

**ARIZONA GAME AND FISH DEPARTMENT
HERITAGE DATA MANAGEMENT SYSTEM**

Plant Abstract

Element Code: PDROS1E080

Data Sensitivity: No

CLASSIFICATION, NOMENCLATURE, DESCRIPTION, RANGE

NAME: *Purshia subintegra*
COMMON NAME: Arizona Cliffrose, Burro Creek Cliffrose
SYNONYMS: *Cowania subintegra* Kearney
FAMILY: Rosaceae

AUTHOR, PLACE OF PUBLICATION: Henrickson, J. 1986. *Phytologia* 60(6):468.
(Synonym *Cowania subintegra*: Kearney, 1943. *Madroño* 7:15).

TYPE LOCALITY: Two miles west of Burro Creek, K crossing on road from Wikieup to Hillside, southeastern Mohave County, near Yavapai County line, Arizona.

TYPE SPECIMEN: Darrow and Cooks 3, and Darrow and Benson 10890. 18 April 1941.

TAXONOMIC UNIQUENESS: *Purshia subintegra* is closely related to *P. ericaefolia* Torr. of the Trans-Pecos region of Texas. Both species occupy similar habitat and have similar characteristics. Characteristics of *P. subintegra* are: glandularity, tomentosity, grey bark, bushiness and color of young twigs. In the Verde Valley, the range of *P. subintegra* overlaps with the more common cliffrose, *Purshia stansburiana* (Torr.) Henrickson, and introgression or hybridization occurs (Baggs and Maschinski, date unknown, accessed 2001).

The 5-Year Review (USFWS 2013) provides a summary of the most recent thoughts of taxonomic classification, as follows:

Purshia subintegra genetic variability, phenotypic plasticity, and past and recent hybridization with *P. stansburiana* have complicated taxonomic identification. Phenotypic and genetic variability among populations has been studied using morphometrics and molecular (DNA) analysis. Schaack (1987) described the San Carlos Basin (i.e., Bylas) population of *P. subintegra* as *P. pinkavae*, and designated *P. subintegra* to be of hybrid origin involving a cross between *P. stansburiana* and *P. pinkavae*. Kartesz (1994) treats *P. subintegra* as a hybrid. Reichenbacher (1994) states that although there is some character variation between the four populations of *P. subintegra*, multivariate analysis clearly indicates they exhibit a coherent syndrome of characters, and the taxonomy developed by Schaack is not supported by the analysis. The Recovery Plan concludes that *P. subintegra* is distinct from the more common *P. stansburiana*, despite sometimes overlapping plant characteristics (USFWS 1995). Travis et al. (2008) re-examined the genetic variation within *P. subintegra* and state that molecular evidence indicates a distinct classification for the Bylas population in support

of the hypothesis that this population represents a separate species per Schaack (1987). However, the authors conclude that a broader taxonomic analysis of the genus is necessary to confirm such a distinction. Henrickson's unpublished description of *P. subintegra* notes considerable variation in key characteristics within the species. Characteristics used for identification, such as occasionally lobed (or toothed) leaves, exhibit a continuum of variability between and within individuals, change seasonally (e.g., as leaves are shed during drier periods sometimes leaving only unlobed leaves), and sort out independently from other key characteristics. The demarcation between Schaack's *pinkavae* and *P. subintegra* is not discrete (Henrickson, pers. comm., 2013). Pending further studies, the USFWS continues to recognize that the four described populations of *P. subintegra* comprise one distinct species.

Regarding nomenclature, Travis et al. (2008) present strong evidence for a hybrid origin of *P. subintegra*. Based on their molecular data and hypothesized pre-historic biogeography of the region (Anderson 1993), hybridization occurred during the late Pleistocene (11,000 to 13,000 years before the present). There has been a growing consensus for this explanation and increased use of the following nomenclature indicating a hybrid origin: *Purshia* ×*subintegra* (Kartesz 2013; Integrated Taxonomic Information System, 2013). However, such a designation for a species believed to be of hybrid origin is discretionary (International Code of Botanical Nomenclature (Article H:3.3) 2012).

