U.S. Fish & Wildlife Service

Astragalus holmgreniorum (Holmgren Milk-Vetch)
and
Astragalus ampullarioides (Shivwits Milk-Vetch)

RECOVERY PLAN

September 2006

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(Holmgren milk-vetch)

and

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(Shivwits milk-vetch)

RECOVERY PLAN

Prepared by
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for

Region 6
U.S. Fish and Wildlife Service
Denver, Colorado

Approved: [signature]
Regional Director, Region 6

Date: 9/22/06

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Recovery plans can be downloaded from http://www.fws.gov/endangered/recovery/index.html.

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EXECUTIVE SUMMARY

Current Species Status: *Astragalus holmgreniorum* (Holmgren milk-vetch) is endemic to the northern reaches of the Mojave desert around St. George, Utah, while *Astragalus ampullarioides* (Shivwits milk-vetch) is found in landscape belonging to both the Mojave desert and neighboring Colorado plateau. These perennials were listed as endangered in October 2001 due to their rarity and declining population trends as well as the threats of urban development, off-road vehicle (ORV) use, grazing, displacement by invasive plants, and mineral development. On March 29, 2006, USFWS proposed to designate approximately 8,896 acres (ac) (3,600 hectares (ha)) of critical habitat for the two federally endangered plants. For the purpose of recovery, each species comprises six extant populations. All of *A. ampullarioides* populations are located in Washington County, Utah. Four of the six *A. holmgreniorum* populations are entirely in Washington County, Utah, while one population crosses into Mohave County, Arizona, and another is only found in Mohave County, Arizona. While this represents the known historic distribution, it is probable, due to human induced impacts, that both species occupied more habitat in the past.

Habitat Requirements and Limiting Factors: *A. holmgreniorum* occurs at elevations between 2,480-2,999 feet (ft) (756-914 meters (m)) in areas that drain to the Santa Clara and Virgin rivers. It is typically found on the skirt edges of hill and plateau formations slightly above or at the edge of drainage areas; it occurs on soils characterized by small stone and gravel deposits and where living cover averages less than 15% of the landscape. *A. holmgreniorum* is associated with geological layers or parent materials found within the Moenkopi formation. *A. ampullarioides* is predominately found in isolated pockets of purple-hued, soft clay soil found on Chinle formation around St. George. Occupied sites are small, and populations are found between 3,018-4,363 ft (920-1,330 m) in elevation in sparsely vegetated habitat with an average 12% cover. *A. holmgreniorum* is thinly and discontinuously distributed within its habitat; *A. ampullarioides* is found in dense patches. Depending on precipitation, *A. holmgreniorum* has variable seedling output followed by a low rate of survivorship, limiting the number of reproductive adults within a population. *A ampullarioides* is constrained by the isolation of appropriate soil substrate and limited mechanisms for seed dispersal, with fluctuating population numbers that may be dependent on rainfall.

Recovery Strategy: Recovery of *A. holmgreniorum* and *A. ampullaroides* will hinge on conservation of extant populations and establishment of enough additional populations to ensure long-term demographic and genetic viability. This will require the active involvement of experts and the public as well as a continuing recognition of the role each milk-vetch plays in the ecology of southwestern Utah and, in the case of *A. holmgreniorum*, northwestern Arizona. Because of the biological and historical uncertainties regarding the status and recovery potential of these species, the recovery strategy is necessarily contingent on a growing understanding of the species and their ecological requirements. Consequently, a dynamic and adaptive approach will be key to making effective progress toward full recovery.

Recovery Goals and Criteria

To reach the goal of **reclassifying** of each species from endangered to threatened status, the following recovery criteria must be met for each species:

- Species presence is maintained at all recovery populations.
- Population trends for four out of six recovery populations of each species are primarily stable or improving, as indicated by occupied habitat, density of occupied habitat, and predictive modeling.
- The habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations.
- Population and habitat management is implemented for all recovery populations of each species in accordance with site-specific management plans.
- Permanent land protection is achieved for at least four recovery populations of each species.
- Site-specific conservation agreements are in place for all recovery populations and their habitat to protect these milk-vetches within existing State laws.
- The conservation of these species is included in a long-term State plant conservation agreement.
- Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within *A. ampullarioides* and *A. holmgreniorum* recovery populations.
- For at least four recovery populations of each species, effective measures are in place to control potential negative effects on invasive nonnative species that could harm these milk-vetches and/or their habitats.
- The protected habitat base for at least four recovery populations of each species is large enough to offset loss or restriction of the species' pollinators.
- Use of pesticides or herbicides detrimental to either of the milk-vetches or their pollinators is prohibited in the vicinity of all recovery populations.
- Research indicates genetic fitness, alleviating concern about inbreeding or outbreeding depression.
- Seed collection/storage is underway for all extant *A. holmgreniorum* and *A. ampullarioides* populations.

The goal of **delisting** will be reached when the following additional recovery criteria are met:

- Two additional populations of each species are either located or successfully introduced to habitat in proximity to extant populations. Thus, a minimum of eight recovery populations will be needed to delist each species.
- The available habitat base for each newly discovered or introduced recovery population is large enough to allow for natural population dynamics, population expansion where needed,

and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and among populations.

- Population trends for all *A. holmgreniorum* and *A. ampullarioides* recovery populations are primarily stable or improving, as indicated as indicated by species presence, occupied habitat, density of occupied habitat, and demographic modeling.
- Each of the eight *A. holmgreniorum* and eight *A. ampullarioides* recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective.
- Permanent land conservation is achieved for all recovery populations whether extant or introduced (a minimum of 8 populations), such that Endangered Species Act (ESA) protection is no longer needed to compensate for regulatory inadequacies.
- Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within all *A. ampullarioides* and *A. holmgreniorum* recovery populations.
- A long-term offsite conservation program is ongoing for all milk-vetch recovery populations.

Actions Needed

1. Conserve known extant *A. holmgreniorum* and *A. ampullarioides* populations and their habitat.

2. Locate and conserve additional extant populations, if any.

3. Monitor *A. holmgreniorum* and *A. ampullarioides* sites for population information and trends.

4. Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers.

5. Develop and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations.

6. Augment extant populations and/or establish new populations of each species in accordance with the rangewide strategy.

7. Promote effective communications with partners and stakeholders regarding the milk-vetches' recovery needs and progress.

8. Develop and implement educational and outreach programs.

9. Provide oversight and support for implementation of recovery actions.

10. Establish a technical working group to regularly review the status of the species and track the effectiveness of recovery actions.

11. Revise the recovery program when indicated by new information and recovery progress.

ESTIMATED COST OF RECOVERY (in $1000's)

	RECOVERY ACTION											
Fiscal Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**TOTAL**
FY 1	449	28	78	168	20	—	8	7	10	2	—	770
FY 2	436	20	28	78	28	—	6	4	10	2	—	612
FY 3	647	20	28	86	—	—	8	7	10	2	—	808
FY 4	662	30	28	33	—	—	6	4	10	2	—	775
FY 5	661	30	28	31	40	40	8	7	10	2	25	882
FY 6-30	12,502	349	720	351	—	400	134	136	250	50	100	14,992
TOTAL	15,357	477	910	747	88	440	170	165	300	60	125	18,839

Estimated Date of Full Recovery: If the recovery actions needed to meet all recovery criteria are accomplished on schedule, full recovery of both species is anticipated to be achieved in the year 2037. However, it should be recognized that recovery of these species is in an early stage and the recovery program may change over time; consequently, the estimated date for delisting may be revised.

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PART I. BACKGROUND

INTRODUCTION

Astragalus holmgreniorum (Holmgren milk-vetch) and *Astragalus ampullarioides* (Shivwits milk-vetch) are members of the pea family (Fabaceae or Leguminosae) endemic to the Mojave Desert in the vicinity of St. George, Utah. These narrowly distributed perennials were federally listed as endangered in October 2001 (50 CFR 17.12) following a final rulemaking published in September 2001 (66 FR 49560-49567). The decision to list the two species was based upon their rarity and declining population trends as well as the threats of urban development, ORV use, grazing (for *A. ampullarioides*), displacement by nonnative invasive plants, and mineral development. Individually, these threats affect the two *Astragalus* species to varying degrees, but in combination they pose an extinction risk for both species.

After listing, both milk-vetches were assigned a recovery priority number[1] of 5C. This ranking indicates a high degree of threat from the activities listed above and, in particular, imminent conflicts with land development. The 5C ranking further indicates the presence of significant obstacles and a relatively low potential for full recovery, i.e., under current circumstances, the pressures facing both species appear to be outpacing protective mechanisms and precluding important recovery opportunities. Finally, the ranking is indicative of the plants' taxonomic standing as full species.

Part I of this plan includes the biological and status information pertinent to recovering both milk-vetches, and Part II presents a general strategy for bringing about their long-term recovery in the wild. Part III outlines the recovery goals, objectives, and criteria specific to each milk-vetch and describes the action program for achieving recovery objectives. Part IV provides a schedule for implementing each recovery action. Recovery of these species is in an early stage; thus, it should be anticipated that the recovery program will change over time as informed by new information and the outcomes of implementing recovery actions. The recovery plan will be revised as needed to reflect changes in information, strategies, and/or actions.

DESCRIPTION AND TAXONOMY

The flowering plant genus *Astragalus* L. is the largest genus of vascular plants on earth (Mabberley 1997). With the common names "milk-vetch" or "locoweed" (family Fabaceae or Leguminosae), the genus contains over 2,000 species, which are distributed world-wide although primarily found in the northern hemisphere (Barneby 1989; Zomlefer 1994). Many *Astragalus* species are narrow endemics, while relatively few are widespread. Within this cosmopolitan genus, *A. holmgreniorum* and *A. ampullarioides* account for 2 of the 23 milk-vetches listed as federally endangered or threatened (USFWS 2006). *Astragalus* species are typically suited to

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[1] Recovery priority numbers, which are determined in accordance with the criteria laid out in 48 FR 41985, are used to identify those species that should receive highest priority for recovery plan preparation and implementation. Recovery priority numbers range from a high of 1C to a low of 18, with "C" indicating an imminent conflict with development activity and thus elevating the species' priority.

moderately moist environments; their proliferation into dry climates and otherwise unfavorable microhabitats is a more recent phenomenon that has produced many geographically restricted genotypes, such as *A. holmgreniorum* and *A. ampullarioides* (Barneby 1989).

A. holmgreniorum is a stemless, mostly prostrate, herbaceous perennial that produces leaves and small purple flowers in the spring and dies back to its roots after the flowering season (Figure 1). The following description is derived primarily from Barneby (1989) and Welsh et al. (2003). The compound leaves are pinnate (opposite), arise directly from the root crown, and are pressed close to the ground. They measure 1.5-5.1 inches (in.) (4.0-13.0 centimeters (cm)) long and have 9-15 leaflets that are 0.3-0.6 in. (0.8-1.6 cm) long and broadly obovate (egg-shaped). Flowers of *A. holmgreniorum* are 0.7-0.9 in.(1.8-2.4 cm) long and 0.2-0.4 in.(0.6-0.9 cm) wide and have the distinctive papilionaceous flower shape of a legume, i.e., pea-like flowers with five petals that include a large petal on top enclosing two lateral petals and two smaller lower petals. The plant has a raceme inflorescence with, typically, 6 to 16 flowers. The peduncle, which is 0.8-3.6 in.(2.0-8.5 cm) long, rises directly from the root crown and is erect during anthesis (opening of the flower) and prostrate when the plant is in fruit. The fruits are pods 1-2 in. (3.0-5.0 cm) long and 0.2-0.4 in.(0.6-0.9 cm) wide. The pods retain seeds even after they fully open up along the margin; with age, each pod eventually dries out and opens up at both the top and bottom ends.

A. holmgreniorum was first collected in 1941 by Melvin Ogden; the species was subsequently rediscovered by Rupert Barneby and Noel and Patricia Holmgren in 1979. Barneby recognized the species as a unique taxon occurring along the western Utah-Arizona border and graciously named the species for his co-discoverers.

A. ampullarioides (Welsh) Welsh, in contrast to the typically prostrate form of *A. holmgreniorum*, is considered a tall member of the pea family (Figure 2); however, some plants have a shorter appearance because of grazing impacts. The following description is derived primarily from Barneby (1989), Welsh (1986, 1998), and Welsh et al. (1987). Stems may grow along the ground or to a height of 8-20 in. (20-50 cm), although ungrazed flowering stems may attain a height of 40 in. (1 m). The leaves are pinnately (arranged opposite) compound, 1.6-7.1 in. (4-18 cm) long, and have 11 to 23 elliptical leaflets. Each plant produces approximately 45 small cream-colored flowers about 0.8 in. (2.0 cm) long on a single stalk in the spring. Seeds are produced in small pods, and the plant dies back to its root crown after the flowering season. The fruit is a short, broad pod between 0.3-0.6 in. (0.8-1.5 cm) long and 0.2-0.5 in. (0.6-1.2 cm) wide.

Discovered by Duane Atwood in 1976, the collection was identified by Welsh as *A. eremiticus,* while Atwood thought it to be a look-alike for *A. ampullarius.* A type collection was made on a return visit in 1982 and was formally described by Stanley Welsh (1986) as a variety of *A. eremiticus,* which also is found in Washington County, Utah. Barneby (1989) questioned the taxonomic significance of the variety and submerged *A. eremiticus* var. *ampullarioides* within typical *A. eremiticus*. Later research by Harper and Van Buren (1998) and Stubben (1997) demonstrated significant ecological and genetic differences between typical *A. eremiticus* and

FIGURE 1. *A. holmgreniorum* in fruit (courtesy of R. Van Buren).
(See front cover for *A. holmgreniorum* in flower.)

FIGURE 2. *A. ampullarioides* in fruit and flower (courtesy of R. Van Buren).

A. eremiticus var. *ampullarioides*. These differences are summarized as follows--
(1) *A. ampullarioides* has more flowers per stem, (2) *A. ampullarioides* has longer flower stalks (from last leaf to flower), (3) *A. ampullarioides* has wider pods, (4) *A. ampullarioides* has taller stems, (5) *A. ampullarioides* has hollow stems while *A. eremiticus* stems are solid, and (6) *A. ampullarioides* plants are highly palatable to grazing animals while typical *A. eremiticus* is seldom if ever eaten (Barneby 1989; Welsh 1986, 1998; Welsh et al. 1987; Van Buren 1992; Harper and Van Buren 1998).

The variation between *ampullarioides* and *eremiticus* at the genetic level became apparent through research by Stubben (1997), who used random amplified polymorphic DNA (deoxyribonucleic acid) (RAPD) markers to examine three areas of *A. eremiticus* var. *ampullarioides* and two areas of *A. eremiticus* var. *eremiticus.* Analysis results showed that the two milk-vetches were only 26.8% similar, leading to evaluation of *A. eremiticus* var. *ampullarioides* as a species (Welsh 1998). Welsh's (1998) subsequent revision elevated the taxon to full species status as *A. ampullarioides.*

Both *A. holmgreniorum* and *A. ampullarioides* were described as full species in the 2001 rule listing them as endangered (66 FR 49560).

DISTRIBUTION AND RANGE

At the time of listing, three known populations of *A. holmgreniorum* and five populations of *A. ampullarioides* were identified (66 FR 49560); the term "population" denoted a locality within which individuals of these species were concentrated.[2] However, the listing rule noted the discontinuous distribution of plants within each population. Since then, the three major concentrations of *A. holmgreniorum* have been subdivided into six populations that are sufficiently discrete to be considered populations for recovery purposes by the USFWS, although evaluation will continue as further information becomes available. Likewise, one of the five *A. ampullarioides* concentrations has been subdivided into two discrete clusters, and, for the purpose of recovery, the USFWS now considers this species to consist of six populations.

These *Astragalus* populations are distributed across a limited range. Known populations of *A. holmgreniorum* occur within approximately 10 miles (mi) (16 kilometers (km)) of St. George in Washington County, Utah, and Mohave County, Arizona (Figure 3, page 6; see Appendix B for maps of individual *A. holmgreniorum* populations). The largest concentration of this species spans the Utah-Arizona border, extending from the Atkinville Wash area eastward across Interstate 15 (I-15) to the Arizona Strip Highway; this concentration comprises three populations--State Line, Gardner Well, and Central Valley. Two populations, South Hills and Stucki Spring, are found south of the City of Santa Clara. An isolated population called Purgatory Flat is associated with a limestone outcrop found east of St. George. About half of the areas occupied by *A. holmgreniorum* are on lands owned and managed by the State of Utah (Van Buren and Harper 2003a).

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[2] Terminology also includes "subpopulation," which is sometimes used to refer to discrete clusters of plants within each population. The term "occurrence" is used to indicate a record of one or more individual plants, and "site" refers to the land that supports individuals of the species.

All known locations of *A. ampullarioides* occur within Washington County, Utah (Figure 4, page 6; see Appendix C for maps of individual *A. ampullariodes* populations). To the west of St. George, the Shivwits population is found on the Shivwits Indian Reservation, and the Pahcoon Spring Wash population located adjacent to the Reservation. East of St. George, the most southerly population, Coral Canyon, is located adjacent to a golf course and residential subdivision. Another population is located south of Quail Creek and contains two main areas of occupancy, Harrisburg Bench and Cottonwood; these populations occur within 1 mi (1.6 km) of each other, and one Cottonwood is in the median of I-15. The Silver Reef population (its name references the silver mining that once occurred in the area) is found north of Harrisburg Bench. An additional disjunct population occurs within Zion National Park (Van Buren and Harper 2003a, 71 FR 15979) and is managed by the National Park Service (NPS).

Historical distribution is not known for either species, that is, records are not available to ascertain whether the current distribution of *A. holmgreniorum* and *A. ampullarioides* populations represents either a loss of individual populations or a range contraction for either species. Given historical configurations of available habitat, it is possible that additional populations once occurred on the landscape. It is unknown, but also is possible that these species are relatively new endemics, which have speciated relatively recently in or near their present locations. One way to verify these inferences may be to query the seedbank to determine if populations of seeds still exist or to assess current population genetic variation to infer past historical processes, but no such work has been done to date. Suitable habitat has not yet been exhaustively searched for the species' presence, although botanists and land managers have surveyed several areas that have been thought likely to harbor each species, without success (R. Van Buren, Utah Valley State College, and R. Douglas, Bureau of Land Management (BLM), pers. comm. 2006).

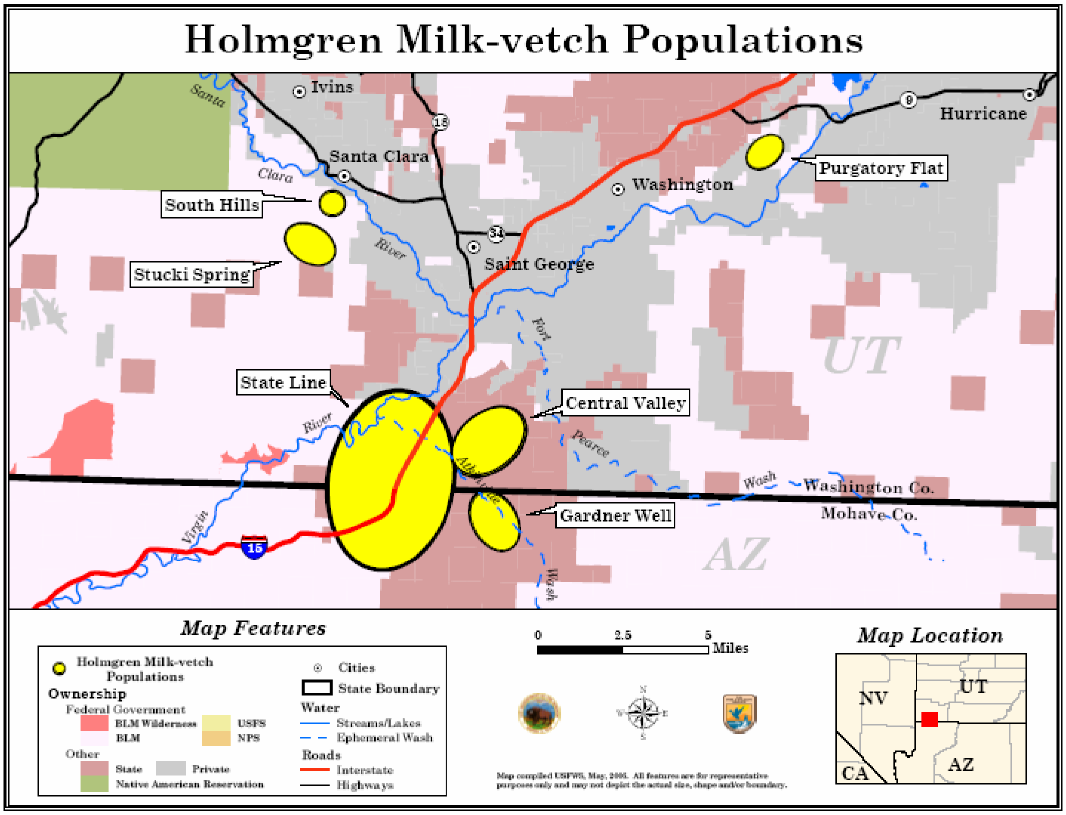


FIGURE 3. Distribution and range of *A. holmgreniorum*.

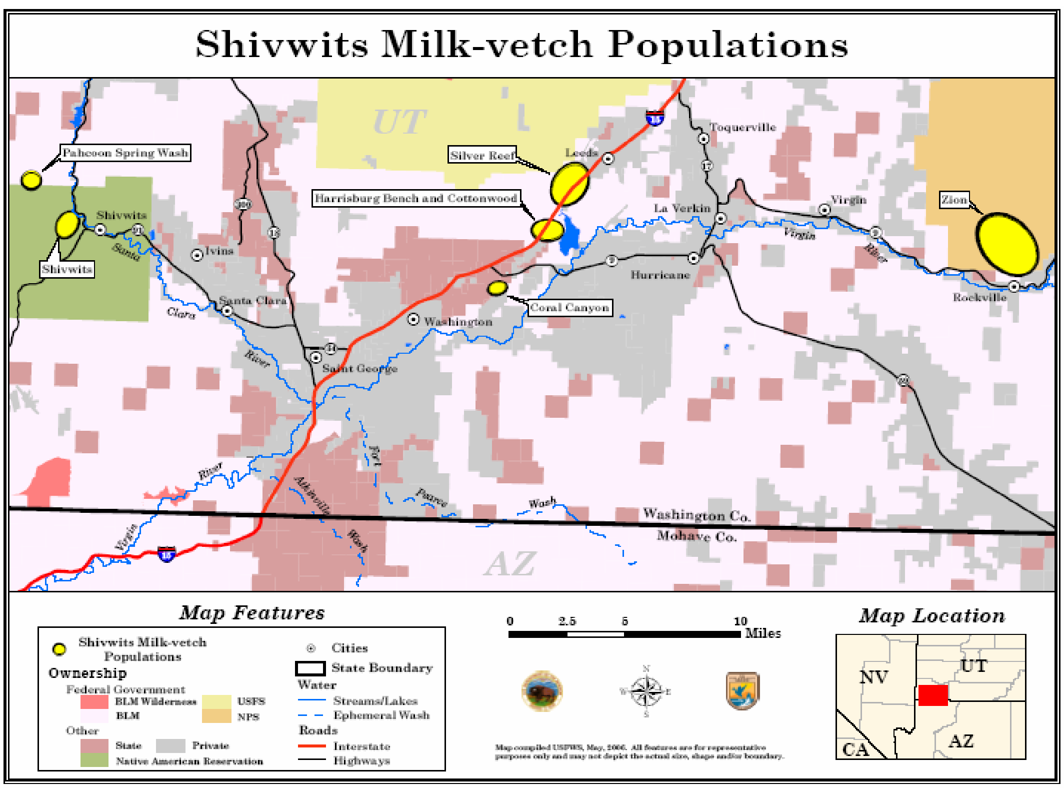


FIGURE 4. Distribution and range of *A. ampullarioides*.

LIFE HISTORY

Astragalus holmgreniorum

A. holmgreniorum is an extremely short-lived perennial herb with low survivorship from germination to 1 year-old juvenile or reproductive adult. Few plants live past two growing seasons (Stubben 1997; Van Buren and Harper 2003) and less than 2% of seedlings (nonreproductive plants with a rosette diameter of 0-2.4 in. (0-6 cm)) tracked in 1993 lived into their fourth growing season (Van Buren and Harper, 2001a). Although very few plants live to exhibit this quality *A. holmgreniorum* is iteroparous, capable of producing seed in more than 1 year. Nonseedlings, i.e., plants entering their second year of growth or older plants, appear several weeks before seedlings, generally in late February or early March, although some emerge as early as mid-January. Seedlings are present several weeks following adult emergence. The best time to detect the species is while it is producing flowers and fruit. Flowering occurs between March and April, and the majority of plants set fruit by the end of April. Seed pods persist until the end of May. Plants then die back to roots between late May and mid-June (Van Buren and Harper 2003a).

Individual plants bear 6-16 flowers on each flower stalk and may have several stalks. From 1993-1996, Stubben (1997) found that reproductive adults averaged 47 flowers per plant, while from 1992 to 2000, Van Buren and Harper (2003a) found an average of 16.4 flowers per plant. Additional information on infloresences, flowers, fruits, and fruit set with standard deviation can be found in Tepedino (2005).

Solitary bees are the primary pollinators of *A. holmgreniorum*. *Anthophora poterae*, a widespread bee in the western United States, appears to be the plant's most frequent visitor (Tepedino 2005). Other pollinators include *Anthophora coptognatha*, *Anthophora dammersi*, *Eucera quadricincta*, *Osmia titusi*, two *Dialictus* species, an undetermined *Anthophora* species also seen with *A. ampullarioides*, and the introduced honeybee, *Apis mellifera* (Tepedina 2005). Bees utilize natural habitat for nesting (Steffan-Dewenter and Tscharntke 1999). For bees to be present in a landscape, habitat must provide suitable nesting substrate and resources such as food, water, and nesting materials (Tepedino et al. 1997, Tepedino 2000). With the diversity of bees visiting *A. holmgreniorum*, a variety of suitable ground nesting substrates is probably required for these pollinators (V. Tepedino, pers. comm. 2006). Also, several of these species nest in wood rather than the ground (V. Tepedino, pers. comm. 2006). Additionally, sufficient quantity of flowers and density of flowering plants is needed to attract bees (Harper et al. 2000). Optimal pollination occurs when there is an abundance of bees (Greenleaf 2005).

A. holmgreniorum does not appear to be capable of vegetative reproduction; thus, the setting of seed is necessary for future offspring. The species is partially self-compatible, i.e., the pollen is capable of fertilizing the female reproductive structures on the same plant and capable of self-pollination within an individual flower. Although flowers on some *A. holmgreniorum* can produce fruit autogamously (i.e., without insect visitation), self-fertilized flowers produce fewer fruits, which ultimately negatively influences the number of offspring (Tepedino 2005). Fruit is produced in the form of a bivalve pod that can contain 30-34 ovules, the body of which becomes seed after fertilization (Welsh 2003). Stubben (1997) found that average seedfill in 1992 was 25 seeds with an average of 11 fruits per plant. Similarly, from 1992 to 2000 Van Buren and Harper (2003a) found an average of 11.1 fruits per plant.

The landscape holds an unknown quantity of seeds, referred to as a seedbank. Although initial results of a continuing study indicate the presence of *A. holmgreniorium* seed reserve (R. Van Buren, pers. comm. 2006), high mortality of seedlings in some years limits the number of adults that contribute to future seedbanks (Van Buren and Harper 2004a). Functional longevity of *A. holmgreniorum* seeds is unknown; however, germination rates are likely reduced over time. *Astragalus* seeds generally have hard seed coats that retain their viability longer than many soft-coated seeds (Hull 1973), and other *Astragalus* species have germinated after decades of storage to almost a century after collection (Hull 1973; Bowles et al. 1993).

A. holmgreniorum habitat is dynamic, and within a given locality occupancy and distribution of plants may shift over time. Seeds are thought to be dispersed by water, as the plants are generally found on the skirt edges of washes or in run-off channels around mounds (Van Buren and Harper 2004a). Rodents and smaller, ground-dwelling birds are other likely dispersal agents (S.L. Welsh, Brigham Young University, pers. comm. 2005).

Astragalus ampullarioides

Collection of demographic and life history data for *A. ampullarioides* began in 1992. *A. ampullarioides*, a perennial herb, has an unknown lifespan, although tracking of seedlings from 1995 indicates a lifespan of at least 9 years (Van Buren and Harper 2003b). Flowering occurs between April and late May; by the end of June plants dry up, although vestiges of dried plants may persist for several months. The perennial rootstock allows *A. ampullarioides* to survive dry years, and in a drought year plants may not emerge (Van Buren and Harper 2003b). Dormancy is one strategy by which longer-lived plant species can survive changing climatic conditions, particularly in relation to rainfall (Epling and Lewis 1952). Epling and Lewis (1952) indicate that the adaptive traits of plant species utilizing dormancy allow some individuals to remain dormant in one growing season while others may breed, producing population components that maintain different norms to fit prevailing conditions.

Each *A. ampullarioides* plant is capable of bearing up to 45 flowers per flower stalk (Welsh et al. 2003, 66 FR 49560), and plants frequently have several stalks. From 1992 to 2000, Van Buren and Harper (2003a) documented an average of 86.7 flowers per plant. The number of seeds per pod ranges from 2 to 17, with 7 to 80% of all ovules producing seed (Tepedino 2005). From 1992 to 2000, Van Buren and Harper (2003a) found an average of 21.8 fruits per plant; however, due to the time of year the information was collected, this number may not indicate all fruits produced. Additional information on infloresences, flowers, fruits, and fruit set with standard deviation can be found in Tepedino (2005).

Primary pollinators of *A. ampullarioides* include the native bees *Anthophora coptognatha, A. dammersi, Anthophora* spp., *Eucera quadricincta, Bombus morrisoni, Hoplitis grnnellei, Osmia clarescens, O. marginata,* and *O. titusi,* as well as the nonnative honeybee *Apis mellifera* (Tepedino 2005). *A. ampullarioides* relies solely on the production of seeds for reproduction, and pollination is thus highly linked to the survival of the species. Although flowers on *A. ampullarioides* plants can produce fruits through self-pollination, this strategy produces significantly fewer seeds per fruit than cross-pollination by insect visitors (Tepedino 2005). Overall, Tepedino (2005) found that pollinator visitation increases the total number of fruit and seed produced, resulting in more genetically diverse offspring.

Methods of *A. ampullarioides* seed dispersal have not been researched. However, water patterns, landscape erosion, and soil slumping likely contribute to the development of appropriate habitat sites and may transport seeds within sites (Van Buren and Harper 2003a). The disjunct populations of *A. ampullarioides* also could imply bird dispersal (S.L. Welsh, pers. comm. 2005).

A ampullarioides seedbank viability and longevity are just beginning to be examined. Van Buren and Harper (2003) data suggest that *A. ampullarioides* maintains a long-lived seedbank. Genetic diversity is likely enhanced by the coexistence in the soil of the seed products of different years (V. Tepedino, pers. comm. 2006) and their random germination. Bench (2006) found in preliminary research on a small sample size that 68.2% of seed collected in the top 1.6 in.(4 cm) of soil from Pahcoon Spring Wash and Coral Canyon was viable. Average seedbank density at the 2 sites was 536 seeds/square foot (ft^2) (49.8 seeds/square meter (m^2) with 852 seeds/ft^2 (79.2 seeds/m^2) found at Pahcoon Spring Wash, which is a high plant-density site (M. Miller, USGS, pers. comm. 2006), and 219 seeds/ft^2 (20.37 seeds/m^2) found at the lower plant-density site (M. Miller, pers. comm. 2006) of Coral Canyon (Bench 2006). This research did not relate seedbank density to density of established plants nor did it consider potential reduced seed production due to herbivory, factors that may influence seed densities in the soil.

Regarding genetic diversity, Stubben (1997) could not conclusively determine whether *A. ampullarioides* plants from the Shivwits population are distinct from the Coral Canyon and Harrisburg Bench and Cottonwood populations, which are over 18.6 mi (30 km) away. Results indicated only 64.1% similarity; however, owing to sampling methods these results were deemed inconclusive by the researcher. Further study is needed to obtain more quantitatively valid data, along with information concerning genetic variation, if any, among individuals.

HABITAT CHARACTERIZATION

Astragalus holmgreniorum

A. holmgreniorum populations occur at elevations between 2,480-3,000 ft (756-914 m) in areas that drain to the Santa Clara and Virgin rivers. The landscape has small and large hill and plateau formations worn by water erosion. *A. holmgreniorum* is most frequently found on the skirt edges of these formations, slightly above or at the edge of intermittent drainages (Van Buren and Harper 2003, 2004) in areas where the soil surface is characterized by small stone and gravel deposits (Van Buren and Harper 2004). Runoff received from nearby sloping areas, combined with slower evaporation due to shading produced by the stone and gravel, may increase water availability for the plants in excess of regional rainfall (Harper 1997; Harper and Van Buren 1997).

