. Improve our understanding of current conditions, trends, threats, and outcomes of management actions through monitoring of all Bartram's stonecrop populations, its habitat, and its pollinators.
5. Improve our understanding of Bartram's stonecrop genetics, geography, ecology, biology, viability, threats, compatible land uses, and habitat and fire regime restoration through scientific research, thereby enabling better management of Bartram's stonecrop.

### Recovery Criteria

“The term ‘endangered species’ means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this chapter would present an overwhelming and overriding risk to man.” 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 ESA definitions of threatened or endangered due to amelioration of threats. Determining whether a species should be downlisted or delisted requires consideration of the same five factors that were considered when the species was listed, as discussed above, and which are specified in section 4(a)(1) of the ESA and at 50 C.F.R. 402.02.

Recovery criteria are conditions that, when met, indicate that a species may warrant 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 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 more is learned about the species and the threats, it is possible that a status review may indicate that delisting is warranted even if not all recovery criteria are met. Conversely, it is possible that the recovery criteria could be met, and a status review may indicate that delisting is not warranted. For example, a new threat may emerge that is not addressed by the current recovery criteria.

Full recovery of the species to the point that protections of the ESA are no longer necessary (delisting) consists of a combination of conditions that, when met, indicate the species may warrant reclassification from threatened status. These criteria are described in detail in the Delisting Criteria section of this document.

**Note:** please see below for justifications and definitions of specific terms used in the recovery criteria.

### Recovery Criteria

The following are objective, measurable criteria which, when met, would result in a determination that Bartram's stonecrop will be considered for removal from the endangered species list. Note that Recovery Criterion one (1) has an option one and an option two, either of which may be completed to achieve recovery.

1. **Option One:** Fifty or more populations occur throughout the species' geographic range in the United States and Mexico, including populations in the three representation areas as follows:
  - a.i. Western Representation Area –including at least 41 populations within the Baboquivari, Pajarito / Atascosa, Patagonia, Rincon, Santa Rita, and Whetstone Mountain Ranges in Arizona and the Sierra Las Avispas Mountain Range in Sonora, Mexico.

and

  - a.ii. Eastern Representation Area – including at least 7 of the current extant populations within the Chiricahua, Dragoon, and Mule Mountain Ranges in Arizona or the Sierra San Luis, Chihuahua, Mexico.

and

  - a.iii. Southern Representation Area – including at least 2 of the current extant populations within Sierra La Escuadra and Sierra La Estancia in Chihuahua, Mexico.

These 50 or more populations may include existing, newly discovered, augmented, or successfully introduced populations in strategic sites.

Of the 50 or more populations referenced above, at least:

- a. One population supports a minimum of 800 adult individuals within three or more subpopulations.
- b. Six populations support a minimum of over 300 adult individuals within three or more subpopulations.
- c. Ten populations support a minimum of 150 adult individuals within two or more subpopulations.
- d. The remaining 33 or more populations will contain at least 50 adult individuals in at least one subpopulation.

These population numbers will be maintained for a total of at least 20 years over the last 25-years of the period of recovery (40 years), as indicated by monitoring in the fall every 1 to 8 years, including during the three most recent monitoring events. This allows for some fluctuation due to drought or other threats. Additional monitoring is encouraged, but not required as we recognize the required time and cost commitment.

To count toward achieving this criterion within the period of recovery (40 years), existing or introduced populations that are used to evaluate this criterion may be augmented for the first 15 years of recovery to achieve population and subpopulation numbers. To show that

populations are viable, no augmentation can occur within populations being evaluated under this criterion in the last 10 years of recovery for populations considered as contributing to possible delisting.

1. **Option Two:** Thirty-five or more populations occur throughout the species' geographic range in the U.S. and Mexico, including populations in the three representation areas as follows:
  - a.i. Western Representation Area –including at least 28 populations within the Baboquivari, Pajarito / Atascosa, Patagonia, Rincon, Santa Rita, and Whetstone Mountain Ranges in Arizona and the Sierra Las Avispas Mountain Range in Sonora, Mexico.

and

  - a.ii. Eastern Representation Area – including at least 6 of the current extant populations within the Chiricahua, Dragoon, and Mule Mountain Ranges in Arizona or the Sierra San Luis, Chihuahua, Mexico.

and

  - a.iii. Southern Representation Area – including at least 1 of the current extant populations within Sierra La Escuadra and Sierra La Estancia in Chihuahua, Mexico.

These 35 or more populations may include existing, newly discovered, augmented, or successfully introduced populations in strategic sites.

Of the 35 or more populations referenced above, at least:

- a. One population supports a minimum of 800 adult individuals within three or more subpopulations.
- b. Six populations support a minimum of over 300 adult individuals within three or more subpopulations.
- c. Twenty populations support a minimum of 150 adult individuals within two or more subpopulations.
- d. At least 8 of the remaining populations will contain more than 50 adult individuals in at least one subpopulation.