DESCRIPTION: Low, straggling woody shrub, 1 - 2 m (3 - 6 ft.) in height, usually less than 1.0 m (3.3 ft) high. In the Cottonwood population, plants can reach a maximum of 2.4 m (8 ft.) and 3.7 m (12 ft.) in diameter (USFWS, Recovery Plan 1995). Base of stem 3.0 - 5.0 cm (1.2 - 2.0 in.) diameter; stems are more or less persistently woolly; bark ashy gray on older branches (becomes shreddy), while new shoots tend to be red-brown and pubescent with a red dot below fascicle. Leaves narrow, short, and entire, but occasionally has 1 or 2 rounded, shallow lobes below the leaf tip; not gland-dotted or sticky, margins revolute. The upper leaf surface is usually loosely arachnoid-pubescent, but may be hairless. The lower leaf surface is densely white-lanate. Flower about 10.0 mm (0.4 in.) diameter, with 5 white or pale yellow petals, born on a single peduncle. Pistils are 3 - 7. Fruit an achene with long 2.0 cm (0.8 in.) plumose persistent styles (tails). Young twigs and leaves are tomentose.

AIDS TO IDENTIFICATION: The only other *Purshia* likely to occur in the areas where *P. subintegra* may be found is *Purshia stansburiana*. The latter species is a tall, erect shrub up to 7.6 m (25 ft.) in height, and has leaves that are usually 3 - 5 lobed (deeply lobed). Leaves (hairless) and young twigs are glandular (sticky), and young twigs are red, not tomentose. *Purshia subintegra* is more graceful, more open and shorter.

ILLUSTRATIONS:

Drawings of leaf (Benson and Darrow, 1981: p.273).

Photos: <http://www.naturesongs.com/vvplants/azcliffrose.html>.

TOTAL RANGE: Endemic to Arizona.

RANGE WITHIN ARIZONA: Central Arizona, below the Mogollon Rim: Near Horseshoe Lake, Maricopa County; near Cottonwood, Yavapai County; near Burro Creek, Mohave County; and near Bylas, Graham County.

SPECIES BIOLOGY AND POPULATION TRENDS

GROWTH FORM: Woody perennial shrub.

PHENOLOGY: Flowers from late March through early May. Fruit dispersal occurs during the summer, when the summer rains dislodge seeds from the plants (USFWS, Recovery Plan 1995). Timing of seed germination and seedling establishment is unknown.

Arizona Cliffrose plants appear to be long-lived and capable of a large reproductive output, however, it is not yet known what recruitment rates are necessary to maintain population viability. Recruitment rates appear to vary among populations. According to Denham and Forbes (1992) in USFWS, Recovery Plan (1995), areas within the Cottonwood population have been discovered to support a relatively large number of established seedlings. The other three Arizona Cliffrose populations do not appear to have sufficient recruitment.

BIOLOGY: Plants vary considerably in size, though this is not an adequate criterion for determining different age classes. Per Fitts et al (1993), “flowers may be pollinated on any of the first three days following anthesis (flower opening), ...and are mainly pollinated by bees.” Native wild bees and introduced honeybees (*Apis mellifera*) are the most important pollinators, the latter becoming the predominant pollinator later in the flowering season (Fitts et al. 1993). They are primarily cross-pollinated, but are partially self-compatible. Self-pollinated flowers produce significantly fewer seeds. Propagation by stem cuttings has been tried, but with varying results.

Purshia subintegra populations are genetically variable, exhibit phenotypic plasticity in response to environmental conditions, and hybridize with *P. stansburiana*. Gene exchange through backcrossing hybrids (introgression) of *P. subintegra* and the more common *P. stansburiana* has resulted in hybrid swarms in the Cottonwood and Horseshoe Lake populations (USFWS 1995). A hybrid swarm is a “hybrid population,” maintained by backcrossing and/or crossing with other hybrids, which may be stable or spread. The proliferation of hybrids has the potential to negatively affect long-term population dynamics of *P. subintegra* through interference competition and loss of genetic integrity (Fitts et al. 1993; Baggs and Maschinski 2001b). At the same time, hybridization may act as a mechanism to increase genetic diversity in a population, enhancing adaptation and survival, therefore potentially benefiting conservation of *P. subintegra* (Baggs and Maschinski, 2001b). Hybrid swarms illustrate the migratory and dynamic nature of evolving plant populations, and may

provide the key to the future of the genus and species. For this reason, conservation of these hybrid swarms is important (USFWS 1995). A recent study by Travis et al. (2008) confirmed the presence of a hybrid swarm in the Verde Valley and emphasized its conservation significance. Because introgressed forms appear to possess potential fitness advantages under hotter, drier conditions, they may provide a viable refuge for *P. subintegra* genome in the face of climate change (Travis et al. 2008). The paper also identified three distinct genetic lineages of *P. subintegra*: the Cottonwood (Verde Valley) population, which is currently undergoing introgression; the Burro Creek and Horseshoe Lake populations, which exhibit an ancient natural hybrid origin; and the Bylas population, which is genetically distinct from the others. These findings underscore the complex genetics of this species and the importance of conserving all four populations.