The primary geological layers or parent materials associated with *A. holmgreniorum* occurrences include the Virgin Limestone member and Upper Red member of the Moenkopi Formation (Harper and Van Buren 1997). *A. holmgreniorum* also has been found on Chinle shale (Petrified Forest member) with a thin gravel stratum from the Shinarump Conglomerate member (Harper and Van Buren 1997), and it may be affiliated with the Middle Red member of the Moenkopi Formation (L. Hughes, BLM, pers. comm. 2006). Parent materials and their weatherable mineral content greatly influence the formation of soils (USDA et al. 1977). Soil texture by weight contains 30.8% clay, 32.5% silt, and 36.8% sand, and its depth is about 16.9 in. (4.3 cm) (Van Buren and Harper 2003). Percentage of gravel and rock on site is 47.9 (Van Buren and Harper 2003).

Data from 2,824 survey occurrence points gathered in Utah from 2003 to 2006 by R. Van Buren (unpubl. data) correlated to the following soil map units (as described in USDA et al. 1977) ― Badland (80%); Hobog-Rock land association (9%); Isom cobbly sandy loam, 3-30% slope (5%); Badland, very steep (4%); and Eroded land-Shalet complex, warm (1%). These soil map units display attributes of being well-drained to somewhat excessively well-drained, gently sloping and rolling to steep, shallow gravelly or shallow sandy loams, and rock land. Similar data points are lacking for Arizona; however, reconnaissance work done in the late 1980s and early 1990s indicates known sites may be associated with the following soil map units (USFWS unpubl. data 2005) ― Ruesh very gravelly fine sandy loam, 3-20% slopes; Gypill-Hobog complex, 6-35% slopes; and Gypill very cobbly sandy loam, 15-40% slopes series (as described in USDA et al. 1977). The majority of plants (approximately 95%) are found on a 20% slope or less (USFWS unpubl, data 2005). Since map units describe only the predicted distribution of particular soils, opportunities to refine the habitat characterization for *A. holmgreniorum* include fine-scale mapping of surficial hydrologic and/or geomorhphic features (M. Miller, pers. comm. 2006).

At the landscape level, the dominant plant community or land cover within which *A. holmgreniorum* occurs is described as Sonora-Mojave Creosotebush-White Bursage Desert Scrub (NatureServe 2003) and, alternatively, as Mohave Mixed Shrub and Mohave Creosote/Bursage habitats (Bennett et al. 2004). Plants usually occur on bare soils with less than 20% living cover (Van Buren and Harper 2003a, 2004a).

Native plant species associated with *A. holmgreniorum* include perennial shrubs such as *Acamptopappus sphaerocephalus* (desert goldenhead), *Ambrosia dumosa* (white burrobush), *Ephedra nevadensis* and *E. torreyana* (Nevada jointfir and Torrey’s jointfir), *Krameria parvifolia* (range ratany), *Lycium andersonii* (Anderson wolfberry), and *Gutierrezia microcephala* and *G. sarothrae* (threadleaf and broom snakeweed). Native forbs and grasses include *Astragalus nuttallianus* (small flowered milk-vetch), *Chaenictus carphoclina* and *C. stevioides* (dusty-maiden species), and *Hilaria rigida* (big galleta) (Van Buren and Harper 2003a, 2003b, 2004a).

Because of historical and ongoing land disturbance, dominant forb associates include the introduced weedy species *Bromus rubens* (red brome), *Erodium cicutarium* (storksbill), *Malcolmia africana* (African mustard), and *Bromus tectorum* (cheatgrass) (Armstrong and Harper 1991; Van Buren 1992; Stubben 1997; Harper and Van Buren 1998, 2000b; Van Buren and Harper 2003a, 2003b, 2004a). Nonnative annuals make up the highest percentage of living cover in *A. holmgreniorum* habitat, and they tend to emerge prior to *A. holmgreniorum*, thus potentially competing for soil moisture and nutrients.

Astragalus ampullarioides

A. ampullaroides populations are found at elevations between 3,018-4,367 ft (920-1,330 m), typically on purple-hued patches of soft clay soil of which 99% are associated with isolated outcrops of the Petrified Forest member of the Chinle Formation (Armstrong and Harper 1991; Harper and Van Buren 1997; M. Miller, pers. comm. 2006). This substrate, which is light, airy, and unstable when dry (Van Buren and Harper 2003a), expands greatly with precipitation, becoming slick and glue-like and forming mounds (Harper 1997). Equal contraction upon drying often results in the formation of deep, wide fissures, constricting root systems so that few perennial plants persist on Chinle soils (Harper 1997). Less than 1% of known occurrences are associated with the Dinosaur Canyon member of the Moenave Formation (M. Miller, pers. comm. 2006). Additionally, other geologic units such as the Upper Red member of the Moenkopi might provide suitable habitat because of their fine-grained texture, which is similar to that of the Petrified Forest member of the Chinle (M. Miller, pers. comm. 2006).

Because *A. ampullarioides* sites are small and unique, milk-vetch presence is coarsely associated with the following soil map units and plant community information (USFWS unpubl. data 2005). *A. ampullarioides* is documented from the following soil map units described by USDA et al. (1977) ─ Stony colluvial land; Naplene silt loam, 2-6% slope; Eroded land-Shalet complex; Badland, very steep; Mathis-Rock outcrop complex, 20-50% slope; Rock land, stony; Bond sandy loam, 1-10%; Clovis fine sandy loam, 1-5% slope; Badland; and Rock land Hobog association (USFWS unpubl. data 2005). Soil texture by weight is 48.9% clay, 25.1% silt, and 26.0% sand, with an undetermined depth (Van Buren and Harper 2001). Percentage of gravel and rock on site is much lower than *A. holmgreniorum* and measures 13.8% (Van Buren and Harper 2003a).

The dominant plant communities within which *A. ampullarioides* occurs include the Great Basin Pinyon-Juniper Woodland, Colorado Plateau Blackbrush-Mormon-tea Shrubland, Mojave Mid-Elevation Mixed Desert Scrub, Intermountain Basins Mixed Salt Desert Scrub, Sonora Mojave Creosote-Whitebursage Desert Scrub, Intermountain Basins Semi-Desert Shrub Steppe, and North American Warm Desert Lower Montane Riparian Woodland and Shrubland (NatureServe 2003). Site-specific soil and plant community distinctions are being further evaluated by USGS (M. Miller, pers. comm. 2006).

A. ampullarioides habitat is sparsely vegetated, with an average 12% cover (Van Buren and Harper 2003a). Due to soil shrinkage and expansion, native plant species found with *A ampullarioides* are generally herbaceous forbs and grasses including *Calochortus flexuosus* (sego lily), *Dichelostemma pulchellum* (bluedicks), *Hilaria rigida* (galleta), *H. jamesii* (James' galleta), *Sporobolus airoides* (alkali dropseed), and *Lotus humistratus* (hill lotus) (Van Buren and Harper 2003a; M. Miller, pers. comm. 2006). Other native species occurring at *A. ampullarioides* sites nearby include trees and perennial shrubs such as *Pinus edulis* (pinyon pine), *Gutierrezia microcephala* (broom snakeweed), *Coleogyne ramosissima* (blackbrush), *Atriplex canescens* (fourwing saltbrush), and *Artemesia tridentate* var. *wyomingensis* (Wyoming big sagebrush) (Van Buren and Harper 2003a; M. Miller, pers. comm. 2006).

As with *A. holmgreniorum*, the most frequently found forbs associated with *A. ampullarioides* are introduced invasive species such as *Bromus tectorum* (cheatgrass), *Bromus rubens* (red brome), *Erodium cicutarium* (storksbill), and ― of particular concern for this milk-vetch ― *Moluccella laevis* (Bells of Ireland) (J. Alexander, Zion National Park, pers. comm. 2004; Van Buren and Harper 2003b, 2004b). It is unknown if these nonnative invasive species are competing negetatively for soil and water resources.

CRITICAL HABITAT

The final rule listing *A. holmgreniorum* and *A. ampullarioides* as endangered species also found designation of critical habitat to be prudent for both species (66 FR 49560). Critical habitat is defined in section 3(5)(A) of the ESA as ― (a) specific areas within the geographical area occupied by a species at the time of listing on which are found those physical or biological features essential to the conservation of the species and that may require special management consideration or protection, and (b) specific areas outside the geographical area occupied by a species at the time of listing if determined by the Secretary to be essential for the conservation of the species. Critical habitat designation directly affects only Federal agency actions through consultation under section 7(a)(2) of the ESA. This section requires Federal agencies to ensure that the activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or destroy or adversely modify its critical habitat. These regulatory provisions are in effect as long as the species remain listed under the ESA.

In accordance with section 4(3)(a) of the ESA, a proposed rule to designate three units of critical habitat for *A. holmgreniorum* and five units of critical habitat for *A. ampullarioides* has been prepared for public and peer review (71 FR 15966). The proposed units and population subunits for each species are described below, and maps are provided in Appendix C and D. Population numbers within these units are detailed in the following section, Population Abundance and Trends. This proposal is expected to be finalized in late 2006.

Astragalus holmgreniorum

As proposed, critical habitat for *A. holmgreniorum* would encompass 6,475 ac (2,620 ha) occupied by the species. This acreage is divided into three units, which are, in turn, subdivided into a total of six subunits. Units and subunits include:

> <u>Unit 1. Utah-Arizona Border</u> ― This unit encompasses the primary population of *A. holmgreniorum*, found south of St. George in Washington County, Utah, and Mohave County, Arizona. Although this is the biggest population, number of plants varies widely from year to year, based on environmental conditions. The years of highest individual counts (e.g., years with precipitation from January-April) are often the years of high

seedling numbers (Van Buren and Harper 2003a). Plant clusters within this population are separated by I-15, areas of urban development, and patchy natural habitat. Proposed subunits, with acres of occupied habitat, include:

Subunit 1a: State Line – 4,027 ac (1,630 ha)

Subunit 1b: Gardner Well – 564 ac (228 ha)

Subunit 1c: Central Valley – 1,148 ac (466ha)

Unit 2. Santa Clara — West of St. George and south of Santa Clara, this unit consists of two populated areas. The proposed subunits are separated by distance and watershed and include:

Subunit 2a: Stucki Spring – 412 ac (167 ha)

Subunit 2b: South Hills – 155 ac (59 ha)

Unit 3. Purgatory Flat — This unit, found east of St. George, contains a single population and 177 ac (72 ha) of occupied habitat.

Astragalus ampullarioides

Proposed critical habitat for *A. ampullarioides* encompasses 2,421 ac (980 ha) divided into five units, one of which is further divided into two subunits. Units and subunits include:

Unit 1. Pahcoon Spring Wash — This unit, on the western edge of the species' range, contains a single population and encompasses 134 ac (55 ha) of occupied habitat.

Unit 2. Shivwits — This unit, on the Paiute (Shivwits band) Indian Reservation, contains the type locality and single population occupying 240 ac (97 ha).

Unit 3. Coral Canyon — This unit contains a single population with 87 ac (35 ha) of habitat.

Unit 4. Harrisburg Junction — This unit is located near Harrisburg Junction and includes four distinct populated areas, which have been separated into two subunits separated by distance and Quail Creek, a natural waterway:

Subunit 4a: Harrisburg Bench and Cottonwood – 297 ac (120 ha)

Subunit 4b: Silver Reef – 462 ac (187 ha)

Unit 5. Zion — This unit is located within Zion National Park boundaries and encompasses a single population occupying 1,201 ac (486 ha) of habitat. The total area proposed for critical habitat encompasses greater than 95% of the currently known occupied habitat for *A. holmgreniorum* and all currently known occupied habitat for *A. ampullarioides*. Two outlying sites of uncertain status are not included within the proposed critical habitat units for *A. holmgreniorum*. The first is an occurrence of several individuals located north of Atkinville Wash and the State Line subunit on private lands held by Sun River; this area is now under development and the occurrence may be extirpated. The second occurrence, east of the State Line subunit, was documented in 1993 by Ben Franklin, Utah Natural Heritage Program (pers. comm. 2006), but has not been relocated in subsequent surveys (Van Buren 2004a, R. Van Buren pers. comm. 2006). It should be noted that suitable habitat occurs outside the proposed unit boundaries, and future surveys may locate more populations.

POPULATION ABUNDANCE AND TRENDS

Census counts and field reconnaissance indicate that the populations of both *A. holmgreniorum* and *A. ampullarioides* fluctuate widely from year to year, which is thought to be due primarily to extreme variations in local precipitation. Despite variable numbers, both species were considered to be declining at the time of their listing in 2001 (66 FR 49560). Surveys and monitoring efforts for both milk-vetches have been ongoing since the early 1990s.

Both plants have sites where demographic studies have been conducted. These studies involve tagging individuals and categorizing the plant species by age class. Evidence of herbivory, diameter of basal rosette, reproductive output (number of flowers/fruit each year), and, in the case of *A. ampullarioides*, flowering stem height and number of stems are reported for each plant within demographic sites. Additionally, 328 ft (100 m) transects provide estimates of population density, percent cover, associated plant species, frequency of nonnative plants, and other site characteristics. (Because research can negatively affect both the landscape and target populations, related impacts and protective protocols are addressed under recovery action 4.2).

Population counts and plant density are discussed below for each species. As part of the recovery planning process, a preliminary examination of precipitation data gathered at St. George, Utah, (station number 427516) is examined for the life cycle of both species. Other data concerning these species can be found in works by R. Van Buren and K.T. Harper, cited in Part V. Of signal importance is the summary of demographic trend information, such as age class survivorship for these species, in Van Buren (2005). Although this information has not been analyzed, it may provide the basis for modeling current and long-term population trends for the milk-vetches, e.g., population viability analysis.

Astragalus holmgreniorum

In 2001, estimated population sizes for the three identified areas of *A. holmgreniorum* (66 FR 49561) were:

- Utah-Arizona Border (State Line, Gardner Well, Central Valley) ― 9,000-10,000 plants distributed in a patchy pattern,
- Santa Clara (Stucki Spring, South Hills) ― a total of 1,000 plants on 2 sites, and
- Purgatory Flat (Purgatory Flat) ― 30 plants.

The number of acres occupied at the time of listing was not calculated; however. the populations currently being monitored are found in the same areas they were observed in decades ago (R. Van Buren, pers. comm. 2006). The areas containing *A. holmgreniorum* have been surveyed and monitored to some degree since 1988, with more intensive monitoring at the State Line and Gardner Well sites (Utah-Arizona population) since 1992, and at the Central Valley site since 2003 in an area referred to as the South Block (Utah-Arizona population). Survey data for these sites are available in annual reports submitted to various agencies such as BLM and USFWS and organizations such as the State Institutional Trust Lands Administration (SITLA) and The Nature Conservancy (TNC) (Van Buren 2003).

Results from census and demographic work conducted at the Central Valley population (in 2003), within the State Line site (2004 and 2005), and at the South Hills population (2005) are summarized in Table 1. Field reconnaissance also was conducted in 2006, but results are not yet available. These survey results, done in the same areas described at listing, indicate that in years with above-average precipitation, plant numbers are higher than the 2001 population estimates. Approximately 2,500 ac (1,012 ha), with a total of 39,679 individuals, were inventoried at these three populations. Ninety-two percent were seedlings, which are non-reproductive plants with a rosette diameter of 0-2.4 in. (0-6 cm); however, nearly 100% of the Holmgren individuals counted in 2003 and 2004 were seedlings. It is important to recognize that these surveys occurred in different areas and in different years and are not comparable to each other or frequent enough to represent species trends.

Data from a demographic study site at the State Line population indicated that population mortality rates were 97% between the years 2003 and 2004 and 70% between 2004 and 2005. Consequently, the number of individuals that become reproductive adults or reproduce the following year is relatively low (Van Buren 2005).

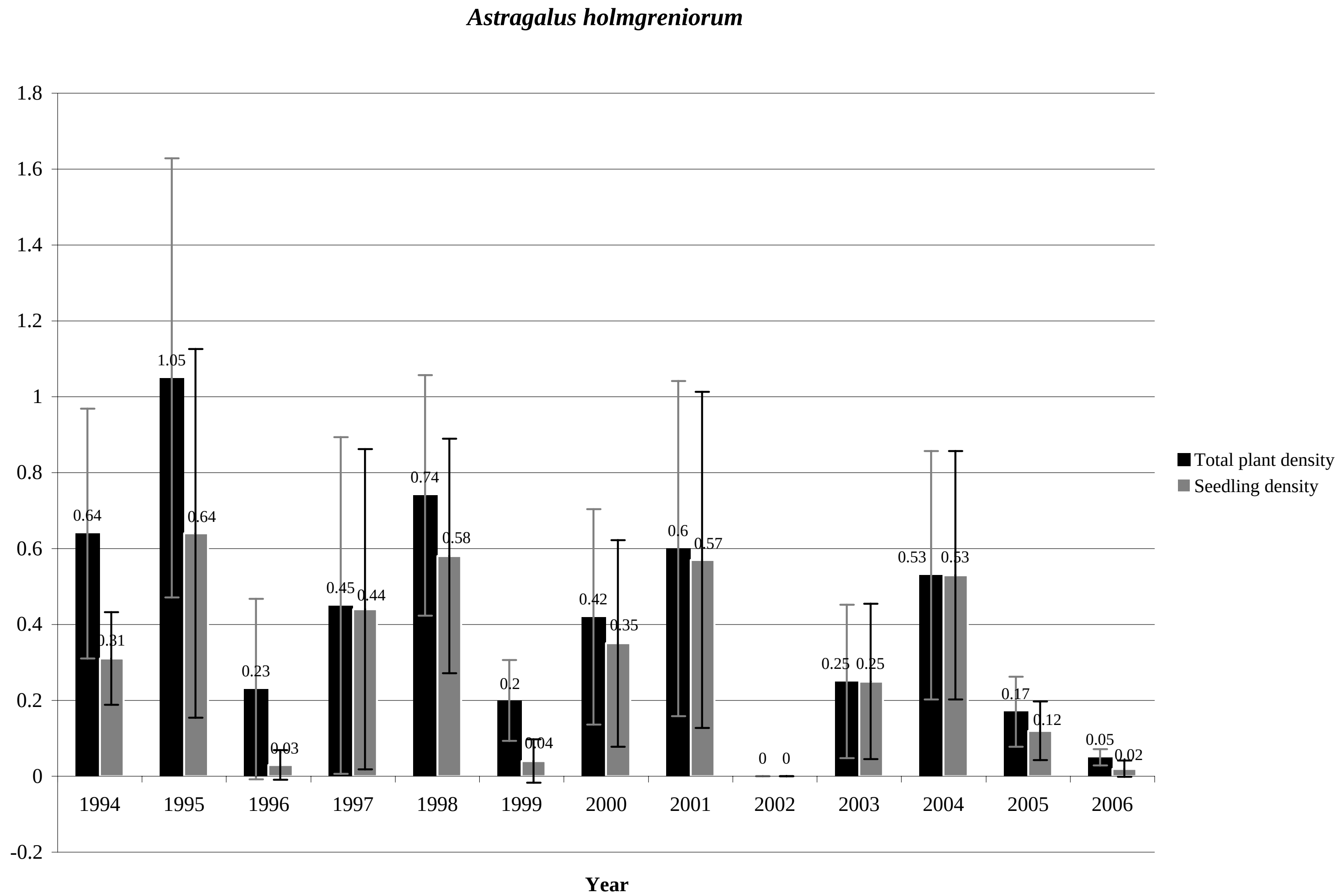
It is undetermined how seedling mortality is affecting the seedbank and future recruitment, but some preliminary inferences can be drawn from available research. Monitoring at the demography plot indicated 4.2% seedling survival between the years 2003 and 2004 and 17.2% survival between the years 2004 and 2005. Demography data from the early 1990s (Stubben 1997) indicated that 21% of plants flower in the second year.

The potential 2004 reproductive output from individuals surveyed in 2003 is estimated at 109 reproductive adults, and the 2005 output of individuals surveyed in 2004 is estimated at 574 reproductive adults. Using a conservative estimate of 11 fruits per plant with an average of 25 seeds, individuals from Central Valley population surveyed in 2003 could provide a return of approximately 29,975 seeds in 2004, and the 2005 estimated seed return from plants on SITLA lands surveyed in 2004 could be 157,850 seeds. Uncertainties, such as percentage of seed loss, are not estimated. Overall, this may suggest that the rate of seed return is sufficient to maintain high seedling flushes; however, research is needed before any conclusions can be reached.

TABLE 1. Recent demographic data for three of six *A. holmgreniorum* populations.

THREE POPULATIONS DESCRIBED IN FINAL RULE	RECOVERY PLAN POPULATIONS	YEAR OF INTENSIVE SURVEY	APPROX ACREAGE SURVEYED	LANDOWNER	TOTAL PLANTS	FLOWERING ADULTS	SEEDLINGS	EST DENSITY PER ACRE
UTAH-ARIZONA BORDER	State Line	2004	600	SITLA	15,902	1	15,819	56.5
		2005	1,100	BLM	11,254	2,338	8,462	10.2
	Gardner Well	-	-	State	-	-	-	-
	Central Valley	2003	700	SITLA	12,315	6	12,290	17.5
SANTA CLARA	South Hills	2005	80	BLM	208	157	24	2.6
	Stucki Spring	-	-	BLM	-	-	-	-
PURGATORY FLAT	Purgatory Flat	-	-	BLM	-	-	-	-
		TOTALS	**2,500**		**39,679**	**2,502**	**36,595**	**15.8**

FIGURE 5. *Astragalus holmgreniorum* density over 13 years, 1994-2006. The black bars represent the mean density of plants per m^2 for six populations. The gray bars represent the mean density of seedlings per m^2 for six populations. The error bars represent standard error.



General density information for six *A. holmgreniorum* study sites (five within the State Line population in Utah and one within the Gardner Well population in Arizona) is summarized in Figure 5 (provided by Van Buren 2006). Number of plants per m^2 (~1 square yard (yd^2)) was measured at each site by counting individuals within a 4 m^2 (~4 yd^2) plot at 20 random points along a permanent transect (Harper and Van Buren 1996, 1997, 1998, 1999; Van Buren 2005). Figure 5 gives some idea of the variation in population size and percentage of seedlings for these years.

A. holmgreniorum seedling density is correlated (r^2 value = 0.20, F = 0.1259) with precipitation in the months January through April (Van Buren and Harper 2003a; R. Van Buren, pers. comm. and unpubl. data, 2006); see Table 2. Precipitation in the months of January-April ranges from 0.2 in. (0.5 cm) in 2002 to 8.35 in. (21.2 cm) in 1993. Density data show a lack of *A. holmgreniorum* individuals in 2002. From 1994-2005, three of the four lowest *A. holmgreniorum* density years (1996, 1999, and 2002) correspond to less than 4 in. of rainfall in the first 4 months of the year. The notable exception is 2005.

Precipitation patterns based on monthly precipitation for St. George, Utah (station number 427516) from 1893 to present were preliminarily examined to determine the length of time necessary for data collection. The sum of the first 4 months of precipitation was rounded to the nearest whole number, as was the sum for all months within the year for purposes of this analysis. Average precipitation in January-April is 4 in. (10.2 cm). Early season precipitation (January-April) that equaled 2 in. (5.1 cm) or less is considered low precipitation, while precipitation of 6 in. (15.2 cm) and above is considered high precipitation. Within the same span (1893-2005), average annual precipitation for the year is roughly 8 in. (20.3 cm). To be conservative, annual precipitation which was equal to or fell below 6 in. (15.2 cm) is defined as low and that which equaled or exceeded 10 in. (25.4 cm) is defined as high. Years with low annual precipitation that also have low precipitation in the first 4 months overlap roughly 55% of the time, while years with high annual precipitation overlap 67% of the time with the first 4 months. Based on the largest gaps seen between precipitation cycles (see Table 3), we believe a minimum of 20 years' worth of data is necessary to exhibit most trends for *A. holmgreniorum*, which forms the basis for population-based recovery criteria.

TABLE 2. Total monthly precipitation (inches); average *A. holmgreniorum* density ft^2 (m^2).

YEAR(S)	JAN	FEB	MAR	APR	MONTHLY TOTAL	ANNUAL TOTAL	AVERAGE DENSITY ft^2 (m^2)
1994	0.1	1.62	0.63	1.45	3.8	8.91	0.060 (0.640)
1995	2.4	0.76	3.34	1.04	7.54	11.03	0.098 (1.051)
1996	0.41	0.74	0.47	0.11	1.73	6.48	0.021 (0.228)
1997	3.86	0.61	0	0.36	4.83	10.68	0.041 (0.445)
1998	0.9	3.11	0.93	1.12	6.06	13.97	0.069 (0.742)
1999	0.34	0.49	0.13	0.85	1.81	5.52	0.018 (0.198)
2000	0	1.87	0.56	0.09	2.52**	6.70	0.039(0.415)
2001	0.79	1.17	1.45	0.86	4.27	6.41	0.056 (0.598)
2002	0.01	0.06	0.13	0	0.2	3.18	-
2003	0.1	2.09	0.98	0.55	3.72*	5.80	0.024 (0.253)
2004	0	3.02	0.15	1.3	4.47**	10.98	0.049 (0.525)
2005	2.69	2.49	0.92	2.24	8.34*	9.17	0.015 (0.165)
2006	0.38	0.02	5.09	0.47	5.96**		0.005 (0.050)

*missing < 5 days of data

**missing > 10 days of data

***data is being re-examined for consistency

TABLE 3. Occurrence of low and high precipitation within first 4 months of the year and yearly since 1893.

113 Years	Number of Low Precipitation Years	Largest Gap of Years for Low Precipitation	Number of High Precipitation Years	Largest Gap of Years for High Precipitation
January-April	**35**	**11**	**18**	**15**
January-December	**33**	**19**	**37***	**10**
Overlap	**18**		**12***	

* Incomplete 2006 data

Astragalus ampullarioides

A. ampullariodes population trends are difficult to detect because sufficient data has not been gathered. Based on climatic or other conditions, the number of *A. ampullarioides* individuals documented in a given year and location varies; life strategies like plant dormancy make estimating numbers of individuals in a particular year difficult (Epling and Lewis 1952). Recent survey results for nine *A. ampullarioides* study sites are provided in Table 4. At the time of listing, the total number of *A. ampullarioides* plants was estimated at 1,000 individuals, (66 FR 49561), whereas 2006 surveys and site visits resulted in an estimate of over 5,000 plants. The higher number of individuals is influenced by the more recent, extensive surveys in Zion National Park, as well as yearly variation in precipitation and the effect on new recruitment (i.e., production of seedlings). Survey numbers also are influenced by the date of survey, climatic conditions, and early seedling mortality. For example, in Zion early monitoring in mid-April of 2006 to mid-June of 2006 of 130 seedlings documented a mortality of at least 30% in the first month of study (M. Miller, USGS, pers.comm. 2006). Application of this information to the numbers at the site counted in mid-April, leads to a predicted reduction of close to 400 individuals if the timing of the survey occurs 30 days later.

TABLE 4. Survey results for nine *A. ampullarioides* study sites.

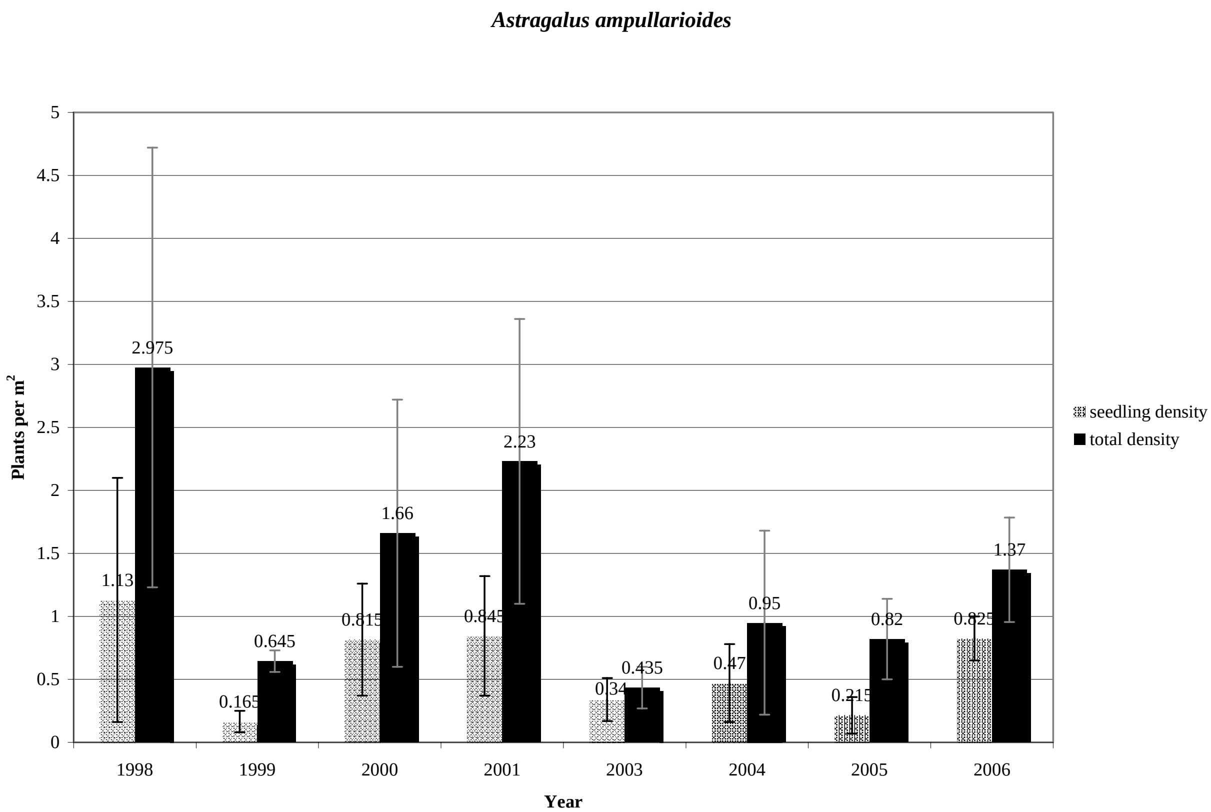
POPULATION	SITE	LANDOWNER	ESTIMATE AT TIME OF LISTING (2001)	CURRENT ESTIMATE*
Pahcoon Spring Wash		BLM	135	400
Shivwits		Tribal	50	37
Coral Canyon		Private	50**	192
HARRISBURG JUNCTION	Harrisburg Bench	BLM		292
	Cottonwood	BLM	300	50
Silver Reef		BLM		12***
ZION	Zion Hilltop	NPS		2,545
	Zion Trailside	NPS	300 — 500	645
	Zion Petrified Forest	NPS		32
TOTALS			1,000	5,185

***** Based on observations made by R. Van Buren and M. Miller 2004-2006.
****** 1,000 individuals estimated in 1995; 200 individuals in 1998.
******* Approximately 150 individuals in 2005.

In 1992, a demographic study site was established for the Coral Canyon population and this population was monitored until the study was relocated to the Pahcoon Spring Wash site on BLM lands in 1995. General density information for the Pahcoon Spring Wash and Harrisburg Bench study sites is summarized in Figure 6. Number of plants per m^2 (~ft^2) was measured at each site by counting individuals within a 4 m^2 (~43 ft^2) plot at 20 random points along a permanent transect (R. Van Buren, pers. comm. 2006). These numbers represent current data and corrections that may differ from prior reporting (R. Van Buren, pers. comm. 2006).

Although no correlation has been established for this species, the early months of the year are likely important in terms of seedling germination and mortality for *A. ampullarioides* (Van Buren and Harper 2003a; R. VanBuren, pers. comm. 2006). Similar to *A. holmgreniorum*, we recognize that comparing population numbers to precipitation needs further refining and analysis; however, we consider a minimum of 20 years data collection sufficient to span most population trends for *A. ampullarioides*, a time length used in defining population based recovery criteria (P-1).

FIGURE 6. ***Astragalus ampullarioides* total plant and seedling density over 8 years from two study plots.** Black bars represent the mean density of total plants from two study plots. The gray bars represent the mean seedling density from two study plots. Data from 2002 was not available due to the lack of plants. Standard error is represented.



LISTING FACTORS AND CONTINUING THREATS

As discussed above, the limited number of populations and restricted habitat of both milk-vetches make them extremely vulnerable to human-caused and natural disturbances. Overall, *A. ampullarioides* is a rarer species with smaller and more isolated populations than *A. holmgreniorum*, but *A. holmgreniorum* is threatened with more pervasive losses due to human activity.