These population numbers will be maintained for a total of at least 20 years over the last 25-years of the 40 year period of recovery, as indicated by monitoring in the fall every 1 to 8 years, including during the three most recent monitoring events. This allows for some fluctuation due to drought or other threats.

To count toward achieving this criterion within the period of recovery (40 years), existing or introduced populations that are used to evaluate this criterion may be augmented for the first 15 years to achieve population and subpopulation numbers. To show that populations are viable, no augmentation can occur within populations being evaluated under this criterion in the last 10 years of recovery for populations considered as contributing to possible delisting.

2. All of the populations referenced in Recovery Criteria #1: Option One or Option Two above must have documented natural recruitment that is greater than or equal to documented plant loss during three or more monitoring events in the fall (every 1 to 8 years) over the last 25-years of the period of recovery (40 years). The monitoring should capture recruitment events and ensure fluctuations in population number are accounted for and that no population is considered extirpated prematurely.
3. A collection of seed representing the geographical, morphological, and genetic diversity of Bartram's stonecrop is harvested at regular intervals (every five years) following Center for Plant Conservation guidelines (Center for Plant Conservation 2019 pp. 1–14) during the period of recovery and maintained in at least two Center for Plant Conservation partner botanical or seed storage institutions for conservation purposes.
4. A living collection of plants representing the geographical, morphological, and genetic diversity of Bartram's stonecrop and following Center for Plant Conservation guidelines (Center for Plant Conservation 2019 pp. 1–14) is established within 10 years of the finalization of this recovery plan and is maintained long-term in at least two botanical institutions (e.g., Desert Botanical Garden and the Arboretum at Flagstaff) for educational and conservation purposes.
5. At least one conservation easement or other conservation mechanisms appropriate to the land status are held on land parcels of over 10-acres in size and totaling at least 100 acres in either or both the Western and the Eastern Representation Areas, having direct conservation value for the Bartram's stonecrop through protection or successful introduction.
6. During the period of recovery, the threat of large-scale high severity wildfire moving through the 500-meter radius surrounding Bartram's stonecrop populations referenced in #1 is reduced such that population abundance criteria can be met. Specifically, the following must be met, as further quantitatively described in the Bartram's stonecrop Recovery Implementation Strategy:
  - a. In watersheds supporting Bartram's stonecrop populations, land management and site-specific plans are developed and fully implemented, such that over a 25-year period:
    - i. there is a reduction in surface and ladder fuels and canopy connectivity such that there is restoration of resilient forest structure similar to historical patterns, and the probability of individual Bartram's stonecrop burning, native overstory trees that provide shade burning or dying of insects or disease, or post-fire flooding removing Bartram's stonecrop or impacting its habitat, is greatly reduced (Factors A and E),
7. To ensure the continued existence of Bartram's stonecrop and to help meet population-based criterion number one, watershed-scale conservation and management plans address the threat of Madrean Woodland habitat loss and degradation, groundwater withdrawal and reduction of intermittent and perennial water, and the direct threats to Bartram's stonecrop, native overstory trees that provide shade, and pollinators. Specifically, the following must be met, as further quantitatively described in the Bartram's stonecrop Recovery Implementation Strategy:

- a. In watersheds supporting Bartram's stonecrop populations, land management and site-specific plans are developed and fully implemented, such that over a 25-year period:
  - i. any current or future groundwater withdrawal does not negatively affect the vigor and viability of Bartram's stonecrop populations, associated pollinator plants, or native overstory trees that provide shade,
  - ii. there is a reduction in nonnative plants and promotion of native plant diversity (including using locally sourced native plants and propagules to augment surrounding native plant populations) on lands supporting Bartram's stonecrop such that the viability and vigor of Bartram's stonecrop populations, associated pollinator plants, and native overstory trees that provide shade are improved (Factors A and E),
  - iii. there is a reduction in erosion, sedimentation, burial, trampling, and removal of Bartram's stonecrop and associated native plants caused by border related activity, mining activity, livestock trampling activity, recreation activity, flooding, and other activities to a level that ensures Bartram's stonecrop population viability is not negatively affected by these activities or events (Factor A),
  - iv. there is habitat restoration to promote soil moisture retention including adding rock dams and similar structure as appropriate and the removal of native and nonnative trees and shrubs, such as velvet mesquite (*Prosopis velutina*) or tree of heaven (*Ailanthus altissima*), that utilize groundwater and reduce spring, seep, and stream flow, thus promoting the vigor and viability of Bartram's stonecrop populations, associated pollinator plant, and native overstory trees that provide shade (Factors A and E), and
  - v. illegal collection of Bartram's stonecrop is decreased to the point that population viability is not negatively affected by this activity.
- b. data on the biology, ecology, conservation, and management of Bartram's stonecrop continues to be collected and shared regularly among land managers and researchers.

### **Justification for Recovery Criteria**

Justification for recovery criteria consists of an explanation of concepts and rationale in the context of the species viability (resiliency, redundancy, and representation), and amelioration of threats, as described below.

