Arizona Cliffrose
(Purshia subintegra)

5-Year Review:
Summary and Evaluation

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U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
Phoenix, Arizona

August 2013

5-YEAR REVIEW
Arizona cliffrose / *Purshia subintegra*

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (USFWS) is required by section 4(c)(2) of the Endangered Species Act (ESA) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, or reclassified between endangered and threatened. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the ESA. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review:

The USFWS conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the ESA (16 U.S.C. 132 *et seq.*). We provided notice of this status review in the Federal Register (72 FR 20134) requesting information on the status of 24 species including the Arizona cliffrose (*Purshia subintegra*). No comments from the public were received. This 5-year review was completed by the USFWS lead biologist for this species, using the Recovery Plan (USFWS 1995) as the basis for the analysis, with updates from interviews of personnel at the land management agencies with responsibility for the species, ESA section 7 consultations, and literature published since the Recovery Plan was approved. On May 19, 2009, the USFWS requested information from the San Carlos Apache Tribe about the Bylas population of Arizona cliffrose located on the San Carlos Reservation. The preceding year we visited the Bylas population on a field trip conducted by the Tribe's botanist, Seth Pilsk. On August 7, 2013, we provided a draft of this 5-year review to Mr. Pilsk for technical review; no comments were received.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review: 72 FR 20134

1.4.2 Listing history

Original Listing
FR notice: 49 FR 22326
Date listed: May 29, 1984
Entity listed: *Purshia* (= *Cowania*) *subintegra* (50 CFR § 17.12; 10-1-89 Edition) (Henrickson 1986)
Classification: Endangered without critical habitat

1.4.3 Associated rulemakings: Not applicable

1.4.4 Review History: A 5-year review for all species listed before 1991 was initiated on November 6, 1991 (56 FR 56882), but no documentation was prepared for this species. This is the first 5-year review for this species.

1.4.5 Species' Recovery Priority Number at start of 5-year review: 2; meaning the listed entity's taxonomic status is a species, and its degree of both threat and recovery is high.

1.4.6 Recovery Plan or Outline

Name of plan or outline: Arizona Cliffrose (*Purshia subintegra*) Recovery Plan (Recovery Plan)
Date issued: 6/16/1995
Dates of previous revisions, if applicable: None

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

The DPS policy does not apply to *P. subintegra* because it is a plant.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes. The species has a final, approved recovery plan that contains several objective, measurable criteria. However, the first downlisting criterion does not define viability for the species, or what is meant by a significant upward trend toward viability. This criterion should be developed further.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

No. Information published since the Recovery Plan was approved provides a greater understanding of the species' habitat requirements, specifically with respect to soil moisture conditions that are relevant to the threat of aridity associated with droughts and long-term climate change.

2.2.2.2 Are all the 5 listing factors relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

No. New information indicates that the species is at greater risk of extinction due to increased aridity and decreased precipitation from climate change projected for the southwestern United States (U.S.). This is particularly relevant for first and fifth listing factors (habitat modification or range curtailment; and other natural or anthropogenic factors) and has implications for all of the recovery criteria. Agencies' ability to manage *P. subintegra* over the long-term will be challenged as changing climatic conditions result in relatively rapid landscape-scale changes to habitat quality and continuity, ultimately influencing population viability.

2.2.3 Progress in Meeting Recovery Criteria

The four recovery criteria for *Purshia subintegra* are comprised of three downlisting criteria and a fourth criterion for delisting.

Downlisting Criteria:
Criterion 1. Scientific data indicate each of the four recovery unit populations is viable or on a significant upward trend toward viability that is sustained for at least 15 years.

Criterion 2. Protect unfragmented and high-quality habitat sufficient to ensure long-term survival and recovery within each recovery unit. Prevent further habitat loss and/or degradation by securing commitments from land managers to: protect *P. subintegra* from adverse effects of livestock grazing; prevent habitat loss and degradation due to mineral exploration and development; retain all Federal lands containing *P. subintegra*; protect private and state lands containing *P. subintegra*; and prohibit off-road vehicle traffic within all recovery units along with enacting designations to effectively remove traffic within occupied or recoverable *P. subintegra* habitat.

Criterion 3. Implement regulatory mechanisms or written land management commitments to provide adequate long-term protection of the species and its habitat sufficient to ensure long-term recovery and survival of the population in each recovery

unit. Achieving this criterion will depend on the implementation of management plans for each of the four recovery units.

Delisting Criterion:
Criterion 4. The USFWS determines that *P. subintegra* is no longer an endangered species, as defined by the ESA. This criterion will be initiated after the first three downlisting criteria are met, and will depend mainly on research, studies and other actions for monitoring the species' status and guiding recovery efforts.

A summary of progress that has been made toward meeting the first three recovery criteria is as follows:

Criterion 1. Scientific information indicates that each of the four recovery unit populations is viable or is on a significant upward trend toward viability that is sustained for at least 15 years. This criterion has not been met.

No systematic, long-term demographic monitoring of *P. subintegra* in any of the recovery units has been completed to date; limited monitoring has been conducted. The four recovery units identified in the Recovery Plan are analogous to the four known populations of the species, each of which is necessary for the survival and recovery of the species (USFWS 1995). They are as follows:

- Burro Creek population in the western foothills of the Aquarius Mountains (Mohave County);
- Cottonwood population in the Verde Valley (Yavapai County);
- Horseshoe Lake population in the Tonto Basin (Maricopa County); and
- Bylas population on the San Carlos Apache Tribe's San Carlos Reservation (Graham County) (Figure 1).

Burro Creek Population
The Bureau of Land Management (BLM), Kingman Field Office (KFO), has been monitoring the effects of livestock browsing on *P. subintegra* in plots in the Burro Creek population since 1987. Cages were constructed around 25 plants to prevent browsing by livestock, wild burros, and mule deer. Twenty-five plants were left uncaged as a control. The BLM continued monitoring *P. subintegra* utilization after a fence was constructed in 1989 to exclude cattle and burros from a one square mile area, which included the caged and uncaged plants. Monitoring results indicated that livestock and burros were responsible for most of the browsing activity on *P. subintegra* (BLM 1993). Although various parameters of population dynamics (e.g., age class) were recorded, this information has not been analyzed for long-term trends.