At the time of listing, threats to these species were categorized into the five factors set forth in section 4(a)(1) of the ESA--(1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) overutilization for commercial, recreational, scientific, or education purposes; (3) disease or predation; (4) the inadequacy of regulatory mechanisms; and (5) other natural or manmade factors affecting the species' continued existence. Within these categories, factors identified as contributing to the probability of extinction of *A. holmgreniorum* and *A. ampullarioides* included habitat loss and fragmentation caused by land development and urban expansion in the St. George area; habitat degradation caused by ORV use, mineral exploration and development, and cattle trampling; competition and displacement by exotic weeds, with associated fires; loss or restriction of pollinators; herbicide and pesticide use. *A. ampullarioides* was further determined to be threatened by herbivory and activities associated with clay quarry mining and unauthorized waste disposal (66 FR 49560). Either singly or in combination, these threats diminish the long-term survival prospects of the milk-vetches.

The discussion under each listing factor, below, addresses both the threats identified at the time of listing and newly identified and/or predicted threats that are likely to occur in the foreseeable future (e.g., the next 20 years).

FACTOR A. The present or threatened destruction, modification, or curtailment of habitat or range.

Astragalus holmgreniorum

The final rule noted that the rangewide population of *A. holmgreniorum* is threatened by habitat loss and fragmentation caused by urban expansion in the St. George area (Harper 1997, Stubben 1997). Human population in and around St. George is estimated at 130,000 and is growing rapidly with approximately 1,000 new residents each month (St. George Area of Commerce, Demographics Website, 2006). At the time of listing, residential, commercial, and recreational development was believed to have already eliminated a considerable amount of occupied and potential habitat with continued losses predicted (Harper 1997, Stubben 1997). Habitat loss continues to be the greatest threat to *A. holmgreniorum.* In particular, the economic value of State and private lands for development is shifting open land uses to increased urban development. Current and planned land-use development for housing and community amenities affects the State Line, Gardner Wells, Central Valley, South Hills, and Purgatory Flat milk-vetch populations.

Approximately 50% of occupied habitat for *A. holmgreniorum* occurs in areas targeted for development on Arizona State Land Department (ASLD) and SITLA lands. The primary mission of these agencies is to dispose of their lands for maximum value in order to provide revenue for State school and institutional programs. Housing and community development plans exist for the entirety of two of six *A. holmgreniorum* populations, Central Valley (SITLA) and Gardner Well (ASLD), comprising 25% of proposed critical habitat, as well as parts of the State Line population (Northwest Economic Associates, 2006).

Since listing in 2001, private housing developments have increased on lands occupied by *A. holmgreniorum* in the northern part of the State Line population. The Central Valley population, which supports an estimated one-third of all *A. holmgreniorum* individuals, is within the “South Block” lands proposed for development as a high-density residential community. As envisioned, the development will include residential housing, a new city center, elementary and high schools, and commercial and industrial areas. Similar development is planned for lands under the fiduciary responsibility of ASLD, such as Gardner Well and portions of the State Line population. Real estate development on these properties will result in direct individual plant loss, loss of genetic diversity, and accelerated loss and fragmentation of plant habitat. The overall reduction of plant population viability limits the potential for species' recovery. Because private, State, or other non-Federal funding is involved, land development can continue without review under the ESA.

The BLM lands south of the City of Santa Clara are under active consideration for land trades to support projected community development. The BLM policy authorizes the exchange or sale of land to State or private interests if the transfer results in acquisition of better habitat for a listed species or provides for suitable management by another qualified agency or organization; these exchanges also must comply with the ESA, which requires Federal agencies to ensure that actions they permit are not likely to jeopardize the continued existence of a listed species. Although BLM may compensate for the loss of *A. holmgreniorum* habitat in this area by acquiring property with *A. holmgreniorum*, the net result would be a global loss for the species. Recent correspondence (J. Crisp, BLM, pers. comm. 2006) indicates Federal land exchanges no longer constitute a potential future threat to the South Hills and Stucki Spring *A. holmgreniorum* populations.

Several activities associated with urbanization that were identified as possible threats to *A. holmgreniorum* at the time of listing remain so today with the exception of the new airport location. These activities include the construction of new roads, highways, electric power transmission lines, pipelines, and maintenance of existing roads (66 FR 49560).

Development of new surface roads is expected to keep pace with the expanding housing market and the proposed creation of highway corridors in the vicinity of St. George. For example, the Southern Corridor is a proposed 4-lane, limited-access highway, originating near milepost 2 of I-15 and connecting with State Route 9 near Hurricane. Direct impacts to *A. holmgreniorum* include loss of individual plants, and indirect impacts include induced urban development associated with access provided by the highway. The USFWS biological opinion on the Southern Corridor recommended that "Federal Highway Administration (FHWA) ensure full compensation for all direct and indirect effects associated with the Southern Corridor. Compensation should consider protection or purchase of Holmgren milk-vetch habitat in the area of influence of the proposed action; the South Block Lands proximal to the Southern Corridor." Although the FHWA has committed to provide mitigation for *A. holmgreniorum* through land acquisition in the Central Valley population for a plant preserve (Utah School and Institutional Trust Lands Administration et al. 2005, loss of plants and fragmentation of *A. holmgreniorum* habitat will result from completion of this project.

As part of its transportation planning process, the Dixie Metropolitan Planning Organization is examining the potential for a Western Corridor connecting the city of Ivins to the Sun River Parkway and I-15, near milepost 2. The need for this project has not yet been determined and it is in its early planning stages; however, the currently considered pathway of the Western Corridor is likely to bisect or disturb occupied and supporting habitat of the Stucki Springs and South Hills populations.

Regular road maintenance activities for I-15 that are expected to occur within the *A. holmgreniorum* State Line population include refurbishing signs, pavement rehabilitation, upgrading guardrails and crash attenuators, replacing delineators, installing rumble strips, and placing buried conduit for electronic traffic management systems (P. West, Utah Department of Transportation (UDOT), pers. comm. 2006). Another associated activity is vegetation control, which may include herbicide application, prescribed burning, mowing, and seeding. These activities are subject to the development of Best Management Practices to reduce or remove species impacts. None of these activities occurs regularly, and some of them constitute potential rather than actual threats.

Information on pipelines and their potential impact on the species is lacking. A utility corridor exists within the State Line population and a substation and transmission lines exist at the Central Valley population. Powerlines are located within other populations such as the Stucki Spring and Purgatory Flat. In general, utility maintenance is low and new impacts to the species' habitat are not foreseen at this time.

Similarly, the final listing rule indicated that mining might result in habitat-related impacts for the species. Mining activities are unknown in the past decade and are not considered to be future threats for *A. holmgreniorum.*

Maintenance of river corridors may present a new albeit temporary threat. In response to the 2005 Virgin River flooding, stabilization efforts in 2006 resulted in construction of a haul road along the Southern Corridor alignment. This haul road may have affected a larger and/or different land area than that of the Southern Corridor. The USFWS and Natural Resources Conservation Service are further analyzing actual impacts. Future river corridor maintenance could similarly affect habitat areas in the State Line population.

Recreational facility development is affecting the species. Within the Purgatory Flat area, lands are leased from the BLM (St. George) for a shooting range, which Washington County now proposes to privatize for the creation of a Southern Utah Shooting Sports Park (Northwest Economic Associates, 2006). The lease in 1999 indicated that special management by BLM, USFWS, and the State would include monitoring of the *A. holmgreniorum* population there to assure that it remains in a stable or expanding trend. If the population is found to decrease as a result of the proposed action, measures would be taken to mitigate the negative effects. At this time, no regular monitoring program exists.

Habitat fragmentation is associated with habitat loss and is often a consequence of land development and urban expansion. In some cases, the effects of habitat fragmentation may be more deleterious than the development itself. One such case is where I-15 has bisected the State Line population of *A. holmgreniorum.* This division reduces the likelihood of successful genetic interchange, as pollinators crossing the roads face potential mortality in collisions with oncoming cars. Although some studies suggest that site fidelity rather than roads may limit movement of certain pollinators (Primack and Gerwin 2003), this is debatable (V. Tepedino, pers. comm. 2006).

In the 2001 final listing rule, the USFWS identified habitat degradation from ORV use (also known as off-highway vehicle (OHV) use) as a threat for *A. holmgreniorum.* Within the State of Utah, registered off-highway vehicles have risen 195% in Utah since 1998, with a 437% increase in Washington County, Utah (F. Hayes, Utah Division of Parks and Recreation, pers. comm.

2005). This is a serious and continuing threat. The ORV activities exploit the area's hill and plateau formations by trailing up and down the sides and denuding the landscape of vegetation and biological soil crusts that maintain soil stability. Hydrologic patterns can be affected, which may unnaturally restrict population size and seed dispersal. The ORV activities increase habitat fragmentation and create favorable conditions for invasive plant species. The ORV use currently degrades or has the potential to degrade habitat for all known *A. holmgreniorum* populations, especially Stucki Spring and Central Valley.

Milk-vetch habitat degradation also is caused by cattle trampling, recreational trail use, and military operations, which disturb the soil surface and seedbanks for these species (R. Van Buren, pers. comm. 2006). Cattle allotments exist within the State Line and Gardner Well populations. It was noted in the 2001 final listing rule that habitat degradation resulted from military training operations conducted by the Utah Army National Guard on State lands now referred to as the Central Valley population (66 FR 49560). The Utah Army National Guard has since redirected training to areas outside of habitat (L. England, USFWS, pers. comm. 2006). Recreational trail use is mostly found at State Line, Stucki Springs, and South Hills populations.

Finally, a growing and potentially widespread phenomenon is the increased likelihood of fires associated with invasive plant species. Invasive annual grasses such as cheatgrass and red brome grow in sufficient densities and become dry enough to sustain a fire over large areas. The native Mojave Desert vegetation is not adapted to a frequent fire regimen (R. Bolander, BLM, pers. comm. 2005). For example, lands managed by the BLM's Arizona Strip District and evaluated from 1980 to 2002 showed most fires were small, 0.1 ac (0.04 ha) in size, with fires ranging from 0.1 ac (0.04 ha) to 16,816 ac (6,805 ha) in size (Schussman and Gori 2004). In the past, desert communities experienced an historic return interval of 250 years for fire occurrence (Schussman and Gori 2004). A high number of fire occurrences in non-fire adapted areas in the northwest corner of Arizona near the Arizona-Utah border were mapped by Schussman and Gori (2004); however, specific details such as fire size and return frequency were not refined at a small-scale level to determine potential effect on *A. holmgreniorum*. Typical post-fire habitat changes show an increase in invasive annual grasses, which in turn increases the rate of fire return and displacement of native species (M. Falk, USFWS, pers. comm. 2006). Annual invasives and fire have the potential to cause permanent changes in vegetative communities that harbor the milk-vetches.

Astragalus ampullarioides

Habitat loss due to the growing development pressures in the vicinity of St. George and associated infrastructure also threaten *A. ampullarioides* populations. Residential and commercial development, which indirectly affects known occupied areas, is occurring at the Coral Canyon population and, to a lesser degree, at the Harrisburg Bench and Cottonwood and Silver Reef populations. New roads, highways, electric power transmission lines, and pipelines were constructed in *A. ampullarioides* areas prior to the final listing rule and probably caused past impacts on *A. ampullarioides* populations. For example, the construction of highway I-15 altered the Cottonwood site within the Harrisburg Bench and Cottonwood population areas. It is not known if additional utility or transportation corridors will be constructed in the future. Current and future highway maintenance (see *A. holmgreniorum* above for description of projected activities) is a potential threat.

Habitats supporting the Coral Canyon and Shivwits *A. ampullarioides* populations occur primarily on non-Federal lands. The Coral Canyon population is located on a site that has undergone multiple land use changes. It is located between the edge of a golf course and a county-maintained road. This site was disturbed as a clay pit and unauthorized waste disposal area prior to golf course development. The species is persisting, but housing development is projected across the road, further reducing the natural landscape on which native pollinators may persist. No land development is predicted at the Shivwits population site, where the Tribe has expressed the desire to develop a management plan for conserving the Shivwits population.

Within the Zion population, a recreational trail poses a potential threat to individuals and habitat, albeit the frequency of habitat disturbance and/or direct plant loss is unknown. Research on user impact has been suggested so that Zion National Park can better manage and assess continuing threats of this species on its lands.

In the final listing rule, an electric power transmission line was projected to pass through the Pahcoon Spring Wash and Shivwits *A. ampullarioides* populations at the western edge of the species' range, as well as through the easternmost population within Zion National Park. Prior to these projects, surveys conducted for this species did not result in any new *A. ampullarioides* sites being found (L. England, pers. comm. 2006). In response to potential adjacent utility corridor activities, the Shivwits band of the Paiutes fenced the main area of plant occupancy.

Silver mining diminished by the early 1900s (R. Douglas, pers. comm. 2005) and is not believed to be a future threat for *A. ampullarioides.* Other mining, such as removal of landscaping rock, exists at a distance to the Pahcoon Springs Wash population but does not appear to constitute a threat.

At the time of listing, habitat degradation from ORV use was identified as a threat for *A. ampullarioide,s* and it continues to be a serious threat, given the increasing popularity of ORV activities in Washington County (see *A. holmgreniorum* above for more details). The ORV activities in *A. ampullarioides* habitat are particularly damaging, as the localized clay substrate lacks soil stability and is easily disturbed. The ORV activities lead to associated plant loss, habitat degradation, and changes in native plant communities. Although fencing will not abate all ORV use within *A. ampullarioides* habitat, fencing at the Pahcoon Spring Wash, Harrisburg Bench and Cottonwood, and Silver Reef population, which is expected to be completed in October 2006, will reduce direct ORV impacts to sites on BLM lands. The Silver Reef population currently experiences the highest levels of ORV use, but a portion of the this population has been incorporated into the Red Cliffs Desert Reserve (Washington County Habitat Conservation Plan (HCP), 1995) due to a boundary adjustment (J. Crisp, pers. comm. 2006) and thus will be afforded better protection through site-specific planning for recreational management, recreation use monitoring, and law enforcement.

Milk-vetch habitat degradation is caused by cattle trampling, which disturbs the soil surface and seedbanks for these species. This is an issue for the Pahcoon Spring Wash, Shivwits, and Silver Reef *A. ampullarioides* populations. In particular, the Pahcoon Spring Wash habitat has recently experienced severe cattle trampling (Van Buren 2005), disturbing the fragile clay soils found on the Chinle and Moenave formations and crushing individual plants. Supporting soils are especially susceptible to disturbance and compaction caused by trampling and overuse (R. Van Buren, pers. comm. 2006). In addition to cattle trampling, *A. ampullarioides* may incur damage during survey efforts if these activities are conducted without sufficient caution. Cattle or human trampling is expected to diminish in the future in light of recently funded fencing projects expected to be completed in October 2006.

Finally, as described for *A. holmgreniorum*, St. George, Utah, and surrounding areas are experiencing an increase in fires due to exotic, nonnative grasses such as cheatgrass and red brome. In 2005, fire ran through the Harrisburg Bench site of the Harrisburg Bench and Cottonwood population. Site visits in 2006 documented species presence and indicated a healthy return. Timing of the 2005 fire coincided with annual plant dormancy patterns, which appears to have reduced detrimental effects (R. Van Buren, pers. comm. 2006). Fires in past years and in 2006 occurred close to the Pahcoon Springs Wash and Shivwits populations on the eastern slopes of the Beaver Dam Mountains. Both BLM and the Tribe are aware of *A. ampullarioides* population locations and efforts will be made to protect the plants.

FACTOR B. Overutilization for commercial, recreational, scientific, or educational purposes.

A. holmgreniorum and *A. ampullarioides* do not have any known commercial, recreational, or scientific use, nor was any evidence of over-collection by botanists or horticulturists cited during the listing process for these species.

FACTOR C. Disease or predation.

There is no indication that diseases threaten the continued survival of either *A. holmgreniorum* or *A. ampullarioides*. In terms of predation, *A. holmgreniorum* may be occasionally susceptible to herbivory, while *A. ampullarioides* is extremely palatable to both wildlife and domestic livestock. Tepedino (2005) indicates losses to herbivores, including cattle for research done at the State Line (*A. holmgreniorum*) and Coral Canyon (*A. ampullarioides*) populations; however, this information was not quantified. At the time of listing, livestock grazing at the two western *A. ampullarioides* populations, Pahcoon Spring Wash and Shivwits, was of concern. However, protective fencing at the Shivwits population has greatly reduced the threat at that site, as will fencing slated to be installed at the Pahcoon Spring Wash in October 2006.

Overgrazing by livestock can eventually cause a shift in the plant communities, favoring invasive plants to the detriment of both *A. holmgreniorum* and *A. ampullarioides* (see Factor E). Recent herbivory at the *A. ampullarioides* demography study site at Pahcoon Spring Wash population is tentatively attributed to rabbits (Van Buren 2005), although it is not known if the level of herbivory negatively affects the plants at the population level. Some degree of natural herbivory occurs every year in *A. ampullarioides* populations (Van Buren 2005). High herbivory was seen in preliminary research conducted in 2006 at Zion National Park, where 90% reduction in fruit production was attributed to vertebrate herbivores.

One additional factor that warrants further research is the potential for parasitism and insect infestations, particularly in regard to potential effects on *A. ampullarioides* populations. Past monitoring documented aphid infestations associated with *A. ampullarioides.* Also, an outbreak of white moths, which visited flowers in April 2005, may have restricted production of seeds. By May, flowers dropped off the stem, inhibiting fruit development, and these symptoms could either be related to white moth predation or to a coincidental lack of pollination. If this reoccurs, it will become a priority for further investigation.

FACTOR D. The inadequacy of existing regulatory mechanisms.

In Utah, occupied *A. holmgreniorum* habitat occurs on BLM, SITLA, and privately owned lands and *A. ampullarioides* occurs on BLM, SITLA, NPS, and Tribal lands. In Arizona, *A. holmgreniorum* is restricted to BLM and State lands immediately adjacent to the Utah border.

Some policy-level protection from BLM is afforded through the St. George Field Office's Record of Decision and Resource Management Plan (BLM 1999) and under the upcoming Arizona Strip Resource Management Plan Revision. However, populations of both species remain in areas valued for future urban expansion, including some public lands. The Draft EIS for the Arizona plan includes a statement that BLM will not dispose of designated or proposed critical habitat and, due to the recently proposed critical habitat for *A. holmgreniorum*, 417 ac (169 ha) of public lands administered by the Arizona Strip Field Office (ASFO) will be retained in Federal ownership (M. Herder, BLM ASFO Wildlife Team Lead, pers. comm. 2006).

Apart from the ESA, which is applicable to listed plants on Federal lands and to actions funded with Federal dollars, other existing regulations or laws provide only limited protection for these milk-vetches or their habitat. As referenced on the Arizona Department of Agriculture website (2005), the Native Plant Law of 1993 includes the following requirement: "Lessees of state or federal land must obtain specific authorization from the landlord agency to remove protected native plants. Theft of protected native plants from private, state, or federal lands may result in a felony charge, as well as native plant law violation." However, this does not provide any protection for plant habitat in Arizona. The State of Utah does not have any plant protection laws.

An analysis of past recovery plan efforts found that listed species, including plants, whose primary habitat contains 50% or greater Federal lands had a higher level of implemented recovery tasks (Hatch et al. 2002). Lack of Federal jurisdiction may limit the ability of recovery teams to implement recovery tasks on non-Federal lands (Hatch et al. 2002), as there is no legal protection for either species on State lands in Utah or Arizona or on private property. For *A. holmgreniorum* less than 50% of its primary habitat is on Federal lands, while for *A. ampullarioides* 90% or greater are on Federal lands.

FACTOR E. Other natural or manmade factors affecting the species' continued existence.

Past habitat disturbance has caused the proliferation of invasive annual weeds into both species' occupied habitat (Harper 1997 and Van Buren and Harper 2000a, 2000b *in* 66 FR 49560). In fact, all populations of both *A. holmgreniorum* and *A. ampullariodes* have been affected to some degree by invasive nonnative annuals, which make up the highest percentage of living cover in the habitat of both species (Van Buren 2004). Because invasive annuals tend to emerge prior to the milk-vetches, competition for soil moisture and nutrients and displacement of the milk-vetches is an emerging threat.

A. holmgreniorum and *A. ampullarioides* are pollinated by native solitary ground-dwelling bees (Tepedino 2005). Fragmented, disjunct habitats hamper pollinator exchange between populations, which could cause genetic isolation and potentially lead to inbreeding and local extirpation of isolated populations (Heschel and Paige 1995). Urban expansion and associated impacts may directly and indirectly affect pollinators through loss of pollinator habitat (Tepedino 2005). For both species, lack of pollinators would result in a gradual decrease in the number of seeds in the seedbank (Tepedino 2005). Additionally, small and restricted sites of other rare *Astragalus* were found to receive lower levels of pollinator vistors (Karron 1987). The Gardner Well, Stucki Spring, South Hills, and Purgatory Flat *A. holmgreniorum* sites are small and disjunct. Similarly, all *A. ampullarioides* sites, except for Zion, are small and disjunct.

Climate change has emerged as a significant concern, particularly in regard to the potential for increasingly prolonged drought cycles (Miller 2005; R. Van Buren, pers. comm. 2006). Both *A. holmgreniorum* and *A. ampullarioides* have higher germination and survivorship rates during and following years of increased precipitation (Van Buren and Harper 2003a), and if consecutive years of low reproductive output caused by drought conditions outlast seedbank longevity, the affected populations could become extirpated (R. Van Buren, pers. comm. 2006). Given that drought events occur at a regional scale (Miller 2005), this could prove to be a serious limiting factor for both species. Frost kill also affects both species and could become a more prevalent problem with long-term seasonal changes (R. Van Buren, pers. comm. 2006). Additionally, some *A. holmgreniorum* and *A. ampullarioides* are small-sized and could be threatened by stochastic events.

THREATS ASSESSMENT

Recovery of *A. holmgreniorum* and *A. ampullarioides* depends on the reduction of risks to the point where these species are no longer in foreseeable danger of extinction. This in turn requires an understanding of the relative level of extinction risk posed by individual and combined threats to the species' continued survival, which is derived from structured threats assessments. Using the ranking criteria below, the following assessment[3] considers--(1) the extent to which the milk-vetches are exposed to each threat described in the preceding section, and (2) the level of risk posed by each identified threat.

[3] This threats assessment is adapted from TNC's methodology. The TNC approach involves the use of matrices to identify and characterize known stressors and their sources according to their scope, immediacy, severity, and irreversibility (TNC 2005).

- **Exposure**, i.e., the extent to which the species and the threat (which includes the stressor and/or source of stress) actually overlap in space and/or time. For the milk-vetches, exposure was determined in terms of actual or potential effect on individuals within each population. No ranking score was assigned to this category.

- **Immediacy**, i.e., the action time frame of the threat. This entails assessing whether the stressor is present and acting on the species now, is anticipated in the future, or has already occurred (in which case restoration is more appropriate than threat abatement). Rankings were assigned as follows:

  3 = present and acting on the species now
  2 = anticipated in the future
  1 = impact has already occurred

- **Severity**, i.e., the intensity or strength of the threat where it occurs.

  3 = high severity (e.g., permanent population loss or mortality)
  2 = moderate severity (e.g., temporary population loss or reduced recruitment)
  1 = low severity (impacts on individuals, but no population-level effects)

- **Recovery/Management Potential**, i.e., how possible it will be to reverse and abate the threat, based on technical expertise and management capabilities.

  3 = high potential (management techniques are well-known and success is highly likely)
  2 = medium potential (management techniques are known but success is less predictable)
  1 = low potential (no known management techniques, no way to predict success at this point)

Matrices have been used to assess the threat to each milk-vetch. These charts provide both a quick overview of threats and the ability to assess where recovery efforts should be focused. For example, the addition of ranking criteria, for example 3+3+3 gives the highest result, i.e. a 9, which indicates an area of where a threat is ***present*** and acting on the species, has high severity, and the potential to address this threat is well-known and success is highly likely. A narrative summary of the results and their implications accompanies each matrix. It should be noted that the threats assessments cover only those listing factors that have a foreseeable effect on each species. In particular, Factor B, overutilization, is not applicable to either species, and Factor D, inadequacy of regulatory mechanisms, is not amenable to assessment as a direct threat to these species.

Astragalus holmgreniorum

As the matrix in Table 5 shows, all *A. holmgreniorum* populations are exposed to some threats: some activities threaten a majority but not all of the populations, and some affect only a minority. Pervasive threats to this species include land development/urban expansion, invasive plant species, and the prospect of prolonged drought caused by climate change. Of these, land development and invasive plants pose current and ongoing threats to *A. holmgreniorum*, and land development represents a threat of the highest order.

Development activities result in an irredeemable loss of habitat, unlike invasive species, which may be amenable to control if effective management techniques can be developed. Land development not only causes direct habitat destruction, it also can result in disturbance of nearby habitat (e.g., through soil disturbance, changes in hydrology, and increased human access), which could in turn set the stage for additional problems with invasive species. Together, habitat loss and disturbance could cause the extirpation of local populations and, through synergistic effects, rangewide extinction. This is an acute problem for the Central Valley population, which coincides with the planning area for a large residential community that will destroy most of the plant's habitat. Some onsite areas are being set aside for the plant, but as planned, these will provide habitat for only a small, isolated portion of the extant population, and there are doubts about the long-term continued viability of this population unless additional and linked habitat preserves can be secured. The acquisition of land and its protection would directly offset population loss and would highly improve recovery scenarios. Unfortunately, habitat conservation through land acquisitions and easements is costly due to sharply increasing property values in the vicinity of St. George.

Introduction of invasive plants is one of the fastest growing threats for many rare and endangered species, and bringing invasive species under control once they are established has proven to be a difficult issue; however, as long as the soil substrate and seedbank for *A. holmgreniorum* are protected, a remedy to invasive species may be achieved. Just as invasive species affect all known *A. holmgreniorum* populations, so could fires associated with the spread of nonnative invasive species. The spread of fire through vegetation communities occupied by *A. holmgreniorum* has not been a problem in the past and is not an active concern at the present time, but as exotic plant species become more prevalent within the Mojave Desert ecosystem, fire holds the potential to affect this species throughout its range.

Although long-term changes in regional precipitation and temperature regimes may affect the distribution and viability of this and other endemic plant species in the future, much uncertainty remains about climatic trends and the ability of *A. holmgreniorum* to adapt to gradual changes. The primary concern at this point with regard to climate change is the potential for drought — whether part of a broader climatic trend or not — to outlast the period over which the species can withstand consecutive years of reduced reproductive output and seedbank depletion. Thus, while climate change is viewed as a potential rather than current threat, drought years warrant close observation for effects on each population. Measures to mitigate loss of reproductive adults and seed output may be necessary on an emergency and ongoing basis.

Natural resource utilization for outdoor recreation, particularly ORV use, affects all populations; however, human use at one population (Purgatory Flat) has been effectively controlled with fencing. Other human uses in milk-vetch habitat have included the illegal dumping of household items. Subsequent use of these household items for target practice results in increased litter accumulation from ammunition cartridges. If left unabated, these activities, particularly ORV use in the direct localities of the plants, could cause long-term, irreparable harm. Although known populations of *A. holmgreniorum* could rebound and persist with effective management controls, the required enforcement efforts will be substantial. In addition, the demand for recreational and general access is likely to grow as the regional population increases and land development expands, exerting more pressure on *A. holmgreniorum*.

Presence of pollinators depends on meeting their habitat and foraging requirements, which can be impaired by the same activities that affect the plants. Reduced availability of pollinators could severely reduce *A. holmgreniorum* population viability; thus, impacts on the plants and their pollinators must be considered together.

Impacts associated with cattle include trampling of individual *A. holmgreniorum* plants (R. Van Buren, pers. comm. 2006), as well as the defoliation and removal of palatable plant species, which changes plant community structure, soil compaction, abrasion, and destabilization, and redistribution of soil nutrients and ecological succession (Fleischner 2006; Cole and Landres 1996). The normal grazing period for the River Pasture, containing the State Line population, within the Curly Hollow Allotment is November 1 to January 31; however, due to recent wildfires, adjustments have allowed Spring grazing in River Pasture to allow the restoration of other pastures within this allotment (J. Crisp, BLM, St. George Field Office, pers. comm. 2006). Additionally, the Gardner Well population experiences grazing under a Arizona State grazing lease (Lizard allotment). Soil compaction due to cattle activities, can indirectly impact the soil seedbank. If seedlings cannot emerge from the soils, germination will not occur (R. Van Buren, pers. comm. 2006). Also, soil compaction reduces the ability for moisture to penetrate into soils and thus be available to seeds (R. Van Buren, pers. comm. 2006). Nonetheless, the effects of cattle at the State Line and Gardner Well populations are considered to be of low severity due to undemonstrated potential.

Herbicide use may affect the State Line population due to vegetation control on Interstate highway I-15 (Northwest Economic Associates 2006). Herbicide use within or adjacent to other *A. holmgreniorum* populations has not been documented. The threat of herbicide use is thus localized and of lesser concern with regard to *A. holmgreniorum* survival and recovery. However, it should be noted that threat scenarios can change over time, and all activities thought to pose a current or future threat to the species should be monitored and addressed.

TABLE 5. *A. holmgreniorum* threats matrix ("x" indicates *present* at site)

LISTING FACTOR/STRESSOR	SOURCE OF STRESS	EXPOSURE						IMMEDIACY	SEVERITY	RECOVERY/ MANAGEMENT POTENTIAL
		UTAH-ARIZONA BORDER			SANTA CLARA BUTTE					
		State Line	Gardner Well	Central Valley	Stucki Spring	South Hills	Purgatory Flat			
Factor A. The present or threatened destruction, modification, or curtailment of the species' habitat or range.	Land development/urban expansion	x	x	x	x	x	x	3	3	2
	ORV use/unauthorized recreational access	x	x	x	x	x		3	3	2
	Illegal dumping/waste disposal	x	x	x	x	x		3	1	2
	Cattle associated impacts	x	x					3	1	3
	Fires (associated with invasive, nonnative plants)	x	x	x	x	x	x	2	2	2
Factor E. Other natural or manmade factors affecting the species' continued existence.	Over-competition & displacement by invasive plants	x	x	x	x	x	x	3	3	2
	Small sites and/or habitat restriction for pollinator services		x		x	x	x	3	2	1
	Herbicide use	x						2	1	3
	Prolonged drought caused by climate change	x	x	x	x	x	x	2	2	1

In terms of *A. holmgreniorum* populations that are under more or less threat, the State Line population is subject to the greatest variety of threats. However, the Central Valley population is under imminent threat of development and is thus the population of most acute concern at the present time. The Purgatory Flat population, albeit small and less studied than most of the other *A. holmgreniorum* populations, is subject to the fewest threats.

Based on the need for a recovery response at the species level, threats to *A. holmgreniorum* are prioritized in rough order of highest to lowest concern and ability to effectively address through management efforts:

- Land development/urban expansion
- Invasive plant species and the potential for associated wildfires
- ORV use and other unauthorized recreational land uses
- Impacts on pollinators
- Prolonged drought caused by climate change
- Unauthorized land uses such as waste disposal and gun target practice
- Cattle activities
- Herbicide use

Astragalus ampullarioides

The threats matrix in Table 6 shows that all known *A. ampullarioides* populations are threatened by ORV and other recreational uses, invasive plants and the fires associated with their establishment, prolonged droughts caused by climate change, and herbivory. Current land development poses an indirect threat to three of the six *A. ampullarioides* populations (Coral Canyon, Harrisburg Bench and Cottonwood, and Silver Reef); however, it is not considered as pervasive a threat for this species as it is for *A. holmgreniorum.* If development pressures increase, they may constitute a significant extinction risk for this plant, similar to that occurring in *A. holmgreniorum* population areas.

The ORV and other recreational uses affect all *A. ampullarioides* populations except, possibly, the Shivwits population. Recreational uses within this plant's habitat have been restricted since its listing, but unauthorized uses continue and if left unabated they could cause long-term, irreparable damage to the populations. Silver Reef in particular is an area subject to significant ORV use. Although the long-term management needed to control unauthorized access is substantial and may become even more challenging as futuredemand for recreational access grows, proposed fences at the Pahcoon Spring Wash population, the Harrisburg Bench site, the Cottonwood population, and the Silver Reef population (planned for installation in October 2006) should ameliorate the threat of ORV use in these populations.