#### *Explanation of Concepts*

##### Background

- **Border Related Activity** – Cross-border violators (people illegally attempting crossings of the U.S.-Mexico border), drug cartel, U. S. Border Patrol, and other law enforcement activity in this area may degrade Bartram's stonecrop habitat by creating new roads and trails, disturbing vegetation, and soils, and moving nonnative plant seeds or plant parts, leading to their spread into unoccupied areas. Significant impacts may occur when travel moves off existing roads causing vegetation destruction and soil compaction. Hydrology may also be altered by trails and routes used by human and drug traffickers as well as by border enforcement efforts. In addition, illegal campfires increase the chance of wildfires in the areas supporting Bartram's stonecrop.



Recovery Criterion #1

- **Population** – Resilient Bartram's stonecrop populations must be large enough that stochastic events do not eliminate the entire population. We define a population as all of the Bartram's stonecrop individuals that occur within the same water course (i.e., stream) in a sky island range, and within the distance pollinators can travel allowing for gene flow and movement through cross-pollination and/or through the movement of seeds in water. Within populations, individual plants are commonly separated geographically into subpopulations (punctuated by areas with no plants, but within the same water course) and these in turn may be further arranged geographically into groups of individuals. A visual representation of this is provided in the Species Status Assessment for *Graptopetalum bartramii* Bartram's stonecrop. There are 54 known populations across the range of the species, 4 of which have been extirpated. Populations contain up to 11 subpopulations per population and within subpopulations, up to 12 groups per subpopulation have been recorded.
  - **Number of Populations** –The criteria in this recovery plan require:
    - **Option 1** - at least 50 populations to ensure redundancy. These include at least 41 populations from the Western Representation Area which represent 46.2 percent of all known Bartram's stonecrop plants, 7 populations from the Eastern Representation Area which represent 52.4 percent of all known Bartram's stonecrop plants, and 2 populations from the Southern Representation Area representing 1.2 percent of all known Bartram's stonecrop plants.
- Or**
- **Option 2** - at least 35 populations to ensure redundancy. These include at least 28 populations within the Western Representation Area which represent 46.2 percent of all know Bartram's stonecrop plants, 6 populations from the Eastern Representation Area which represent 52.4 percent of all known Bartram's stonecrop plants, and 1 population from the Southern Representation Area representing 1.4 percent of all known Bartram's stonecrop plants.

Options are included to allow for two paths to recovery. The first path includes more populations with fewer individuals, while the second option includes fewer populations containing greater numbers of individuals. Both options include approximately the same total number of individuals; however, they allow for different arrangements of these individuals.

- **Representation Area** – We define the representation area as an area representing the geographical and climatological separation between the three groupings of populations, within the United States and Mexico. There are populations from Sonora and the United States in the Western Representation Area, populations from Chihuahua and the United States in the Eastern Representation Area, and populations in Chihuahua in the Southern Representation Area.

- **Subpopulation** – For populations of Bartram's stonecrop to be resilient and redundant, they need multiple subpopulations per population, so that local stochastic events do not eliminate the entire population. This allows the population to recover through its own seedbank or seed dispersal from other subpopulations within the population. Subpopulations of Bartram's stonecrop plants must occur within geographic proximity to facilitate gene flow through pollen exchange and seed dispersal. Subpopulations are separated from one another through clear geographic separations within the same drainage (population). Because subpopulations can be separated by up to 10 km (6.2 mi), due to their spatial relationships within individual drainages, it is possible that some stressors may impact some subpopulations but not others.
- **Number of Individuals and Subpopulations** – The number of individuals and subpopulations needed for recovery was derived from Pavlik (Pavlik 1996 p. 137) and the population factors of the Bartram's Stonecrop SSA (U.S. Fish and Wildlife Service 2020). Pavlik recommends minimum viable population sizes ranging from 50 individuals to 2,500 individuals for the conservation of rare plants, depending on various life-history characteristics of the taxon (Pavlik 1996 p. 137). We applied Pavlik's methods for determining minimum viable population sizes for rare plants based on the life history characteristics of the species (e.g., perennial, succulent, seed duration, lack of ramet production) and estimated Bartram's stonecrop would require a minimum population size of 1,117 individuals.

Because we currently have only one population with greater than 795 individuals, we acknowledge the use of Pavlik's method is not suitable for Bartram's stonecrop. Therefore, we plan to retain this one population at its current size or greater and maintain its current three subpopulations or more. In addition to this single large population, we call for 6 populations to support a minimum of 300 adult individuals in three or more subpopulations; this is considered high condition according to the Bartram's stonecrop SSA (U.S. Fish and Wildlife Service 2020).

In addition to the numerical criteria above, we also call for:

**Option One** - at least 10 populations support a minimum of 150 adult individuals within two or more subpopulations. All remaining populations (33 or more) support at least 50 adult individuals.

**Or**

**Option Two** - at least 20 populations support a minimum of 150 adult individuals within two or more subpopulations. Eight or more additional populations support at least 50 adult individuals.

- **Time Period** – The period required to meet Recovery Criterion 1.