Overall, there is a significant lack of basic biological information on pollination, seed germination and establishment, growth rates, and other life history characteristics, which could enhance understanding of *P. subintegra*.

HABITAT: Rolling, rocky, limestone hills and slopes within Sonoran Desertscrub. The species occurs where the winters are mild, summers are hot, and the 22.9 - 86 cm (9 - 34 in.) of rainfall is evenly distributed between summer and winter rainfall periods. The landscape is dissected by ephemeral drainages and is sparsely vegetated.

ELEVATION: 2,050 to 3,500 feet (625 - 1067 m) based on HDMS records.

EXPOSURE: All exposures; 0 - 40% slope.

SUBSTRATE: The species requires white Tertiary (Miocene and Pliocene) limestone lacustrine (lakebed) deposits high in lithium, nitrates, and magnesium. The distinctive white color of these soils is visible from a distance. These soils are relatively infertile and have significantly lower amounts of phosphorus and organic matter compared with surrounding areas where *P. subintegra* is absent (Anderson 1986, 1993). The geographic and local distribution of *P. subintegra* appears to be limited by competition from other plant species rather than a requirement for a specific soil type. These surrounding areas are typically dominated by creosotebush (*Larrea tridentata*), which is thought to have a competitive advantage over *P. subintegra* due to its aggressive seedling establishment (Anderson 1993). Creosotebush is unable to grow on the relatively infertile lacustrine soils.

PLANT COMMUNITY: A unique plant community occurs on these limestone soils. *Purshia subintegra* tends to be the dominant or co-dominant shrub. All four known sites can be considered part of the *Larrea tridentata* - *Canotia holocantha* (Creosotebush - Crucifixion thorn) Association of the Arizona Upland Subdivision of the Sonoran Desertscrub (Brown 1982 in USFWS, Recovery Plan 1995). Other dominant woody species at more than one site include: *Aloysia wrightii* (Wright lippia), *Baileya multiradiata* (desert marigold), *Berberis haematocarpa* (red barberry), *Caenothus greggii*, *Dalea formosa* (feather plume), *Dyssodia acerosa* (dogweed), *Eriogonum fasciculatum* (flat-topped wild buckwheat), *Eriogonum*

inflatum (desert trumpet), *Fouquieria splendens* (ocotillo), *Glossopetalon spinescens*, *Gutierrezia sarothrae* (snakeweed), *Krameria parvifolia* (little-leaved rattany), *Melampodium leucanthum* (Plains blackfoot daisy), *Oryzopsis hymenoides* (Indian ricegrass), *Parthenium incanum*, *Simmondsia chinensis* (jojoba), *Tiquilia canescens* (shrubby coldenia), and *Ziziphus obtusifolia* (gray-thorn).

POPULATION TRENDS: Four disjunct populations of Arizona Cliffrose exist along a 322 km (200 mi) wide area of central Arizona. The Cottonwood population includes the greatest number of individual plants, including seedlings.

The following summary of the population numbers and trends for *P. subintegra* is taken from the 5-Year Review (USFWS 2013):