TABLE 6. *A. ampullarioides* threats matrix ("x" indicates *present* at site)

LISTING FACTOR/ STRESSOR	SOURCE OF STRESS	EXPOSURE						IMMEDIACY	SEVERITY	RECOVERY/ MANAGEMENT POTENTIAL
		Pahcoon Spring	Shivwits	Coral Canyon	Harrisbug Bench	Silver Reef	Zion National Park			
Factor A. The present or threatened destruction, modification, or curtailment of the species' habitat or range.	Land development/urban expansion			x	x	x		3	2	2
	ORV use and recreational access (including road/trail development and use)	x			x	x	x	3	3	2
	Illegal dumping/waste disposal				x	x		1	1	2
	Cattle associated impacts	x	x			x		3	2	3
	Fires (associated with invasive, nonnative plants)	x	x	x	x	x	x	2	2	2
Factor C. Disease or predation	Herbivory	x	x	x	x	x	x	3	1	2
	Insect infestations/parasitism	x	x	x	x	x	x	3	1	2
Factor E. Other natural or manmade factors affecting the species' continued existence.	Overcompetition and displacement by nonnative plants	x	x	x	x	x	x	3	2	2
	Small sites and/or habitat restriction for pollinator services	x	x	x	x	x		3	3	1
	Pesticide/herbicide use			x	x			2	2	3
	Prolonged drought caused by climate change	x	x	x	x	x	x	2	2	1

Establishment of invasive plants is a serious concern and bringing them under control is a difficult problem; however, as long as *A. ampullarioides* habitat and seedbanks remain intact, it is possible that an effective management remedy will be found. The threat of fire associated with invasive exotics is increasing. In 2005, a fire encroached upon occupied habitat at the Harrisburg Bench site (east of I-15) within the Harrisburg Bench and Cottonwood population, although data from 2006 indicate that the milk-vetch population was unaffected by the fire (R. Van Buren, pers. comm. 2006). It is unknown whether the time of this fire in July and likely plant dormancy contributed to this benign result, nor can we ascertain at this point if fire under different conditions would produce more adverse results.

Because of the plant's palatability, excessive herbivory also is a rangewide concern for *A. ampullarioides*. Some level of herbivory by wildlife is natural and the species' evolutionary and life history is adapted to it, but overgrazing at levels that decimate a population can be sustained only as long as the seedbank remains viable. Although the listing of this species focused on livestock grazing at Pahcoon Spring Wash and Shivwits populations (which is now largely excluded at Shivwits and designed to be excluded at Pahcoon Spring Wash), all *A. ampullarioides* populations are potentially susceptible to the effects of overgrazing by livestock and setbacks to survival or productivity caused by overgrazing in combination with adverse environmental conditions.

Any prolonged drought (whether or not part of a broader climatic trend) that outlasts seedbank longevity constitutes an extinction risk for *A. ampullarioides*. While climate change is viewed as a potential rather than current threat, the species needs to be carefully monitored during periods of drought in order to predict and mitigate loss of reproductive adults and seed output.

Impacts on pollinators, which could impede gene flow between populations, threaten all but the largest *A. ampullarioides* population (i.e., the population in Zion National Park). The presence of pollinators can be limited by the same activities that affect the plants themselves, and this threat is thus paired with threats posed by land development, habitat degradation caused by recreational activities and cattle trampling, invasive species, and climatic extremes.

Cattle trampling is an issue of moderate concern for the Pahcoon Spring Wash population, of low concern for the Shivwits population, and of possible concern for Silver Reef population . Silver Reef, along with the Harrisburg Bench population, also is affected by illegal waste disposal activities. Coral Canyon and the Cottonwood site within the Cottonwood and Harrisburg Bench, due to their respective proximity to a golf course and I-15, are potentially threatened by herbicide use; however, these threats are localized and of marginal concern to the rangewide population.

In terms of the number and variety of threats affecting each *A. ampullarioides* population, Silver Reef appears to be subject to the greatest variety of impacts, and Zion appears to be the most secure population. However, all populations of this species are subject to multiple threats, any of which could, either individually or in various combinations, severely inhibit population persistence.

Based on the need for a recovery response at the species level, threats to *A. ampullarioides* are prioritized in rough order of highest to lowest concern and ability to effectively address them through management efforts, as follows:

- ORV use and other recreational land uses
- Invasive plant species and the potential for associated wildfires
- Land development/urban expansion
- Impacts on pollinators
- Cattle activities
- Herbivory
- Prolonged drought
- Herbicide use
- Unauthorized land uses such as waste disposal

CONSERVATION MEASURES AND ASSESSMENT

Efforts to conserve these milk-vetches and their habitat have been underway prior to and since the time of listing. The aim of recovery is for conservation to outpace threats until the ability of these species to persist within their natural ecosystems becomes assured. This section thus identifies the conservation measures that have been taken and informally assesses their contribution to recovery relative to the level of threat that still faces each species.

Astragalus holmgreniorum

In 2005, a letter of intent to conserve *A. holmgreniorum* habitat was signed by SITLA, TNC, USFWS, BLM, UDOT, and FHWA. Accomplishment of the habitat preservation goal established within this document has a time frame of January 1, 2015. The letter expresses the intent to acquire a 166-ac (67-ha) area within the State Line population, west of I-15 and on the southern boundary of the Sun River residential development, for a plant preserve (failure to achieve this intent would likely result in availability of the property for housing development). Both the BLM St.George Field Office and TNC have shown interest in protecting this property to enable plant preservation, with BLM's main objective being extension of the Atkinville BLM area. The BLM St.George Field Office is currently in the process of acquiring the SITLA lands for protection of the State Line population (R. Douglas, pers. comm. 2006).

The letter of intent also addresses the large (1,150-ac/465-ha) Central Valley *A. holmgreniorum* population. Establishment of one plant preserve (approximately 17 ac/7 ha), as FHWA mitigation for the Southern Corridor, is imminent. Discussions with SITLA are ongoing to incorporate open space or corridors in the planned residential community affecting this population, which will allow a greater proportion of the milk-vetch's habitat to remain undeveloped. The outcome of these discussions is uncertain, and the degree to which this population is lost will affect recovery success. Conservation of more than the committed 17 ac (7 ha) is essential to maintaining the diversity and viability of this *A. holmgreniorum* population, and this issue remains under active interagency coordination.

The following conservation measures contained in the St. George Field Office's Record of Decision and Final Resource Management Plan (1999) for the protection and management of Shivwits and Holmgren milk-vetches include ─ (1) In collaboration with interested local, State, and Federal agencies, institutions, and Indian Tribes, BLM will prepare conservation agreements and strategies designed to stabilize declining populations, and will promote protective management to ensure survival of the species. (2) To reduce conflicts and additional disturbance, habitat areas will be designated as rights-of-way avoidance areas and closed to fuelwood and mineral material sales. Plants will be protected by restricting mountain bike use and off-road vehicle travel to designated roads and trails. (3) Prior to surface-disturbing exploration or development associated with fluid mineral leasing, botanical surveys will be completed and known populations avoided to eliminate the taking of plants. (4) Habitat areas will be kept free from use of chemical pesticides and herbicides. (5) Where necessary to protect small isolated populations of Hermit's milk-vetch (aka Shivwits milk-vetch) under 10 ac (4 ha) in size, BLM will fence areas to prevent inadvertent destruction of plants. Additionally, BLM (St. George, Utah) is considering future amendments to the management plan that would provide additional protection for listed plant populations (J. Crisp, pers. comm. 2006).

The BLM's Santa Clara River Reserve Recreation and Open Space Management Plan includes proposals to reduce or influence ORV recreational use by designating ORV trails and trailhead parking. At one time this included a proposed trailhead and parking lot at or near the Stucki Spring *A. holmgreniorum* site; however, this is now being re-evaluated in regard to locating parking and trailheads outside of *A. holmgreniorum* habitat. Examination of trails to provide the best protection to the species will occur with interagency coordination and site analysis. Further review of the Santa Clara River Plan is needed in order to determine the net conservation benefits.

Occupied habitat at the Purgatory Flat population was fenced in 1999 as part of the Washington County Shooting range. Periodic observations confirm the continuing presence of *A. holmgreniorum*. The fence remains intact and no ORV use is currently seen. Fencing along a BLM access road near South Hills and Stucki Spring has partially reduced ORV use, although these fences are often cut by ORV users and ORV activities continue within the landscape. Further funding to provide fence monitoring and timely maintenance and repair is a high conservation need if fencing is to be successful.

Utah's Statewide Land Use Plan Amendment for the Proposed Fire and Fuels Management and Five Fire Management Plans (2005) includes some conservation measures for *A. holmgreniorum* on BLM lands in relationship to fire and fuels management. Guidelines and prescriptions have been developed for those fire management activities that could adversely affect the milk-vetch, including wildfire suppression, wild land fire use, prescribed burning, non-fire fuels treatments (mechanical and chemical), and emergency stabilization and rehabilitation following wildfires. In accordance with the objectives of the proposed actions and applicant-committed resource protection measures, the location of authorized actions, implementation of post-wildland fire

Emergency Stabilization and Rehabilitation activities, and design of preplanned projects would generally--(1) avoid an increase in invasive plant species within suitable habitat; (2) avoid high mortality of the species during wildland fire suppression, unless the resource protection measures could not be implemented due to firefighter or public safety or other necessary reasons; and (3) if it has departed from historic levels, bring the return interval in line with a more nature fire regime.

Comprehensive inventory efforts were conducted for this species in 2003, 2004, 2005 (see Table 1). Prior to this, extensive survey efforts were undertaken in the late 1980s and 1990s by BLM and others (Armstrong and Harper 1991; Van Buren 1992; Hughes 1992). Potentially occupied habitat that has not been surveyed in recent years includes the areas between South Hills and Stucki Spring and between Stucki Spring and the Virgin River. More survey work also is needed for the Arizona portion of the species' range, as extensive surveys have not been conducted there since the early 1990s. In addition to searches and plant counts, BLM has shared costs with Brigham Young University and Utah Valley State College for demographic and trend monitoring, which has been conducted at three *A. holmgreniorum* study sites, as described in Population Abundance and Trends, from 1992 to the present day. Data collection techniques for all surveys and population studies need to be evaluated in order to ensure that the information allows for comparative analysis and provides for detection of population trends.

Astragalus ampullarioides

Conservation measures similar to those for *A. holmgreniorum* have been developed under the Utah Statewide Land Use Plan Amendment for the Proposed Fire and Fuels Management and Five Fire Management Plans (2005). Additionally the new Zion National Park Fire Management Plan (2005) includes restrictions on fire management within a 0.75-mi (1.2-km) buffer zone of known *A. ampullarioides* habitat.

A partnership has been established between Zion National Park and the USGS to investigate biotic soil conditions and invasive weed interactions, in terms of effects on habitat conditions and performance for *A. ampullarioides.* As part of this project, the rangewide distribution and abundance of *A. ampullarioides* and associated invasive exotic plants relative to soil properties, geomorphic setting, and plant community composition is being examined. Additional experimental studies will be conducted in a field setting at Zion National Park and in a greenhouse to evaluate effects of exotic species on soil biological properties and on seedling recruitment, reproductive output, and mycorrhizal colonization of *A. ampullarioides*. Soil seedbank studies also were anticipated to evaluate effects of exotic plants on seedbank composition of plant communities in which *A. ampullarioides* occurs; however, some change in research plans are being appraised (M. Miller, pers. comm. 2006). This is anticipated to bring about the development of new conservation measures and guidelines, in particular for restoration and augmentation planning.

On Tribal lands, the Shivwits Band of the Paiute Tribe has provided protective fencing for the dominant area of *A. ampullarioides* on their lands adjacent to a utility corridor. This fencing provides protection for activities necessary for the maintenance of the utility corridor and excludes impacts associated with intermittent cattle grazing (G. Rogers, Shivwits Band of Paiute Tribe, pers. comm. 2005). Some individual plants occur outside this protective fence, and construction of a fence to protect all individuals and habitat resources is under discussion.

At the Pahcoon Spring Wash population, Harrisburg Bench site, and Silver Reef populations, the BLM and TNC have entered into a cost-share agreement to provide signs and protective fencing to minimize human use within areas of high plant occupancy. Ideally, this fencing will reduce or eliminate human- and cattle-induced impacts such as soil disturbance and plant trampling. The TNC will monitor these fenced areas to determine the effectiveness of fencing, and the BLM has agreed to maintain fences. Providing fence monitoring, fence assessment, and timely maintenance and repair is a high-priority conservation need if these fences are to be effective.

Inventory efforts occurred for *A. eremeticus* var. *ampullarioides* (later elevated to *A. ampullariodes*) in the 1990s (Armstrong and Harper 1991; Van Buren 1992; BLM 1997). Onsite counts or estimation of individuals occurred at all sites in 2006 (see Table 2). Zion National Park began conducting extensive surveys in 2001, resulting in an increase of known localities and numbers, and additional surveys in potential habitat are proposed for the future. Delineation of additional potential habitat at Zion National Park occurred in 2006, which indicates a need for future survey (M. Miller, pers. comm. 2006).

Monitoring efforts are described in Population Abundance and Trends. Evaluation of monitoring efforts for sensitivity to site and soil conditions is appropriate at this time to define how to provide the best data for assessment without negatively impacting small sites.

BIOLOGICAL CONSTRAINTS AND NEEDS

Recovery entails the need to identify those biological limiting factors that must be honored when designing any management/conservation program for *A. holmgreniorum* or *A. ampullarioides* and evaluating project effects on these species. Biological constraints for *A. holmgreniorum* and *A. ampullarioides* include seedbanks, plant dormancy, life cycle limitations, soil restrictions, herbivory, and interdependence with pollinators for reproductive success and with animals and abiotic variables for seed distribution. Moisture regimes, temperatures, and fire patterns also must be considered. Biological constraints common to both species are discussed first, followed by species-specific constraining factors.

Astragalus holmgreniorum and ***Astragalus ampullarioides***

A. holmgreniorum and *A. ampullarioides* are perennials that grow in Mojave Desert and Colorado Plateau conditions, under an irregular moisture regime. The persistence of seeds in the soil through unfavorable germination conditions, i.e., the seedbank, as well as adult plant dormancy (for *A. ampullarioides*) are survivorship mechanisms that represent a biological constraint, since an unknown percentage of genetic heritage is dormant within the soil (R. Van Buren, pers. comm. 2006). For example, in 2002 all surviving monitored *A. ampullarioides* individuals were not seen due to dormancy (Van Buren and Harper 2004). For plants with seedbanks, assessment of population extent and viability is challenging, and questions such as the viable longevity of these seeds need resolution before population dynamics can be fully understood. Nonetheless, due to recurring drought patterns, the importance of protecting these species' seedbanks is indisputable.

Reduction and loss of the species' habitat and seedbank may reduce overall resiliency to such factors as drought. Therefore, maintaining and improving the quality and condition of the species' habitat and soils are high priorities. Retention of suitable habitat proximal to occupied habitat is advantageous to recovering this species. Protecting soil conditions may include building and maintaining protective fences to exclude or limit deleterious human and livestock usage. Reducing soil compaction can occur by diverting areas of use and travel routes outside habitat or limiting, directing, and enforcing management of use within habitat.

Extended periods of abnormal climatic conditions such as extended drought, high periods of rainfall, and late-season killing frosts may adversely affect either species (R. Van Buren, pers. comm. 2006). Droughts trigger dormancy and loss of reproductive activity, and late-season frosts can cause flower and fruit damage in both species. Although species-level conservation actions cannot protect against climatic extremes, offsite measures such as seed repositories may help protect the genetic legacy of these plants and potentially aid in meeting restoration, augmentation, and recovery objectives.

Invasive exotic plants are abundant within both species' habitats. Their presence provides competition with native plants, which alters vegetation composition and structure, soil-resource dynamics, and changes the fire regime (Miller 2005). Invasive exotic annuals are known to exhibit qualities such as high seed production, long-lived seeds, rapid seedling growth, rapid growth to reproductive stage, and tolerance for a wide range of climatic and soil conditions, and they thus compete for space and resources on the landscape. This is especially true for wind-pollinated, nonnative grasses, which may overtake the native flora upon which pollinators depend. *A. holmgreniorum* and *A. ampullarioides* appear to prefer areas of low vegetation and may not be co-adapted to high interspecies competition. Also, for example, some invasive nonnatives, such as *Molucella laevis* (Bells of Ireland), may be very attractive to pollinators, potentially attracting pollinators at the expense of nearby *A. ampullarioides* individuals (V. Tepedino, pers. comm. 2006). Research is needed to elucidate and substantiate the biological constraints posed by invasive exotic plants. Other factors such as habitat disturbances, which tend to increase the presence of nonnative species, and the use of native and nonnative seed mixes may need to be examined in regard to their effects on *A. holmgreniorum* and *A. ampullarioides.*

Prior to the incursion of exotic plant species, both *A. holmgreniorum* and *A. ampullarioides* inhabited sparse vegetated areas that were not prone to fire. Neither species is believed to be fire-adapted, and both may have biological limitations in their ability to survive fire conditions. Invasive annual grasses such as red brome, cheatgrass, and other exotics now represent over 35% of the living cover in *A. holmgreniorum* and *A. ampullarioides* habitat (Van Buren and Harper 2003a). The density of these exotics creates a continuous fuel supply that can carry fire across the landscape. In recent years, fire events have increased in the St. George area near occupied milk-vetch areas (R. Megown, USFWS, pers. comm. 2006), and, for the first time in 2005, fire consumed lands containing *A. ampullarioides* individuals. One affected site was occupied by

A. ampullarioides in the spring prior to the fire. By the time of the fire in late summer, plants may have already become dormant in response to the summer heat; however, in general the temperature and duration of the fire can affect even dormant plants. Site visits in 2006 indicated no immediately determined negative effect (R. Van Buren, pers. comm. 2006). Additionally, fires may produce intense heat that can kill latent seed embryos and reduce seedbank viability. As fire is presumed to increase with the presence of exotics, measures need to be developed to protect both species from more frequent and intense wildfires as well as potentially disruptive fire suppression activities.

Neither *A. holmgreniorum* nor *A. ampullarioides* reproduces through vegetative methods, and their sexual reproduction is contingent on pollen reaching receptive stigmas for seed production. This biological process can be constrained by factors pertaining to pollen quality, quantity, and origin of pollen received. Research indicates that plants can produce fruits without insect visitation (i.e., autogamously); however, self-fertilized flowers produce less seed in *A. ampullarioides* and produce fewer fruits in *A. holmgreniorum* (Tepedino 2005). In the case of *A. holmgreniorum,* roughly 60% of studied individuals were unable to self-reproduce (Tepedino 2005). Although Tepedino (2005) indicates that in 1999 there was no evidence that fruit or seed production was being limited by inadequate pollination, it is important to confirm that this still holds true. A reduction or loss in pollinators over time could decrease the genetic viability and variability of both species and decrease the number of seeds within the seedbank (Tepedino 2005). Even with a sufficient pool of pollinators, in years when plant numbers are low, fruit and seed production may be reduced either by poor pollination if pollinators are attracted to other co-flowering species, or by a reduction in plant mating types (V. Tepedino, pers. comm. 2006). Studies indicate that reproductive processes such as seed output diminish as plants become more thinly dispersed across the landscape (Harper et al. 2000).

Successful species conservation and restoration requires adequate genetic variability to enable species to respond to changing environmental circumstances. The genetic make-up of either species is unknown. Of primary concern is inbreeding depression, i.e., the decrease in fitness associated with mating with close relatives. This phenomenon often is regarded as the primary selective force promoting outcrossing in plants (Lande and Schemske 1985; Latta and Ritland 1994) and is especially relevant to conservation of rare species, because individuals in small populations tend to be more inbred than those from larger populations. Because these populations possess relatively low genetic variation in terms of allele richness and/or heterozygosity, they may experience low survivorship and reproduction.

Barrett and Kohn (1991) have noted that the major threats that compromise attempts to maintain the long-term viability of rare plant species are--(1) the loss of genetic variation through stochastic forces (i.e., random genetic drift within small populations), and (2) the deleterious effects of inbreeding within small populations. Several studies have demonstrated the occurrence of inbreeding depression in natural plant populations (e.g., Karron 1989; Fenster 1991; Rathcke and Real 1993). Additionally, a large number of studies have examined levels of allelic richness and heterozygosity in plant populations and have noted the debilitating effects of low genetic variability on population viability (e.g., Polans and Allard 1989; Godt and Hamrick 1993).

Research is recommended to determine the genetic differentiation among populations and within species, to determine whether inter-occurrence crosses (within species) result in more or larger fruits or seeds, and to ascertain differences, if any, in viability, longevity, germinability, etc., between seeds produced by selfing and seeds produced by outcrossing. The purpose of this research is to answer whether any urgent management attention is needed for genetic reasons.

Astragalus holmgreniorum

A. holmgreniorum biological constraints center on the transition from seedling to reproductive adult, as the transition from seedlings to adulthood appears to be a limiting factor in reproductive success. Many plants follow a general life pattern moving from seed to germination, germination to seedling, seedling to juvenile (non-reproductive), juvenile to adult (reproductive), and adult to seed. Plants may exhibit high mortality or low reproductive success at one of these transitional phases, which then limits population expansion. As an extremely short-lived perennial, *A. holmgreniorum* does not consistently exhibit a juvenile stage, flowering directly in its second season or, in an unusually favorable growing season (2005), exhibiting producing flowers in its first year (Van Buren 2005). Research on *A. holmgreniorum* indicates that in years of high precipitation, seedlings are seen at a greater frequency than any other plant stage, and *A. holmgreniorum* sporadically exhibits high flushes of seedlings. This appears to be related to moisture in the first 4 months of the year (Van Buren and Harper 2003a), and long-term drought would thus severely impact seedling and adult presence. Low survivorship to reproductive adults further places emphasis on the need to reduce human-induced ground-disturbing activities that impact seedling and adult survivorship. As habitat and population numbers decrease due to urban expansion, efforts to improve seedling survivorship rate need attention.

Although further research is needed, the limited survivorship of *A. holmgreniorum* seedlings to adulthood also could be a result of species competition. *A. holmgreniorum* occurs in areas lacking *Larrea tridentata* (creosote bush), which is found adjacent to occupied sites at the same elevation and on the same geological formations. It has not been determined why *L. tridentata* and *A. holmgreniorum* are allopatric (occupying different areas). If the presence of *L. tridentata* indicates a biological constraint produced by *L. tridentata* presence, then the potential encroachment of *L. tridentata* into *A. holmgreniorum* habitat may need to be managed to prevent further milk-vetch habitat loss.

It may be inferred that water is a likely dispersal mechanism for *A. holmgreniorum,* given the species' proximity to intermittent water pathways that capture runoff from land formations during precipitation events (Van Buren and Harper 2003a). This would indicate that hydrologic patterns based on these formations constitute a limiting factor for this species. However, natural soil erosion, wind, birds and small ground animals also may play a role in seed movement.

Astragalus ampullarioides

Habitat alteration by invasive exotic plants threatens all populations of this species, and information is urgently required to better understand comparative environmental relations of invasive exotics and *A. ampullarioides*, as well as effects of invasive exotic plants on habitat conditions and performance of this endangered species. It is possible that invasive exotic plants have the ability to affect biological soil properties and compete with *A. ampullarioides*, thus potentially affecting seedling recruitment and dormancy patterns of *A. ampullarioides*. Additionally, future restoration planning may require soil seedbank studies to understand the composition of native and nonnative plant seedbanks.

Many areas exist where the Petrified Forest member of the Chinle and Dinosaur Canyon member of the Moenave geological formation layers are exposed; however, the distribution of *A. ampullarioides* is limited by its association with particular clay-rich soil outcroppings that are frequently small and most often noncontiguous. The close association between species and substrate as it relates to this milk-vetch's limited distribution needs further research. Until parameters pertaining to soil specialization are further defined, it should be assumed that the opportunities for finding or establishing additional populations of this species will be very limited and, therefore, that extant populations should be considered essential to the species' long-term conservation.

PART II. RECOVERY STRATEGY

Strategic considerations for implementing an effective *A. holmgreniorum* and *A. ampullarioides* recovery program include the species' current status relative to recovery needs and opportunities, the need for a general vision that will provide direction for the recovery process, and the need for broad solutions to problems that are affecting the milk-vetches' ability to persist in the wild. These considerations are discussed in the following sections.

Current Recovery Status

In general, a species' recovery status is based on the balance between continuing threats and the amount of conservation that has been achieved, i.e., the degree to which threats have been abated and population viability has been ensured. As indicated previously, threats to the long-term persistence of *A. holmgreniorum* and *A. ampullarioides* in the wild continue to outpace conservation efforts. In particular, land development, recreational land uses, and the effects of invasive plants have the potential to cause loss of individual populations and significant overall population declines. The rarity of the two milk-vetches increases their vulnerability to these and other threats; it also increases their susceptibility to loss of fitness due to deleterious small-population effects such as genetic drift and inbreeding depression.

Both of these species are in the earliest phase of the recovery process, so it should not be surprising that threats outweigh recovery achieved to date. Likewise, the recovery program for each milk-vetch is characterized to a large extent by biological uncertainties and information gaps. Nevertheless, the type of threats ― particularly land development ― facing *A. holmgreniorum* and *A. ampullarioides* could lead to extinction in the foreseeable future if bold action is not taken to curb their impacts on these plants and their habitat. The recovery status of *A. holmgreniorum* and *A. ampullarioides* can thus be measured by their intrinsic vulnerability, the array of threats facing each species, and the relatively rapid pace at which these threats could lead to extinction.

Guiding Biological Principles

Conservation programs, including recovery programs for listed species, are strengthened by adherence to three primary principles of conservation biology--representation, resiliency, and redundancy (Shaffer and Stein 2000). Each concept focuses on a different aspect of ensuring a species' long-term survival. Representation involves conserving the breadth of the genetic makeup and natural variation across a species' range in order to conserve adaptive capabilities. Resiliency entails ensuring that each population is viable and sufficiently large to withstand stochastic events. Redundancy involves protecting an adequate number of populations to provide a margin of safety for the species to withstand catastrophic events (Shaffer and Stein 2000). The recovery program for *A. holmgreniorum* and *A. ampullarioides* will take these principles into account when looking at population conservation needs for each species.

Joint Species Recovery Strategy

Recovery under the ESA is the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the ESA are no longer needed (National Marine Fisheries Service 2004). As implied, this means that population trends are favorable for long-term persistence in the wild, that evolutionary and ecological processes are intact and will remain so, and that specific threats, including but not limited to all those that led to listing the species in the first place, no longer pose a risk of extinction.

Using this definition and the principles outlined above as a conceptual framework for envisioning recovery of the two milk-vetches, it is clear that the status of both species must be greatly improved before either can be considered fully recovered. In addition, the recovery vision is based on two assumptions--first, that historic population numbers exceeded current numbers, and second, that continuing population declines are likely if conservation actions are not implemented.

Recovery of *A.holmgreniorum* and *A. ampullaroides* will hinge on conserving extant populations, primarily by abating threats such as land development and recreational land uses, and establishing or finding enough additional populations to ensure long-term demographic and genetic viability. This will require the active involvement of experts and the public. It also will require a continuing recognition of the role each milk-vetch plays in the ecology of southwestern Utah and, in the case of *A. holmgreniorum*, northwestern Arizona. Because of the biological and historic uncertainties regarding the status and recovery potential of these species, the recovery strategy is necessarily contingent on a growing understanding of the species and their ecological requirements. Consequently, a dynamic and adaptive approach will be key to making effective progress toward full recovery.

Full recovery will include--(1) the sustained and stable presence of extant populations of each species and the discovery or introduction of additional populations, with the aim of ensuring representation and redundancy of each milk-vetch; (2) long-term conservation of the ecosystems within which each species is found (including the open land area needed for individual and population growth, natural soil conditions, associated land formations and natural water hydrology, habitat for pollinators, and seedbanks), as a further means of ensuring redundancy; and (3) positive population trends and maintenance of natural population dynamics and genetic diversity, as a means of ensuring the resiliency of each species.

The milk-vetch populations that must sustained in order to reach full recovery are designated as “recovery populations.” This includes extant and, if feasible, introduced populations of each species. Where currently found, *A. holmgreniorum* is comprised of six recovery populations ― State Line, Gardner Well, Central Valley, South Hills, Stucki Spring, and Purgatory Flat. *A. ampullarioides* also is comprised of six extant recovery populations ― Pahcoon Spring Wash, Shivwits, Coral Canyon, Harrisburg Bench and Cottonwood, Silver Reef, and Zion.

Recovery Solutions

JOINT SOLUTIONS

Joint recovery solutions for *A. holmgreniorum* and *A. ampullarioides* center on the removal of obstacles to their long-term viability, including the species' vulnerability to a variety of anthropogenic threats, information gaps, and a lack of legal and political safeguards coupled with the need for stronger public support. Recovery of the milk-vetches will be based on resolving these problems through a variety of possible solutions.

The key recovery solution for both species is protection of occupied and suitable habitat through fee title purchases, conservation easements, and designated open spaces, and management of these properties as plant preserves. In conjunction with these habitat protection measures, habitat fragmentation can be remedied (that is, a needed level of connectivity among protected populations can be ensured) by setting aside open space and/or corridors via easement or acquisition, regulatory mechanisms, or other means. Land protection initiatives will alleviate both of the threats of highest concern to these milk-vetches, i.e., land development and ORV impacts.

Controlling ORV impacts without exacerbating conflicts among competing interests will require creative solutions and partnerships that go beyond simply setting land aside. Fencing occupied habitat and designating ORV trails should help reduce impacts, but a long-term solution will ultimately be based on--(1) finding a way to meet recreational demand without impinging on the plants' survival needs, (2) enlisting interested ORV users to campaign for responsible use of areas in proximity to fragile land formations and habitats, and, if necessary, (3) crafting and enforcing sensible regulatory controls for recreational use of valued natural resources.

Restoring landscapes affected by nonnative invasive species and associated fire events also will be linked to reduction of human uses such as ORV activity and cattle grazing. More directly, the solution to the current spread of invasive plant species will involve the development and application of effective treatments to control or eliminate invasive species where they encroach on the native plant community.

The other major concern for both species, the potential for prolonged drought caused by climate change, cannot be resolved at the species-recovery level. However, during prolonged periods of drought, more aggressive management, which may seem unrealistic, may become necessary, including steps to ameliorate rangewide population losses through solutions such as watering, seed storage and propagation, and establishment of new populations in areas that may be more hydrologically conducive to survival of the plants and seedbanks through dry periods.

Although population viability analysis for these species is not yet feasible, studies for other rare species suggest a general need for retaining and possibly increasing the population size and distribution of rare and declining species (Matthies et al. 2005, Menges 1991, Shultz and Hammond 2003). Thus, in addition to conserving milk-vetch populations and their habitat through direct control of threats, another general solution aimed towards maintaining adequate redundancy and representation involves the introduction of milk-vetch populations to currently unoccupied but suitable habitat. Unoccupied habitat with characteristics similar to occupied habitat exists across the range of both milk-vetches, indicating that available habitat may not be at carrying capacity and that potential habitat could become occupied either through natural events or other means. Given the multiple and accelerating threats facing both these species, priority will be given to ascertaining where habitat with a high potential for natural or managed colonization occurs on the landscape and whether additional populations can be successfully established through offsite propagation and outplanting or through translocations. It should be noted that although establishing new populations is viewed as a key recovery need for both species, this conservation tool remains untested. Introductions will be regarded as strictly experimental and research-oriented, recognizing that we cannot afford to lose current plant resources based on conservation efforts that involve a high level of uncertainty. If repatriation becomes a key component of recovery, then a rangewide repatriation strategy will be developed before proceeding on an operational basis.

All of these actions will require a more robust information base for both species, and research that addresses questions affecting both species, e.g., pollinator requirements, will be promoted as a recovery priority, particularly during the early phases of the recovery process. Research will be directed toward answering those questions that have the greatest bearing on the recovery needs of these species. Significant areas of uncertainty remain, with crucial implications for recovery. The evolutionary history and potential of the species is perhaps the key question related to their recovery, and although we may never know what their historical population numbers and distribution were, focused investigations could lead to solid inferences about the evolutionary trajectory and needs of these milk-vetches. Uncertainties about the viability of individual populations under different threats and management scenarios, genetic variability, breeding and dispersal systems, and how to address various threats also pose likely impediments to long-term recovery if left unresolved. Thus, research will be given equal priority to active management at this stage of recovery. Specific research priorities will be identified, beginning with population and effectiveness monitoring to ensure that any evidence of a declining trend is detected so that the cause(s) can be immediately addressed.

Building public support for recovery along with implementation of regulatory protections will be undertaken in an effort to create a strong and lasting constituency for milk-vetch conservation. Along with the general public and interest groups, cooperative efforts will be pursued with Federal and State agencies, the Shivwits Band of the Paiute Tribe, St. George, and other local municipalities.

Eventually, a clearer understanding of the biological requirements of the milk-vetches will lead to more predictability about their recovery prognosis. This in turn is likely to lead to refinement of recovery criteria and actions for the species, and the recovery plan will be revised accordingly.