- **The 40-year** period of recovery includes 10 to 15 years of seed collection, development of germination and outplanting strategies, site restoration, etc., and 25 years for stability and increase in population size.
- **The 25-year** period for stability or increase in population size required to meet Recovery Criterion 1 assures that target numbers of Bartram's stonecrop are maintained through fluctuations in high severity fire, drought, nonnative plant invasion, and other disturbances, thus demonstrating that the species is resilient. For populations that require augmentation or introduction, this occurs following 10 to 15 years of site restoration and preparation, seed collection, and propagation and outplanting trials.
- **Successfully introduced plants** – we define successfully introduced plants as introduced plants (augmented at existing or in introduced populations) that are fully functioning (reproducing and past a juvenile stage of development) in their environment as indicated by post-introduction monitoring. Because introduced plants may experience mortality after introduction, additional introductions and time may be necessary to improve introduction success and help achieve Recovery Criterion 1.
- **Strategic site** –we define a strategic site as a Madrean evergreen woodland habitat that provides the resource needs of Bartram's stonecrop as outlined in the SSA (U.S. Fish and Wildlife Service 2020). This includes proximity to intermittent or permanent water; adequate shade; suitable temperature, precipitation, humidity; and natural disturbance regimes that promote forest and woodland health. It has appropriate wildfire prevention and mitigation, is dominated by a native vegetation community, and has protections in place preventing impacts from threats such as mining activity, border related activity, road maintenance, livestock trampling activity, and recreation activity.

#### Recovery Criterion #2

All of the populations referenced in Recovery Criterion 1: Option One and Option Two above must have documented natural recruitment that is greater than or equal to documented plant loss during three or more monitoring events in the fall (every 1 to 8 years) over the last 25-years of the period of recovery.

- **Natural recruitment** – In natural Bartram's stonecrop populations, we define natural recruitment as juveniles that survive to adulthood (a size greater than 1.5 cm in diameter).

#### Recovery Criteria #3 and #4

A collection of seed and living collection of plants representing the geographical, morphological, and genetic diversity of Bartram's stonecrop is harvested at regular intervals (every five years) following Center for Plant Conservation guidelines.

- **Geographic range** – is defined as an area within southern Arizona and northern Mexico that support Bartram's stonecrop populations.

- **Center for Plant Conservation Guidelines** – is defined as a collection of no more than 10 percent of an individual or population seed production in one season and, for living collections, at least one plant per maternal line, and at least 50 maternal lines, if possible, is maintained at a botanical garden, tissue culture lab, or in the nursery.

*Rationale for Recovery Criteria –Achieving Species Viability (3Rs), and Ameliorating Threats*  
Below we justify our recovery criteria in the context of the 3Rs (resiliency, redundancy, and representation) used to assess the species' long-term viability, and how our recovery criteria address threats to Bartram's stonecrop.

3Rs:

**Resiliency** is met by having enough individuals and subpopulations within populations to withstand disturbances such as random fluctuations in germination rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities. Little is known regarding the numbers of plants required to achieve resilient Bartram's stonecrop populations; however, in general having more individuals across populations will provide greater resiliency. This plan's Recovery Criteria call for 1 population to support a minimum of 800 individuals within a minimum of 3 subpopulations, for a population that falls within the high resiliency condition (U.S. Fish and Wildlife Service 2020 pp. 84–86), and 6 populations to support a minimum of 300 individuals within a minimum of 3 subpopulations, also falling within the high resiliency condition. In addition to the numerical criteria above, we also call for:

Option One - at least 10 populations support a minimum of 150 adult individuals within two or more subpopulations, each of these populations fall within the moderate resiliency condition; and all remaining populations (33 or more) support at least 50 adult individuals, each of these populations fall within the low resiliency condition.

Option Two - at least 20 populations support a minimum of 150 adult individuals within two or more subpopulations, each of these populations fall within the moderate resiliency condition, and eight or more additional populations support at least 50 adult individuals, each of these populations fall within the low resiliency condition.

Greater resiliency will enable the species to better withstand the effects of its various threats and increase the likelihood of species viability.

**Redundancy** is met by having multiple populations and subpopulations distributed across the species' range. Because Bartram's stonecrop plants in populations are separated from plants in other populations, they are less likely to be simultaneously affected by catastrophic events (e.g., high severity fire) or locally important events (e.g., illegal collection). Therefore, with increased redundancy, the species will be more likely to withstand such events, reducing the risk of extinction. The Recovery Criteria require a minimum of 35 populations distributed throughout the species' geographic range in the United States and Mexico.

**Representation** is met by maintaining populations within the Western, Eastern, and Southern Representation Areas across the geographic distribution of Bartram's stonecrop. No genetic studies of this species have been performed to date, though one study is being planned which

will help identify genetic isolation, genetic differences between populations, and inform outplanting strategies. We assume there will be different genetic and ecological diversity between the three Representation Areas based on geography and differences in habitat features and elevations. This information will be updated in the Species Status Assessment for *Graptopetalum bartramii* Bartram’s stonecrop as needed.