The total number of plants in the four *P. subintegra* populations is not known, but has been estimated. Not all areas of potential habitat have been surveyed, and in some areas, such as Cottonwood, the presence of hybrids between *P. subintegra* and *P. stansburiana*, or introgressed forms, has complicated population estimates (USFWS 2001). Despite the potential conservation significance of hybrids, the USFWS considers these plants to be outside the definition of the species (USFWS 1995) and are not included in population estimates. In 1988, a total number for all four populations (i.e., recovery units) was estimated to exceed 40,000 plants, although a large percentage may have included hybrids (USFWS 1988). About 10,000 plants are thought to currently occur in the predominant subpopulation at Burro Creek (USFWS 2004). At the time of listing, the USFWS estimated 243 ha (600 ac) of habitat at Burro Creek, and 40 ha (100 ac) at Bylas with an estimated 700 plants (USDI 1984). The Horseshoe Lake population is estimated to include 750 plants (USFWS 1987) over an unspecified area. The Cottonwood population covers the largest area, estimated at over 405 ha (1,000 ac) (USFWS 1995), with the amount of occupied habitat recently calculated to be 78 ha (194 ac) (Goodwin 2012). Total Cottonwood population numbers were previously not known, but were conservatively estimated to include tens of thousands of plants (USFWS 2007). The most recent, intensive survey places this number considerably lower, at a total of 8,272 *P. subintegra* plants within the Cottonwood population (Goodwin 2012). Acceptance of this figure would result in a downward adjustment of the estimated total numbers of known plants in the four populations by one-half, or to about 20,000. This adjustment may be the result of a more intensive survey as opposed to a large scale decline in numbers. We have no demographic trend information from monitoring the four populations, but population viability modeling suggests that *P. subintegra* will slowly decline in the Cottonwood population under more arid scenarios (Maschinski et al. 2006).

There is a lack of long-term demographic data to assess trends such as to whether recruitment is sufficient to maintain or increase the population size of this long-lived species.

SPECIES PROTECTION AND CONSERVATION

ENDANGERED SPECIES ACT STATUS: LE (USDI, FWS 1984), without Critical Habitat
STATE STATUS: Highly Safeguarded (ARS, ANPL 1993)
OTHER STATUS: None.

MANAGEMENT FACTORS: Few populations, habitat-specificity, and various threats make this species vulnerable. Threats include: browsing by livestock and burros, poor reproduction, mineral exploration and development, construction and maintenance of roads and utility corridors, recreation, off-road vehicle (ORV) use, urbanization, pesticides, and inundation (USFWS, Recovery Plan 1995). The relative importance of each of these threats varies from population to population.

As reported in the 5-Year Review (USFWS 2013), Maschinski et al. (2004) examined factors limiting both *P. subintegra* distribution and potential for expansion. They found that surface soil moisture significantly explained between 62 and 71 percent of variation in recruitment, with the driest sites having the fewest seedlings and juveniles. This susceptibility to lower soil moisture may already be exhibited in the low levels of seedling recruitment observed in the Burro Creek, Bylas, and Horseshoe Lake populations. Despite the cliffrose's apparent preference for dry soils, population viability modeling under more arid scenarios suggests that this species is slowly declining in the Cottonwood population and will be at greater risk of extinction with increased aridity (Maschinski et al. 2006). They also found that drier sites had the largest, most fecund adult plants. This was explained by the underlying soil structure that retains moisture at depth. This difference in suitable soil conditions for reproductive adults compared with seedlings and juveniles, suggests that suitable habitat for *P. subintegra* may be more limited than previously thought. This is supported by a recent survey of *P. subintegra* that found it to occur in a relatively small portion of what was previously thought to be suitable habitat.

The 5-Year Review (USFWS 2013) also presented a Five-Factor Analysis that considered the current status of the threats to the species noted at the time of listing:

Habitat Loss from Development. Threats to the Cottonwood population continue and are considered to be moderate to high. Urbanization and related effects derive from an increasing human population that demands continued development and ancillary factors such as increased recreational demand, including unauthorized use on private, State land and USFS holdings. Continued urbanization in the Cottonwood area may also result in the further proliferation of weedy plant species, which may impact *P. subintegra* directly through competition for resources or indirectly through the promotion of wildfires. Road and community development work has both directly and indirectly impacted the Cottonwood population, even though a number of conservation measures were incorporated into the projects. No projects were identified that would impact any of the other three populations.

Overutilization for commercial, recreational, scientific or educational purposes. No known threats.

Disease Threats. Knowledge of diseases affecting *P. subintegra* is not developed at this time.

Predation (herbivory) Threats. Overall, negative impacts from grazing appear to be low for the known populations. The information available is summarized below:

The main Burro Creek population has been fenced and all populations have been monitored by the BLM since 1989. Percent utilization, as measured during the six years prior to 2012, has been 3-9.4% within the ACEC (Area of Critical Environmental Concern), and 2.5-8% for the two outlier populations. Evidence at all sites suggests that the herbivory is from wildlife. It is also well below the 20% utilization that would trigger consideration for a formal consultation.