Cottonwood Population
In 1996, the Arboretum at Flagstaff established 24 monitoring plots in the Cottonwood population of *P. subintegra* for the purpose of determining long-term viability of the species. Specific objectives include assessing population trends, determining the most vulnerable life history stage, and predicting risk of extinction. Several variables, such as height, canopy width, and age, were used to classify the life history stage of several

hundred individuals, each of which were then tracked from year to year. As of 2001, the Arboretum had collected five years of data and began developing a model of the population. Preliminary results suggest that most of the change in the population is seedling mortality, indicating that seedling survival is a vulnerable stage in the life history of *P. subintegra*. Future modeling is planned to determine if recruitment is high enough to maintain the Cottonwood population of *P. subintegra* (Baggs and Maschinski 2001a). A summary of monitoring for the past decade will be included in a management plan for the Verde Valley Botanical Area (VVBA) currently schedule for completion in late 2013 (Murray, pers. comm., 2013).

In 1987, the Coconino National Forest (CNF) established a series of six 100-foot linear transects in the Cottonwood population, in or adjacent to the VVBA, to monitor vegetation trends for *P. subintegra* and associated species. Data were collected in 1987, 1993, and 2008 and appear to indicate a decline in canopy cover of *P. subintegra*. However, these data have yet to be statistically analyzed for long-term trends.

Horseshoe Lake Population
In the early 1990s, the Tonto National Forest (TNF), in association with Bob Smith, Mesa Community College, established monitoring plots in the Lime Creek area of the Horseshoe Lake population for the purposes of evaluating the effects of wildlife and livestock browsing on *P. subintegra*. A final report is not on file with the TNF, and the plots have not continued to be read (Wong, pers. comm., 2009).

Criterion 2. Protect unfragmented and high-quality habitat sufficient to ensure long-term survival and recovery within each recovery unit. This criterion has been partially met.

Burro Creek Population
For the Burro Creek population or recovery unit, about 98 percent of known *P. subintegra* are contained within the 451-hectare (ha) (1,114-acre [ac]) Clay Hills Research Natural Area of Critical Environmental Concern (ACEC). The ACEC does not include 2 small subpopulations located about 2 and 4.3 kilometers (km) (1.2 and 2.7 miles [mi]) to the northeast, comprised of about 25 and 100 plants, respectively. The goal of the ACEC is to maintain a viable population of *P. subintegra* (BLM 1993). In 1998, the BLM withdrew the ACEC (actual area 453 ha [1,119.25 ac]) from surface entry and mining for 50 years to protect *P. subintegra* and its habitat (BLM 1998). Livestock grazing is excluded from the ACEC. Off-road vehicle use is prohibited, and unauthorized "vehicle ways" within the ACEC have been closed and rehabilitated (Peck 2009a).

Cottonwood Population
Within the Cottonwood recovery unit, the 461-ha (1140-ac) VVBA was established by the CNF in 1987 to protect *P. subintegra* and unique associated plant communities. The VVBA includes an estimated 50-60 percent of the Cottonwood *P. subintegra* population. Protection is afforded through a prohibition on off-road driving and limitations on recreational use. Grazing has been excluded from a portion of the VVBA since 1992.