Further species-specific recovery solutions are discussed below.

Astragalus holmgreniorum

Initial recovery solutions for *A. holmgreniorum* will center on taking the necessary measures to ensure that the species' current status does not further deteriorate, which hinges on the overriding need to address both imminent and long-term population losses caused by expanding land development and land use activities in the region. Such losses create an extinction risk for *A. holmgreniorum*, which is inherently vulnerable because of its rarity coupled with its occurrence on developable sites.

Thus, top priority will be given to, first, maintaining the current number of populations at a size and distribution indicative of the species' population dynamics and known range, and, second, conserving the habitat for these populations and their pollinators. This will require appropriate resolution of threats involving habitat loss and land degradation, as well as actions to fully compensate for unavoidable impacts to extant populations. A large portion of *A. holmgreniorum* occupied habitat is located on State and private lands, where it is not protected, and establishing plant preserves or working with landowners to retain adequate open space or corridors within developing areas will play a key role in stabilizing species loss and enabling recovery. Likewise, protection of known sites on federally managed lands may need to be boosted through special designations, management commitments, or other administrative tools. Whether on Federal or non-Federal lands, management will be needed both to restore habitats currently in degraded condition and to prevent further habitat degradation, including moving ORV use away from areas occupied by the species, reducing other types of disturbances, and implementing control measures to exclude invasive species.

There is not only a need for retaining but also for increasing this species' population size and distribution. It is possible that *A. holmgreniorum* occurred in more locations historically than it now does, given the past loss of areas with habitat conditions similar to occupied habitat for this plant. This could be indicative of either a long-term, rangewide decline that needs to be reversed in order to achieve full recovery or if *A. holmgreniorum* is neo-endemic (speciated relatively recently), this could be indicative of a species struggling to establish itself (L. Johnson, Brigham Young University, pers. comm. 2006). Due to past surveys, it is unlikely (while not impossible) that additional natural populations will be found. The negative search results since the six known populations were discovered poses fundamental questions such as--Why has *A. holmgreniorum* not colonized what appears to be appropriate existing habitat, and what needs to be known in order to address expansion as an appropriate solution?

There is some basis for optimism regarding the possibility of artificially establishing new populations, although this conservation tool remains untested for *A. holmgreniorum*. As such, any population repatriation attempts at this early stage of recovery will be regarded as strictly experimental, and introduced populations will not compensate for impacts on extant populations, nor will they count toward meeting recovery objectives unless and until we are certain they will remain viable over the long term. If repatriation becomes a key component of recovery, then a rangewide repatriation strategy will be developed.

Recovery criteria based on trends and other population parameters will drive recovery actions such as research and monitoring, population management, and habitat management for each of these populations. Threats-based criteria for recovery of *A. holmgreniorum* stem from the threats assessment for this species, which, along with land development, identified motorized recreational activities and associated road and trail development, over-competition by invasive species and the associated potential for wildfires, impacts on pollinators, prolonged drought cycles, and trampling of soils and plants as significant concerns. The most imminent threats to *A. holmgreniorum* will be addressed on a site-specific basis. Recovery will be promoted by conducting problem-solving discussions centering on habitat protection, by tracking and alleviating threats, and by building a shared understanding of projected threats and recovery needs.

Astragalus ampullarioides

The *A. ampullaroides* recovery strategy is predicated on the rarity and endemism of this species, the assumption that historical population numbers exceeded current levels, and the fundamental aim of securing the milk-vetch's long-term survival through habitat and population management. Initial recovery solutions will focus on ensuring that the species' current status does not deteriorate and that the information necessary to achieve full recovery is obtained.

Priority will first be given to maintaining the current number of populations at a size and distribution indicative of the species' population dynamics and known range. This takes into account the fact that populations are few in number, small in size and at possibly critical levels in terms of demographic and genetic viability. They also are isolated due to natural patchiness and human-induced habitat fragmentation, and — despite all these limitations — remain persistent. Recovery criteria based on numbers of individual plants, population trends, and other population parameters will drive recovery actions for each of these populations. The actions needed to directly meet population-based recovery criteria include research and monitoring programs, population augmentation or supplementation, and habitat management as needed. Given the unfortunate reality of unavoidable habitat losses, recovery will hinge on conservation of extant populations to the maximum extent possible and recognize the potential need to find or establish additional populations in order to meet recovery objectives. Implementation of recovery actions will follow an adaptive management approach, including careful coordination, design, monitoring, and modification.

Recovery of *A. ampullaroides* is highly contingent on abating the central threats on a population basis. The results of the site-specific threats assessment for this milk-vetch indicate that disturbance due to motorized recreational activities, habitat loss due to land development, over-competition by invasive species (either exotic or natural), herbivory, prolonged droughts, and trampling by cattle need to be addressed. Vigorous attention will be given to identifying and implementing means of ameliorating these threats through appropriate recovery actions. In addition, building public support for recovery and promulgation and/or implementation of regulatory protections will be undertaken as a general threats-reduction strategy.

PART III. RECOVERY PROGRAM

RECOVERY GOALS

The goal of this recovery program is to achieve the long-term viability of *A. holmgreniorum* and *A. ampullarioides* in the wild, resulting in their reclassification from endangered to threatened and, ultimately, their removal from the Federal List of Endangered and Threatened Plants (50 CFR 17.12). Each of these species will be considered to be biologically secure when--(a) a survival probability of at least 95% over 100 years can be projected, (b) long-term retention of current levels of heterozygosity and population diversity is ensured, and (c) sufficient habitat with naturally reproducing populations of the species is protected and managed to allow for continuation of natural selection.

RECOVERY OBJECTIVES

The shared recovery objectives for *A. holmgreniorum* and *A. ampullarioides* are to:

- Maintain representative distribution of these rare plant species to the extent practicable throughout their current ranges;
- Effectively manage the species' habitat, taking into account environmental changes and new insights;
- Effectively monitor population trends, emerging threats to the species, and the performance of protection strategies;
- Ensure that needed offsite measures are in place to minimize extinction risk from catastrophic events; and
- Engage partners in a long-term and active commitment to full recovery and post-delisting conservation of these milk-vetches.

RECOVERY CRITERIA

Achievement of the recovery objectives for these species will be measured by a dual set of recovery criteria--population-based criteria and threats-based criteria. Meeting the criteria will lead to reclassification and delisting proposals. Although the criteria apply to both milk-vetches, they must be met independently for each species, and each species can be independently reclassified or delisted. It is important to remember that these criteria may change, if and when new information or accomplishment of recovery actions indicates the need for adjustments in the recovery process.

Population-Based Criteria

Note: The term "recovery population" applies only to known extant populations of each species unless and until populations introduced to unoccupied habitat are successfully established in accordance with a rangewide reintroduction plan, at which point the introduced population may then be considered a recovery population.

A. holmgreniorum and *A. ampullarioides* will be considered for **reclassification** from endangered to threatened status when:

P-1. Based on analysis and modeling implemented under recovery actions 3.1, 4.1, and 4.4.8, trends for *A. holmgreniorum* and *A. ampullarioides* recovery populations are shown to be stable or improving according to the following measures:

A. holmgreniorum

a) Species presence is maintained at all recovery populations, **and**

b) At a minimum of four recovery population sites, plant density within occupied habitat is shown to be generally stable or improving over a 20-year period, based on annual plant counts at permanent and/or random transects conducted in accordance with a standardized monitoring protocol, **and/or**

c) For a minimum of four recovery populations, predictive modeling using data from a 20-year period, collected in accordance with a standardized monitoring protocol, provides a preliminary indication of long-term demographic stability as well as a projected survival probability of at least 95% over 100 years.

A. ampullarioides

a) Species presence is maintained at all recovery populations, **and**

b) At a minimum of four recovery populations, plant density within occupied habitat is shown to be generally stable or improving over a 20-year period, based on annual plant counts at permanent and/or random transects or regular census counts, using a standardized monitoring protocol in either case, **and/or**

c) For a minimum of four recovery populations, predictive modeling using data from a 20-year period collected in accordance with a standardized monitoring protocol provides a preliminary indication of long-term demographic stability as well as a projected survival probability of at least 95% over 100 years.

P-2. The available habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations. Habitat size and connectivity parameters will be set through recovery action 4.4 (see also 4.4.2, 4.4.3, 4.4.5, 4.4.6, 4.4.8).

P-3. Population and habitat management is implemented for all recovery populations in accordance with site-specific management plans developed under recovery action 1. Each management plan will include a course of action that addresses the following needs: habitat protection and management, population enhancement (if warranted), population establishment (if warranted), threats abatement, biological and threats monitoring, and reporting and evaluation.

A. holmgreniorum and *A. ampullarioides* will be considered for **delisting** when, in addition to recovery criteria P-1 through P-3:

P-4. Two additional populations of each species are either (a) discovered or (b) introduced to habitat in proximity to extant, and these populations show evidence of successful establishment in accordance with a rangewide introduction strategy as per recovery actions 2 and 5. Thus, a minimum of eight recovery populations will be needed to delist each species.

P-5. The available habitat base for each additional recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and, where possible, among populations. Habitat size and connectivity parameters will be set through recovery action 4.4 (see also 4.4.2, 4.4.3, 4.4.5, 4.4.6, 4.4.8).

P-6. Population trends for all *A. holmgreniorum* and *A. ampullarioides* recovery populations are shown to be primarily stable or improving as indicated by the following measures:

A. holmgreniorum

In addition to continuing to meet the persistence measure reclassification (recovery criterion P-1.a),

a) At all eight recovery populations, plant density in occupied habitat is shown to be generally stable or improving over an additional 10-year period, based on annual plant counts at permanent and/or random transects conducted in accordance with a standardized monitoring protocol, **and/or**

b) For all eight recovery populations, predictive modeling using data from an additional 10-year period, collected in accordance with a standardized monitoring protocol, provides a preliminary indication of long-term demographic stability as well as a projected survival probability of at least 95% over 100 years.

A. ampullarioides

In addition to continuing to meet the presence parameters for reclassification,

a) At all eight recovery populations, plant density in occupied habitat is shown to be generally stable or improving over an additional 10-year period, based on annual plant counts at permanent and/or random transects or census counts taken every 3-5 years and using a standardized monitoring protocol in either case, **and/or**

b) For all eight recovery populations, predictive modeling using data from an additional 10-year period, collected in accordance with a standardized monitoring protocol, provides a preliminary indication of long-term demographic stability as well as a projected survival probability of at least 95% over 100 years.

P-7. Each of the eight *A. holmgreniorum* and eight *A. ampullarioides* recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective. Each plan must include a post-delisting monitoring strategy and projected conservation needs and must identify long-term funding sources.

Threats-Based Criteria

The following recovery criteria address threats to the two milk-vetches, arranged according to the five listing factors.

Reclassification of *A. holmgreniorum* and *A. ampullarioides* from endangered to threatened status will be considered when threats to the species' long-term survival are abated as follows:

FACTOR A. The present or threatened destruction, modification, or curtailment of habitat or range.

T-1. Permanent land protection is achieved for a minimum of four *A. holmgreniorum* and four *A. ampullarioides* recovery populations. Protected areas must meet the size and connectivity parameters developed pursuant to recovery action 4.4 (see also 4.4.2, 4.4.3, 4.4.5, 4.4.6, 4.4.8). Protection can be achieved via fee acquisition, conservation easement, and/or long-term management agreements or plans.

T-2. Management agreements or plans are in place and being implemented for all *A. holmgreniorum* and *A. ampullarioides* recovery populations. These agreements or plans should include, at a minimum, a primary purpose of preserving the onsite soil seedbank of each population through the entire duration of the recovery period, along with provisions to--(a) effectively control unauthorized land uses, particularly those identified as damaging to the milk-vetches and their habitat, such as ORV use, waste disposal, and gun target practice; (b) direct road and trail development away from milk-vetch populations such that neither construction nor use has a negative effect on the plants or their habitat; (c) effectively exclude cattle from occupied habitat areas.

T-3. The long-range conservation of *A. holmgreniorum* and *A. ampullarioides* is included as an explicit provision in a long-term plant conservation agreement with the State of Utah and, in the case of *A. holmgreniorum* Arizona.

FACTOR B. Overutilization for commercial, recreational, scientific, or educational purposes.

No threat of overutilization for commercial, recreational, scientific, or educational purposes has been identified for either *A. holmgreniorum* or *A. ampullarioides*. Therefore, no recovery criteria are needed to address this listing factor.

FACTOR C. Disease or predation.

T-4. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within *A. ampullarioides* and *A. ampullarioides* recovery populations, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under recovery action 3.1. Programs to control excessive herbivory, disease, or predation, if needed, will be conducted adaptively as prescribed in the management plan for each recovery population per criterion P-3.

FACTOR D. The inadequacy of existing regulatory mechanisms.

T-5. Conservation and/or management agreements are developed and implemented to protect these milk-vetches and their habitat to the maximum extent possible within existing Federal, State, Tribal, and local laws and regulations.

FACTOR E. Other natural or manmade factors affecting the species' continued existence.

T-6. Means are identified and management is initiated to control invasive nonnative species that compete with or otherwise harm (e.g., through associated fires) *A. holmgreniorum* and/or *A. ampullarioides* recovery populations or their habitats. For a minimum of four recovery populations for each species, control measures are shown to be effective through demographic monitoring.

T-7. In conjunction with recovery criterion P-2, the available habitat base for each of the four recovery populations designated under criterion P-1 is large enough to offset the threat of loss or restriction of the species' pollinators. Size and connectivity parameters and values will be set through recovery action 4.4 (see also 4.4.2, 4.4.3, 4.4.5, 4.4.6, 4.4.8).

T-8. Use of pesticides or herbicides known or thought to be detrimental to either of the milk-vetches or their pollinators is prohibited in the vicinity of all recovery populations, either by local or State ordinances or through conservation agreements.

T-9. Research shows evidence of the genetic fitness of *A. holmgreniorum* and *A. ampullarioides* populations, alleviating concerns about inbreeding or outbreeding depression. Research will be conducted under recovery action 4.4.5.

T-10. Offsite conservation, e.g., seed collection and storage, is underway for all extant *A holmgreniorum* and *A. ampullarioides* populations, averting the risk of immediate extinction from stochastic events or environmental catastrophes.

Delisting of *A. holmgreniorum* and *A. ampullarioides* will be considered when, in addition to meeting reclassification criteria, threats to the species are further abated as follows:

FACTOR A. The present or threatened destruction, modification, or curtailment of habitat or range.

T-11. Permanent land protection is achieved for all eight *A. holmgreniorum* and all eight *A. ampullarioides* recovery populations, based on the size and connectivity parameters developed through 4.4 (see also 4.4.2, 4.4.3, 4.4.5, 4.4.6, 4.4.8). Protection can be achieved via fee acquisition, conservation easement, and/or long-term management agreements and should be such that ESA protection is no longer needed to compensate for regulatory inadequacies.

FACTOR C. Disease or predation.

T-12. Adverse population-level effects from herbivory, disease, or predation, if any, are quantified and, as needed, abated within *A. ampullarioides* and *A. holmgreniorum* recovery populations through effective control measures, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under recovery action 3.1.

FACTOR D. The inadequacy of existing regulatory mechanisms.

T-13. Land protection covering the habitat of all recovery populations for both species and/or statutory and regulatory protections for plants in Utah and Arizona are such that the protections of the ESA no longer need to compensate for regulatory inadequacies. Protective mechanisms can be developed and implemented under recovery actions 1.1.1, 1.1.2, 1.1.3, and 1.4.

FACTOR E. Other natural or manmade factors affecting the species' continued existence.

T-14. A long-term offsite conservation program, developed under recovery action 1.6.2, is ongoing for all extant *A. holmgreniorum* and *A. ampullarioides* populations.

If the recovery actions needed to meet all recovery criteria are accomplished on schedule, full recovery of both species is anticipated to be achieved in the year 2037.

Note--The following recovery program for *A. holmgreniorum* and *A. ampullarioides* is divided into four major areas of action--(1) protection, (2) research, (3) communication, and (4) coordination. Overall, these sets of actions are tied directly to achievement of the recovery criteria for each species, and they are arranged in hierarchical order, with more specific actions stepping down from the broad actions that link to the criteria. An outline of recovery actions is provided for ease of reference, followed by a narrative description of each action.

RECOVERY ACTION OUTLINE

Protection

1. Conserve known extant *A. holmgreniorum* and *A. ampullarioides* populations and their habitat.

1.1 To the extent possible, avoid loss of occupied habitat due to land development activities.

1.1.1 Protect plant populations on Federal lands.

1.1.2 Work with the Shivwits Band of the Paiute Tribe to conserve the *A. ampullarioides* population on their land.

1.1.3 To the extent possible, protect plant populations on non-Federal lands.

1.1.4 Minimize the effects of highway projects near occupied habitat.

1.2 Prevent human disturbance of known populations and their habitat.

1.2.1 Locate trails away from occupied sites.

1.2.2 Protect sites with fencing and maintain fences.

1.2.3 Implement effective ORV-use control measures.

1.2.4 Enforce existing regulations to prevent unauthorized land uses.

1.3 Effectively manage livestock grazing activities in *A. holmgreniorum* and *A. ampullarioides* habitat.

1.4 Incorporate plant protection into Federal agency planning documents.

1.5 Protect the vegetation communities/ecosystems associated with each species.

1.6 Protect the seedbanks of each species.

1.6.1 Protect the *in situ* (onsite) seedbank of each species.

1.6.2 Protect seeds *ex situ* (offsite).

1.6.2.1 Develop seed collection and permitting guidelines.

1.6.2.2 Collect and store seeds representing the genetic variability of each species.

2. Locate and conserve additional extant populations, if any.

2.1 Standardize rangewide survey procedures for each species.

2.2 Implement new searches in potential habitat areas.

2.2.1 Delineate appropriate potential habitat areas and conduct surveys on Federal lands.

2.2.2 Obtain permission from Tribal, State, and private landowners to conduct surveys.

2.2.3 Create a spatial database for survey efforts, including negative results.

2.3 Apply the conservation measures detailed in recovery action 1 to each additional site.

3. Monitor *Astragalus holmgreniorum* and *A. ampullarioides* sites for population information and trends.

3.1 Develop a rangewide monitoring plan and protocol for each species.

3.2 Implement standardized monitoring on Federal lands.

3.3 Obtain permission from landowners and conduct monitoring on Tribal and non-Federal lands.

3.4 Create a database for long-term collection and evaluation of monitoring data.

3.5 Develop post-delisting and conservation monitoring plans.

Research

4. Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers.

4.1 Analyze available data and identify data needed to evaluate population trends.

4.2 Develop standard procedures for setting annual research priorities and evaluating proposals.

4.3 Establish protocols for protecting milk-vetch populations during the course of field studies.

4.4 Conduct needed investigations and identify recovery applications of research results.

4.4.1 Nonnative weeds.

4.4.2 Pollinators.

4.4.3 Habitat substrates and soil conditions.

4.4.4 Fire effects.

4.4.5 Genetic variation within and among populations.

4.4.6 Seedbank viability and longevity.

4.4.7 Parasitism and/or disease.

4.4.8 Modeling.

4.4.9 Other topics, as identified through recovery action 4.1.

5. Develop and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations.

5.1 As needed, identify potential population establishment sites for each species.

5.2 Develop population augmentation and introduction protocols.

5.3 Develop procedures for monitoring and evaluating success of expansion efforts.

6. Augment extant populations and/or establish new populations of each species in accordance with the rangewide strategy.

6.1 Conduct pre-release preparation and release activities.

6.2 Conduct post-release activities.

Communication

7. Promote effective communications with partners and stakeholders regarding the milk-vetches' recovery needs and progress.

7.1 Maintain an active dialogue with Federal, State, and municipal agencies about recovery issues.

7.2 Maintain government-to-government communications with the Shivwits Band of the Paiute Tribe regarding conservation of the Shivwits *A. ampullarioides* population.

7.3 Establish productive communications with ORV user groups and other interest groups.

7.4 Conduct ongoing and timely information exchanges with agencies and organizations involved in fire management and other emergency operations.

8. Develop and implement educational and outreach programs.

8.1 Tap the growing interest in rare plant species to garner public support for milk-vetch recovery.

8.1.1 Integrate milk-vetch recovery into broader interpretive programs.

8.1.2 Coordinate a recovery volunteer program.

8.2 Develop materials and make presentations for educational institutions.

Coordination

9. Provide oversight and support for implementation of recovery actions.

10. Establish a technical working group to regularly review the status of the species and track the effectiveness of recovery actions.

11. Revise the recovery program when indicated by new information and recovery progress.

RECOVERY ACTIONS

Protection

1. Conserve known extant *Astragalus holmgreniorum* and *A. ampullarioides* populations and their habitat.

For *A. holmgreniorum*, there are six known populations. Plants are scattered across the landscape and found primarily on skirts of formations and adjacent to areas of water drainage. For *A. ampullarioides,* there also are six known populations. Plants are clustered in high densities on intermittently distributed purplish-red, clay outcroppings. To preserve the integrity of the landscape and to adequately support pollinators, hydrology, and sites for seed dispersal, the area needed for recovery populations is greater than the number of acres of physically occupied habitat. The protection measures needed for individual populations should be evaluated on a site-specific basis, and the specified measures should be documented into a concise management plan for each population/site.

1.1 To the extent possible, avoid loss of occupied habitat due to land development activities. Long-term conservation of occupied and potentially occupied habitat, both public and privately owned, requires maintaining land in a natural state that will support the ecological requirements of both plant species over the long term.

1.1.1 Protect plant populations on Federal lands. Long-term management agreements, management plans, land designations, and other potential methods should be used to ensure protection for areas of sufficient size and connectivity for full recovery of each milk-vetch species. These administrative protections will be undertaken in cooperation with Federal land management agencies such as the BLM and NPS. On-the-ground management activities are covered under other recovery actions, e.g., action 1.2.

1.1.2 **Work with the Shivwits Band of the Paiute Tribe to conserve the *A. ampullarioides* population on their land.** The USFWS should maintain a government-to-government dialogue with the Tribe to develop and implement a long-term management plan for the conservation of Shivwits milk-vetch on the Reservation.

1.1.3 **To the extent possible, protect plant populations on non-Federal lands.** Land protection tools such as conservation easements and fee acquisition should be used to either bring plant population sites into the public domain or establish plant conservation as a primary land use objective for the site. Accomplishment of this action will rely on the cooperative efforts of, among others, the Shivwits Band, SITLA, Arizona's Trust Lands Administration, municipalities, non-governmental landholders such as TNC, and private landowners.

1.1.4 **Minimize the effects of highway projects near occupied habitat.** A consistent protocol should be developed with the Utah and Arizona Departments of Transportation to minimize the impacts of highway maintenance, pullouts, or turnarounds within highway rights-of-way in order to reduce habitat damage.

1.2 **Prevent human disturbance of known populations and their habitat.** Human recreational activities such as hiking, biking, horseback riding, dog walking, and ORV travel can lead to degradation of the landscape by increasing erosion, changing hydrology and vegetation patterns, compacting soils, and/or inadvertently trampling plants. Habitat should be managed to maintain or enhance viable populations of *A. holmgreniorum* and *A. ampullarioides*, to protect pollinators, and to allow for the functioning of natural ecosystems. Note: Research-related impacts are addressed in recovery action 4.3.

1.2.1 **Locate trails away from occupied sites.** Human activities and travel across the landscape can be guided by the establishment of trails. In federally managed areas, established trails, designated or otherwise, should be controlled or eliminated in areas of occupied habitat. Placement of new trails should be based on an evaluation of the need for and use of a proposed trail in relation to the recovery of *A. holmgreniorum* and *A. ampullarioides*. To the extent possible, new trails should be established to redirect human activities outside of occupied habitat. Trails should reduce direct human interface with individual plants and be sensitive to areas of existing potential habitat.

1.2.2 **Protect sites with fencing and maintain fences.** Many non-authorized activities exist within *A. holmgreniorum* and *A. ampullarioides* landscape and habitat. Where adverse effects cannot be effectively abated by relocating roads and trails, fencing is recommended to reduce immediate impacts. Maintaining fences in good repair is a challenge in Washington and Mohave Counties (e.g., fences are frequently vandalized by individuals or groups seeking unrestrained access), and repair costs should thus be taken into account and obligated as an integral component of the fencing project.

1.2.3 Implement effective ORV use control measures. At a minimum, control of ORV use could include designating trails and access corridors outside of occupied or potential habitat, preparing designated trail maps, and installing signs to indicate where trail use is acceptable.

1.2.4 Enforce existing regulations preventing unauthorized land uses. In the past, unauthorized land uses have included illegal dumping, ORV use, target practice, and fence cutting, and these activities are continuing to occur at several milk-vetch sites. Protection of *A. holmgreniorum* and *A. ampullarioides* habitat will require a heightened awareness on the part of law enforcement regarding the recovery needs of these species and the necessity of maintaining a vigilant presence in these areas.

1.3 Effectively manage livestock grazing activities in *A.holmgreniorum* and *A. ampullarioides* habitat. Federal lands with suitable habitat for *A. holmgreniorum* and *A. ampullarioides* should be surveyed in areas of active grazing allotments. Effective grazing management may include fence construction, water trough placement, rest-rotation grazing, and revisions of allotment plans, grazing schedules, and stocking levels to maintain plant habitat. Monitoring of grazing impacts should be developed for all known sites found within grazing allotments and should be conducted on a regular basis.

1.4 Incorporate plant protection into Federal agency planning documents. Advances in the development of best management practices will aid planning actions and can be made readily available for incorporation into planning documents. Best management practices should be developed and/or periodically evaluated for all activities that may occur regularly or repeatedly across the landscape. Examples include but are not limited to recreational activities, invasive nonnative weeds, pre- and post-fire activities, cattle grazing, and trail development.

1.5 Protect the vegetation communities/ecosystems associated with each species. Habitat protection for *A. holmgreniorum* and *A. ampullarioides* includes the greater natural ecosystem, particularly in terms of pollinators, seed dispersal, germination requirements, and maintenance of natural regimes. Both species utilize insects for pollination and sexual reproduction; therefore, a loss in pollinators would decrease the genetic diversity and population fitness of *A. holmgreniorum* and *A. ampullarioides* (Tepedino 2005). Pollinators require floral resources and a land base for their life cycle, and to conserve the milk-vetches, maintenance of as many of these visitors as possible is essential in order to account for natural bee population fluctuations (Roubik 2001, Tepedino and Stanton 1980 *in* Tepedino 2005, Tepedino 2005). Methods of seed dispersal are unknown and may be provided by birds or small animals, as well as abiotically through hydrology, shifting soil, wind, etc. Requirements for germination most likely involve abiotic and biotic soil conditions. Given all this, at some level the disturbance or change alteration of natural regimes is likely to preclude recovery. The research described in recovery action 4.4 can further illuminate the elements essential for recovery. Protection needs of the vegetation communities and ecosystems within which these species are found should be evaluated and prioritized. Evaluation of needs should include , but not be limited to, impacts related to landscape fragmentation and loss of occupied lands to development; nonnative weeds; areas where overuse has created land-scars; and the deleterious effects domestic animals. This evaluation should occur for all extant populations and be extended to any additional discovered or established populations (see recovery actions 2 and 5).

1.6 Protect the seedbanks of each species.

1.6.1 Protect the *in situ* (onsite) seedbank of each species. Presumably, areas within and near plant occupancy retain seeds within the soil. Seeds represent future offspring while preserving genetic diversity of past generations. Actions to reduce seed loss require protection from ground disturbance, e.g., soil compaction, erosion, and loss of natural soil biotic conditions. Habitat protection actions will reduce or abate loss and damage to seeds contained in the soil. Onsite seed conservation also will require the establishment of best management practices to ensure the protection of natural soil conditions and seeds. Research pertaining to this topic is described below in action 4.4.6.

1.6.2 Protect seeds *ex situ* (offsite). Seed-storage, although by no means meant to replace conservation of wild populations in their natural habitat, can increase the survival prospects of imperiled plant species by preventing unique genotypes from disappearing altogether. Seed-storage can effectively preserve and maintain viable seeds in long-term storage, thereby reducing the possibility of extinction and contributing to recovery.

1.6.2.1 Develop seed collection and permitting guidelines. A protocol for seed collection that will minimize effects to *A. holmgreniorum* and *A. ampullarioides* is needed. The number of seeds collected and the collection interval should be determined in conjunction with the most current standards and models used by such entities as the national Center for Plant Conservation. Standards should be determined in advanced of collection activities, and seed collection permits should be assessed for need and duplication. At a minimum, permit holders should provide documentation of activities, with specific information on the number of plants at collection site, number of plants collected from, and number of seeds removed per plant.

1.6.2.2 Collect and store seeds representing the genetic variability of each species. The rarity of *A. holmgreniorum* and *A. ampullarioides* make these species highly vulnerable to random environmental and human-caused events. As a protection against significant loss of genetic material, seed representing the diversity of both taxa should be collected and stored for long term conservation in at least one Center for Plant Conservation approved facility. The stored seed could be used for efforts to establish new populations and periodic testing will be necessary to estimate the rate of viability loss during seed storage. This estimate will help establish the correct interval, adequacy, and quantity of seed collection and storage.

2. Locate and conserve additional extant populations, if any.

2.1 Standardize rangewide survey procedures for each species. Information on known occupied habitats is based on GIS data, anecdotal observations, hand-drawn maps, and field reconnaissance work and spot surveys. More consistent documentation of this information is needed, and standard survey procedures should be developed and uniformly applied to ensure consistency and accuracy across both species' ranges. This also should facilitate a systematic search for as yet unidentified populations.

2.2 Implement new searches in potential habitat areas. The discovery of new populations would enhance future recovery options.

2.2.1 Delineate appropriate potential habitat areas and conduct surveys on Federal lands. Habitat elements required by both species can be evaluated through existing information such as soil type and geological formation maps and aerial photos. As new information about habitat requirements becomes available, it should be used to refine habitat delineation and create maps of potential habitat within the species' ranges. Determination of survey requirements should be based on identifying data gaps for areas of suitable habitat currently thought to be unoccupied. Additionally, survey efforts could include soil sampling of appropriate habitats for dormant seedbanks, as dormancy of seedbanks is a likely underlying cause of some colonization events (Harrison et al. 2000).

2.2.2 Obtain permission from Tribal, State, and private landowners to conduct surveys. Surveys on non-Federal lands should follow procedures consistent with surveys on Federal lands, with priority given to areas where activities may affect habitat or where habitat may be acquired or managed for conservation.

2.2.3 Create a spatial database for survey efforts, including negative results. In order to complete inventory efforts for these species before assessing the need for introduction of new populations, a systematic approach for compiling and analyzing survey results should be developed and consistently utilized by management entities.

2.3 Apply the conservation measures detailed in recovery action 1 to each additional site. Land development, purchases, trades, and disposal actions could negatively affect the species' ranges, distribution, and rates of recovery. Measures should be implemented to conserve occupied and suitable habitats across both species' ranges.

3. Monitor *A. holmgreniorum* and *A. ampullarioides* sites for population information and trends.

3.1 Develop a rangewide standardized monitoring plan and protocol for each species. A cohesive plan for acquiring the quality and quantity of information required to detect population trends is needed for each species. Results from past monitoring efforts should be used to inform improved monitoring protocols with the aim of facilitating consistency of data collection and analysis on a rangewide basis.

3.2 Implement standardized monitoring on Federal lands. Monitoring for *A holmgreniorum* is being conducted by Dr. Renee Van Buren incoordination with BLM (Utah) and Utah SITLA, and data collection sites have been established at the State Line, Gardner Well, and Central Valley areas. Dr. Van Buren also is conducting monitoring for *A. ampullarioides* through agreements with BLM (Utah) at Pahcoon Wash and Harrisburg. Monitoring activities in Zion National Park include land surveys, individual counts or estimations, and current research under the direction of Mark Miller of the USGS. A joint effort on the part of Federal agencies and interested parties is needed to identify monitoring needs and applications. There is a fundamental need for rangewide assessment of population trends in order to evaluate threats abatement measures, population health and stability, and effectiveness of recovery implementation. A standardized monitoring program should provide an assessment of population numbers as a means of determine the species' biological status, e.g., stable, improving, or declining.

3.3 Obtain permission from landowners and conduct standardized monitoring on Tribal and non-Federal lands. Non-Federal landowners are key to the long-term conservation of both species. Realistic deference to the legitimate concerns of non-Federal governing entities and private landowners will form the basis for gaining access to conduct surveys and other monitoring activities on their lands. Although long-term conservation agreements are ideal, any form of ongoing permission ― based on sustained mutual trust ― to collect and use data for population trends will help advance the recovery program for the milk-vetches.

3.4 Create a database for long-term collection and evaluation of monitoring data. Collection of monitoring data should be jointly available to interested parties. Participating users should develop a single repository and common data base for all monitoring data.

