Sentry milk-vetch
(*Astragalus cremnophylax* var. *cremnophylax*)
Draft Recovery Plan Revision

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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ACKNOWLEDGEMENTS

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LITERATURE CITATION AND AVAILABILITY

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TABLE OF CONTENTS

INTRODUCTION

The U.S. Fish and Wildlife Service (herein referred to as "we") finalized the Sentry Milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*) Recovery Plan in 2006 (USFWS 2006, entire). Since then, we and our partners have made progress implementing the recovery actions. As a result, we have learned more about sentry milk-vetch distribution and taxonomy and gained experience propagating and introducing the plant into unoccupied habitat. We determined it necessary to revise the recovery plan to reflect the best available information about sentry milk-vetch.

This recovery plan revision describes criteria for determining when sentry milk-vetch should be considered for reclassification from endangered to threatened and to recovered status under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA); lists site-specific actions that will be necessary to meet those criteria; and provides estimates of the time and cost required to carry out those measures needed for recovery. Additionally, cursory information on the species' biology and status are included, along with a brief discussion of factors limiting its populations. A Species Status Assessment (SSA) Report (USFWS 2024, entire), which provides a more detailed accounting of the species status, biology, and threats, and a Recovery Implementation Strategy (RIS), which describes the activities to implement the recovery actions, are available online at the ECOS Sentry Milk-vetch Species Profile. The SSA Report and the RIS will be updated on a routine basis.

SPECIES INFORMATION AND STATUS

Marcus E. Jones made the first collection of sentry milk-vetch[1] (*Astragalus cremnophylax* Barneby var. *cremnophylax* Barneby) in 1903, though the species was not described until 45 years later by Rupert Barneby (Barneby 1948, p. 83). Sentry milk-vetch and the other varieties of *A. cremnophylax* belong to the genus *Astragalus* of the section *Humillimi* in the pea family (Fabaceae). Plants in this section have silvery-haired leaves and stems. Flowers have short, campanulate calyxes with pale, purplish-pink petals and white-tipped wings. The *A. cremnophylax* varieties differ morphologically from the other species in the section *Humillimi*. They have compact, 3 to 12 millimeter (mm) (0.1 to 0.5 inch [in]) long, pinnately compound leaves that bear 5 to 9 minute leaflets, and small white to pale-purple flowers with banners 5 to 6

[1] Barneby (1948, p. 83) assigned the entity the common name "sentry milkvetch" and used "milkvetch," unhyphenated, for the common names of other *Astragalus* species (Barneby 1989, entire). We referred to the entity as "sentry milk-vetch" in the proposed listing rule (54 FR 42820) and subsequent documents. We are hyphenating "milk-vetch" in sentry milk-vetch in this document for consistency with our past documents.

mm (0.2 in) in length and keels not over 4.5 mm (0.2 in) long (Figure 2). Pistils have 4 to 6 ovules. The pods are 3.0 to 4.5 mm (0.1 to 0.2 in) long, obliquely egg-shaped, densely hairy (Barneby 1964, p. 1006), and unilocular (comprised of a single compartment) with a single row of seeds (Arizona Rare Plant Committee 2000, n.p.; Arizona Cooperative Extension 2023, n.p.).

Sentry milk-vetch occurs on the Fossil Mountain Member, a pure white layer of Kaibab limestone, the uppermost rock layer in the Grand Canyon (Canyon). The plants grow in shallow soil on platforms of bedrock on the rim of the Canyon at the edge of pinyon-juniper woodlands on the South Rim and mixed conifer forests on the North Rim. Most of the plants occur on the edge of the Canyon and on limestone shelves below the rim. Most plants grow in full sun (Busco and Makarick 2012, p. 4).

Sentry milk-vetch is found entirely in Grand Canyon National Park (GRCA) in Coconino County, Arizona, and is managed by the National Park Service (Figure 1). At the time of listing, we knew of one sentry milk-vetch occurrence, on the South Rim at Maricopa (55 FR 50184–50187). We found two additional occurrences on the South Rim near Grandview Point and Lollipop Point in 1991 and 2002, respectively. During surveys of potentially suitable habitat, researchers found the first occurrences on the North Rim in 1994 and have found new occurrences on the North Rim as recently as 2021 (D. Boughter, GRCA, pers. comm., 26 January 2022a). Known occurrences are along a straight-line distance of approximately 20 kilometers (km) (12.5 miles [mi]) from Maricopa Point to Grandview Point and on the Walhalla Plateau on the North Rim (Figure 1).