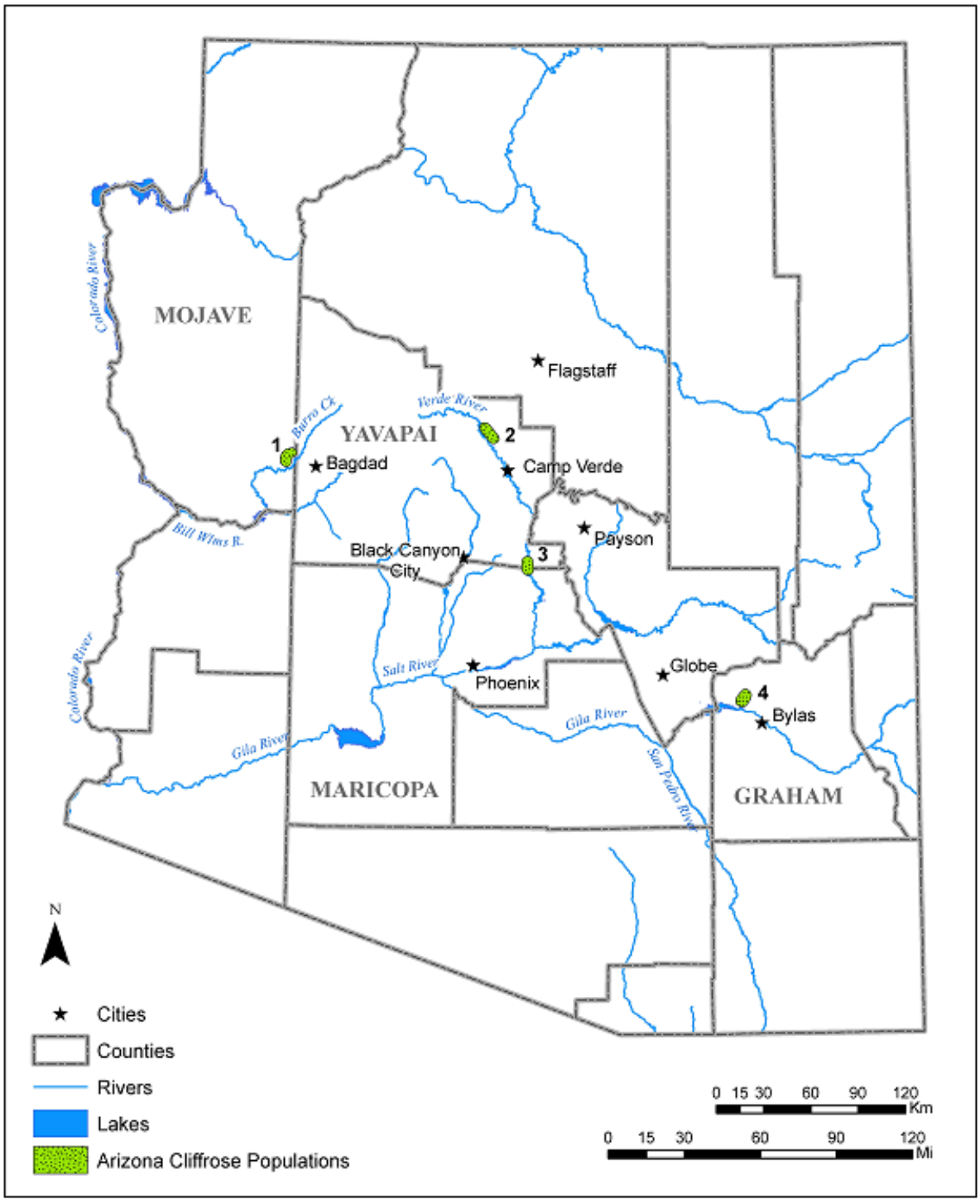

Figure 1. Map of Arizona cliffrose populations in the State of Arizona: 1 = Burro Creek; 2 = Cottonwood; 3 = Horseshoe Lake; 4 = Bylas

As part of the Mingus Avenue Extension section 7 consultation, Yavapai County acquired 144 ha (357 ac) of Arizona State Land Department (ASLD) lands to be transferred into Federal ownership via an exchange with the CNF, then included in the

VVBA for *P. subintegra* management (see section 2.3.2.1 below). This area, located in section 36, Township 16 North, Range 3 East, is within the City of Cottonwood corporate boundary and is identified as the "Cliff Rose Preserve Area" (City of Cottonwood 2003). However, the ASLD-CNF land exchange is pending.

As part of the proposed Bella Montaña Residential Community Development (Bella Montaña), three conservation measures were developed to protect and enhance habitat (USFWS 2007). The first is a 6 ha (15.37 ac) parcel will be set aside to protect 574 *P. subintegra* plants (92 percent of the *P. subintegra* on the property) and occupied habitat. Protection of these plants will be afforded by a fence, which is maintained by the residential association and natural features (i.e., a large and deeply-incised arroyo). The second covers plants that cannot be avoided, as these will be protected and will be transplanted by the Flagstaff Arboretum from areas to be developed to an on-site conservation area. This will be accomplished by transplanting smaller individual plants and taking cuttings from large individuals to be grown into adult plants and then transplanted on-site. The cuttings from one plant can produce several new plants. To offset plant mortality, four plants grown from one plant will be transplanted. The third will establish a collection agreement between the applicant and the CNF that will provide $36,000 to the CNF for activities geared to the conservation of *P. subintegra*. These activities may include: livestock exclosure fencing, existing fence repair, road/trail closure/obliteration or relocation, signage, interpretive facilities for public education, noxious weed surveys and control efforts along roadways in or near *P. subintegra* habitat, and/or funding for completion of the draft management plan for the VVBA and/or additional monitoring, survey, or research activities. As of July 2013, Bella Montaña had yet to be developed.

Habitat protection is particularly important in the Cottonwood population because hybrid plants appear to grow more readily in disturbed areas (USFWS 2001). Baggs and Maschinski (2001b) noted disturbance associated with road construction in *P. subintegra* habitat may favor the spread of introgressed forms along roads and increase the likelihood of more introgression. See section 2.3.1.3 for a discussion of hybridization.

In 2008, the Cottonwood City Council directed their staff to begin the process of annexing 22 square kilometers (km^2) (8.5 square miles [mi^2]) of CNF land in sections 11-14, 23 and 24, and parts of sections 10, 15, 22, 25, 26 and 27, Township 16 North, Range 3 East, G&SRB&M, Yavapai County. This area contains all of the Cottonwood cliffrose population on the CNF that is not already within the City's corporate boundary. Annexation does not change landownership, but does mean that city regulations will apply and city services will be available in the area. In 2009, the City of Cottonwood proposed an intergovernmental agreement with the Town of Clarkdale to work with the CNF to ensure that these lands remain part of the National Forest and out of consideration for future land exchanges (City of Cottonwood 2009). The CNF has indicated that no lands containing endangered species will be exchanged out of Federal ownership (USFWS 1995).

Horseshoe Lake Population
Within the Horseshoe Lake recovery unit, *P. subintegra* plants and habitat were probably inundated when Horseshoe Lake was filled after construction was completed in 1946 (Fraser Design 1991). If the conservation pool level of the lake is raised above the current elevation of 617 meters (m) (2,026 feet [ft]), additional plants and habitat would probably be inundated (USFWS 1995). The Habitat Conservation Plan for Horseshoe and Bartlett reservoirs (Salt River Project 2008) provides specific direction for operation of both reservoirs. It was determined that all reservoir operation alternatives for Horseshoe Reservoir were unlikely to impact occupied and potential locations of *P. subintegra* (USFWS 2008). Although areas where *P. subintegra* occurs are open to mining, currently there are no active claims in these areas. All off-road motor vehicle use has been prohibited throughout the TNF (USFS 2002). In addition, the Lime Creek subpopulation is located within a congressionally-designated roadless area (USFS 2001).

Bylas Population
Within the Bylas recovery unit, no measures specifically to protect *P. subintegra* have been implemented by the San Carlos Apache Tribe because ongoing land-use practices are not considered a threat, and the population receives protection from the Tribe's project review process and traditional cultural perspective on conservation (Pilsk, pers. comm., 2008). Based on a joint Tribal-USFWS field trip to a few sites in the recovery unit in 2008, this population appeared to be doing well; individual plants of various age classes looked healthy and there were no signs of significant, ongoing impacts.

Criterion 3. Implement regulatory mechanisms or written land management commitments to provide adequate long-term protection of the species and its habitat sufficient to ensure long-term recovery and survival of the populations in each recovery unit. This criterion has been partially met.

Burro Creek Population
The BLM KFO Resource Management Plan (RMP), described in the Recovery Plan, was approved in 1995 (BLM 1995). The RMP designated the 451-ha (1,114 ac) Clay Hills ACEC, which contains about 98 percent of known *P. subintegra* in the Burro Creek area, estimated to be about 10,000 plants (USFWS 2004). The goal of the ACEC is to maintain a viable population of *P. subintegra* (BLM 1993). The RMP includes 16 management prescriptions, which are described in the Recovery Plan.