3.5 Develop post-delisting monitoring and conservation plans. As recovery actions, criteria, objectives, and goals are met and recovery thus achieved, a post-delisting plan that spans a statutory minimum of 5 years of monitoring should be developed. Such a plan should be completed long before delisting in order to ensure an appropriate level of consistency between monitoring conducted as part of the recovery process and monitoring conducted to demonstrate the continued viability of each species after delisting. In addition, to ensure that active management of the species and their habitat continues after their delisting, brief but site-specific and long-term conservation plans should be developed prior to delisting.

Research

4. Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers.

Although some aspects of the biological requirements of these species are known, if full recovery and conservation is to be achieved, more must be learned. Research for recovery purposes will be aimed specifically at the protection and conservation of *A. holmgreniorum* and *A. ampullarioides*. Studies also may reveal new techniques or actions for recovery, which will be incorporated into an updated plan as appropriate (see recovery action 11).

4.1 Analyze available data and identify data needed to evaluate population trends. Multiple years of raw data have been collected for both species. Analysis of these long-term data will provide an important baseline for future trend analyses as recovery proceeds. The data also may indicate further data collection needs and provide a platform for refining and standardizing data collection methods. During the course of analyzing available data, experts should identify the data inputs needed for an appropriate quantitative predictive model, such as a population viability analysis. These activities should be coordinated with recovery action 3.1.

4.2 Develop standard procedures for setting annual research priorities and evaluating proposals. To provide recovery in the most expedient and cost-effective fashion, research activities should be consistently prioritized in terms of benefit, need, and cost-value. Criteria such as urgency, scale, benefits to one or both species, significance of data gap, possible negative effects, transference of study results, and ancillary benefits (e.g., to other species or the broader ecosystem) should be standardized and conveyed to interested researchers. A process for using these criteria to direct annual research priorities as well as to evaluate any research proposal that may benefit or affect *A. holmgreniorum* or *A. ampullarioides* should be established. The selection/evaluation criteria should then be disseminated to all prospective investigators.

4.3 Establish protocols for protecting milk-vetch populations during the course of field studies. Although the studies identified below will benefit the species, it is well-acknowledged that research can negatively affect both the landscape and target populations. Prior to initiating recovery-oriented research, a set of fundamental protective protocols should be established by a group of experts as a means of minimizing potential impacts on the milk-vetches and their habitat. These protocols should include, but not necessarily be limited to, measures for controlling human foot traffic and minimizing its effect on living soils and seedbanks (e.g., through soil compaction and erosion), procedures for limiting the spread of nonnative plants via human transport, and effects of research actions on pollinators and potential seed dispersal vectors.

4.4 Conduct needed investigations and identiy recovery applications of research results. The information base for each of these milk-vetches should be as complete as necessary to ensure the effectiveness of recovery efforts, such as determining population status and habitat needs. Problematic gaps remain in our knowledge about each species' reproductive biology, biological constraints, microhabitat requirements, genetics, effective habitat size and connectivity, and the effects of various activities relative to population viability.

4.4.1 Nonnative weeds. Research involving nonnative weeds should--(a) evaluate factors pertaining to interaction, such as competition between nonnative weeds and *A. holmgreniorum* and *A. ampullarioides* for soil and/or pollinator resources; (b) determine the need for nonnative plant control; and (c) study management measures in a controlled setting that may contain similar but unoccupied habitat.

4.4.2 Pollinators. Conservation of pollinators and their habitats is fundamental to recovery of the milk-vetches (see recovery action 1.5). Research is thus needed regarding essential pollinators and their role in the reproductive biology (see recovery action 4.4.5) of *A. holmgreniorum* and *A. ampullarioides*. Preliminary work has identified some insect pollinators and their role, and further research could investigate the adequacy of pollinator visitation, identify nesting substrate of known pollinators, and determine which other flowers these pollinators visit (native and nonnative) and the effects of these other floral resources on pollination for *A. holmgreniorum* and *A. ampullarioides*. Knowledge of pollinator presence, density, preference of floral resources, and nesting substrate may be essential to the viability of the current populations, establishing habitat protection, and the suitability of potential introduction sites.

4.4.3 Habitat substrates and soil conditions. Profiling the biotic, chemical, hydrological, and other natural land conditions at known locations of *A. holmgreniorum* and *A. ampullarioides* may provide insight into current life-supporting conditions for these species, aid in identifying sites of unknown but potential occupancy, and facilitate assessment of sites needed for expansion and/or introduction.

4.4.4 Fire effects. Research is needed to assess the effects of fire on both species. Study results should inform the development of standardized firefighting protocols, including post-fire habitat restoration.

4.4.5 Genetic variation and reproductive biology. The amount of variation within the gene pool of *A. holmgreniorum* and *A. ampullarioides* sites is unknown. Genetic information should be obtained and evaluated with regard to resiliency, genetic drift, and inbreeding depression. Genetic diversity may indicate the level of health, fitness, and adaptability of a population vis-à-vis natural and human-caused stresses. When available, genetic information should be utilized to guide site preservation, restoration, augmentation, and introduction decisions. Information on reproductive biology should include information on seed set and viability in order to build a predictive model to determine population trends (see action 4.4.6 below).

4.4.6 Seedbank viability and longevity. To better understand long-term survival strategy of a species, an understanding of the soil seedbank must be taken into consideration. Seedbank research should be aimed toward quantifying existing seedbanks, investigating seed dispersal mechanisms, and determining the range and viability of seedbanks for both plant species. In particular, these studies should be continued in order to better understand the long-term strategies these species employ for survival. Overall, seedbank research will add to the information needed to effectively advocate for the protection of habitat resources and will assist with understanding the life cycle and survival mechanisms of both plant species.

4.4.7 Parasitism, herbivory, and/or disease. Damage to flowers and inflorescence stalks from disease, herbivory, and parasitism has been identified for some *A. ampullarioides* plants. Additional effort should be given to documenting these events and collecting parasites or diseased stalks. For parasitism, disease, or herbivory, notes should be taken in the field to describe the patterns of effects. If investigation is needed to determine the source of damage and amount of damage, protocols should be established for a data record-keeping system for these phenomena. Quantifying natural seed predation may be needed for predictive modeling. If these phenomena are shown to affect *A. holmgreniorum*, similar documentation and research should be initiated.

4.4.8 Modeling. A population model provides a means of using data on demographic processes and environmental variability to estimate probability of extinction by a specific time, assess recovery success, and determine management needs (Morris et. al 2002). Models should be developed to evaluate alternative management strategies and updated to track recovery progress of these species for both population trends and for size of needed habitat. Available data may suffice for initial development of models. The quality of the models will improve over time commensurate to the availability of information on, for instance, viable seed longevity and survivorship rates. Modeling on *A. holmgreniorum* and *A. ampullarioides* may include factors such as precipitation cycles and response, competition with invasive species, pollinator success, genetic data, and fire cycles.

4.4.9 Other topics, as identified through recovery action 4.1. The topics specified under recovery actions 4.4.1-4.4.8 represent current research priorities; however, this list does not include all research possibilities, and different or additional investigations may be identified in the future as necessary for advancing the conservation of one or both species.

5. Develop and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations.

As more information about habitat conditions and life requirements of *A. ampullarioides* and *A. holmgreniorum* becomes available, it will inform management decisions regarding the potential for establishing or augmenting populations. Rangewide population augmentation and/or establishment strategies and site-specific protocols should be articulated in a reintroduction plan prior to implementing any reintroduction project. The strategy should include:

- The need for and role of reintroductions in meeting the recovery criteria for the species (e.g., abundance, distribution, range expansion, reduced risk of catastrophic loss, connectivity);
- The locations where reintroductions are needed (e.g., range periphery, between extant locations to enhance connectivity, in varied habitats);
- Major uncertainties and pre-project information needs;
- A schedule for implementing reintroductions;
- A protocol for how reintroductions will be conducted;
- Indicators of short- and long-term success (or failure); and
- A monitoring strategy.

Population management should be conducted in coordination with the appropriate Federal and State plant management and land management agencies. If management activities are proposed on Tribal lands or impact Tribal land management, close coordination under

Secretarial Order No. 3206 should be conducted (see recovery action 7.2). Population enhancement efforts should be designed as adaptive management experiments and should include a public education component.

5.1 As needed identify potential population establishment sites for each species. New milk-vetch sites could be located on public or private lands, although public lands are highly preferable over the long term. Site selection should be based, in addition to ecological suitability, on anticipated support from private landowners, local communities, the State, Federal landowners, and/or affected Tribes. Site selection criteria should be developed, and potential sites for population establishment should adhere to the criteria. In general, site selection should stay within the following sideboards:

- The site should be within the historic range of the species;
- Population establishment should only take place where the habitat and landscape requirements of the species are satisfied and are likely to be sustained for the foreseeable future. The area should have sufficient carrying capacity to sustain growth and support a self-sustaining population in the long run;
- There must be some capacity to readily address any threats to the site that may exist and preclude emerging threats;
- In general, introductions should avoid sites with remnant populations in order to prevent disease spread and/or introduction of alien genes. However, there may be instances where such introductions may be considered with careful planning; and,
- There should be some assurance that the site will have long-term protection (whether formal or otherwise). Ideally, the site should be legally protected with rights for long-term management of the species.

5.2 Develop population augmentation and introduction protocols. As an integral component of efforts to augment extant populations or introduce new populations, protocols should be established. These protocols may include the number of years over which releases are expected to occur, the number of propagules that will be released at any one time, the frequency of releases, the locations from which the released plants will be obtained (e.g., controlled propagation facilities, wild populations), and the use of any supplemental watering, protective fencing. As appropriate, protocols should be peer-reviewed and made available to the public.

5.3 Develop procedures for monitoring and evaluating success of expansion efforts. Monitoring of augmentation and/or introduction efforts is a critical management tool for improving the prospects for success, protecting reintroduced individuals, and modifying management techniques and approaches as necessary. Monitoring procedures should address each management effort as a carefully designed experiment, with the capability to test methodology with scientifically collected data. Monitoring the health of individuals, as well as their survival, is important; intervention may be necessary in some cases. The monitoring procedures should take the following factors, into consideration, as applicable:

- Success indicators,
- Status updates,
- Refinements in techniques,
- Effects of management,
- Costs, and
- Any other information that allows USFWS and repatriation cooperators to evaluate the effectiveness of the project on a regular basis.

6. Augment extant populations and/or establish new populations of each species in accordance with the rangewide strategy.

When the necessary forethought has been given to overall population management of each milk-vetch, it will become possible to initiate the needed projects with a reasonable degree of confidence in outcomes that effectively further the conservation of each species. Each stage of project management – pre-release, release, and post-release – will entail several activities. The rangewide strategy and site-specific protocols will provide the best guides for implementing these activities, which may include the following:

6.1.1 Conduct pre-release preparation and release activities. Management may include but will not necessarily be limited to the following activities:

- Build public support;
- Obtain approval or concurrence from authorities and permission from landowners, and initiate coordination with partners;
- Obtain access to expert technical advice for all phases of the project;
- Secure adequate funding for all phases of the project;
- Initiate appropriate health and genetic screening for donor and, as applicable, recipient populations, including screening of closely related species in the area of population management activities;
- Implement appropriate horticultural measures as required to ensure health of released stock throughout the project; and
- Initiate conservation education for long-term support, professional training of individuals involved in the project, public relations, and involvement, where appropriate, of the local community in the project.

6.1.2 Conduct post-release activities. These management activities may include but will not necessarily be limited to the following:

- Conduct post-release monitoring for all or a sample of individuals;
- Study processes of long-term adaptation by individuals and the populations;
- Implement interventions (e.g., supplemental watering, horticultural aids) when necessary;

- When necessary, make decisions with regard to revision, rescheduling, or discontinuation of the project, and conduct an analysis of the causes of the project's failure or need for changes;
- Initiate or continue habitat management or restoration activities where necessary; and
- As appropriate, keep the scientific community and the public informed about the project's status over time through outreach activities.

Communication

7. Promote effective communications with partners and stakeholders regarding the milk-vetches' recovery needs and progress.

Recovery success requires the engagement of key parties through personal contacts, effective working relationships, and ongoing dialogues with recovery partners and stakeholders. Communications should focus on the role that various governmental and non-governmental groups play in implementing recovery actions and facilitating recovery progress. The USFWS also should exhibit a willingness to enter into open discussions about the potential effects of various recovery actions on stakeholders in order to develop implementation strategies that are realistic and can gain the public's support.

7.1 Maintain an active dialogue with Federal, State, and municipal agencies and private interests about recovery issues. It is imperative that all planning and management agencies influencing land use decisions and management actions for areas occupied by *A holmgreniorum* and *A. ampullarioides* be kept apprised of recovery needs and opportunities for these species. In addition to equipping decision-makers with good information, recovery partners should become involved with agency and community initiatives involving recreation, economic planning and development, and use of environmental resources. The aim of this action should be to foster development plans, regulatory mechanisms, and other initiatives that can meet socio-economic needs while advancing milk-vetch recovery.

7.2 Maintain government-to-government communications with the Shivwits Band of the Paiute Tribe regarding conservation of the Shivwits *A. ampullarioides* population. The USFWS will work in cooperation with the Shivwits band to ensure that meaningful government-to-government communication occurs regarding conservation of *A. ampullarioides*. Communications will occur in accordance with Secretarial Order #3206: American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the ESA. In carrying out a government-to-government working relationship, the USFWS will offer technical assistance and information, and pursue funding for the development and implementation of Tribal management plans to promote the conservation of the milk-vetch and its habitat on Shivwits' lands. In addition, the USFWS should identify and enlist Tribal participation in incentive programs such as the Tribal Landowner Incentive Program.

7.3 Establish productive communications with ORV and other interest groups. Many individuals and groups enjoy using motorized vehicles for recreational activities. As more individuals participate in ORV special interest groups, these groups may provide a means to share information about natural landscape issues in Washington and

Mohave Counties. Education outreach to these user groups should be developed to include information about sensitive ecosystems with a focus on milk-vetch habitats. Recovery participants should engage in discussions with special interest groups aimed at reducing land use and plant habitat conflicts. Although these discussions need to address areas of conflict between ORV use and plant habitat, their central purpose should be to work cooperatively and creatively with interested groups to achieve mutually beneficial resolutions.

7.4 Conduct ongoing and timely information exchanges with agencies and organizations involved in fire management and other emergency operations. As nonnative weeds have gained a foothold in the ecosystem of the northern Mojave Desert, the frequency and spread of fire on the landscape has increased. During the active fire season, firefighters unfamiliar with the area are often called in to manage and control wildfire outbreaks. To prevent inadvertent impacts from firefighting actions, information should be developed and disseminated among individuals and organizations involved in fire management, incorporating the results of research into fire effects (see recovery action 4.4.4). This also should extend to other emergency management needs.

8. Develop and implement educational and outreach programs. Generating a broad appreciation of the milk-vetches' recovery needs is essential for achieving their long-term conservation. It will be most effective to convey these needs within the broader contexts of rare plant conservation and outdoor advocacy. The public should be provided opportunities to learn about the recovery process by, for instance, disseminating informational and educational materials through school programs, exhibits, and other venues. Target audiences for these programs could include organized civic and business groups, visitors to interpretive and outdoor education facilities, and students of all ages. Opportunities for individuals and groups to become actively engaged in recovery through volunteer work also should be created.

8.1 Tap the growing interest in rare plant species to garner public support for milk-vetch recovery. Recovery of *A. holmgreniorum* and *A. ampullarioides* rests in some part on evoking a sense of wonder and respect for nature. Many groups and individuals are interested in the natural flora found in Washington and Mohave counties, as well their remarkable natural surroundings. The landscape itself can serve as the best catalyst for discussion about environmental issues, including the issues involved in recovering endangered plants.

8.1.1 Integrate milk-vetch recovery into broader interpretive programs. Although conservation of endangered plant species provides a logical basis for promoting milk-vetch recovery, it may be more compelling to interpret recovery within a broader natural or ecological context that can be conveyed to State and local civic organizations, business and other private organizations, and through exhibits and programs at visitor centers for parks and other public lands. Field presentations, for example, could explore a diversity of topics such as related plant communities, living soils, animal and pollinator interactions, and geological formations. Outdoor advocacy should promote connection to natural places and local diversity wherever these plants exist.

8.1.2 Coordinate a recovery volunteer program. For individuals and community service groups interested in hands-on involvement in recovering these species, one-time and/or regularly scheduled volunteer opportunities should be provided. This could include participation in fence checks, habitat restoration projects, and garbage removal. Introductory education about how to conduct these activities without harming the plants or their habitat would be a necessary element of volunteer service.

8.2 Develop materials and make presentations for educational institutions. Educational institutions often welcome the opportunity to provide fresh information and insights to their students. Understanding rare plant issues reinforces the inherent and learned appreciation of our natural surroundings. As individuals take pride and ownership in the environmental qualities of Washington and Mohave Counties, they can become more meaningfully engaged in enjoying the natural outdoors and protecting the resources, including rare plants, that are integral to this environment. Age-appropriate outreach and educational materials about the milk-vetches and the larger natural context should be developed for elementary and secondary schools, as special presentations and, whenever possible, as teaching units that can be fully integrated into the outdoor education curriculum. Activities should promote the goals of the ESA and the objectives of the recovery program.

Coordination

9. Provide oversight and support for implementation of recovery actions.

To ensure that the recovery process moves as efficiently and effectively as possible toward achieving recovery objectives, a coordinated approach to implementing individual actions is essential. This will involve close communications, early recognition of short-term needs and potential obstacles, and identification of all possible funding opportunities. The USFWS should provide continuing oversight of recovery implementation activities and work with other Federal agencies and private conservation groups to obtain funding through traditional avenues in a regular and resolute manner. New means of funding and support should be developed with the assistance of the States, counties, and cities, as well private land developers and organizations.

10. Establish a technical working group to regularly review the status of the species and track the effectiveness of recovery actions. Annual review of recovery accomplishments, progress toward meeting recovery objectives, and assessment of research and monitoring actions is key to ensuring successful implementation of the recovery program. Standards for monitoring effectiveness and making needed adjustments should be developed by the group at the outset and applied in a consistent manner as the recovery process moves forward. The group should issue an annual report outlining progress and, when called for, significant setbacks in the recovery programs for *A. holmgreniorum* and *A. ampullarioides*. The group also should ensure that tracking results are documented in the USFWS' recovery implementation database.

11. **Revise the recovery program when indicated by new information and recovery progress.** Recovery goals, objectives, criteria, and actions should be validated and, as needed, revised. Whenever possible, keeping this plan current should be done on a frequent, incremental basis. If and when the need for a significant change in recovery direction becomes apparent, the plan should be revised and reissued for public and peer review and comment.

PART IV. IMPLEMENTATION SCHEDULE

The following Implementation Schedule outlines actions and estimated costs for the *A. holmgreniorum* and *A. ampullarioides* recovery programs over the next 5 years. Functioning as a practical guide for meeting the species' recovery goals, this schedule indicates action priorities, action numbers, action descriptions, duration of actions, and estimated costs. In addition, parties with authority, responsibility, or expressed interest in implementing a specific recovery action are identified; however, this neither obligates nor implies a requirement for the identified party to implement the action(s) or secure funding for implementing the action(s). However, parties willing to participate may benefit by being able to show in their own budgets that their funding request is for a recovery action identified in an approved recovery plan and, therefore, is considered a necessary action for the overall coordinated effort to recover these milk-vetches. Also, section 7(a)(1) of the ESA, as amended, directs all Federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of threatened and endangered species. The schedule will be updated as recovery actions are accomplished.

Key to Implementation Schedule Priorities (column 1)

PRIORITY 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

PRIORITY 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

PRIORITY 3: All other actions necessary to provide for full recovery of the species.

Key to Responsible Agencies (column 6)

Acad Inst	=	Academic Institution(s)
ASLD	=	Arizona's Trust Lands Administration
BIA	=	Bureau of Indian Affairs
BLM	=	Bureau of Land Management
DOT	=	Department of Transportation (Utah and Arizona)
FHWA	=	Federal Highway Administration
LG	=	Local governments
NGO	=	Non-governmental organizations such as The Nature Conservancy
NPS	=	National Park Service
OSA	=	Utah and Arizona State agencies other than SITLA and ASLD
Private	=	Private landowners
SB	=	Shivwits Band of the Paiute Tribe
SITLA	=	Utah State Institutional Trust Lands Administration
USFWS	=	U.S. Fish and Wildlife Service, Region 6
USGS	=	U.S. Geological Survey

RECOVERY IMPLEMENTATION SCHEDULE

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
1	1.1.1	P-3,T-1, T-11	Protect plant populations on Federal lands	20	USFWS, BLM, NPS	no	800	40	40	40	40	40	Involved agencies to incorporate recovery actions into planning and management decisions as required by ESA; extending 20 years
1	1.1.2	P-3, T-1, T-11	Work with Shivwits Band of Paiute Tribe to conserve *A. ampullarioides* population on their land	5	USFWS, SB, BIA	no	1,650	55	55	55	55	55	Cost estimates include administrative expenses, fence maintenance, and grazing management
1	1.1.3	P-3,T-2, T,3, T-11, T-13	To extent possible, protect populations on non-Federal lands	30	USFWS, SITLA, ASLD, OSA, LG, NGO, Private	yes	13,600	200	200	400	400	400	Conservation easements and fee title acquisitions: 2 years at $200K, 8 years at $400K, 20 years at $500K
1	1.1.4	T-2, T-11	Minimize effects of highway projects near occupied habitat	15	USFWS, FHWA, DOT	no	1,100	20	20	20	20	20	Cost included in planning actions, possible plant preserve: $20K FY1-10, $50K FY11-14, $700K FY15
1	1.2.1	T-2, T-11	Locate trails away from occupied sites	10	USFWS, SB, BLM, NPS, SITLA, ASLD, Private	no	340	30	30	50	50	50	$30K for first 2 years, $50K for next 5 years, $10K for last 3 years
1	1.2.2	T-2, T-11	Protect sites with fencing and maintain fences	30	USFWS, SB, BLM, NPS, SITLA, ASLD, Private	no	550	40	40	40	40	40	$40K for first 5 years, $30K for next 5 years, $20K for following 10 years
1	1.2.3	T-2,T-5	Implement effective ORV-use control measures	30	USFWS, BLM, NPS, SITLA, ASLD, LG, NGO, Private	no	160	8	8	8	8	8	$8K for first 10 years, $5K for next 10 years, $3K for following 10 years
1	1.2.4	P-3, T-5	Enforce existing regulations to prevent unauthorized land uses	30	USFWS, BLM, NPS, SITLA, ASLD, Private	no	160	8	8	8	8	8	$8K for first 10 years, $5K for the 10 years, $3K for following 10 years

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
1	1.5	P-2, T-1, T-2	Protect vegetation communities/ecosystems associated with each species	30	USFWS, SB, BLM, NPS, SITLA, ASLD, LG, NGO, Private	no	300	10	10	10	10	10	Repeat costs over 30 years
1	1.6.1	T-2	Protect *in situ* (onsite) seedbank for each species	30	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Private	no	150	5	5	5	5	5	Repeat costs over 30 years
1	2.2.1	P-4, P-6	Delineate appropriate potential habitat areas and conduct surveys on Federal lands	7	USFWS, BLM, NPS	no	78	6	12	12	12	12	First year delineation of habitat, 6 years of surveys
1	3.1	P-1, P-6	Develop a rangewide monitoring plan and protocol for each species	30	USFWS, SB, BLM, NPS, USGS, SITLA, ASLD, NGO, Acad Inst	yes	100	13	3	3	3	3	$10K to create database, $3K for annual updates for 30 years
1	3.2	P-1, P-6	Implement standardized monitoring on Federal lands	30	USFWS, BLM, NPS	no	390	42	12	12	12	12	$30K to determine standards, $12K to implement for 30 years
1	3.3	P-1, P-6	Obtain permission from landowners and conduct monitoring on Tribal & non-Federal lands	30	USFWS, USGS, SB, SITLA, ASLD, OSA, TNC, NGO, Acad Inst, Private	yes	300	10	10	10	10	10	$10K/year for duration of recovery period; monitoring costs (no USFWS salary costs)
1	4.1	P-1, P-6	Analyze available data and identify data needed to evaluation population trends	1	USFWS, USGS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	yes	20	20	-	-	-	-	One-time cost

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
1	4.4.1	T-6	Investigate nonnative weeds.	periodic, 30	USFWS, USGS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	no	135	15	15	15	-	-	For 3 years; repeat every 10 years
1	4.4.2	T-7	Investigate pollinators	periodic, 15	USFWS, BLM, NPS, USGS, SB, SITLA, ASLD, NGO, Acad Inst	no	60	-	10	10	10	-	$10K for 3-year period in 15 years
1	4.4.3	P-2, P-5	Investigate habitat substrates and soil conditions	3	USFWS, USGS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	no	90	30	30	30	-	-	Already initiated for *A. ampullarioides*
1	4.4.5	T-9	Investigate genetic variation within and among populations	periodic, 10	USFWS, USGS, Acad Inst	no	60	30	-	-	-	-	$15K per species, repeat for changes in 10 years
1	4.4.6	P-2, P-5	Investigate seedbank viability and longevity	15	USFWS, USGS, SB, BLM, NPS, NGO, Acad Inst	no	28	10	2	2	2	2	$10K to initiate, "stash" seeds for longevity tests, annual for 5 years, every other year for 10 years
1	4.4.8	P-1, P-6	Conduct population modeling	30	USFWS, USGS, BLM, NPS, SB, SITLA, ASLD, NGO, Acad Inst	no	100	13	3	3	3	3	$10K to examine information & build model, $3K/yr for 30 yrs to maintain
1	7.3	T-2	Establish productive communications with ORV user groups and other interest groups	10	USFWS, SB, BLM, NPS, NGO	no	20	2	2	2	2	2	$2K/year for 10 years

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
1	9	T-2	Provide oversight and support for implementation of recovery actions	30	USFWS, BLM, NPS, SB, BIA, NGO, Acad Inst	yes	300	10	10	10	10	10	$10K annually for 30 years
1	10	T-2	Establish a technical working group to regularly review status of each species and track effectiveness of recovery actions	30	USFWS, USGS, SB, BLM, NPS, LG, NGO, Acad Inst	yes	60	2	2	2	2	2	2 meetings each year, $2K/year
2	1.3	T-4	Effectively manage livestock grazing activities in species' habitat	periodic, 30	USFWS, BLM, SB, SITLA, ASLD	no	60	6	-	-	6	-	Periodic surveys and assessed every 3 years
2	1.4	T-5, T-13	Incorporate plant protection into Federal agency planning documents	20	USFWS, BLM, NPS, FHWA	no	400	20	20	20	20	20	Involved agencies to incorporate recovery actions into planning and management decisions as required by ESA; extending 20 years
2	1.6.2.1	T-10, T-14	Develop seed collection and permitting guidelines	1	USFWS	yes	2	2	-	-	-	-	FWS salary
2	1.6.2.2	T-10, T-14	Collect and store seeds representing genetic variability of each species	periodic, 30	USFWS, SB, BLM, NPS, NGO, Private	no	35	5	-	-	-	5	$5K every 5 years for seed collection and conveyance to storage facility
2	2.1	P-1, P-6	Standardize rangewide survey procedures for each species	1	USFWS, BLM, NPS, USGS, NGO, Acad Inst	yes	4	4	-	-	-	-	FWS, BLM-AB, NPS salary plus technical working group participation
2	2.2.2	P-1, P-4	Obtain permission from Tribal, State, and private landowners to conduct surveys	30	USFWS, USGS, SB, NGO, Acad Inst	yes	150	5	5	5	5	5	$5K/year for 30 years
2	3.4	P-1, P-6	Create a database for long-term collection and evaluation of monitoring data	30	USFWS, BLM, NPS, USGS, Acad Inst	yes	100	13	3	3	3	3	$10K to create database, $3K for annual updates for 30 years

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
2	4.3	P-1, T-2	Establish protocols for protecting milk-vetch populations during course of field studies	1	USFWS, BLM, NPS, USGS, NGO, Acad Inst	yes	4	4	-	-	-	-	FWS, BLM-AB, NPS salary plus technical working group participation
2	4.4	P-3	Identify recovery applications of research results	10	USFWS, SB, BLM, NPS, USGS, NGO, Acad Inst	no	40	4	4	4	4	4	Applications must be reported with research results; research funding should add on cost of researcher attending recovery meeting for presentation & group discussion.
2	4.4.4	P-3	Investigate fire effects	5	USFWS, BLM, NPS, USGS, NGO, Acad Inst	no	50	10	10	10	10	10	$10K/yr for 5-year period
2	4.4.7	T-12	Investigate parasitism and/or disease	5	USFWS, BLM, NPS, USGS, NGO, Acad Inst	no	20	4	4	4	4	4	$4K/yr for estimated 5 years
2	5.1	P-3, P-4	As needed, identify potential population establishment sites for each species	2	USFWS, SB, BLM, NPS, USGS, NGO, Acad Inst	no	40	20	20	-	-	-	Anticipated to be salary and travel cost of participating agencies in recovery meetings
2	5.2	P-4	Develop population augmentation and establishment protocols	1	USFWS, SB, BLM, NPS, USGS, NGO, Acad Inst	no	8	-	8	-	-	-	Anticipated salary and travel cost of participating agencies in recovery meetings
2	5.3	P-4	Develop procedures for monitoring and evaluating success of expansion efforts	1	USFWS, SB, BLM, NPS, USGS, NGO, Acad Inst	no	40	-	-	-	-	40	Anticipated salary and travel cost of participating agencies in recovery meetings and writing
2	6.1	P-4	Conduct pre-release preparation and release activities	10	USFWS, SB, BLM, NPS, USGS, NGO, Acad Inst	yes	400	-	-	-	-	40	Beginning FY5 at $40K per year, 10 years
2	6.2	P-4	Conduct post-release activities	10	USFWS, SB, BLM, NPS, USGS, NGO, Acad Inst	yes	40	-	-	-	-	-	Monitoring efforts; beginning FY6 at $8K annually, 5 years

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
2	7.2	T-2, T-5	Maintain government-to-government communications with Shivwits Band of Paiute Tribe	30	USFWS, SB, BIA	yes	120	4	4	4	4	4	FWS salary. $4K/year for duration of recovery process.
2	7.4	T-2	Conduct information exchanges with agencies and organizations involved in fire management and other emergency operations	periodic, 30	USFWS, SB, BLM, NPS, USGS, SITLA, ASLD, LG, NGO, Private	no	30	2	-	2	-	2	Salary of involved Federal agency personnel. Multi-agency effort.
2	8.2	T-2	Develop materials and make presentations for educational institutions	periodic, 30	USFWS, SB, BLM, NPS, USGS, SITLA, ASLD, NGO, Private	no	45	3	-	3	-	3	$3K every other year Multi-agency effort
3	2.2.3	P-1	Create a spatial database for survey efforts, including negative results	30	USFWS, SB, BLM, NPS, USGS, FHWA, ASLD, SITLA, OSA, NGO, Acad Inst	no	100	13	3	3	3	3	$10K to create database, $3K for annual updates for 30 years
3	2.3	T-1, T-2	Apply conservation measures detailed in recovery action 1 to each additional site	30	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Private	no	145	-	-	-	10	10	$0K first 3 years, $10K FY4-5, $5K FY6-30
3	3.5	P-7	Develop post-delisting monitoring and conservation plans	7	USFWS, SB, BLM, NPS, USGS, SITLA, ASLD, NGO, Acad Inst	yes	20	-	-	-	-	-	Develop by FY18 to ensure compatibility with recovery monitoring.