In the SSA Report we delineated sentry milk-vetch sites and subsites (USFWS 2024, p. 13–17). We delineated sites by applying a 1,200 m (0.75 mi) buffer around areas occupied by sentry milk-vetch to group them into sites that include all the occurrences that could potentially occur within the typical flight range of an *Osmia ribifloris* and *O. r. ribifloris*, the plant's most common pollinators (Busco and Douglas 2011, p. 1; Guédot et al. 2009, p. 160). Thus, we estimate that pollination, and consequently gene flow, occurs relatively frequently within sites but is rare between sites. We further delineated subsites within the sites by applying a 50-meter (m) (164-foot [ft]) buffer around groups of plants to estimate the limit an ant could potentially disperse a seed (Ness *et al.* 2004, p. 1247). Thus, we do not expect natural recolonization of sentry milk-vetch between subsites.

Our site and subsite delineation methodology yields six sites, four on the South Rim (Maricopa, Shoshone, Lollipop, and Grandview) and two on the North Rim (Walhalla Glades and Cape Final) comprised of 19 native (non-introduced) subsites (USFWS 2024, p. 17). Three sites (Maricopa, Shoshone, and Grandview) contain one native subsite each, one site (Lollipop) contains four, one site (Walhalla Glades) contains five, and one site (Cape Final) contains seven. In addition to the native subsites, there are two subsites where GRCA has introduced sentry milk-vetch plants to habitat where they had not been previously documented; the numbers of individuals in these subsites are declining. We further group the sites by the North Rim ecotype and the South Rim ecotype, because of their different habitats and low likelihood of gene flow between them. The South Rim ecotype contains four sites with eight native subsites and two introduced subsites (Figure 3); the North Rim ecotype contains two sites with 12 native subsites (Figure 4).

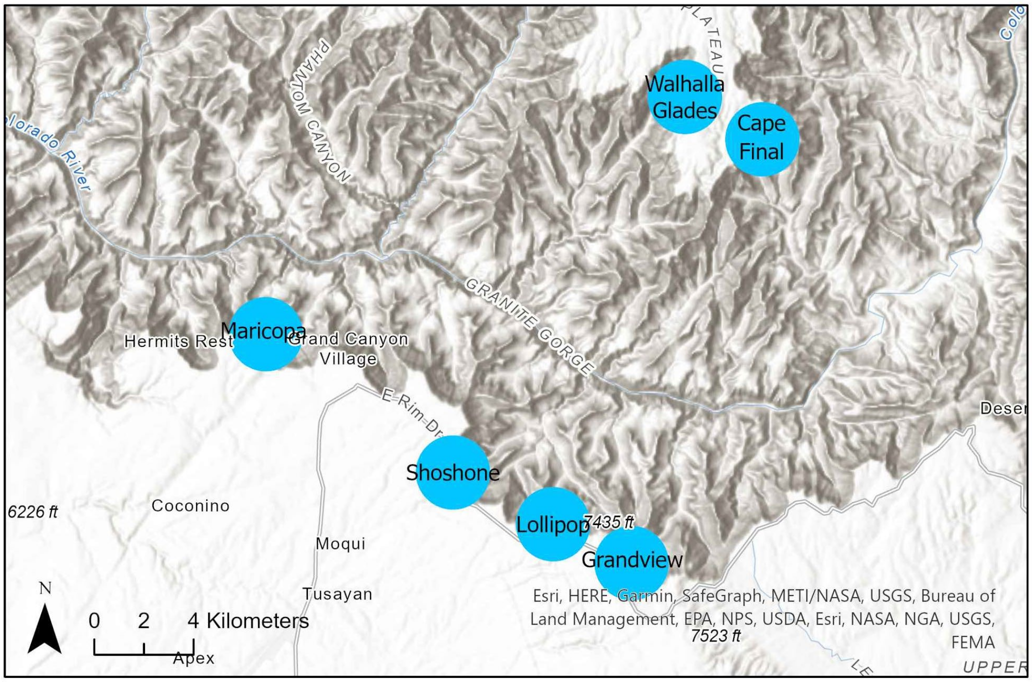

Figure 1. Locations of sentry milk-vetch sites (blue polygons), Grand Canyon National Park, Arizona.