Cottonwood Population
An estimated 60-80 percent of the Cottonwood population occurs on CNF land, with the remainder on land belonging to ASLD, Arizona State Parks, Yavapai County, and privately held lands (USFWS 2001). The 461-ha (1140-ac) VVBA was established by the CNF in 1987 to protect *P. subintegra* and its unique associated plant communities. The VVBA includes an estimated 50-60 percent of the Cottonwood population. Protection is afforded through a prohibition on off-road driving and limitations on recreational use (USFS 1987, 2011). The Coconino Forest Plan states that the CNF will withdraw the VVBA from locatable mineral entry within 10 years of the implementation of the Forest Plan (USFS 1987). To date, this withdrawal has not been completed. A

draft management plan has been developed for the VVBA (The Arboretum at Flagstaff 2002), is scheduled for completion in late 2013 and will include a summary of long-term monitoring (Murray, pers. comm., 2013).

Horseshoe Lake Population
The TNF Land and Resource Management Plan (LRMP) does not specifically address *P. subintegra* because the Horseshoe Lake population was not discovered until the LRMP was finalized. However, the LRMP provides general management direction for wildlife, including managing threatened and endangered species with the goal of increasing population levels that will support delisting (USFS 1985). The LRMP also contains general management prescriptions for all federally-listed species. These prescriptions include the identification and surveying of habitat; identifying management conflicts and enhancement opportunities; correcting management conflicts; and conducting environmental clearances for all projects for threatened, endangered, proposed, and candidate plant and animal species. The LRMP is currently being revised but is not expected to be finalized for at least five years (Wong, pers. comm., 2012). The TNF Travel Management Rule, which addresses *P. subintegra*, was completed in 2012, but is undergoing further National Environmental Policy Act review. The Rule does not identify any new roads in occupied *P. subintegra* habitat (Wong, pers. comm., 2009).

Bylas Population
There was little information about the status of the Bylas population of *P. subintegra* at the time of the Recovery Plan, and there is no significant new information. The San Carlos Apache Tribe has not developed a management plan for this population because ongoing land-use practices are not considered a threat, and the population receives protection from the Tribe's project review process and traditional cultural perspective on conservation (Pilsk, pers. comm., 2008).

2.3 Updated Information and Current Species' Status

2.3.1 Biology and Habitat

Purshia subintegra is a long-lived, xerophytic, edaphic endemic woody perennial in the family Rosaceae. Plants are of low stature and open growth form compared with its congener Stansbury, or common cliffrose (*P. stansburiana*). Flowers are perfect (contain female and male parts) and pollination can occur on any of the first three days of anthesis (flower opening). Other life history traits, such as age at first reproduction, gross and net reproductive rates, and longevity, are unknown (USFWS 1995).

Purshia subintegra generally flowers from late March through early May and is visited by a wide variety of insects, including lepidopterans, dipterans, and bees. Typically, hundreds of flowers are produced on each mature plant, which can reproduce for many years (USFWS 1995). Flower and seed production varies between years based on climatic conditions, plant vigor, browsing, and other factors. 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).

Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995). Experiments have shown that this species is partially self-compatible, but sets significantly more seeds and produces fruit more often when outcrossed (Fitts et al. 1993).

This species has narrow habitat requirements and occurs at four widely separated areas across central Arizona (Figure 1; 2.2.3, Criterion 1 summary of progress; and 2.3.1.5). These sites differ slightly in elevation and associated vegetation, but all sites have limestone soils (generally white but also reddish in color) derived from Tertiary lacustrine (lakebed) deposits. At each site *P. subintegra* is part of a locally unique vegetative community (Anderson 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 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). 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. However, it has been found growing together with *P. subintegra* in the Verde Valley, in areas with higher amounts or organic matter and phosphorus. This suggests that the distribution of *P. subintegra* within these limestone soil conditions is limited primarily by competition from creosotebush, rather than a requirement for specific soil properties (Anderson 1986, 1993, 1996).

2.3.1.1 New information on the species' biology and life history:

See 2.2.3 (summary of progress toward meeting Criterion 1) for new information regarding *P. subintegra* life history.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

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 (see 2.3.1.3), 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) (see 2.3.1.6).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

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.

2.3.1.4 Taxonomic classification or changes in nomenclature:

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).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species within its historic range, etc.):

All known occurrences of *P. subintegra* are located in four disjunct populations, which occur along the sub-Mogollon region of central Arizona over a distance of 320 kilometers (200 miles) (Rutman 1992) (Figure 1). We have no updated information since the Recovery Plan was published that indicates a change in the distribution or historical range of *P. subintegra*.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

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). See section 2.3.2.5 for a discussion of the threat of aridity associated with droughts and longer term climate change.

Ironically, Maschinski et al. (2006) 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 in the Cottonwood population as estimated by Denham and Fobes (1992). Goodwin (2012) found that only about 78 ha (194 ac) of the previously described 556-ha (1376-ac) Cottonwood population is occupied by *P. subintegra*. The authors attributed this difference to dissimilar survey methodology, with Goodwin employing an inventory and the previously survey relying on the classification of habitat. The authors also state that some differences could be due to climate change, hybridization of cliffrose, mortality, or habitat loss. Regardless of the reasons, the amount of occupied habitat in the Cottonwood population is considerably less than previously thought.

2.3.1.7 Other Natural or Manmade Factors Affecting the Species' Continued Existence

Understanding the cultivation requirements of *P. subintegra* is considered an important aspect of this species' conservation because it allows for population augmentation and preservation of the genetic representation of individuals impacted by human development (Baggs and Maschinski 2001c). The Arboretum at Flagstaff is engaging in long-term research on cultivation and transplantation of

P. subintegra. Their objectives 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). These studies are being conducted in conjunction with *P. subintegra* demography monitoring (see 2.2.3). Preliminary results include: supplemental watering for at least five months, up to a year, greatly increased the survivorship of transplants; planting in November with watering did not increase survival compared to planning in February without watering; and plants grown in native soil, compared to more standard growing media, had the highest survivorship. A summary report of long-term results will be included in the VVBA management plan due out in late 2013 (Murray, pers. comm., 2013). One aspect of long-term monitoring will be to evaluate the reproductive success of transplants.