Action Priority	Action Number	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
3	4.2	T-2	Develop standard procedures for setting annual research priorities and evaluating proposals	1	USFWS, BLM, NPS, USGS, SB, NGO, Acad Inst	yes	20	20	-	-	-	-	FWS, BLM-AB, NPS salary plus technical working group participation
3	4.4.9	T-2	Investigate other topics as identified through recovery action 4.1	30, periodic	USFWS, SB, BLM, NPS, USGS, SITLA, ASLD, NGO, Acad Inst	no	120	8	-	8	-	8	$8K every other year
3	7.1	T-2	Maintain an active dialogue with Federal, State, and municipal agencies about recovery issues	30	USFWS, SB, BLM, NPS, USGS, FHWA, BIA, DOT, SITLA, ASLD, LG, NGO, Acad Inst	yes	120	4	4	4	4	4	$4K annually for 30 years, salary costs
3	8.1.1	T-2	Implement milk-vetch recovery into broader interpretive programs	30	USFWS, BLM, NPS, USGS, OSA, NGO	no	60	2	2	2	2	2	Salary of involved Federal agency personnel plus guest speaker fees and/or exhibits
3	8.1.2	P-3	Coordinate a recovery volunteer program	30	USFWS, BLM, NPS, USGS, NGO, Acad Inst	no	60	2	2	2	2	2	$2K/year. Salary of involved Federal agency personnel
3	11	P-1, P-2, P-6, T-2, T-4, T-6, T-8, T-9, T-10, T-12	Revise recovery program when indicated by new information and recovery progress	periodic, 30	USFWS, SB, BLM, NPS, USGS, LG, NGO, Acad Inst	yes	125	-	-	-	-	25	$25K every 5 years

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APPENDICES

APPENDIX A. Maps of Individual *Astragalus holmgreniorum* Populations

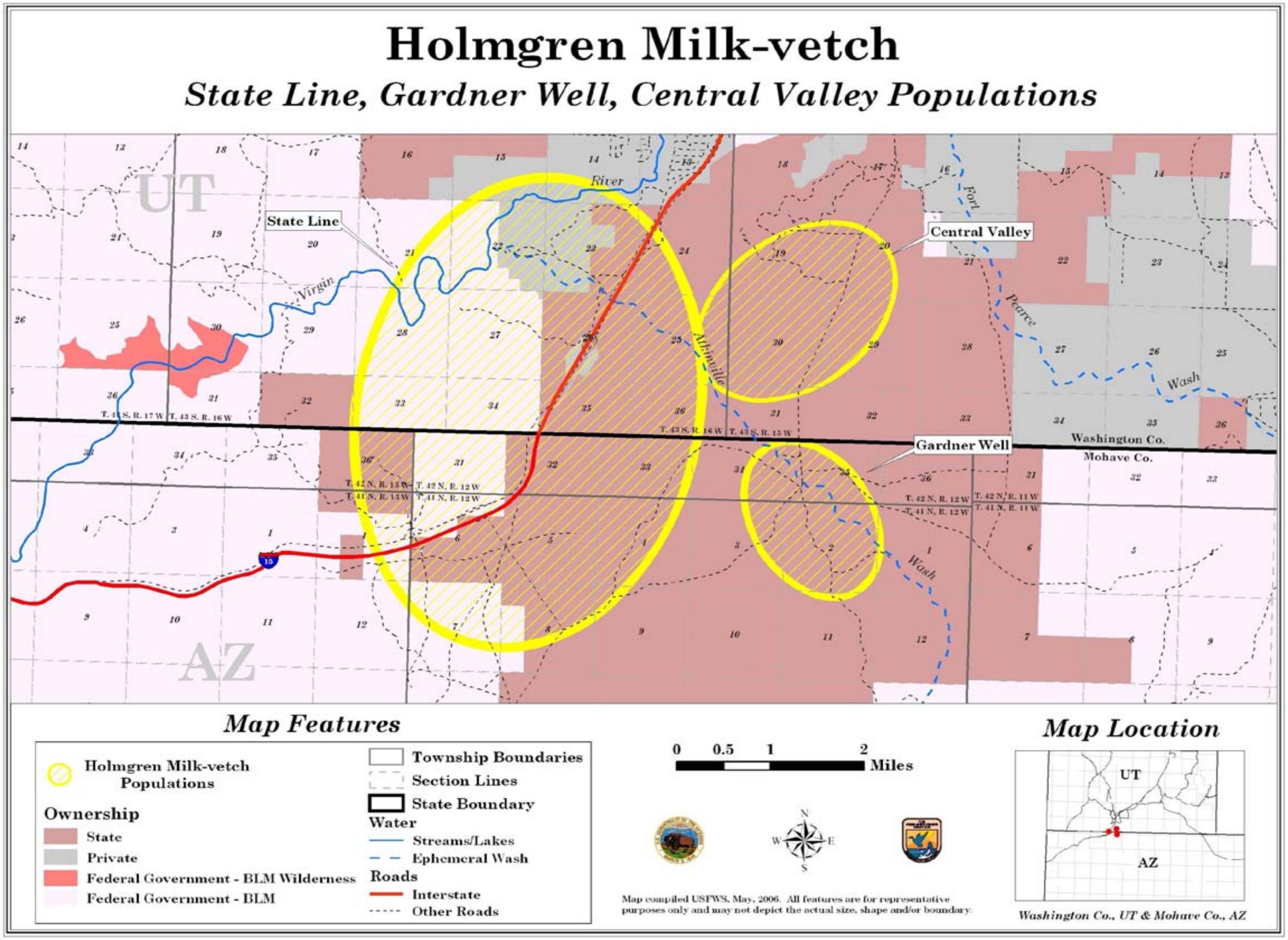
APPENDIX B. Maps of Individual *Astragalus ampullarioides* Populations

APPENDIX C. Maps of Proposed *Astragalus holmgreniorum* Critical Habitat Units

APPENDIX D. Maps of Proposed *Astragalus ampullarioides* Critical Habitat Units

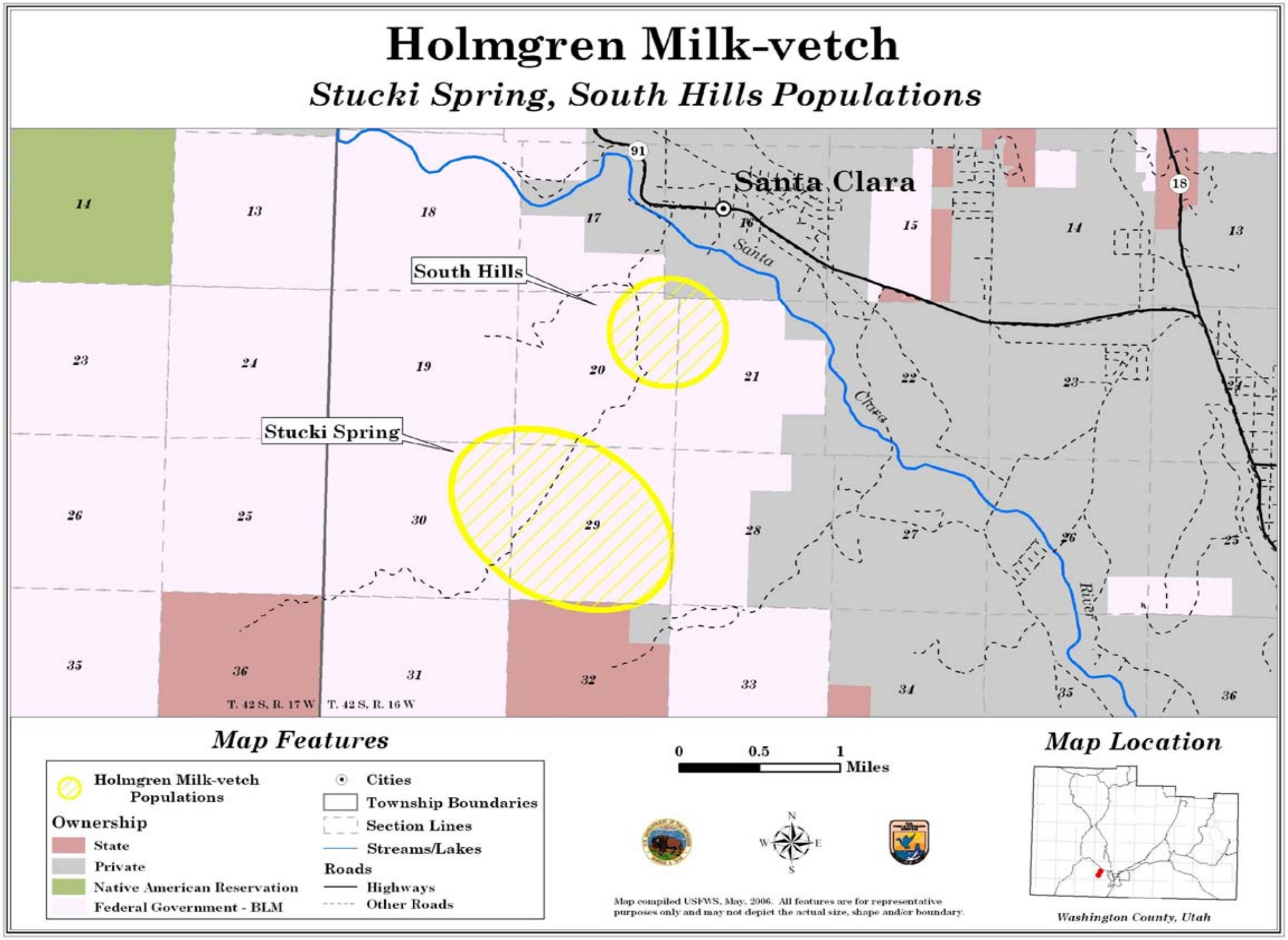
APPENDIX E. Summary of Public Comments and Peer Review

APPENDIX A

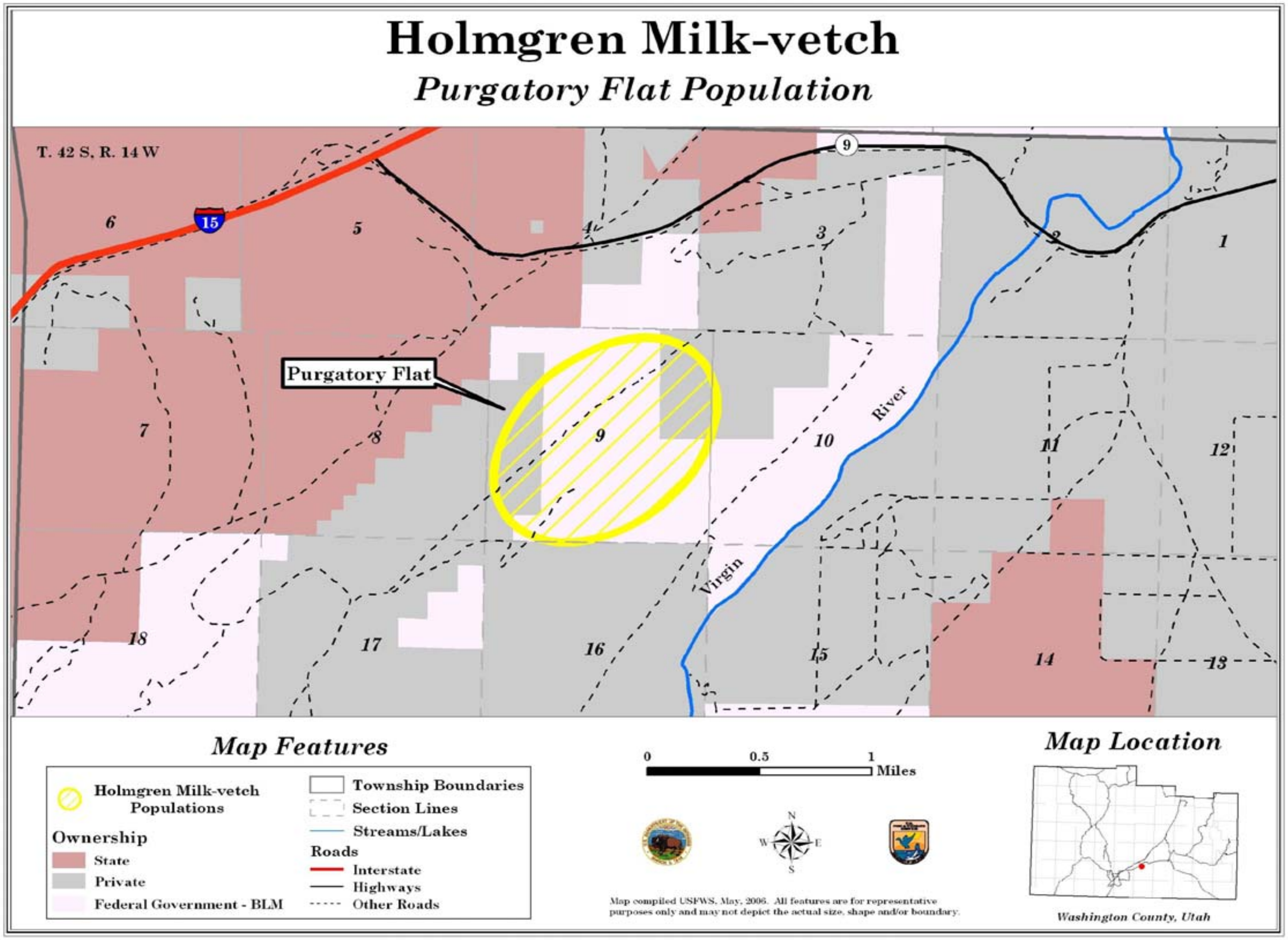


Holmgren Milk-vetch
State Line, Gardner Well, Central Valley Populations
UT
AZ
State Line
Central Valley
Gardner Well
Virgin
River
Fort
Pearce
Wash
Atkinville
Washington Co.
Mohave Co.
Map Features
Holmgren Milk-vetch Populations
Ownership
State
Private
Federal Government - BLM Wilderness
Federal Government - BLM
Township Boundaries
Section Lines
State Boundary
Water
Streams/Lakes
Ephemeral Wash
Roads
Interstate
Other Roads
0 0.5 1 2 Miles
Map compiled USFWS, May, 2006. All features are for representative purposes only and may not depict the actual size, shape and/or boundary.
Map Location
Washington Co., UT & Mohave Co., AZ

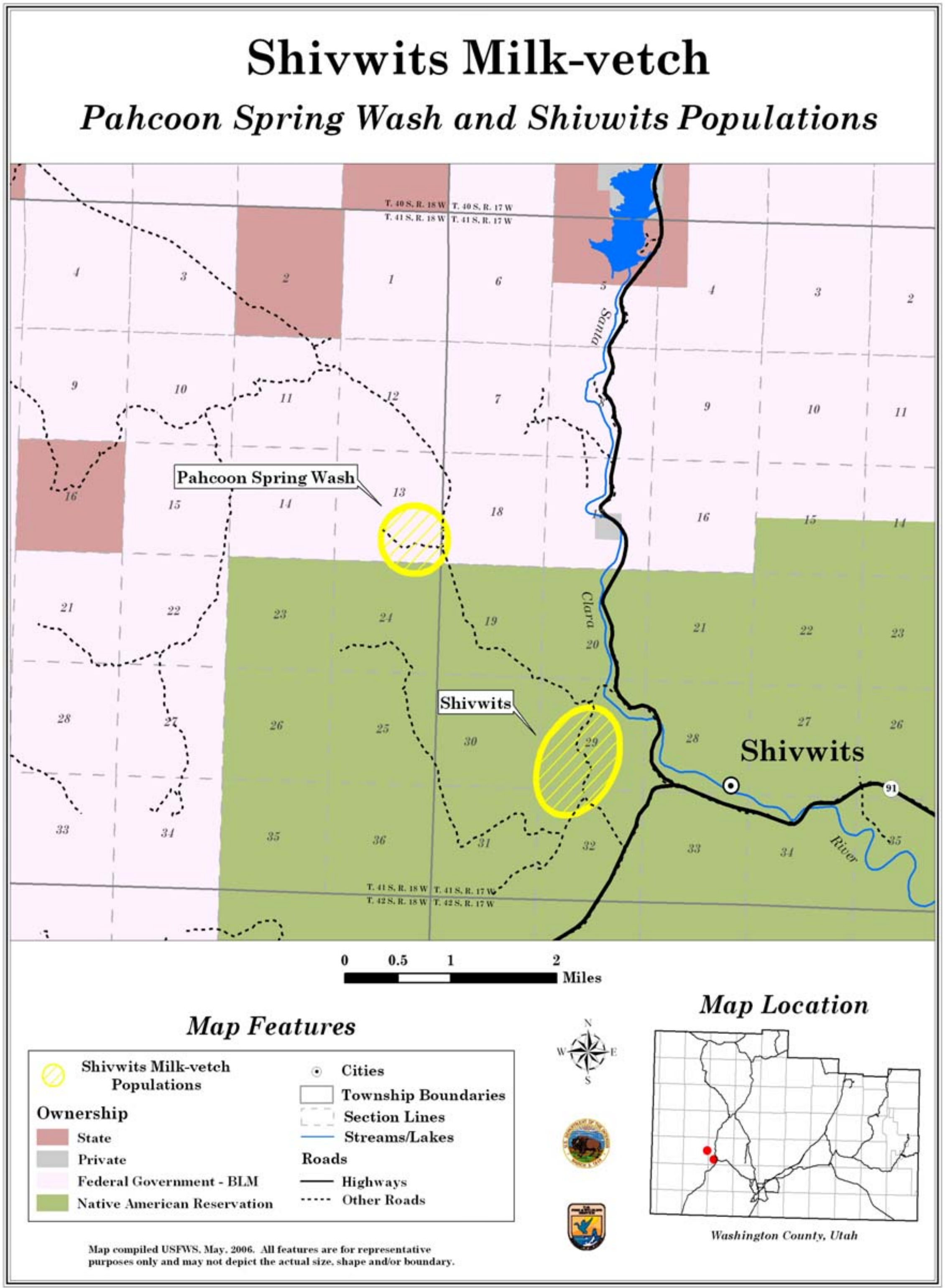
APPENDIX A cont.



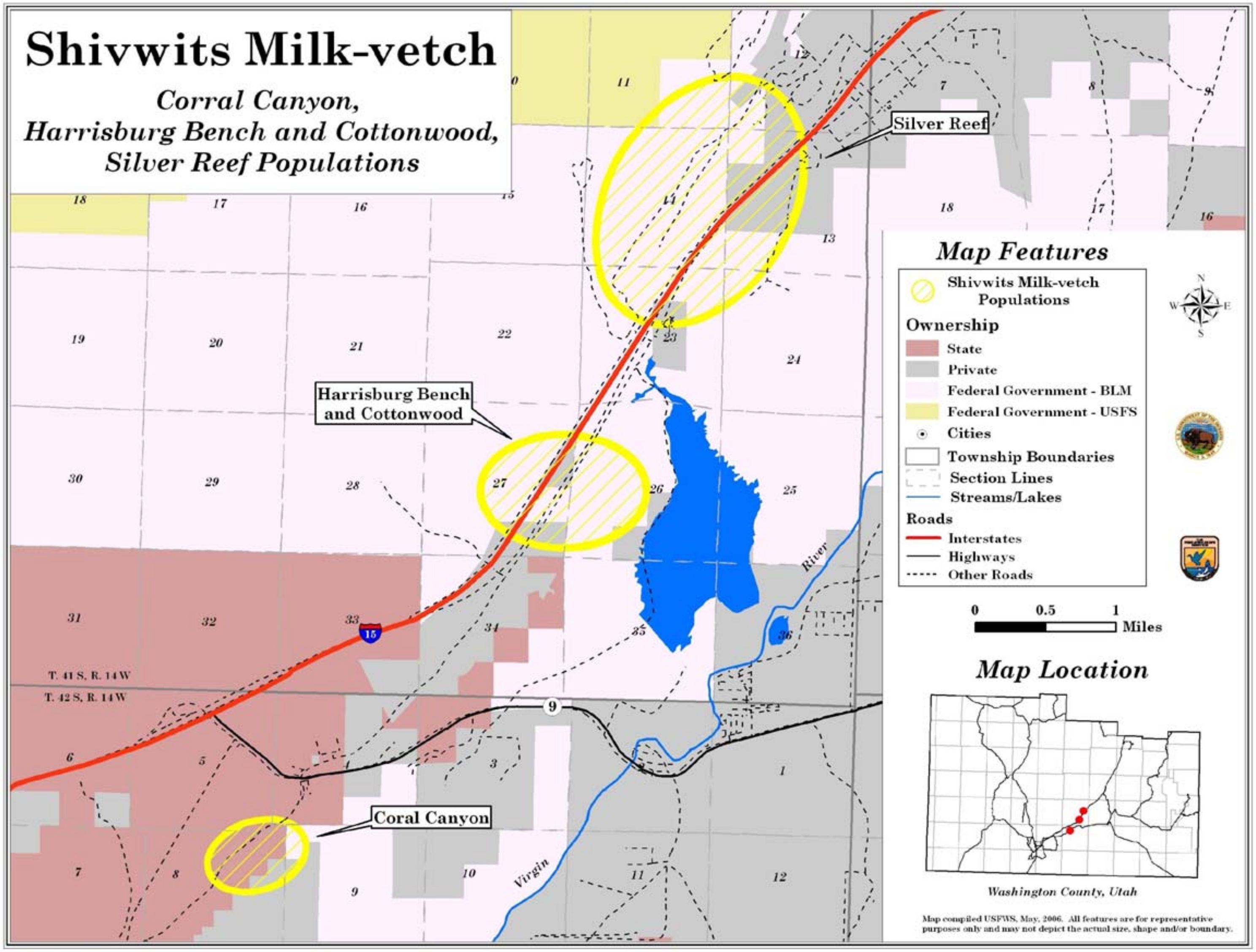
APPENDIX A cont.



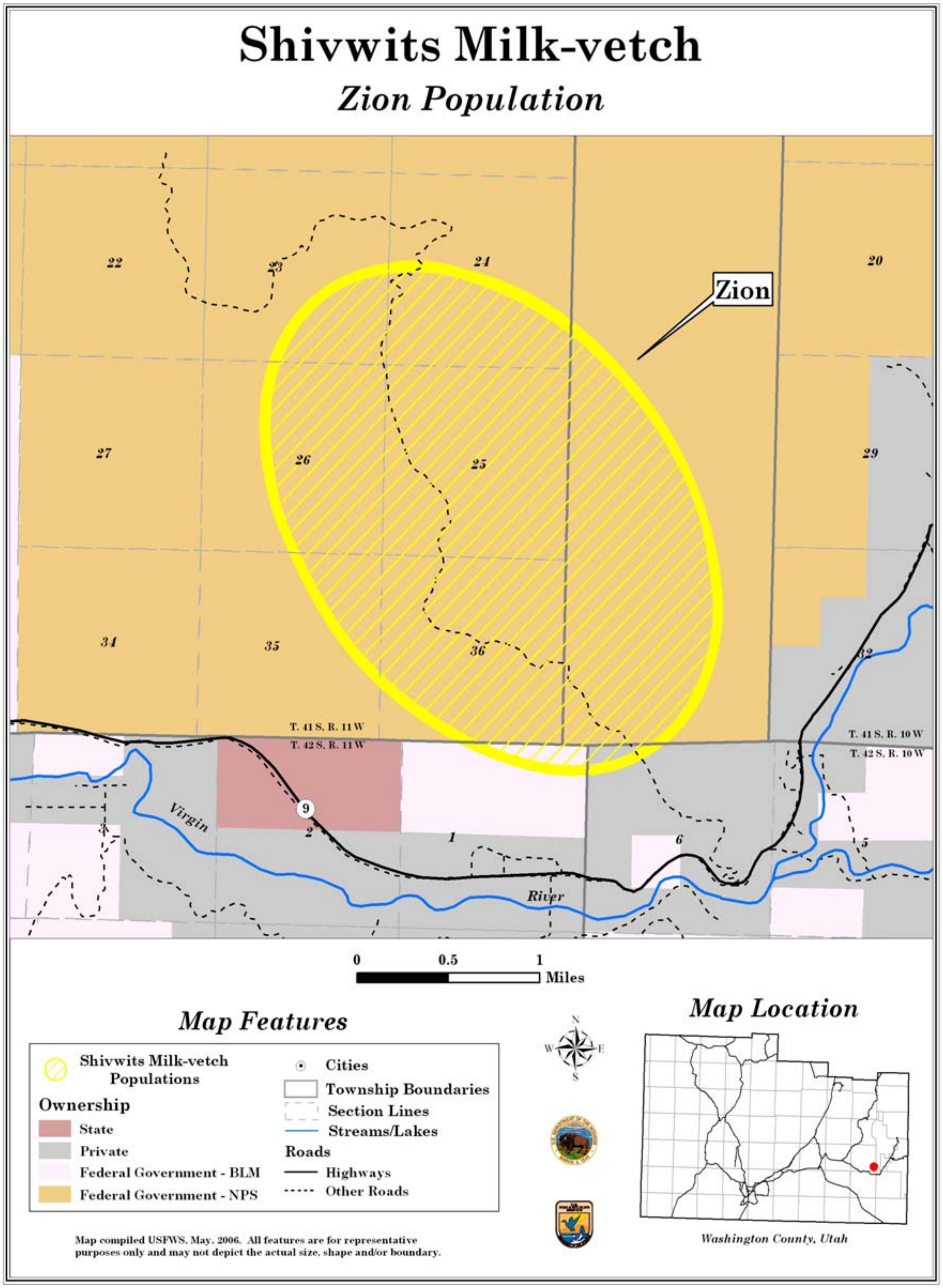
APPENDIX B


Shivwits Milk-vetch
Pahcoon Spring Wash and Shivwits Populations
Pahcoon Spring Wash
Shivwits
Santa
Clara
River
Shivwits
91
0
0.5
1
2
Miles
Map Features
Shivwits Milk-vetch Populations
Ownership
State
Private
Federal Government - BLM
Native American Reservation
Cities
Township Boundaries
Section Lines
Streams/Lakes
Roads
Highways
Other Roads
Map Location
Washington County, Utah
Map compiled USFWS, May, 2006. All features are for representative purposes only and may not depict the actual size, shape and/or boundary.

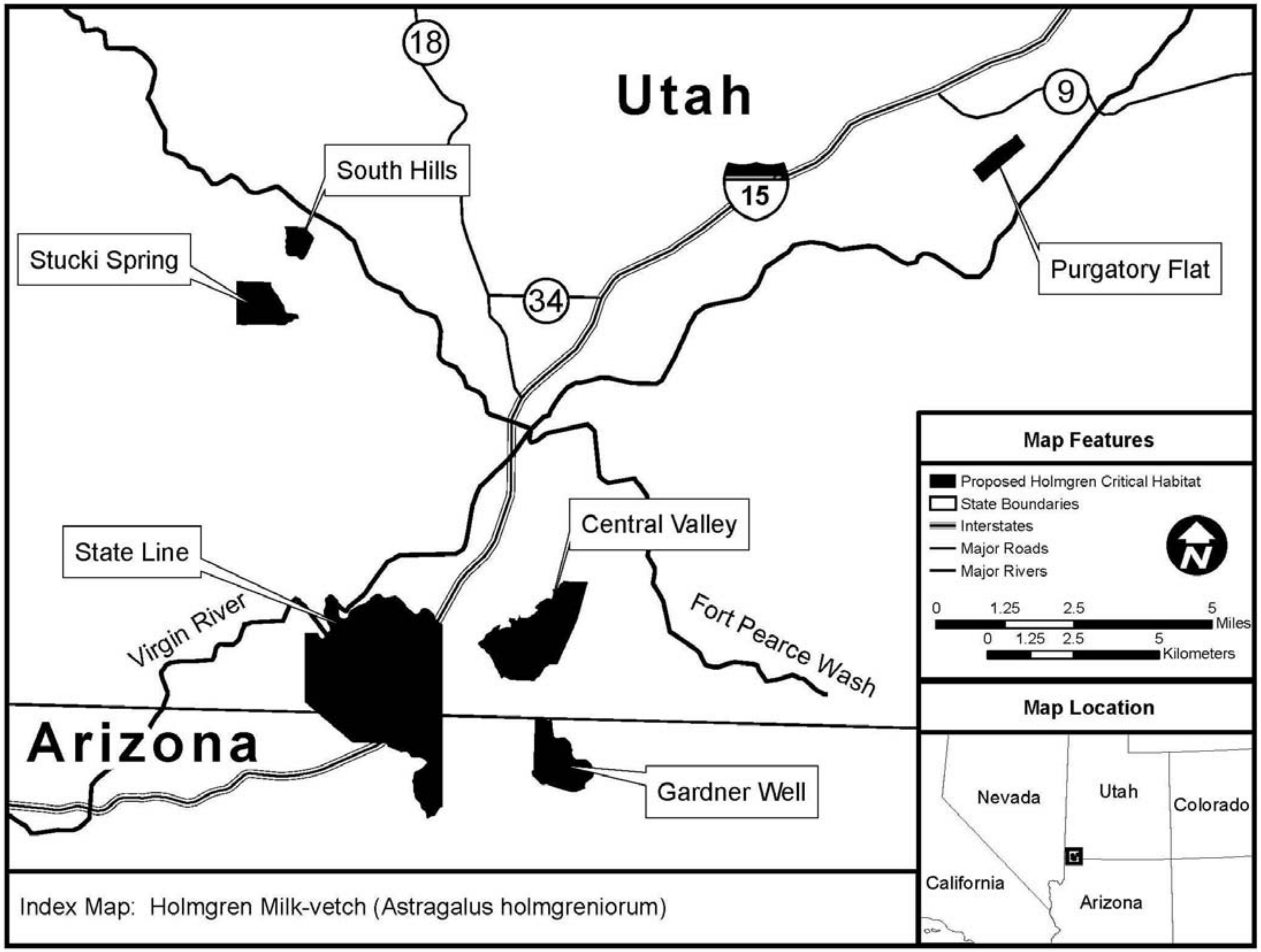
APPENDIX B cont.



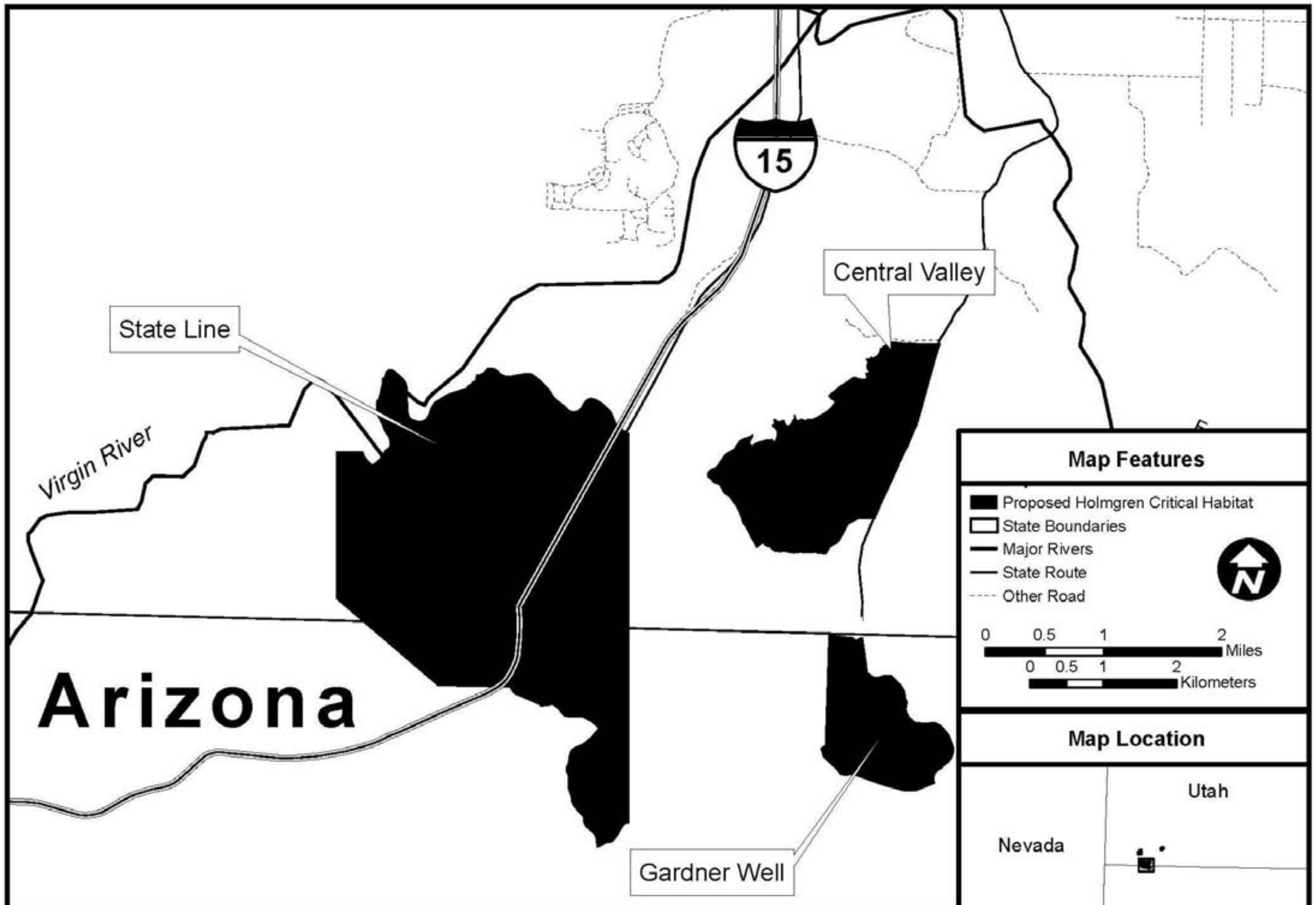
APPENDIX B cont.