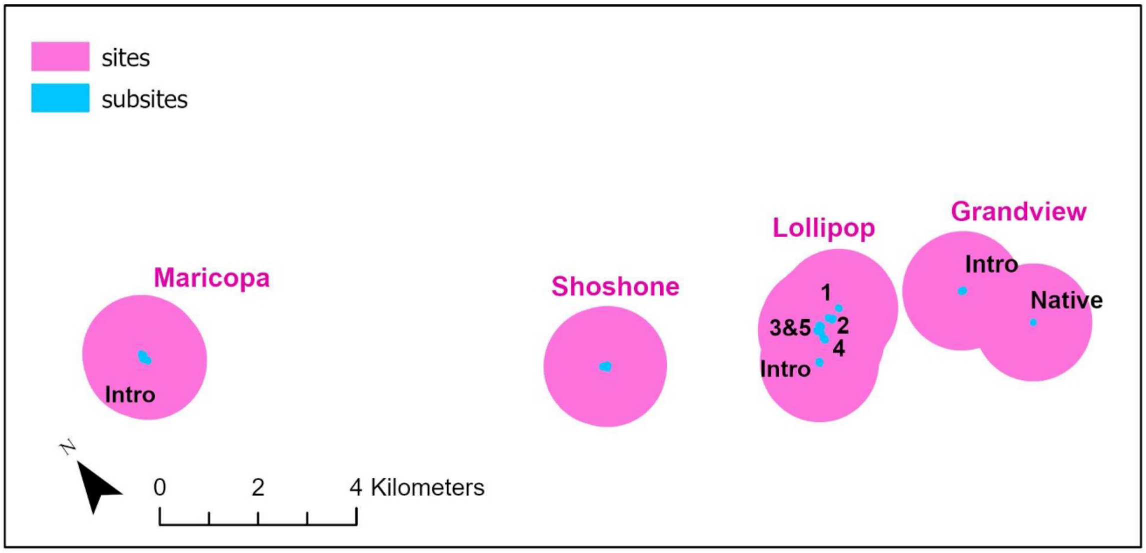

Figure 2. Sentry milk-vetch sites and subsites on the South Rim, Grand Canyon National Park, Arizona. Labels indicate site names (pink text) and subsite names (black text).

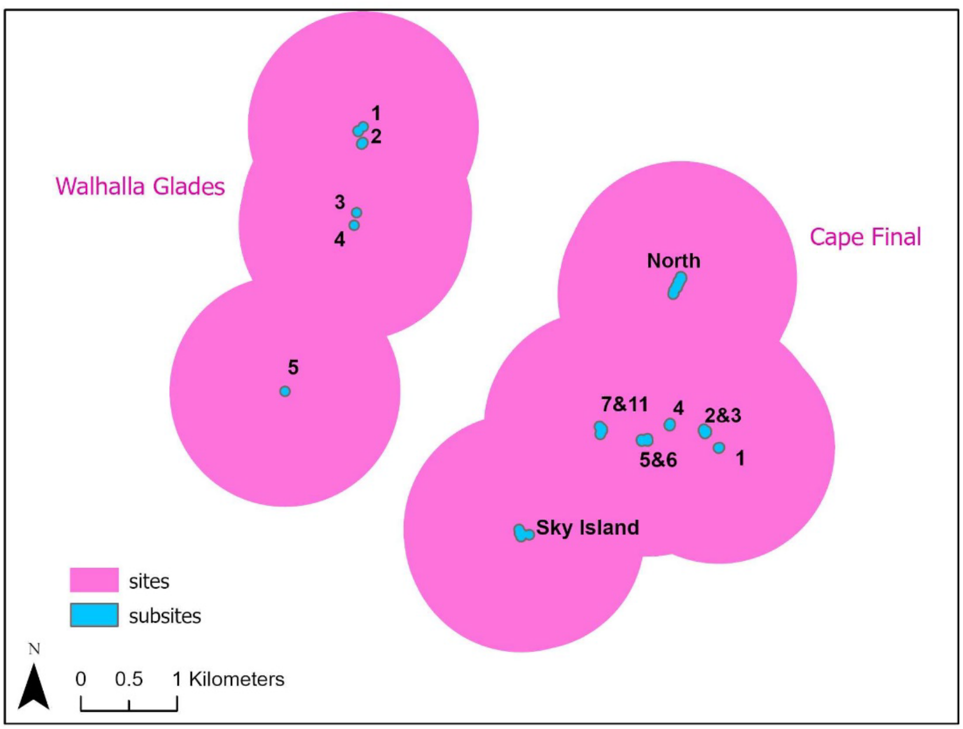

Figure 3. Sentry milk-vetch sites and subsites on the North Rim, Grand Canyon National Park, Arizona. Labels indicate site names (pink text) and subsite names (black text).

THREATS

When we listed sentry milk-vetch as endangered in 1990, we identified human trampling at Maricopa as the major threat to the plant (55 FR 50184–50187). GRCA has ameliorated the threat of human trampling to sentry milk-vetch at Maricopa by constructing a fence in 1990, relocating a parking lot and trail in 2008, and extending the fence in 2010. Despite this, the past trampling may have produced long-term effects on the plants at Maricopa. The declines in numbers of individuals likely caused a genetic bottleneck that resulted in low genetic variation (Allphin *et al.* 2005, p. 817; Massatti *et al.* 2018, p. 6). We have not observed human trampling to be a major threat at any of the other sites.