Portions of the cultivation and transplanting studies are being done in conjunction with development projects. As part of the Mingus Avenue Extension section 7 consultation, Yavapai County funded the collection and propagation of cuttings from each of the impacted plants, and the subsequent transplantation of nursery-grown plants back into the general project area (USFWS 2001). A total of 4,595 cuttings were taken from 513 plants and an additional 23 small plants were collected and potted. Of the plants collected, 405 plants representing 148 individuals were transplanted to portions of the VVBA and Dead Horse Ranch State Park. As of 2007, about 250 plants have survived, representing about 50 percent survival (USFWS 2007). This information will be important not only to address impacts from future projects in *P. subintegra* habitat but also for addressing the threat of climate change, because of its utility in population enhancement both within and outside currently occupied habitat (see 2.3.2.5).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

Threats at listing continue today as discussed below.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat Loss From Development. Threats from continued urbanization are an ongoing concern for the Cottonwood population of *P. subintegra*. The human population in Cottonwood is projected to increase by 36 percent between 2010 and 2030, and will result in greater impacts to *P. subintegra* on both National Forest and other lands (Yavapai County 2012; Phillips et al. 1980). Direct impacts are likely to include removal of additional ***P. subintegra*** habitat and individuals by development of other private lands, including ASLD lands auctioned and sold for private development. Human growth in the area will also result in increased demand for

recreational opportunities, such as hiking and mountain biking trails, picnic areas, and off-highway vehicle use areas. Although the CNF Management Plan addresses the protection of *P. subintegra* on National Forest System lands, an increase in unauthorized public access of CNF, ASLD, and private lands by recreationists can be anticipated. This is expected to result in greater impacts to *P. subintegra* from trampling of plants and compaction of soils. 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. The sale and development of ASLD and private lands within the Cottonwood population would fragment and isolate this population, compromising the long-term integrity of this portion of the population.

The Mingus Avenue Extension (improvement of Segment 2 of US 89A) resulted in loss of about 5 ha (14.7 ac) of *P. subintegra* habitat and removed or indirectly affected 29 plants. This road now bisects the southern portion of the Cottonwood population and directly or indirectly impacted about 600 mature plants and seedlings (USFWS 2007). The proposed Bella Montaña Residential Community Development, a 283-ha (700-ac) parcel located on the eastern-most known extent of the Cottonwood population, will result in the removal of 47 *P. subintegra* (USFWS 2007). Although this development incorporates a number of conservation measures (see 2.2.3) it also increases the potential for indirect effects from associated dispersed recreation and invasive weeds. Although there are several measures in place to protect a large part of the Cottonwood population, continued urbanization, especially associated impacts, presents a moderate to high degree of threat. We know of no proposed development within or near the other three populations that would significantly impact individuals or habitat.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

No threats from overuse are known to exist.

2.3.2.3 Disease or predation:

Disease. Knowledge of diseases significantly affecting *P. subintegra* is undeveloped at this time.

Herbivory. Since 1989, when a fence was set around the main Burro Creek subpopulation, the BLM has continued to monitor grazing on *P. subintegra* in the main population as well as the two subpopulations. Herbivory of *P. subintegra* has been low within the ACEC, recorded at 3 to 9.4 percent utilization for the past six years (Peck 2009b; Peck 2012). Grazing use in the two outlier populations has also been low, ranging from 2.5 to 8 percent. The BLM had predicted livestock grazing at these sites would be light because cattle would be less likely to travel in the area due to the rugged terrain and distance from water. Evidence of herbivory at all sites has been attributed to wildlife, and is well below the trigger of 20 percent for determining if reinitiation of formal consultation is

necessary (Hall 1993). The ACEC fence is inspected annually and repaired as needed.

The VVBA is within the Windmill Allotment. Section 7 consultations with the CNF were conducted in 1992 and 1997 for the Windmill Allotment Management Plan. Grazing has been excluded from the Rocking Chair and Cornville pastures since 1992, while seasonal grazing has continued in the Gyberg pasture under a deferred rest rotation system (USFWS 1995). Range inspection memoranda, from 2001 to 2006, state that there was light to no use of *P. subintegra* within the North Gyberg Pasture.

The Horseshoe Lake *P. subintegra* population on the TNF is contained within three grazing allotments. Current management in the Sears Club/Chalk and the St. Clair allotments is non-use due to the allotments being vacant (Willard, pers. comm., 2012). The Sears Club/Chalk Allotment, which contains most of the population, is scheduled for evaluation, under the National Environmental Policy Act, in 2013. The three pastures in the Cartwright Allotment (Lime Creek, Professor, and Long Canyon) have been removed from grazing (USFS 2008). Currently, the threat from grazing appears to be at a low level at three of the populations; the level of grazing effects at the Bylas population is not quantified to our knowledge.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

We have no updated information about the adequacy of regulatory mechanisms since the Recovery Plan was published. At this time, *P. subintegra* is protected to varying degrees by the following Federal, state, and international trade regulations:

- Endangered Species Act (16 U.S.C. 1531 et seq.), as amended
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Arizona Native Plant Law (ARS Chapter 7, Article 1)
- Lacey Act (16 U.S.C. 3371 et seq.), as amended
- National Forest Management Act

Purshia subintegra 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.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Climate Change. According to the Intergovernmental Panel on Climate Change (IPCC 2007a, p. 1) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Various environmental changes, such as shifts in the ranges of plant and animal species, conditions more favorable to the spread of invasive species, changes in amount and timing of water availability, are occurring in association with changes in climate (IPCC 2007a; Global Climate Change Impacts in the United States 2009).

For the next two decades, warming of about 0.2 degrees Celsius (°C) (0.4 degrees Fahrenheit [°F]) per decade is projected (IPCC 2007a, p. 6). Afterwards, projections increasingly depend on specific emission scenarios (IPCC 2007a). Various emissions scenarios suggest that by the end of the 21st Century, average global temperatures are expected to increase 0.6°C to 4.0°C (1.1°F to 7.2°F) with greatest warming expected over land (IPCC 2007a).