**Viability:**

In summary, viability of Bartram’s stonecrop, or persistence in the wild over the long-term, is achieved by increasing population resiliency and redundancy and maintaining species representation. Resiliency is improved by successful augmentation and/or discovering new individuals. Redundancy is increased by the maintenance of existing populations and subpopulations or introduction of new populations and subpopulations. Representation is maintained by providing the opportunity for genetic exchange within populations and by maintaining populations in the Eastern, Western, and Southern Representation Areas. Additionally, primary threats to the species and its habitat such as nonnative plant invasion, altered fire regime, climate change, mining activity, reduction in groundwater, border related activity, recreation activity, erosion, sedimentation, burial, trampling, illegal collection, or other impacts must be addressed to ensure Bartram’s stonecrop viability.

**Threats:**

The primary factors of concern for Bartram’s stonecrop are Factors A, B, and E. Table 1 below indicates how these primary threats to the species, in the context of the five ESA listing factors, are addressed in the recovery criteria.

**Table 1.** Summary of how significant threats to Bartram’s stonecrop (*Graptopetalum bartramii*) are addressed in the recovery criteria in the context of the five ESA listing factors.

<b>Factor Addressed</b>	<b>Threat Addressed</b>	<b>Criterion Number and Explanation</b>
Factor A – Present or threatened destruction, modification, or curtailment of its habitat or range	Nonnative plant invasion, competition, and alteration of fire regimes	<b>Criteria 6 &amp; 7</b> address the need to reduce nonnative plant invasion and spread and ensure a more natural fire regime in Bartram’s stonecrop habitat through land use management planning and implementation.
	Fire suppression and alteration of fire regimes	<b>Criteria 6 &amp; 7</b> address the need to reduce surface and ladder fuels and canopy connectivity such that there is restoration of resilient forest structure that are resilient to future climate and restored low and moderate severity fire regimes similar to historical patterns in Bartram’s stonecrop habitat through thinning, prescription burning, and other forest restoration treatments.
	Mining activity, border related activity, recreation	<b>Criterion 7</b> address the need to prevent loss of habitat, individual Bartram’s stonecrop plants, and pollinators to a variety of

Factor Addressed	Threat Addressed	Criterion Number and Explanation
	activity, erosion, sedimentation, burial, trampling, severe frost, flooding, and other threats	activities through land use management planning and implementation.
	Groundwater withdrawal and dewatering of streams	<b>Criteria 5, 6, &amp; 7</b> address the need to prevent unnecessary water draw down from invading plants or subdivided land for multiple residences. Land use management plans will also address preventing water loss from mining and other large dewatering impacts and help retain soil moisture through rock dams and other structures.
Factor B – overutilization for commercial, recreational, scientific, or educational purposes	Illegal collection	<b>Criteria 1-4 &amp; 7</b> address the threat of low numbers and limited distribution by: increasing population sizes; increasing numbers of banked seeds and plants in botanical institutions; and providing habitat protection, public education, and threat reduction.
Factor E – Other natural or manmade factors affecting its continued existence	Drought, flooding, and climate change	<b>Criteria 1 - 7</b> address the threat of drought and climate change by: increasing population sizes; increasing numbers of banked seeds and plants in botanical institutions; and providing habitat protection and threat reduction.
	Low numbers and limited distribution	<b>Criteria 1-7</b> address the threat of low numbers and limited distribution by: increasing population sizes; increasing numbers of banked seeds and plants in botanical institutions; and providing habitat protection and threat reduction.

**RECOVERY ACTIONS NEEDED**

Recovery of Bartram’s stonecrop will be accomplished through implementation of the site-specific recovery actions outlined in Tables 2a-e below. In general, implementation of the recovery actions will involve participation from State and Federal agencies, counties, local communities, Tribes, non-federal landowners, nongovernmental organizations, academia, and the public. Recovery actions, organized by recovery objective, are accompanied by estimates of the time and cost required to achieve the plan’s goal to recover Bartram’s stonecrop. The site-specificity of the recovery actions is provided primarily at the geographic scale of the population. 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. The assignment of priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented.

The separate RIS for Bartram's stonecrop provides additional detailed, site-specific activities needed to implement the actions identified here (USFWS 2024). We intend to update the RIS as frequently as needed by incorporating new information, including the findings of future 5-year status reviews. The RIS provides activities that will be continually updated as recovery implementation progresses. Therefore, we anticipate being able to provide a greater degree of site-specificity in the RIS than for the recovery actions in the recovery plan. For example, select introduction locations will be determined based on present-year circumstances. We will revise this recovery plan only if there are needed changes in the recovery criteria, actions, or time and cost estimates.

As stated in the Disclaimer, recovery plans are guidance documents, not regulatory documents. A recovery plan does not commit any entity to implement the recommended strategies or actions contained within it for a particular species, but rather provides guidance for ameliorating threats and implementing proactive conservation measures, as well as providing context for implementation of other sections of the ESA, such as section 7(a)(1) conservation programs, 7(a)(2) consultations on Federal agency activities, or development of Habitat Conservation Plans under section 10(a)(1)(B).