Trampling by bison (*Bison bison*) is a potential threat that was not a threat when we listed sentry milk-vetch as endangered. Bison herd movement data from 2019 through 2022 show that, while bison use habitat on the Walhalla Plateau near sentry milk-vetch sites on the North Rim, specifically in the winter, areas occupied by sentry milk-vetch have received low use and likely only by individual bison (Salganek 2022, n.p.). Surveys have found bison scat, tracks, and wallows within sentry milk-vetch sites on the North Rim. GRCA plans to continue monitoring bison on the North Rim to better understand the magnitude of threat they pose to sentry milk-vetch. Bison do not occur on the South Rim.

Climate models indicate that the transition to a more arid climate is already underway and predict that in this century the arid regions of the southwestern U.S. will become drier and warmer, and have fewer frost days, decreased snow pack, increased frequency of extreme weather events (heat waves, droughts, and floods), declines in soil moisture, and greater water demand by plants, animals and humans (Archer and Predick 2008, p. 23; Garfin *et al.* 2013, pp. 5–6). Sentry milk-vetch germination and seedling establishment decreases during drought conditions (Maschinski 1991, p. 7; Maschinski and Rutman 1993, p. 183). In favorable years, increased recruitment in sentry milk-vetch subsites can likely make up for reduced recruitment during less favorable years. However, subsites could experience reduced recruitment at a magnitude or frequency so great that they cannot compensate for adult mortality during favorable years, thus resulting in a decline in numbers in a subsite. We do not know at what magnitude or frequency this will occur. Additionally, the effects of climate change may interact with effects from other threats and result in synergistic effects that could be greater than the additive effects from those threats (Lawrence *et al.* 2024, pp. 38-39; Souther and McGraw 2014, p. 1471). While we have information supporting that climate can affect sentry milk-vetch, we do not have enough information to predict how climate change may affect long-term trends at subsites.

As a species with small population sizes and limited distribution, sentry milk-vetch is at greater risk of extinction due to effects of catastrophic and stochastic events and limited genetic diversity. Additionally, endemic plant species typically have lower genetic diversity than more widespread species (Ellstrand and Elam 1993, p. 220), and small populations are often associated with low genetic diversity, specifically increased homozygosity as a result of inbreeding depression (Ellstrand and Elam 1993, p. 225; Lammi *et al.* 1999, p. 1075).

Nonnative invasive plant species are species that have invaded and become naturalized into new habitats. They are ubiquitous in many landscapes, and they can alter plant communities by competing with native plants for resources, such as nutrients, water, light, and space (Gioria and Osborne, 2014 pp. 3–4), by affecting pollinator populations (Bartomeus *et al.* 2008, p. 765), and by increasing fire risk (Link *et al.* 2006, entire). GRCA has documented nonnative invasive plant species at Maricopa (Busco and Makarick 2012, p. 12) and, because of their prevalence even in remote areas of GRCA (Crawford *et al.* 2005, pp. 8–9), they likely also occur in or around other subsites. The occurrence of nonnative invasive plants in sentry milk-vetch habitat, their potential to affect native plants in general, and their continued spread into new habitats warrants continued documentation of their presence in sentry milk-vetch habitat and their effects.

While the above threats may be affecting sentry milk-vetch plants, we do not have data to inform their potential effects on sentry milk-vetch viability. The one site with long-term monitoring data, Maricopa, has shown a general decline in abundance since 2014. Increased monitoring of abundance trends and conditions at subsites will increase our understanding of how threats are affecting sentry milk-vetch and which are adversely affecting viability.

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 stochastic events (arising from random factors). Redundancy describes the ability of a species to withstand catastrophic events. Representation describes the ability of a species to adapt to changing environmental conditions. To ensure viability, sentry milk-vetch requires multiple resilient subsites (the spatial groupings of plants within which we think genetic exchange readily occurs) distributed across multiple sites (the spatial groupings of subsites between which we think genetic exchange is unlikely) within the South Rim and North Rim ecotypes (broad areas that differ in habitat, climate, and genetics). The recovery strategy includes: 1) ensuring and maintaining resiliency of sites and subsites, 2) maintaining a sufficient number of resilient subsites across sites to provide adequate redundancy, and 3) maintaining a sufficient number of subsites within sites across the South Rim and North Rim ecotypes to maintain genetic and ecological diversity.