Localized projections suggest the Southwest may experience the greatest temperature increase of any area in the lower 48 states (IPCC 2007a), with warming in southwestern states greatest in the summer (IPCC 2007b). The IPCC also predicts hot extremes, heat waves, and heavier precipitation events will increase in frequency (IPCC 2007a). There is also high confidence that many semi-arid areas like the western U.S. will suffer a decrease in water resources due to climate change (IPCC 2007a), as a result of less annual mean precipitation and reduced length of snow season and snow depth (IPCC 2007b). Milly et al. (2005) project a ten to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. In the Southwest U.S., precipitation forecasts involving the summer monsoons are uncertain with some possibility that annual precipitation might increase (Notaro et al. 2012). Even so, projected warming trends are expected to exacerbate droughts by increasing evapotranspiration and further drying the soil (Weiss et al., 2009). The conditions that are suitable to maintain viable populations of various species in the Southwest U.S. are simulated to shift geographically an average of 93 km (58 miles) in the 21st Century (Notaro et al. 2012).

Long-term increased aridity and decreased precipitation, as projected by climate change models, represents a previously unidentified threat to *P. subintegra*. Using demographic data gathered in wet and dry years from 1996 and 2003, Maschinski et al. (2006) modeled population viability and extinction risk for *P. subintegra* under past, present, and future conditions, the latter involving two scenarios of increased aridity in the Cottonwood population. They found that although moist sites have the highest densities and highest seedling recruitment rates, 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 (Maschinski et al. 2004). 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. Despite its xerophytic nature, *P. subintegra* may be slowly declining in the Cottonwood population and will be at greater risk of extinction with increased aridity, as suggested by Maschinski et al.'s population viability model. Maschinski et al. (2006) suggest that conservation of *P. subintegra* will require population enhancement both within and outside currently occupied habitat, and recommend experiments to introduce *P. subintegra* to higher moisture sites, although this would be complicated by the presence of *P. stansburiana*. 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, such as translocation.

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* as described below.

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.

2.4 Synthesis

The Arizona cliffrose, *Purshia subintegra*, remains in danger of extinction throughout all or a significant portion of its range due to its susceptibility to a number of threats exacerbated by narrow habitat requirements, a small number of known populations (four), and a restricted, disjunct distribution. Major threats, identified in the Recovery Plan, include urbanization and associated impacts (recreation, road development), mining, and grazing. Habitat loss, due to urbanization at the Cottonwood population, continues to be a significant threat. Associated with recreation and road development for this largest population (Cottonwood population) is hybridization of *P. subintegra* with *P. stansburiana*, and the uncertainty that the effects hybridization may have on the population dynamics and evolution of *P. subintegra*. Threats from grazing appear to have been reduced since the Recovery Plan was prepared. However, increased aridity and reduced precipitation associated with climate change in the western U.S. are previously unidentified threats that have significant implications for a species that inhabits sites with unique soils that are already relatively warm and dry. The spread of invasive weeds may also be an emerging threat, given their role as strong competitors for nutrients and moisture and in spreading fire; and because their spread may be facilitated by climate change. None of these newly identified threats are perceived to require immediate, direct intervention, but may have a steadier, long-term, and perhaps increasing impact upon P. *subintegra*. Although there has been no standardized census of the four populations of *P. subintegra*, a population viability analysis model for the Cottonwood population has indicated a declining trend in numbers of individuals under expected climate change conditions (Maschinski et. al. 2006). Despite significant agency conservation efforts to set aside and protect relatively large areas of cliffrose habitat and to implement management prescriptions to address various threats, the threat of climate change may already be having significant impacts on *P. subintegra*. Moreover, a survey report from 2012 indicates that previous total population numbers for *P. subintegra* may have been overestimated by a factor of two. We lack 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. We also lack basic biological information on pollination, seed germination and establishment, growth rates, and other life history characteristics, which could enhance our understanding of the resilience of *P. subintegra*.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X_ No change is needed

3.2 New Recovery Priority Number (RPN): We recommend changing the 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.

Brief Rationale: 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 immanent threats from the time the RPN was designated, new potential threats to the existence of *P. subintegra* have been identified, 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.

3.3 Listing and Reclassification Priority Number: Not Applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

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. The USFWS can assist in coordinating this effort to facilitate consistency and comparability between the various monitoring methods employed by each agency.

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. The USFWS can facilitate this process and assist in monitoring design and coordinating standardization between agencies.

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.

5.0 REFERENCES

Anderson, J.L. 1986. Endangered Plant Program, Yavapai County, Arizona. Unpublished report, unknown source. 5 pp.

Anderson, J.L. 1993. A synthetic analysis of a rare Arizona species, *Purshia subintegra* (Rosaceae). Pages 205-220 In Sivinski, R. and K. Lightfoot (eds.). Proceedings of the Southwestern Rare and Endangered Plant Conference. New Mexico Forestry and Resources Conservation Division, Miscellaneous Publication Number 2, Santa Fe, New Mexico.

Anderson, J.L. 1996. Floristic patterns on late Tertiary lacustrine deposits in the Arizona Sonoran Desert. Madroño 43 (2):255-272.

Baggs, J. E., and J. Maschinski. 2001a. Annual report on the long-term research on *Purshia subintegra* in the Verde Valley for 2000. Unpublished report to the Arizona Department of Transportation. 15 pp.

Baggs, J.E., and J. Maschinski. 2001b. The threat of increasing hybridization of an endangered plant species, *Purshia subintegra*, in the Verde Valley, Arizona. Pages 213-220 In Maschinski, J. and L. Holter (eds.). Southwestern Rare and Endangered Plants: Proceedings of the Third Conference. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

Baggs, J.E., and J. Maschinski. 2001c. From the greenhouse to the field: cultivation requirements of *Purshia subintegra*, Arizona cliffrose. Pages 176-185 In Maschinski, J. and L. Holter (eds.). Southwestern Rare and Endangered Plants: Proceedings of the Third Conference. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

Bureau of Land Management (BLM). 1993. Kingman Resource Area Proposed Resource Management Plan Management Plan and Environmental Impact Statement. Kingman Resource Area, Kingman Area. 606 pp.