The Verde Valley Botanical Area populations occur within three different pastures of the Windmill Allotment. Based on consultations with Coconino National Forest in 1992 and 1997, grazing has been excluded from two of these pastures, and surveys from 2001 to 2006 state that there was light to no use of *P. subintegra* within the third pasture that is still grazed under a deferred rest rotation system.

The Horseshoe Lake populations are found within three grazing allotments on the Tonto National Forest. As of 2012, two of these allotments were vacant, with one scheduled for evaluation in 2013. The one scheduled for the NEPA evaluation contains most of the population. Pastures in the third allotment have been removed from grazing as reported by the USFS in 2008. Overall, the grazing threat for three *P. subintegra* populations appears to be low.

The Bylas site extends over a few sections of land. Nothing is known about livestock grazing management within Arizona Cliffrose habitat on the San Carlos Indian Reservation (USFWS, Recovery Plan 1995). However, Bingham (1977) noted a contrast of reproduction for *P. subintegra* near Bylas between the ungrazed highway right-of-way and the remaining area which was grazed. Juvenile plants occurred along the right-of-way, while on the grazed area no young plants were found in an hour of searching.

Adequacy of Existing Regulatory Mechanisms. *P. subintegra* currently receives varying levels of protection from Federal, State and international regulations. There has been no update on the adequacy of these mechanisms since the Recovery Plan was published. The species could benefit from development or completion of management plans for the Cottonwood population (including the VVBA), the Horseshoe Lake population, and the Bylas population. The plans for each of these populations would be developed by the respective land managing agency (CNF, TNF, and the San Carlos Apache Tribe) with the offered assistance of the USFWS. These management plans could provide a standardized

monitoring protocol and address newly understood or emerging threats such as climate change and invasive weeds.

Other Natural or Manmade Factors affecting the continued existence of the species.

CLIMATE CHANGE. Long-term increased aridity and decreased precipitation, as projected by climate change models, represents a previously unidentified threat to *P. subintegra*. Maschinski et al. (2006) modeled population viability and extinction risk for *P. subintegra* and found that although moist sites have the highest densities and highest seedling recruitment rates presently, these sites conversely had the highest risk of extinction over the shortest time span under scenarios of increased aridity. Seedling recruitment and survival are particularly sensitive to soil moisture. This susceptibility to lower soil moisture may be already being felt in the low levels of seedling recruitment observed in the Burro Creek, Bylas, and Horseshoe Lake populations. The 5-Year Review (USFWS 2013) concludes that climate change presents a potentially moderate to high degree of threat to *P. subintegra* across its range. Because *P. subintegra* is restricted to a very narrow, disjunct habitat, any relatively rapid geographic shift in the suitability of conditions needed to maintain viable populations may outpace the species' response mechanism (e.g., migration, adaptation) and may defy managers' ability to develop and implement mitigation measures.

Climate change may also confer a competitive advantage to invasive species, facilitating the spread of stronger competitors and possibly exacerbating this threat to *P. subintegra*.

INVASIVE PLANTS. An emerging issue is the threat of invasive weeds that may compete with *P. subintegra* for resources and/or increase the threat of wildfire. The nutrient deficient soils upon which *P. subintegra* grows do not support many other plant species. Anderson (1993) concludes *P. subintegra* occurs on these soils to escape competition from creosote bush (*Larrea tridentata*) and other common Upper Sonoran Desertscrub plants, which are excluded from the sites by low soil fertility. However, at least two invasive weeds have been observed or are thought to grow in these soils: red brome (*Bromus rubens*) and Malta starthistle (*Centaurea melitensis*), Fenner 2005. Both of these species are implicated in the spread of wildfire. The CNF and the TNF have identified in their weed management plans, respectively, red brome and Malta starthistle as potential threats to *P. subintegra*, and have developed measures to stop the spread of these invasive species in *P. subintegra* habitat (USFS, 2004; USFS, 2012). All land managers should monitor the spread of invasive species into *P. subintegra* habitat.