Sentry milk-vetch is a narrow endemic; historical records do not indicate that the plants have been more widely distributed than they are currently. Because of this, we think that the current distribution in six sites across two ecotypes (the North Rim and the South Rim) provides the redundancy and representation necessary to support sentry milk-vetch viability. Our recovery strategy therefore focuses on maintaining a number of resilient subsites distributed across those number of sites sufficient to withstand potential threats. Sentry milk-vetch subsites are resilient when habitat and demographic factors support an adequate number of plants and a stable or increasing growth rate. At the time of our SSA, we only have consistent data to assess sentry milk-vetch trends at one subsite. Recovery of the species will require monitoring additional subsites to understand the trends and to identify if threats are reducing their resiliency. When we identify a threat that is reducing subsite resiliency, we will develop and implement management activities to reduce the effects of that threat.

RECOVERY OBJECTIVES

Recovery objectives identify outcomes that will lead to achieving the goal of recovery and delisting. Recovery objectives for sentry milk-vetch are:

1. Maintain sentry milk-vetch plants at sites and subsites that provide resiliency, redundancy, and representation sufficient for viability.
2. Increase our understanding of the effects of potential threats (*e.g.*, climate change, bison trampling, loss of genetic diversity) to sentry milk-vetch and identify those that may substantially reduce viability.
3. Identify and implement measures to protect sentry milk-vetch from threats impeding recovery.

RECOVERY CRITERIA

"The term 'endangered species' means any species which is in danger of extinction throughout all or a significant portion of its range" (16 USC §1532 (6)). "The term 'threatened species' means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 USC §1532 (20)). When we evaluate whether a species warrants downlisting (reclassification from endangered to a threatened status) or delisting (removal from the list of threatened and endangered species), we consider whether the species meets either of these statutory definitions. A recovered species is one that no longer meets the 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, 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 downlisting or delisting. Thus, recovery criteria are mileposts that measure progress toward recovery. Because the appropriateness of delisting is assessed by evaluating the five factors identified in the ESA, the recovery criteria below pertain to these factors. These recovery criteria are our best assessment at this time of what the species needs to be downlisted from endangered to threatened, and delisted. Because we cannot envision the exact course that recovery may take, and because our understanding of the vulnerability of a species to threats is likely to change as more is learned about the species and the threats, it is possible that a status review may indicate that downlisting or delisting is warranted even if not all recovery criteria are met. Conversely, it is possible that the recovery criteria could be met and a status review may indicate that downlisting or delisting is not warranted. For example, a new threat may emerge that is not addressed by the current recovery criteria.

The downlisting criteria for sentry milk-vetch consist of a combination of conditions that, when met, indicate the plant may warrant reclassification from endangered to a threatened status. These criteria are described in detail in the "Downlisting Criteria" section below. Full recovery of sentry milk-vetch to the point that protections of the ESA are no longer necessary (delisting) involves similar criteria as those for downlisting, sustained for a longer period, and are described in detail in the "Delisting Criteria" section below. We describe our justifications for the recovery criteria in the section following the criteria.

Downlisting Criteria

We will consider sentry milk-vetch for reclassification as a threatened species when the following objective and measurable criteria are met:

1. At least twelve sentry milk-vetch subsites have at least 100 mature plants and these subsites are distributed as follows: one at Maricopa, one at Shoshone, and three at Lollipop on the South Rim and four at Cape Final and three at Walhalla Glades on the North Rim.
2. At least four subsites have at least 900 mature plants: two at two different sites on the South Rim and one at each of the two sites on the North Rim.
3. Available data support a stable or increasing trend over at least 10 years at each of the four subsites with over 900 mature plants identified in criterion #1.

Delisting Criteria

We will consider sentry milk-vetch for removal from the endangered species list when the following objective and measurable criteria are met:

1. At least twelve sentry milk-vetch subsites have at least 100 mature plants and these subsites are distributed as follows: one at Maricopa, one at Shoshone, and three at Lollipop on the South Rim and four at Cape Final and three at Walhalla Glades on the North Rim.
2. At least six subsites have at least 900 mature plants: One at Maricopa, one at Shoshone, and two at Lollipop on the South Rim and one at Cape Final and one at Walhalla Glades.

3. We have developed and implement a monitoring plan that regularly and consistently measured the six subsites with more than 900 mature plants in delisting criterion #1. The monitoring effort and methodology are sufficient to detect a statistically significant increasing or decreasing trend over a ten-year period. Monitoring data demonstrate a stable or increasing trend at all six subsites over at least the previous ten years.
4. Available data support a stable or increasing trend over at least 10 years at each of the six subsites in criterion #1 not addressed in criterion #2.