### **Estimated Time and Cost of Recovery**

We expect the status of Bartram's stonecrop to improve such that we can achieve recovery (delisting) in approximately 40 years (2064) for a total estimated cost of \$7,446,500. We anticipate that achieving recovery will take approximately 10 to 15 years to restore and prepare sites, collect seeds, and conduct propagation trials, followed by the 25-year period of Bartram's stonecrop population and habitat amplification and maintenance. The total cost is the estimated cost of completing the recovery actions such that the recovery criteria have been met, and includes those costs borne by all parties. The calculation of the total estimated cost to recovery is included in the Recovery Action Tables (Tables 2a-e). The actions identified in the Recovery Action Tables are those that, based on the best available science, the USFWS thinks are necessary to achieve recovery of Bartram's stonecrop. Time to recovery is based on the expectation of full funding, implementation as provided for in the Bartram's Stonecrop Recovery Plan and RIS, and full cooperation of partners. The estimated cost to implement the first 20 years of recovery actions is \$5,057,900 (i.e., intermediate cost). Note that actions taken to improve Madrean woodland habitats for this species will benefit other listed plant and animal species, and costs for improving habitat of any other listed or rare species found within these Madrean woodland habitats will reduce the recovery cost of this species.

Table 2a-e. Recovery Action Table: Estimated Cost, Time, and Priority for Recovery Actions for Bartram's stonecrop (*Graptopetalum bartramii*). These actions apply to the sites of current Bartram's stonecrop populations, as well as future Bartram's stonecrop introduction sites. The threats we have identified for Bartram's stonecrop, and which are addressed below, include Factors A (the present or threatened destruction, modification, or curtailment of its habitat or

range), B (illegal collection), and E (other natural or manmade factors affecting its continued existence).

2.a **Objective 1.** Increase and maintain the size and number of populations and subpopulations, such that they are viable (improve resiliency and redundancy), within the known geographic range of the species through successful Bartram’s stonecrop propagation and augmentation of existing populations and subpopulations, introduction of new populations and subpopulations, and reintroduction of populations as subpopulations.

Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
1	1a	Survey range-wide and locate new populations or potential sites for Bartram’s stonecrop introduction or reintroduction with appropriate habitat.	1	5	10,000	Factor A Factor E
1	1b	Work throughout the species range with landowners, managers, and researchers to complete all necessary compliance, permits, and approvals for augmentation of some existing populations, introduction, or reintroduction.	1	20	14,000	Factor A; Factor E
1	1c	Attain Bartram’s stonecrop seeds for augmentation of existing Bartram’s stonecrop populations and introduction or reintroduction of new Bartram’s stonecrop populations in strategic sites using appropriate genetic stock to increase the redundancy (number of populations) and resiliency (size of populations) of the species.	1, 3, & 4	20	See Action # 3a – 3b, below	Factor A; Factor E
1	1d	Develop methods for propagation and growth of Bartram’s stonecrop.	1, 3, & 4	20	60,000	Factor A; Factor E
1	1e	Augment some existing Bartram’s stonecrop populations and subpopulations or introduce or reintroduce new Bartram’s stonecrop	1 & 3	20	664,800	Factor A; Factor E



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Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
		populations and subpopulations in strategic sites using appropriate genetic stock to increase the redundancy (number of populations) and resiliency (size of populations) of the species.				

2b. **Objective 2.** Properly manage, restore, and protect the quantity and quality of Madrean woodland habitat areas supporting all Bartram's stonecrop within the known geographic range of the species through successful Bartram's stonecrop habitat improvement.

Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
1	2a	Work with land managers, owners, and planners to develop and update management plans to protect Bartram's stonecrop, its habitat, and its pollinators.	6 & 7	30	40,000	Factor A; Factor E
2	2b	Implement management plans to restore Madrean woodland habitat impacted by fire suppression or wildfires with a large high severity component outside of the historical fire regime.	6 & 7	40	813,600	Factor A
3	2c	Implement management plans to reduce impacts from border or recreation related activity in habitat areas supporting Bartram's stonecrop and its pollinators.	7	0	41,100	Factor A
1	2d	Implement management plans to reduce impacts from livestock trampling	7	40	64,000	Factor A

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Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
		activity in habitat areas supporting Bartram's stonecrop and its pollinators.				
1	2e	Implement management plans to reduce nonnative plant invasion in habitat areas supporting Bartram's stonecrop and its pollinators.	6 & 7	0	3,776,000	Factor A
3	2f	Reduce other threats to Bartram's stonecrop, its habitat, or its pollinators that are identified through research.	1-7	40	x	Factor A; Factor B; Factor C; Factor D; Factor E
2	2g	Protect through acquisition, conservation easement, or other conservation mechanism appropriate to the land status, habitat areas supporting Bartram's stonecrop and its pollinators, as well as sites supporting suitable Madrean woodland habitat where Bartram's stonecrop could be introduced or reintroduced.	1 & 5	20	1,158,000	Factor A; Factor E

2c. **Objective 3.** Ensure long-term Bartram's stonecrop conservation through the establishment of ex-situ plant and seed collections housed at multiple Center for Plant Conservation approved botanical institutions and seed banks.

Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
1	3a	Bartram's stonecrop seed is harvested at regular intervals (every five years) representing the geographical, morphological, and genetic diversity of the species using Center for Plant Conservation guidelines.	1 & 3	0	57,600	Factor A, Factor E
1	3b	Conserve Bartram's stonecrop seed in Center for Plant Conservation approved facilities and periodically test the seed to estimate the rate of viability loss during seed storage.	3	40	150,000	Factor A, Factor E
3	3c	Maintain Bartram's stonecrop plants in captivity at botanical gardens and other USFWS approved facilities for educational purposes, seed amplification, and introduction.	4	0	160,000	Factor A, Factor E

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2d. **Objective 4.** Improve our understanding of current conditions, trends, threats, and outcomes of management actions through monitoring of all Bartram’s stonecrop, its habitat, and its pollinators.

Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
1	4a	Monitor all Bartram’s stonecrop, its habitat, and its pollinators in the fall every 1 to 8 years.	2 & 6	40	86,400	Factor A; Factor E
1	4b	Monitor impacts to Bartram’s stonecrop, its habitat, and its pollinators from nonnative plant invasion, wildfire, drought and climate change, mining activity, border related activity, road and trail maintenance activity, recreation activity, trampling, illegal collection, and other threats as appropriate.	2 & 7	40	160,000	Factor A; Factor B; Factor E
2	4c	Review the status of Bartram’s stonecrop periodically.	2 & 7	40	16,000	Factor A; Factor E

2e. **Objective 5.** Improve our understanding of Bartram’s stonecrop genetics, geography, ecology, biology, pollination, viability, threats, compatible land uses, and habitat and fire regime restoration, through scientific research, thereby enabling better management of Bartram’s stonecrop.

Priority #	Action #	Site-Specific Action	Recovery Criteria	Action Duration (years)	Estimated Total Cost (\$)	Addresses Threat
1	5a	Identify research needs and conduct scientific studies on the geography, habitat, ecology, biology, pollination, viability, and genetics of Bartram’s stonecrop and share results among land managers and researchers.	7	20	100,000	Factor A; Factor B; Factor C; Factor E
3	5b	Identify Bartram’s stonecrop research needs and conduct scientific studies on threats, compatible land uses, and habitat restoration, and share results among land managers and researchers.	7	40	75,000	Factor A; Factor B; Factor C; Factor E

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**APPENDIX A**

A draft of this recovery plan (hereafter referred to as “plan”) was published and distributed for review to all interested parties. The USFWS published a notice on the species ECOS webpage on August 12, 2024, to announce that the document was available for public review and comment. The comment period lasted for 60 days and closed on October 11, 2024. An electronic version of the draft plan was also posted on the USFWS’s Southwest Region website. We also distributed a press release.

**SUBSTANTIVE PEER AND PARTNER REVIEW RESPONSE**

We solicited five peer and five partner reviews on the plan. We received comments from three peer and four partner reviewers. In general, the reviewers agreed with the plan and provided largely editorial comments, which were addressed. In some instances, additional language was added to the Recovery Plan and the Recovery Implementation Strategy for clarity. Multiple reviewers suggested habitat restoration to benefit Bartram’s stonecrop should be at a larger scale than 500 meters around known populations. We acknowledge a watershed scale is needed for forest restoration in general and should be a component of land management and watershed-level planning; however, the difficulty and cost of implementing restoration at this scale is beyond the scope of a single species recovery plan.

**PUBLIC COMMENT RESPONSE**

We received a single public comment letter regarding the Bartram’s stonecrop Draft Recovery Plan during the comment period. The table below shows each comment provided by the commentor, as well as the Fish and Wildlife Service’s response.

Comment	USFWS Response
<p>The reviewer states the recovery plan does too much to encourage more illegal cartel related use of land while discouraging valid existing uses and fire prevention measures. The reviewer notes the Fish and Wildlife Service should advocate for removal of cartel scouts and their paramilitary operation on Arizona mountaintops and not have allegations of border patrol being a threat to the stonecrop.</p>	<p>Edits were made to clarify the intention of the phrase “border related activity” throughout the plan. The recovery plan focus is on the prevention of catastrophic wildfire through forest thinning, prescription burning, and other forest restoration treatments. The plan also includes focusing on reduction of other threats such as border related activity and increasing population numbers and population size.</p>
<p>The reviewer suggests that recovery should occur on the actual Bartram’s stonecrop habitat of rocky north facing ledges and slopes of steep walled canyons where there is moisture, lichens, etc., which is a tiny fraction of the area.</p>	<p>No changes were made. The recovery plan focuses on a 500-meter perimeter of known populations for catastrophic wildfire prevention and leaves watershed level planning, which benefits multiple species, up to individual land management agencies to reduce the cost of recovery.</p>