CONSERVATION MEASURES TAKEN: The main Burro Creek population was completely enclosed with a barbed wire fence to exclude burros and cattle in spring, 1989. The BLM also designated one square mile of the Burro Creek population as an Area of Critical Environmental Concern (ACEC). The two smaller subpopulations are lightly grazed, and have been under a monitoring system since 1992. Monitoring transects were established in the Cottonwood population in 1987, along with a highly managed livestock grazing plan that includes a deferred rest rotation system. One of the subpopulations within the Horseshoe

Lake Populations, is on a 5-pasture rest-rotation system, grazed every other year. The Verde Valley Botanical Area was established in 1987.

Various methods have been employed to help resolve the taxonomic questions regarding hybridization of *P. subintegra*. The combined results of starch gel electrophoresis, and morphometric and genetic (DNA) studies are available in the 1995 Recovery Plan.

The Recovery Plan (USFWS 1995) presents the criteria for downlisting and recovery. This includes the maintenance of four viable populations, protection of sufficient quantity and quality of habitat needed to support viable populations, regulatory mechanisms or written land management commitments that provide for long-term protection.

The ability to cultivate *P. subintegra* is important to the conservation of this species because such techniques can augment or establish populations, and preserve the genetic representation of plants that must be removed for human development actions. The Arboretum at Flagstaff has been conducting long-term research to identify the best practices. The objectives of their research include: 1) determining cultivation requirements for seeds, cuttings, and transplanted individuals; 2) determining the ecological requirements of seedling establishment and survival; 3) determining what endemic soil conditions restrict the expansion of the species in to new habitats; and 4) determining the extent to which the morphological characteristics of the species and its hybrids with *P. stansburiana* persist across nutrient and soil gradients (Baggs and Maschinski 2001a). Results from some of this work in the Verde Valley Botanical Area and Dead Horse Ranch State Park demonstrated a nearly 50% survival rate from mostly cuttings (USFWS 2007).

The 5-Year Review (USFWS 2013) changed the Recovery Priority Number (RPN) from 2 to 8. A RPN of 2 means the degree of threat is high, the recovery potential is high, and the taxon is a species. A RPN of 8 means the degree of threat is moderate, the recovery potential remains high, and the taxon is a species. The rationale for this change is provided below, and taken directly from the 5-Year Review:

Based on this review and our 2008 draft RPN guidance, we find the degree of threats to and the recovery potential of *P. subintegra* to be consistent with a RPN of 8. This may be partly due to a slightly different interpretation of RPNs at the time of the 1995 Recovery Plan, but also reflects progress made in addressing some impending threats since the time the RPN was originally established as a 2. When the RPN was originally designated: 1) threats were fairly well understood, and ongoing significant habitat loss and degradation required intervention to address threats associated with mining, urban development, and grazing to prevent rapid population decline, thus meriting a high degree of threat; and 2) recovery potential was high because limiting factors were understood well enough to implement protection through mechanisms such as management plans and land withdrawals, which had a high probability of affording the necessary protection to address threats.

At this time, although conservation measures have been implemented that have protected *P. subintegra* habitat and reduced more imminent threats from the time the RPN was designated, new potential threats to the existence of *P. subintegra* have been identified [climate change and invasive plants], maintaining a moderate level of threat for this species. A number of high priority recovery measures, which would result in significant conservation benefits, specifically developing or finalizing management plans and survey protocols, are achievable in the foreseeable future.

SUGGESTED PROJECTS: The following recommendations are taken from the 5-Year Review (USFWS 2013). The USFWS offers to assist in each of these recommendations:

- 1) We recommend the development or completion of management plans for the Cottonwood population (including the VVBA), the Horseshoe Lake population, and the Bylas population. The plans for each of these populations would be developed by the respective land managing agency (CNF, TNF, and the San Carlos Apache Tribe) with the offered assistance of the USFWS. These management plans should address newly understood or emerging threats such as climate change and invasive weeds.
- 2) We recommend the appropriate agencies analyze the monitoring data they have collected to date to determine demographic trends in their respective *P. subintegra* populations. This will allow the USFWS to determine whether a given population is viable or on a trend toward viability, in support of downlisting criteria one.
- 3) We recommend the modification or addition of standardized long-term demography monitoring techniques to existing monitoring schemes, or the establishment of standardized long-term monitoring protocols within all four populations.
- 4) We recommend continued research on pollination, seed germination and seedling establishment, propagation, comparison of recruitment rates among populations, life history characteristics, and growth rates to better understand the threats of and potential measures to address climate change.
- 5) We recommend that the terms “viability” and “significant upward trend towards viability,” as used in the first downlisting criterion, be defined or described for *P. subintegra* for the purpose of developing an objective and measurable criterion. The USFWS will lead this effort in coordination with land managing agencies and subject matter experts.