Justification for Recovery Criteria

We explain the concepts and rationale used in the Recovery Criteria in the context of sentry milk-vetch viability (resiliency, redundancy, and representation) and amelioration of threats.

Number of individuals per subsite: The number of individuals per subsite contributes to its resiliency, with higher numbers of individuals making subsites more likely to withstand disturbances such as random fluctuations in germination rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities (Wolf et al. 2015, p. 205). A greater number of individuals in a subsite increases the chance that a portion of the subsite will survive after a disturbance.

We do not know the necessary abundance or minimum viable population size for sentry milk-vetch subsites to be resilient (USFWS 2024, p. 40–41). In our 2006 recovery plan we based our estimate on available occurrence data and literature about rare plants in general that suggest a minimum population size of 100 to prevent inbreeding depression and potentially more than 1,000 individuals to maintain evolutionary potential (USFWS 2006, pp. 21–23; Jamieson and Allendorf 2012, p. 580; Maschinski and Albrecht 2017, p. 392).

The 2006 recovery plan required at least eight populations over 1,000 individuals to delist sentry milk-vetch (USFWS 2006, p. 22). At that time, we considered sentry milk-vetch distributed in three locations, which we now refer to as sites: Maricopa, Lollipop, and Grandview. We did not define "population" other than they should be "geographically distinct" or "geographically separate" (USFWS 2006, p. 21, 22). In this recovery plan revision, we focus recovery criteria regarding abundance and trends on the subsite, because sentry milk-vetch is unlikely to recolonize subsites that become extirpated.

We have since found subsites in new sites; many of the subsites contain far fewer than 1,000 plants. We do not think that the 1,000-plant threshold for a subsite is biologically necessary to recover sentry milk-vetch, because we do not have historical data indicating that eight sentry milk-vetch subsites ever had more than 1,000 plants. Based on the distribution of suitable habitat in small areas and sentry milk-vetch's occurrence in less than 1,000 plants in many subsites, sentry milk-vetch is likely naturally distributed in subsites with relatively low abundances. Furthermore, the limited success from approximately 10 years of introductions and augmentations suggests that habitat limits the number of sentry milk-vetch plants at a subsite. Therefore, we chose 900 mature plants at each subsite in the criteria, rather than 1,000, because, in addition to the four subsites that had over 1,000 mature plants in our SSA, Shoshone had between 900 and 1,000 plants and past data supported that Maricopa has the potential to have between 900 and 1,000 plants (USFWS 2024, p. 21). We have no information supporting that these sites ever contained more than 1,000 mature plants.

In this recovery plan revision, we prioritize maintaining those subsites with at least 900 mature plants, by requiring for delisting the maintenance of the five subsites that had at least 900 mature plants at the time of our SSA (USFWS 2024, p. 21). We consider these subsites highly resilient, because of their relatively large numbers. In addition to these five subsites, we require Maricopa to have more than 900 mature plants; it has had more than 900 plants (including seedlings) in past years' counts that included plants outside of transects (Kelly 2018 p. 3). When Maricopa achieves more than 900 mature plants, we will have some assurance that the reduced genetic diversity at the subsite is not substantially affecting its resiliency.

In addition to those six subsites with more than 900 mature plants, the recovery criteria require four additional subsites on the North Rim and one additional subsite on the South Rim with at least 100 mature plants. While the subsites with fewer than 900 mature plants may be less resilient, these subsites have likely persisted overtime with less than 900 mature plants. In particular, the smaller subsites on the North Rim likely require fewer mature plants to reproduce, because they are self-compatible, unlike the plants at Maricopa (Allphin, L., pers. comm. as cited in Brian 2001a, p. 7; Allphin *et al.* 2005, p. 809). The subsites with less than 900 mature plants are within sites composed of multiple subsites. Though we do not expect seeds to travel between these subsites, we do expect pollen exchange between them. Thus, we expect gene flow between these subsites that would provide some protection against inbreeding depression, thus increasing resiliency.

The number of plants in our recovery criteria refers to mature plants, because seedlings do not contribute to the effective population size and recruitment may be low and vary through time. We do not know the proportion of seedlings and mature plants in some of the abundance data we have for subsites. As we further analyze the data from Maricopa and collect more consistent data on the number of mature plants at subsites, we may find it appropriate to adjust the number of mature plants necessary to indicate recovery.