Comment	USFWS Response
<p>The reviewer states that the Bartram's stonecrop can be monitored annually for a small fraction of the proposed cost by focusing on known locations with botanical students from colleges and universities supplementing Fish and Wildlife Service personnel.</p>	<p>No changes were made. The Fish and Wildlife Service does not monitor these populations, but relies of professional botanists and land management personnel for this work; costs shown in the plan for monitoring reflect current costs of monitoring.</p>
<p>The microsites where the Bartram's stonecrop grow are fragile and should not be disturbed by people. The proposed human involvement risks upsetting the delicate balance of nature that is currently in place.</p>	<p>No changes were made. The Recovery Plan proposes nonnative plant control, catastrophic fire prevention, soil moisture retention, and other similar land management actions that go through review and consultation to decrease risks to the Bartram's stonecrop populations. Similarly, any augmentation action would go through permitting, review, and consultation to mitigate and reduce disturbance from restoration activity.</p>
<p>The reviewer states that the Fish and Wildlife Service quotes the Center for Biological Diversity instead of an unbiased expert botanist (George Ferguson) that had studied Bartram's stonecrop for over 20 years.</p>	<p>No changes were made. The Recovery Plan does not quote the Center for Biological Diversity (CBD) and the Species Status Assessment from which the recovery plan is based only mentions the CBD history that a petition was received in 2010. The Species Status Assessment cites 15 reports, reviews, and emails from Mr. Ferguson, several studies of which were paid for by the Fish and Wildlife Service. The SSA also includes citations of work done by the National Park Service, US Forest Service, the U.S. Geological Survey, the Nature Conservancy, Fish and Wildlife Service Refuges, universities in Arizona and Mexico, the Museum of Northern Arizona, and others.</p>



Comment	USFWS Response
<p>The reviewer states that the Fish and Wildlife Service may find value in investing in public broadcasts and promotional items to teach people more about staying on trails and preventing fires the way the US Forest Service has done with their Smoky bear mascot commercials, promotional items and educational presentation at schools.</p>	<p>No changes were made. The Recovery Plan does propose education of the public through displays of Bartram's stonecrop at public botanical institutions in the state. In addition, Fish and Wildlife Service staff regularly attend public events where information on threatened and endangered species is disseminated.</p>
<p>The reviewer notes there are several other recovery plans that overlap the same lands and they recommend Fish and Wildlife Service focus and prioritize their management strategy by consolidating resource plans.</p>	<p>No changes were made. The Recovery Plan states that "actions taken to improve Madrean woodland habitats for this species will benefit other listed plant and animal species, and costs for improving habitat of any other listed or rare species found within these Madrean woodland habitats will reduce the recovery cost of this species."</p>
<p>The reviewer states that Fish and Wildlife Service copies the paragraphs the Center for Biological Diversity writes and puts them into a digital library and then copies them into documents using Artificial Intelligence models. The reviewer suggest the Fish and Wildlife Service is creating a political attack on border patrol personnel.</p>	<p>No changes were made. The Recovery Plan and Species Status Assessment documents are written by professional biologists and are reviewed by peer, partner, public, and internal field office and regional office reviewers. No Artificial Intelligence or digital copies are used in the creation of these documents, and we welcome new information about the species, trends, threats, etc. from land managers, the border patrol, biologists, and the public to aid in writing assessments and planning documents.</p>

Comment	USFWS Response
<p>The reviewer states that the Fish and Wildlife Service choose different start and end dates for each climate related parameter and this is an example of bias. There is a request for all graphs to be recreated to avoid the perception that data was manipulated.</p>	<p>No changes were made. The Recovery Plan does not have any graphs relating to climate. Climate related graphs in the Species Status Assessment were largely incorporated from the Intergovernmental Panel on Climate Change and the Climate Explorer which is a collaboration of climate experts from the Environmental Protection Agency, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, and the United States Geological Survey.</p>
<p>The reviewer suggests the addition of the Ribbon of Green and The Changing Mile as references.</p>	<p>No changes were made. These two documents relate to riparian forests and not Madrean Woodlands, therefore these references are not necessary.</p>
<p>The reviewer notes there is no value in most actions proposed in the recovery plan for the stonecrop because the proposed actions don’t address the real problems described by botanists including George Ferguson.</p>	<p>No changes were made. The reviewer notes that Ferguson lists among the threats to the species the loss of overstory trees and diminished in-stream flow, desiccation, erosion, poaching, trampling, and predation. The Recovery Plan also lists these threats and proposes recovery actions to reduce these threats.</p>
<p>The reviewer states that the City of Sierra Vista was never contacted during the plan’s creation.</p>	<p>The Bartram's stonecrop Recovery Plan was written internally by two Fish and Wildlife Service biologists. The City of Sierra Vista was contacted directly and through media outreach on August 12, 2024 notifying them that the draft recovery plan was available for public comment.</p>