Other recommendations include further studies to resolve the taxonomic issues; additional state-wide surveys should be conducted to refine the range of the species; enlarge the Verde Valley Botanical Area to include potential habitat; and designate a Botanical Area or equivalent management area for the Horseshoe Lake population.

In June 2019, the USFWS published a proposed Draft Amendment 1 to the 1995 Recovery Plan in the Federal Register. This initiated a period for public comments that closes in July, with the final Amendment to be published at a future date. This draft Amendment incorporates updated downlisting criteria and establishes delisting criteria that were not included in the original recovery plan due to the overall state of knowledge of the species at

that time (1995). These criteria, when incorporated into the final Amendment 1, will supersede those in the 1995 Recovery Plan. As proposed:

Downlisting Recovery Criteria:

1. A single, long-term monitoring plan for all Arizona cliffrose populations and habitat is developed and implemented.
2. Land managers conserve existing habitat, in each recovery unit, in perpetuity to prevent further habitat loss and/or degradation. The following are measures, as identified in the Recovery Plan, needed for habitat conservation:
 - Livestock grazing within the four recovery units meets standards set in recovery task 3b of the Recovery Plan, protecting Arizona cliffrose from adverse effects of livestock grazing.
 - Recovery task 3a (manage mineral exploration and development) is met for all four recovery units as described in the Recovery Plan.
 - Written commitments in place to retain all Federal lands containing Arizona cliffrose.
 - Private and state lands containing Arizona cliffrose are protected from further habitat loss or degradation.
 - Off-road vehicle traffic is prohibited in Arizona cliffrose habitat.
3. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 10 years.

Delisting Recovery Criteria:

1. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 20 years. This would involve the conservation of habitat in all four populations and the indication that the populations are viable, or are on a significant upward trend toward viability, demonstrated through monitoring.

LAND MANAGEMENT/OWNERSHIP: BIA - San Carlos Reservation; BLM - Kingman Field Office; USFS - Coconino, Prescott and Tonto National Forests; State Land Department; Private. Possibly Bureau of Reclamation; Arizona State Parks (Dead Horse Ranch State Park).

SOURCES OF FURTHER INFORMATION

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ADDITIONAL INFORMATION:

FWS decided all individuals showing *P. subintegra* characteristics would be protected pending decisions on taxonomy.

Electrophoretic work by Phillips and Phillips (1987) found no differences between *P. subintegra* and *P. stansburiana*.

Morphometric analysis by Reichenbacher (1989) found insignificant differences between populations of *P. subintegra* but found significant differences between *P. subintegra* and *P. stansburiana*. Discriminant analysis and principle components analysis clearly separated *P. subintegra* from *P. stansburiana* populations, indicating morphologic distinctness of the two species.

Further morphometric analysis (Reichenbacher 1994) segregated out two hybrid groups, *Purshia* "Tonto," and *Purshia* "Verde." The "Tonto" group is generally found in Gila County on lakebed deposits around Roosevelt Lake in the Tonto Creek Basin. The Camp Verde collection site (about 4 miles southeast of Camp Verde) is included in the "Tonto" group. Introgressants in the vicinity of Cottonwood and all other Verde Valley hybrids (except the Camp Verde site) are included in the "Verde" group.

Bob Denham, a volunteer from Cottonwood, compiled a detailed map of the distribution of *P. subintegra* in the Verde Valley, 1991-1992.

Intermediate types of *P. subintegra* occur along Highway AZ 77 between Globe and Winkelman.

In a common garden study conducted by Baggs and Maschinski (date unknown, accessed 2001), the morphological and growth differences of *P. subintegra*, *P. stansburiana*, and the introgressed form across a soil gradient were examined. The soil gradient consisted of soil from 3 habitats: undisturbed limestone outcrops where *P. subintegra* grows, disturbed

limestone roadsides where the introgressed forms grow, and a wash where *P. stansburiana* grows. Each species grew best in the soil from its habitat.

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