<u>Stable or increasing trend</u>: We will document subsite trends through monitoring and census counts. A subsite with a stable or increasing trend will exhibit recruitment equal to mortality ($\lambda = 0$) or greater than mortality ($\lambda > 0$). We expect year-to-year fluctuations in total plant numbers and recruitment and mortality rates; some years may exhibit mortality greater than recruitment ($\lambda < 0$). Maintaining a stable or increasing trend over at least a 10-year period indicates that a

subsite is resilient enough to withstand the effects of current potential threats to the plants and its habitat.

We will use available data (*e.g.*, total counts, transect counts, size class of plants) to assess the overall trend during at least a 10-year period for consideration for downlisting criterion #2 and delisting criterion #2. We will use data from monitoring according to a monitoring plan to assess the overall trend for consideration for delisting criterion #3.

Monitoring plan: At the time of our SSA, we only had long-term data for one of the sites, Maricopa, composed of one subsite. We have counts of the number of plants at the other subsites for a few years; many of the counts are estimates or incomplete counts of the subsite. We need a monitoring plan to provide a consistent, repeatable protocol to assess the number of individuals and detect statistically significant changes over time at subsites contributing to recovery. A monitoring plan should include accessing the number of plants at a subsite and the occurrence of recruitment.

Monitoring could include counts of the total number of plants within a subsite or of the number of plants within transects, plots, or points within a subsite. It is easier to consistently count the total number of plants at subsites with fewer plants in a small, discreet area than subsites with many plants and those with a more scattered distribution of plants. Additionally, it may be difficult for complete counts of the entire area of some subsites because of their inaccessibility without technical equipment and skills (*e.g.*, Lollipop, Shoshone). We may not be able to collect data from each subsite each year because of the remoteness of many of the subsites, particularly on the North Rim, and limited personnel time. When developing a monitoring plan, we will consider the effort needed to detect a trend in the number of plants at a subsite over at least a ten-year period. During the development of a monitoring plan, we may find that we need more than a ten-year period to confidently detect a stable or increasing trend at a subsite. If this is the case, we will adjust the timeframe in delisting criterion #3 accordingly.

Ten-year timeframe: We used ten years to define the minimum timeframe in which we will evaluate data to consider sentry milk-vetch for downlisting or delisting. These ten-year timeframes may overlap, meaning that delisting criteria could be achieved less than ten years after downlisting criteria is achieved.

We chose ten years because this timeframe is long enough to encompass a drought/non-drought cycle during which sentry milk-vetch numbers, especially seedlings, may fluctuate and therefore provides an adequate representation of the trend occurring at a subsite over time. We observed that most of the variability in the number of individuals at Maricopa from 2012 to 2021 was in the number of very small or small plants (GRCA, unpublished data). This is consistent with field observations of low seedling survival (Maschinski 1990, p. 5; 1991, p. 4). Germination and seedling survival is likely greater in wetter years (Maschinski 1990, p. 5; 1991, pp. 4, 7; Brian 1996, p. 7; 2001b, p. 3). Thus, to measure if recruitment exceeds mortality over the long-term, our monitoring timeframe must be an interval that is representative of inter-annual variation of drought conditions. Based on data from 2000 to 2020 in the southwest U.S., a ten-year interval captures at least one multiple-year period of extreme to exceptional drought in the Southwest (Mankin *et al.* 2021, p. 6). Thus, we think that ten years is a reasonable interval to capture drought cycles that sentry milk-vetch experiences. With climate change occurring, drought conditions will likely occur more frequently in the future (Alder 2014, n.p.). If such a scenario results in substantially reduced recruitment, the resulting decreasing population trend at the subsite would not fulfill downlisting and delisting criteria #2. Based on future projections of increased drought in the Southwest (Alder 2014, n.p.), it is unlikely that climate conditions over any particular ten-year period will be favorable enough to recruitment that we would overestimate the trends in the number of individuals at a subsite.

<u>Number of subsites:</u> We have no information indicating that the plants occurred in more locations or in greater abundance in the past than they occur currently. Furthermore, the limited success of introductions into unoccupied habitat suggest that sentry milk-vetch can only exist in very specific habitat (USFWS 2024, p. 37–38). Therefore, we focus on preserving most of the known native subsites. At the time of the SSA we know of twenty-one sentry milk-vetch subsites, nine from four sites on the South Rim and twelve from two sites on the North Rim (USFWS 2024, p. 16–17). While we prefer to conserve all extant subsites, we recognize that natural stochastic events could cause extirpations of a few subsites, especially smaller ones, and that some of these populations may never achieve 900 plants. Extirpations of too many subsites, however, could indicate that threats are reducing sentry milk-vetch viability. In our recovery criteria, we require at least twelve subsites for redundancy. We also prioritized the subsites with the greatest number of plants, as these are likely the most resilient.