Bureau of Land Management (BLM). 1995. Record of Decision for the approval of the Kingman Resource Area Resource Management Plan. Kingman Resource Area, Kingman Arizona. 11 pp.

Bureau of Land Management (BLM). 1998. Public Land Order No. 7341; Withdrawal of public land for the Clay Hills Area of Critical Environmental Concern; Arizona. Federal Register 63 (115):32894-32895. June 16, 1998.

City of Cottonwood. 2003. Cottonwood General Plan 2003-2013/Adopted December 16, 2003. 14 chapters + appendix.

City of Cottonwood. 2009. Staff Report: Intergovernmental agreement relating to preservation of Forest lands and the City of Cottonwood's proposed annexation of 8.5 square miles of Coconino National Forest. August 25, 2009. 2 pp + unsigned agreement with exhibit.

Denham, B., and N. Fobes. 1992. Acreage of *subintegra* habitat in the Verde Valley. In Denham, B. Subintegration: An integration of *subintegra* information. Unpublished report submitted to U.S. Fish and Wildlife Service, Arizona Ecological Services Office, Phoenix, Arizona.

Fenner, P. 2005. Memo to Cave Creek District Ranger. Subject: Arizona cliffrose after the Cave Creek Complex Fire. Tonto National Forest, U.S. Forest Service. 8/8/2005. 2 pp with attachment.

Fitts, R.D., V.J. Tepedino, and T.L. Griswold. 1993. The pollination biology of Arizona cliffrose (*Purshia subintegra*), including a report on experimental hybridization with its sympatric congener *P. stansburiana* (Rosaceae). Pages 359-368 In Sivinski, R. and K. Lightfoot (eds.). Proceedings of the Southwestern Rare and Endangered Plant Conference. New Mexico Forestry and Resources Conservation Division, Miscellaneous Publication Number 2, Santa Fe, New Mexico.

Fraser Design. 1991. Technical Report: Historic American Engineering Record for Horseshoe Dam (HAER No. AZ-24). Arizona Projects Office, Bureau of Reclamation, Phoenix, Arizona.

Global Climate Change Impacts in the United States. 2009. T.R. Karl, J.M. Melillo, and T.C. Peterson (eds). Cambridge University Press, Cambridge, UK, and New York, NY. 189 pp.

Goodwin, G. 2012. Design and implementation of a geodatabase for *Purshia subintegra* (Arizona cliffrose): A practicum submitted in partial fulfillment of the requirements for the degree of Masters in Science in Geograhic Information Science. Unpublished report submitted to Coconino National Forest. 79 pp.

Hall, R. 1993. Biological evaluation for Bagdad Showcase Allotment Management Plan. Bureau of Land Management, Kingman Resource Area, Kingman, Arizona. 5 pp.

Henrickson, J. 1986. Notes on *Rosaceae*. Phytologia 60(6):468.

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the U.S., Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

Kartesz, J.T., The Biota of North America Program (BONAP). 2013. Taxonomic Data Center. (http://www.bonap.net/tdc). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2013. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (in press)].

Integrated Taxonomic Information System (ITIS). Retrieved 8/9/2013. (http://www.itis.gov).

Intergovernmental Panel on Climate Change (IPCC). 2007a. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, Pachauri, R.K., and A. Reisinger (eds.). IPCC, Geneva, Switzerland. 104 pp.

Intergovernmental Panel on Climate Change (IPCC). 2007b. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor, and H.L. Miller (eds.). Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

International Code of Nomenclature for algae, fungi, and plants (Melbourne Code). 2012 (electronic version). McNeill, J., F.R. Barrie, W.R. Buck, V. Demoulin, W. Greuter, D.L. Hawksworth, P.S. Herendeen, S. Knapp, K. Marhold, J. Prado, W.F. Prud'homme van Reine, G.F. Smith, J.H. Wiersma, N. Turland (eds.). Regnum Vegetabile 154. Koeltz Scientific Books. A.R.G. Gantner Verlag KG, Ruggell, Liechtenstein. Retrieved 8/9/2012.

Maschinski, J., J. E.Baggs, and C. F. Sacchi. 2004. Seedling recruitment and survival of an endangered limestone endemic in its natural habitat and experimental reintroduction sites. American Journal of Botany 91(5):689–698.

Maschinski, J., J. E. Baggs, P.F Quintana-Ascencio, and E.S. Menges. 2006. Using Population Viability Analysis to predict the effects of climate change on the extinction risk of an endangered limestone endemic shrub, Arizona cliffrose. Conservation Biology 20:218-228.

Milly, P.C.D., K.A. Dunne, and A.V. Vecchia. 2005. Global pattern of trends in streamflow and water availability in a changing climate. Nature 438:347-350.

Notaro, M., A. Mauss and J.W. Williams. 2012. Projected vegetation changes for the American Southwest: combined dynamic modeling and bioclimatic-envelope approach. Ecological Applications 22(4):1365-1388.

Peck, R. 2009a. Memo to John Nystedt, U. S. Fish and Wildlife Service. Subject: Arizona Cliffrose Way Reclamation Project. September 1, 2009. Kingman Field Office, Bureau of Land Management. 1 p with attachments.

Peck, R. 2009b. Email to John Nystedt, U.S. Fish and Wildlife Service. Subject: cliffrose utilization information for 5 year review. September 24, 2009. Kingman Field Office, Bureau of Land Management. 1 p with utilization monitoring report.

Peck, R. 2012. Email to John Nystedt, U.S. Fish and Wildlife Service. Subject: cliffrose. May 23, 2012. Kingman Field Office, Bureau of Land Management. 1 p with utilization worksheets.

Phillips, A.M., B.G. Phillips, L.T. Green, J. Mazzoni, and E. M. Peterson. 1980. Status report for *Cowania subintegra*. Prepared for U.S. Fish and Wildlife Service. Phoenix, Arizona.

Reichenbacher, F.W. 1994. Identification of *Purshia subintegra* (Rosaceae). Great Basin Naturalist 54(3):256-271.