<u>Distribution of subsites:</u> As a narrow endemic, sentry milk-vetch has an intrinsically small distribution limited to a small area in GRCA. Maintaining multiple resilient subsites distributed across multiple sites within both the South Rim and North Rim ecotypes will preserve existing genetic variation, including any adaptations to variations in climate and aspect associated with sites and ecotypes. Additionally, maintaining subsites distributed across sites will minimize the chance that multiple sentry milk-vetch subsites are simultaneously affected by catastrophic events (*e.g.*, high severity fire) or locally important events (*e.g.*, cliff collapse). Downlisting criterion #1 and delisting criterion #1 require the subsites to be distributed across five sites.

<u>Threat reduction:</u> The primary threat at the time we listed the plant, human trampling at Maricopa, has been reduced (USFWS 2024, p. 26–27). However, there is likely a long-term decrease in genetic diversity at the site from the resulting genetic bottleneck (Allphin et al. 2005, p. 818). We do not know if this effect is decreasing the resiliency of the subsite. We have identified other potential threats, such as climate change and bison trampling, but do not know if these are reducing subsite resiliency (USFWS 2024, p. 28–34). Additional census counts, monitoring, and investigation will advance our understanding of the effects these threats are

having on subsite resiliency and inform management actions, if necessary, to reduce those threats to improve subsite resiliency.

RECOVERY ACTIONS

We will accomplish recovery of sentry milk-vetch through implementation of site-specific recovery actions provided (Table 1). In general, implementation of the recovery actions will involve participation from GRCA, nongovernmental organizations, academia, and other conversation partners. Recovery actions are accompanied by estimates of the time and cost required for implementation and are classified by priority number (48 FR 43098). 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 sentry milk-vetch provides detailed, site-specific activities needed to implement the actions identified here. We intend to update the RIS based on new information, including the findings of future 5-year status reviews. The RIS provides greater site-specificity than the recovery actions in this recovery plan. For example, we will implement measures to reduce threats at subsites as we identify those subsites from long-term monitoring data. We will only revise the recovery actions in this recovery plan if there are changes needed based upon the findings of future 5-year status reviews or other information.

As stated in the Disclaimer, recovery plans are advisory 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)(2) consultations on Federal agency activities or development of Habitat Conservation Plans. Funding and personnel limitations are common challenges for the conservation of listed species; however, these actions are needed recover the species. We encourage agencies (*e.g.*, National Park Service) and organizations to seek funding to implement this plan

Table 1. Recovery actions with estimated cost and priority number.

Recovery Action	Sites/Subsites	Estimated Cost	Priority
1. Collect and analyze data from subsites referenced in delisting criterion #1.	1 subsite at Maricopa, 1 subsite at Shoshone, 3 subsites at Lollipop, 4 subsites at Cape Final, and 3 subsites at Walhalla Glades.	$125,000	1
2. Search for new subsites in unsurveyed potential habitat.	Undocumented sites in modeled potential habitat.	$15,500	2
3. Increase understanding of sentry milk-vetch biology, including differences between sites and subsites.	Various sites/subsites, as identified in recovery action #1.	$40,000 and costs included in action #1.	2
4. Increase understanding of potential threats at subsites.	Potentially any sites.	$25,000 and costs included in action #1.	1
5. Implement measures to minimize effects of threats at subsites experiencing threats reducing their resiliency.	Sites/subsites identified in recovery action #4.	$40,000	1
6. Maintain genetic diversity *ex situ*.	Various sites/subsites from both the South Rim and the North Rim.	$16,000	1
7. Collaborate with conservation partners.	n/a	Costs are a part of existing programs.	3
Total Estimated Cost:		**$261,500**	

Estimated Time and Cost of Recovery

We expect the status of sentry milk-vetch to improve such that we can achieve downlisting criteria in approximately 5 years (*i.e.*, 2029). We expect to achieve recovery (delisting) in approximately 15 years (*i.e.*, 2039). We base this on the existing data we have, the development of a monitoring plan, and anticipated data collection sufficient to indicate a stable or increasing trend to support delisting and downlisting criteria. Time to recovery is based on the expectation of full funding, implementation as provided for in this Recovery Plan, and full cooperation of partners.

We estimate $261,500 for the total cost of recovery. This is the estimated cost of completing the recovery actions such that the recovery criteria have been met and includes those costs borne by all responsible parties. The actions identified in the Recovery Action Table are those that, based on the best available science, the USFWS thinks are necessary to achieve recovery of sentry milk-vetch. Time and cost for recovery may increase if data indicate decreasing trends at subsites, prompting the need for additional recovery actions to identify and mitigate threats.

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