Rutman, S. 1992. Handbook of Arizona's endangered, threatened and candidate plants. Arizona Ecological Services Field Office, Phoenix, Arizona.

Salt River Project. 2008. Habitat Conservation Plan for Horseshoe and Bartlett Reservoirs. Salt River Project, Phoenix, Arizona. 229 pp + appendices.

Schaack, C.G. 1987. A new Arizona *Purshia* (Rosaceae). Phytologia 63:301-303.

The Arboretum at Flagstaff. 2002. Verde Valley Habitat Management Plan. Unpublished report submitted to Coconino National Forest. 48 pp.

Travis, S.E., J. E. Baggs, and J. Maschinski. 2008. Disentangling the role of hybridization in the evolution of the endangered Arizona cliffrose (*Purshia subintegra*; Rosaceae): a molecular and morphological analysis. Conservation Genetics 9:1183-1194.

U.S. Department of the Interior (USDI). 1984. Final rule to determine *Cowania subintegra* (Arizona cliffrose) to be an endangered species. Federal Register 49(104):22326-22329. May 29, 1984.

U.S. Forest Service (USFS). 1985. Tonto National Forest Plan. Southwestern Region, Albuquerque, New Mexico. 220 pp + glossary and appendices.

U.S. Forest Service (USFS). 1987. Coconino National Forest Plan with amendments. Southwestern Region, Albuquerque, New Mexico. 486 pp.

U.S. Forest Service (USFS). 2001. Special Areas; Roadless Area Conservation. Federal Register 66 (9):3244-3273. January 12, 2001.

U.S. Forest Service (USFS). 2002. Order 12-4-2R: Special restrictions – Off-road Motor Vehicle Use. Tonto National Forest, Phoenix, Arizona. 4 pp.

U.S. Forest Service (USFS). 2004. Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds: Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona. Southwestern Region, Albuquerque, New Mexico. 243 pp + appendices.

U. S. Forest Service (USFS). 2008. Decision Notice and Finding of No Significant Impact for the Cartwright Allotment Analysis. Cave Creek Ranger District, Tonto National Forest, Scottsdale, Arizona. 13 pp.

U.S. Forest Service (USFS). 2011. Botany Specialist Report for the Travel Management Rule Environmental Impact Statement. Coconino National Forest, Flagstaff, Arizona. 49 pp.

U.S. Forest Service (USFS). 2012. Biological assessment/evaluation of the integrated treatment of noxious of invasive plant program for the Tonto National Forest. January 4, 2012. Tonto National Forest, Phoenix, Arizona.

U.S. Fish and Wildlife Service (USFWS). 1984. Endangered and Threatened Wildlife and Plants; Final Rule to Determine *Cowania subintegra* (Arizona Cliffrose) to be an Endangered Species. Federal Register Notice Vol. 49, No. 104, May 29, 1984. 49 FR 22326 22329.

U.S. Fish and Wildlife Service (USFWS). 1987. Biological Opinion for Central Arizona Water Control Study Plan 6. March 10, 1987. Arizona Ecological Services Field Office, Phoenix, Arizona. 4 pp.

U.S. Fish and Wildlife Service (USFWS). 1988. Biological Opinion for Mining Plan of Operation near Burro Creek, MPO-88-K-10, Mohave County, Arizona. March 9, 1988. Arizona Ecological Services Field Office, Phoenix, Arizona. 3 pp.

U.S. Fish and Wildlife Service (USFWS). 1995. Arizona Cliffrose (*Purshia subintegra*) Recovery Plan. USDI Fish and Wildlife Service, Arizona Ecological Services State Office, Phoenix, Arizona. 90 pp + appendix.

U.S. Fish and Wildlife Service (USFWS). 2001. Biological Opinion for Mingus Avenue Extension. March 9, 2001. Arizona Ecological Services Field Office, Phoenix, Arizona. 50 pp.

U.S. Fish and Wildlife Service (USFWS). 2004. Biological and Conference Opinion for the BLM Arizona Statewide Land Use Plan Amendment for Fire, Fuels, and Air Quality Management. September 3, 2004. Arizona Ecological Services Field Office, Phoenix, Arizona. 356 pp.

U.S. Fish and Wildlife Service (USFWS). 2007. Biological Opinion for Bella Montaña Residential Community Development. February 5, 2007. Arizona Ecological Services Field Office, Phoenix, Arizona. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2007. Endangered and Threatened Wildlife and Plants; 5-Year Reviews of 24 Southwestern Species. Federal Register Notice Vol. 72, No. 77, April 23, 2007. 72 FR 20134 20136.

U.S. Fish and Wildlife Service (USFWS). 2008. Final Environmental Impact Statement for the Incidental Take Permit for Operation of Horseshoe and Bartlett Reservoirs. March 2008. Arizona Ecological Services Field Office, Phoenix, Arizona. 116 pp.

Weiss, J. L., C. L. Castro, and J. T. Overpeck. 2009. Distinguishing pronounced droughts in the southwestern United States: seasonality and effects of warmer temperatures. Journal of Climate 22:5918–5932.

Yavapai County. 2012. Yavapai County Comprehensive Plan, updated final draft. September, 2012. Prescott, Arizona. 98 pp.

PERSONAL COMMUNICATION

James Henrickson, Professor Emeritus, California State University – Los Angeles, 7/19 – 8/9/2013

Sheila Murray, Research Botanist, Arboretum at Flagstaff, 7/16/2013

Seth Pilsk, Botanist, San Carlos Apache Tribe, 4/4/2008

Todd Willard, District Biologist, Tonto National Forest, 6/1/2012

Fred Wong, Wildlife Program Lead, Tonto National Forest, 7/27/2009, 6/1/2012

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Arizona cliffrose (*Purshia subintegra)*

Current Classification: Endangered, without critical habitat

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: Not Applicable.

Review Conducted By: John Nystedt, Fish and Wildlife Biologist, Arizona Field Office - Flagstaff

FIELD OFFICE APPROVAL:

Field Supervisor, Fish and Wildlife Service

Approve _____ Date 8/8/13

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Fish and Wildlife Service

Approve _____ Date 8/16/13