APPENDIX C
Proposed *Astragalus holmgreniorum* Critical Habitat Index Map

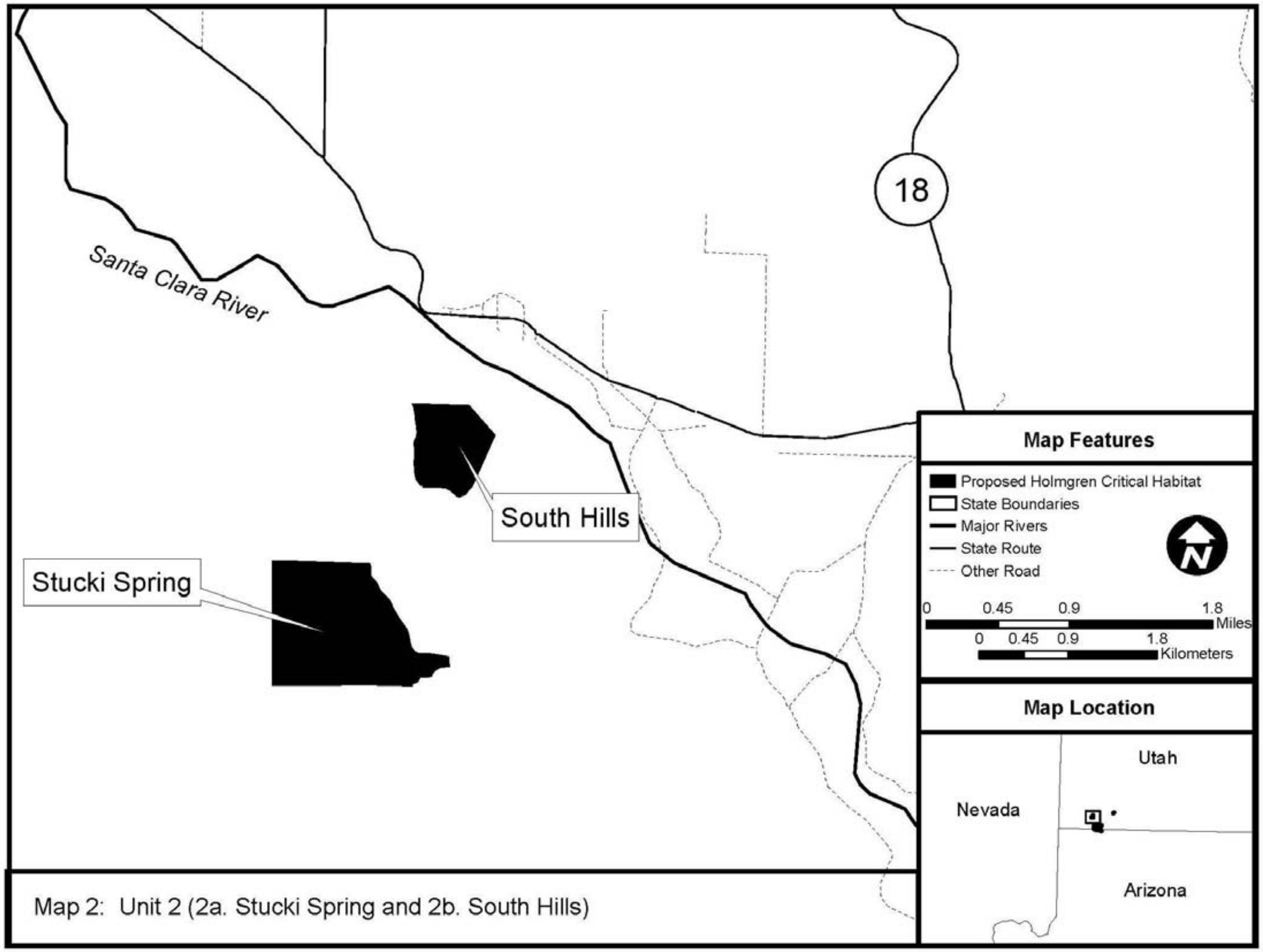


APPENDIX C cont.
Proposed *Astragalus holmgreniorum* Critical Habitat Unit 1 Map

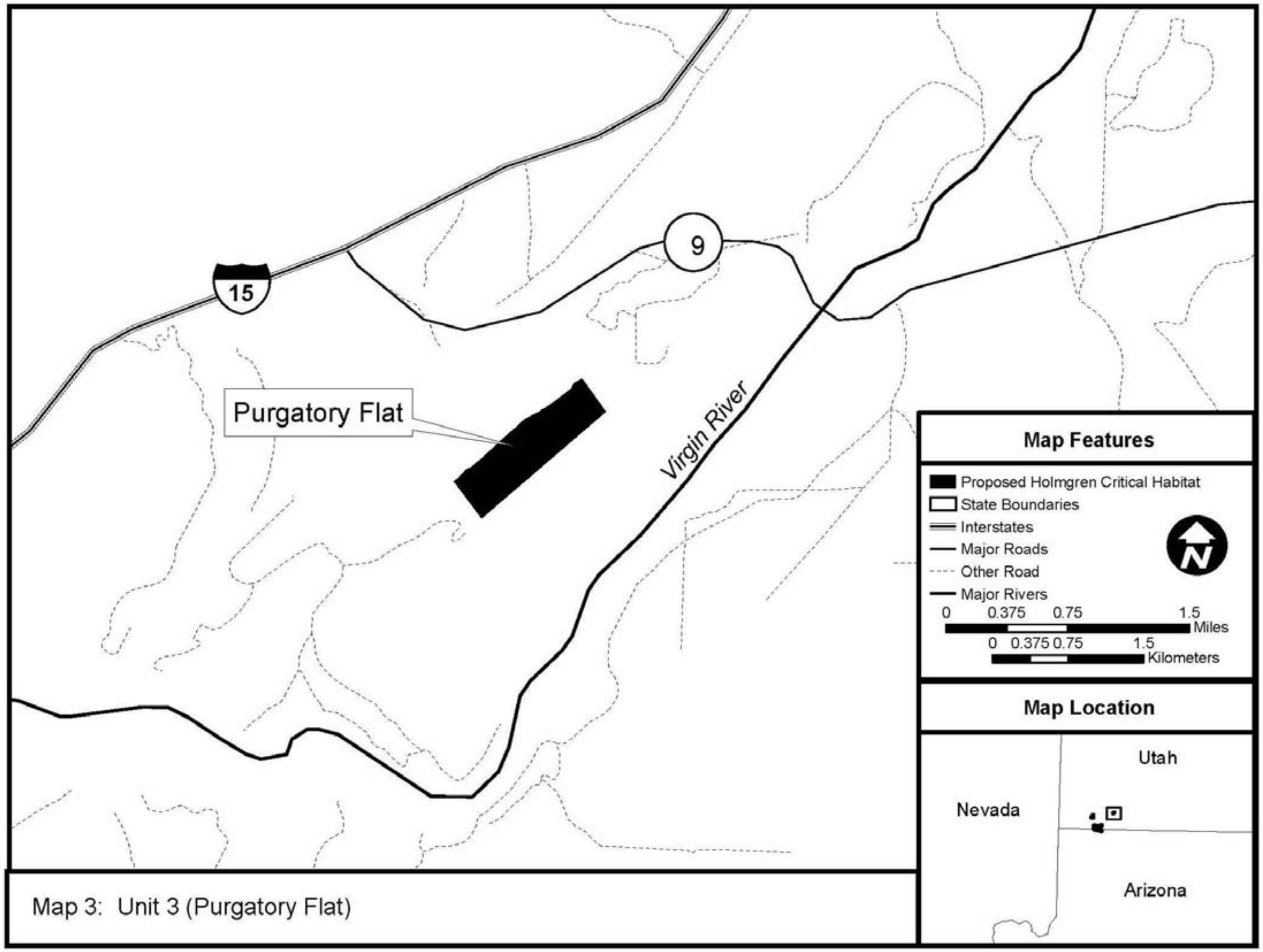


Map 1: Unit 1 (1a. State Line; 1b. Gardner Well; and 1c. Central Valley)

APPENDIX C cont.
Proposed *Astragalus holmgreniorum* Critical Habitat Unit 2 Map

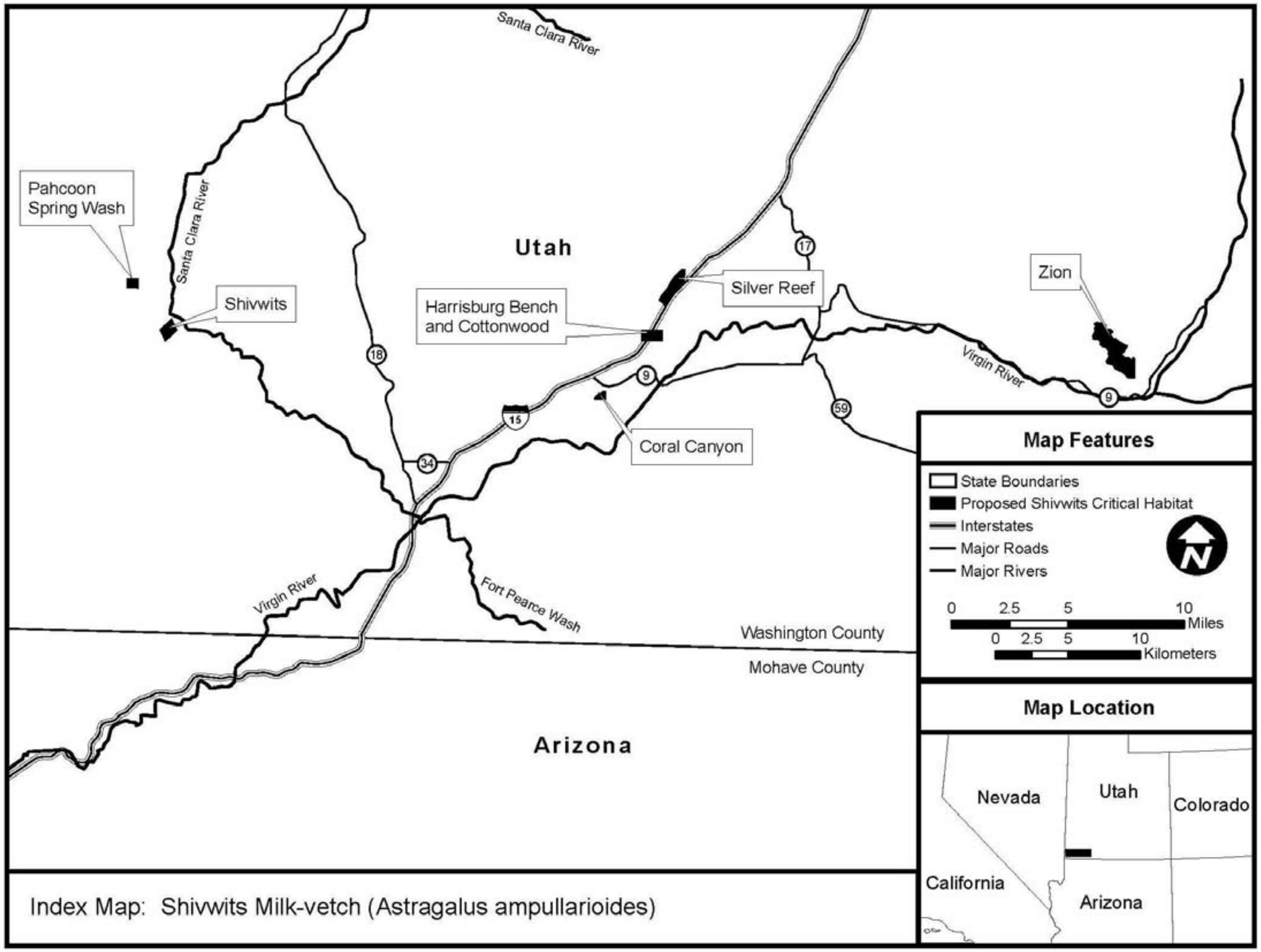


APPENDIX C cont.
Proposed *Astragalus holmgreniorum* Critical Habitat Unit 3 Map

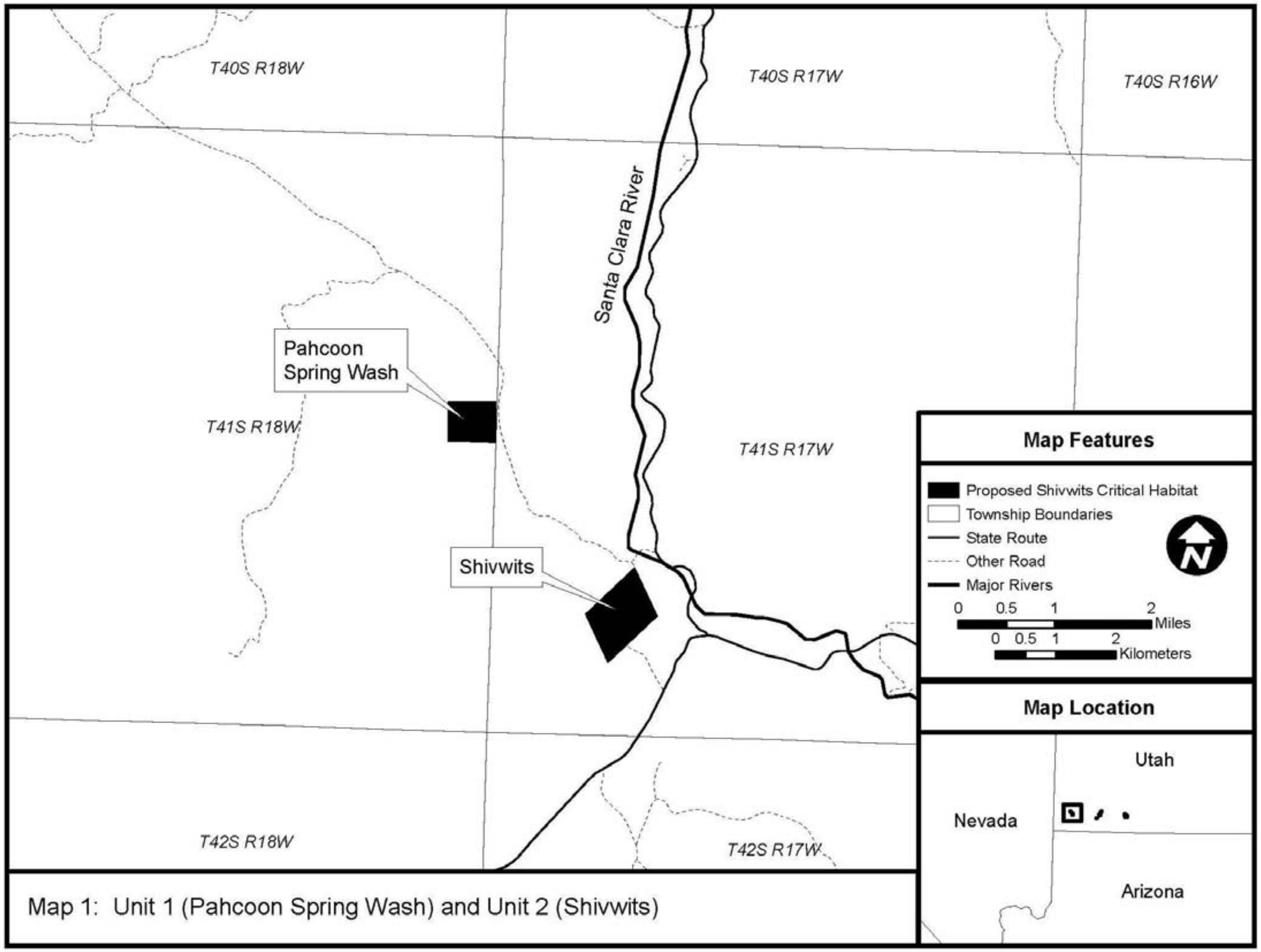


Map 3: Unit 3 (Purgatory Flat)

APPENDIX D
Proposed *Astragalus ampullarioides* Critical Habitat Index Map

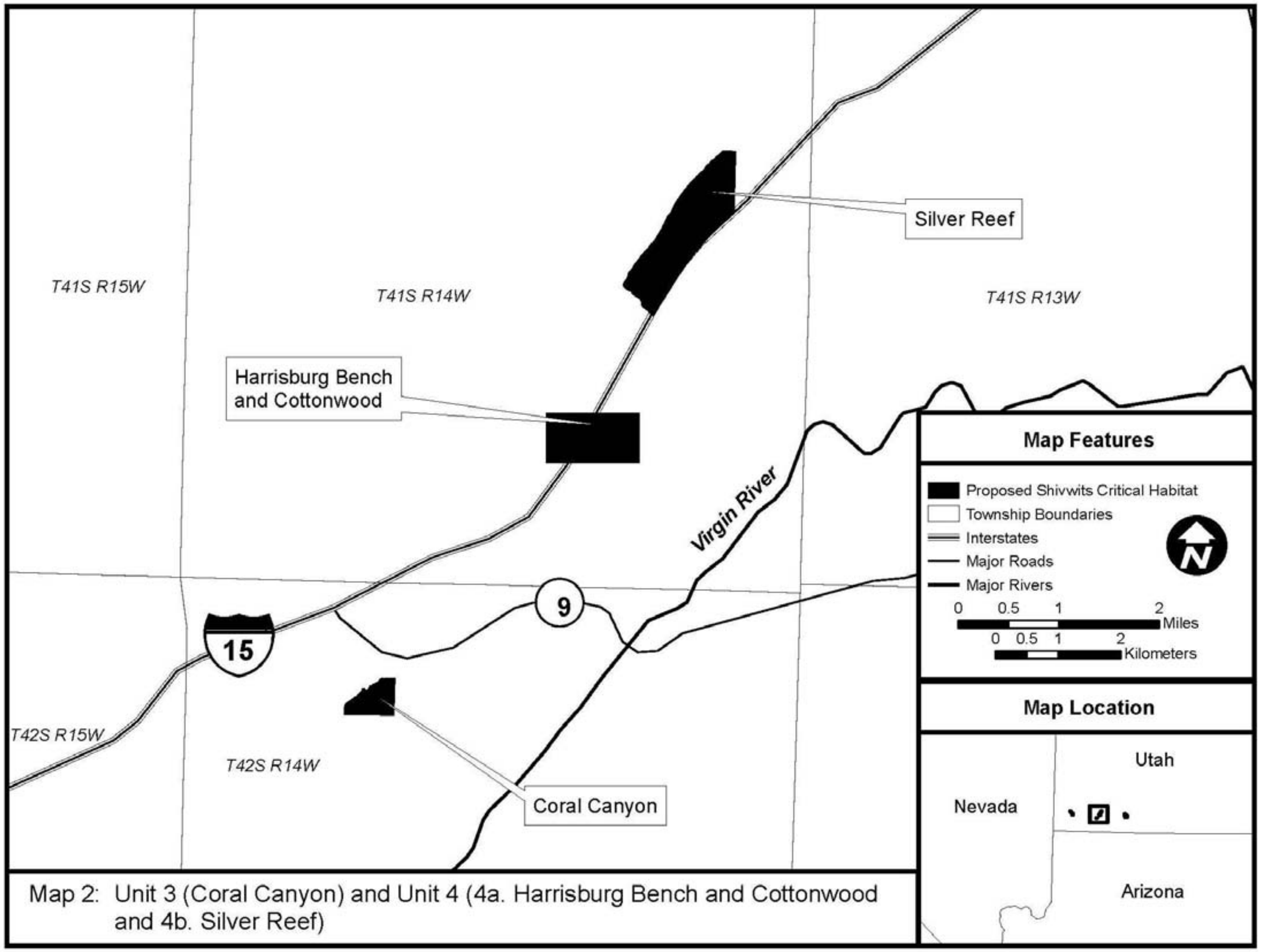


APPENDIX D cont.
Proposed *Astragalus ampullarioides* Critical Habitat Unit 1 Map

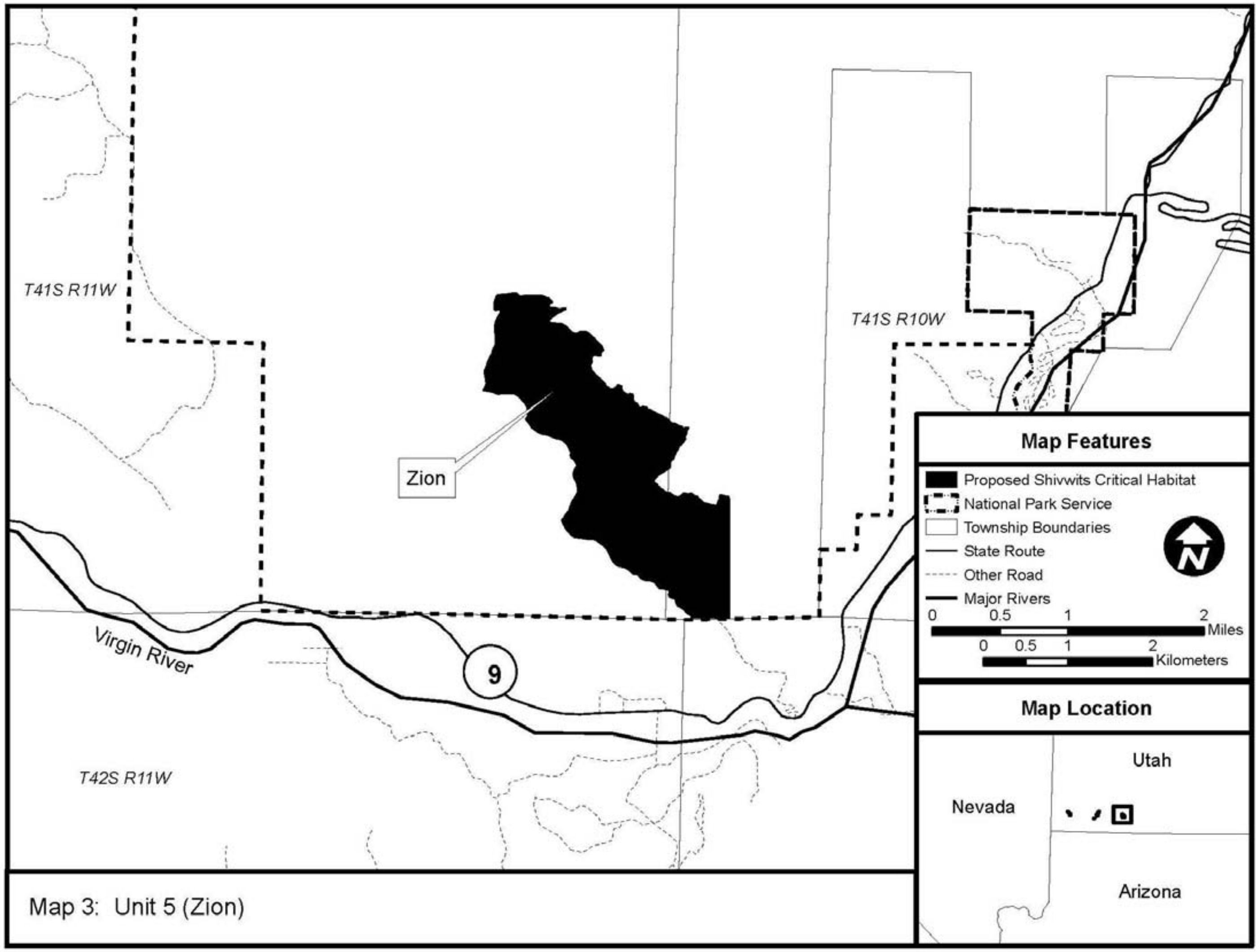


APPENDIX D cont.

Proposed *Astragalus ampullarioides* Critical Habitat Unit 2 Map



APPENDIX D cont.
Proposed *Astragalus ampullarioides* Critical Habitat Unit 3 Map



APPENDIX E

Summary of Public Comments and Peer Review

The draft Holmgren and Shivwits milk-vetch recovery plan was released for a 30-day public comment period on August 1, 2006. At this time we requested independent peer review from nine experts, including species experts and individuals with experience in land management and sensitive environmental issues. In response, we received comments from seven peer reviewers. Comments on the draft recovery plan also were offered by agency representatives. All comment letters are on file in the USFWS Utah Ecological Services Field Office, 2369 West Orton Circle, West Valley City, Utah 84119. Reviewers are listed below:

PEER REVIEWERS

Dr. Duane Atwood, Botanist
Department of Integrative Biology
Brigham Young University
Provo, Utah 84602

Dr. Leigh Johnson, Associate Professor
Department of Integrative Biology
Brigham Young University
Provo, Utah 84602

Dr. Renee Van Buren, Botanist
Biology Department
Utah Valley State College
Orem, Utah 84058

Elaine York, Botanist
West Desert Regional Director
The Nature Conservancy
Salt Lake City, Utah 84102

Mark Madsen, Botanist
Dixie National Forest
Cedar City, Utah 84720

David Tait, Botanist
Fishlake National Forest
Richfield, Utah 84701

Dr. Vince Tepedino, Retired Professor
Collaborating with USDA-ARS Bee Biology & Systematics Lab
Utah State University
Logan, Utah 84322-5310

AGENCY REVIEWERS

John Anderson, Botanist
BLM, Arizona State Office
Phoenix, Arizona 85004

James Crisp, Field Office Manager
BLM, Utah Field Office
St. George, Utah 84790

Mima Falk, Plant Ecologist
USFWS
Ecological Services Field Office
Tucson, Arizona 85745

Mark Miller
USGS
Southwest Biological Science Center
Kanab, Utah 84741

Peer and public review comments ranged from editorial suggestions to providing new information. As appropriate, we have incorporated all applicable comments into the text of the final recovery plan. Following are those substantive comments that were not addressed in the text[1], along with our response to each comment. The comments are arranged into general categories--delineation of milk-vetch populations, recovery goals and criteria, threats and threats abatement, research and monitoring, participation, and use of subjective or ambiguous terms.

DELINEATION OF MILK-VETCH POPULATIONS

Comment — In the absence of determinative genetic data, it was suggested that the milk-vetch populations be categorized differently. It was recommended that as few as three populations be defined for each species. For *A. holmgreniorum*, recovery populations designated as State Line, Gardner Well, and Central Valley would be combined into one population; Stucki Spring and South Hills would be combined into a second population, and the third population would be Purgatory Flat. For *A. ampullarioides*, Pahcoon Spring Wash and Shivwits would be combined into a single population, with a second population comprising Coral Canyon, Silver Reef and Harrisburg Bench and Cottonwood. The third population would be the sites found at Zion National Park.

Response — Although the maps indicating the milk-vetch populations appear close in nature, in most cases known sites are separated by 1 mi (1.6 km) or greater in distance, which greatly decreases the expectation of inter-site pollination. For example, the maximum foraging distances of studied solitary bees are 0.1-0.4 mi (150-600 m) (Gathmann and Tscharntke 2002), which compares favorably to the average distances flown by insects with the mean body size of known *A. holmgreniorum* and *A. ampullarioides* pollinators (Greenleaf 2005; USFWS 2005, unpublished data). In delineating populations, we also considered hydrology for seed dispersal, soils for suitable habitat, elevation changes, and relief to determine range and amount of suitable habitat, and barriers caused by development projects. As indicated in the process described below, we have attempted to define milk-vetch recovery populations in a manner that is consistent and logical (noting an exception within the State Line population), and we have retained the populations as delineated in the draft plan. Numbers below are approximate.

<u>For Shivwits Milk-vetch</u> - The distance from known occurrences between Pahcoon Spring Wash and Shivwits populations is over 1.5 mi (2.4 km). Water does not drain between these sites. Appropriate soils are intermittently found, with a natural 0.5-mi (0.8-km) separation consisting of unsuitable soils.

The occurrences at Coral Canyon are over 2 mi (3.2 km) from the nearest occurrence within Harrisburg Bench and Cottonwood. The majority of terrain between occurrences is either developed or comprises of unsuitable soils.

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[1] Comments received pertaining to the proposed critical habitat do not fall under the purview of the recovery plan. These comments are retained on file at the Utah Ecological Services Field Office and are available upon request.

Plants at Harrisburg Bench and Cottonwood are 1.8 mi (2.9 km) from occurrences at Silver Reef. Harrisburg Bench and Cottonwood are separated by Quail Creek from Silver Reef. Seeds cannot be dispersed by water between these occurrences. Appropriate soils are found between occurrences, with one separation of 0.3 mi (0.5 km) of unsuitable habitat (the drainage of Quail Creek and to some degree the ridgeline of Leeds Reef breaks up the terrain).

FOR HOLMGREN MILK-VETCH - Known occurrences within State Line are separated from Gardner Well by over 1.5 mi (2.4 km). Plants are not hydrologically connected for seed dispersal, and unsuitable soils within the Lizard and Mokaac Washes separate potential habitat by 0.5 mi (0.8 km). Occurrences within Gardner Well and Central Valley are separated by 1 mi (1.6 km), do not share the same hydrology for seed dispersal, and the Atkinville Wash forms an unsuitable habitat barrier.

Occurrences within Stucki Spring and South Hills are separated by 1 mi (1.6 km), are not connected by hydrology, and are separated by geological features such as Cove Wash and changing elevation relief.

An *A. holmgreniorum* occurrence found on the west side of I-15 (approximately 2.3 mi (3.7 km) from the Arizona/Utah border, hereafter referred to as the Sun River occurrence) is separated from the State Line population by 1 mi (1.6 km) and at the time of the draft plan from the nearest recorded plant occurrence within the Central Valley population by 1.2 mi (1.9 km). Although the Sun River occurrence merged with the State Line recovery population due to its slightly closer proximity at the time of the draft plan, re-examination of the geographic area indicates that more suitable and continuous habitat may lie between the Sun River occurrence and the Central Valley population. Additionally, newly documented Holmgren milk-vetch occurrences on the western edge of the Central Valley (0.6 mi/1 km away) reinforce this association (USFWS, unpublished data 2006). Nonetheless, reassignment of the Sun River occurrence to the Central Valley population may be of little value, as areas surrounding the Sun River occurrence are slated for commercial and residential development.

Comment — One reviewer asked for an explanation of the varying numbers of extant populations needed to meet population- and threats-based criteria for downlisting.

Response — The downlisting criteria include a series of population-based criteria, as well as threats-based criteria. These criteria call for a continued presence at all six recovery populations (whether known extant or newly discovered/created) for each species and reduction of threats throughout the range of each species. However, certain individual downlisting recovery criteria specify four out of six populations for each species as the basis for downlisting. This indicates that a significant level of protection has been achieved for each species, although not enough protection to delist either milk-vetch. In sum, in order to downlist, six populations of each species must continue to exist, and protection of over half of these populations (4) must be ensured. Delisting then requires that the continued existence not only of the six populations but of an additional two populations (i.e., eight populations for each species) be ensured over the long run through protection of all populations. These two levels of conservation are indicative of the difference between a species that still requires the protections of the ESA (i.e., is threatened) and a species that no longer needs the ESA to survive in the wild.

Comment — This plan provides for the augmentation of existing populations and the expansion into known potential habitats. Any expansion of habitat should be completed in areas where existing protection is provided (ACECs, Red Cliffs Desert Reserve, etc.).

Response — We acknowledge this recommendation and will take it into account if and when we development and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations is determined to be necessary and feasible (recovery action 5).

RECOVERY GOALS AND CRITERIA

Comment — Recovery goals and criteria need to be measurable. Examples within the text, such as having a population "large enough" to allow for natural population dynamics or with "sufficient" connectivity to allow for gene flow, are neither measurable nor defined.

Response — The process of defining the needed extent and condition of the two milk-vetch species is an ongoing effort. In the early stages of most recovery programs, broad language is necessary to ensure that future and more informed recovery strategies are not restricted to the knowledge possessed today. Recovery criteria must be measurable to *the extent practicable,* and it should thus be anticipated that criteria will become more data-driven and quantitative over time. The recovery program for the milk-vetches includes several research actions that should enable us to develop more measurable recovery criteria as we progress through the recovery process.

Comment — Some of the recovery goals and criteria may conflict with each other. For example, in reference to treatment of invasive nonnative species, the plan mentions the need for effective control measures. The draft recovery plan then says that pesticides or herbicides which are detrimental to the milk-vetches or their pollinators would be prohibited.

Response — The recovery plan attempts to be comprehensive in addressing identified needs and concerns while allowing some flexibility for making management decisions. In the competing priorities cited by the reviewer, the hope is that a conflict could be precluded if, for instance-- (1) nonnative species could be controlled without herbicide, and/or (2) a particular herbicide may exist or be developed that does not affect the milk-vetches or their pollinators. As it is difficult to balance conflicting needs, our intent is to engage in thoughtful problem-solving efforts through the duration of the recovery process.

Comment — One reviewer stated the recovery program, as described, will guarantee that both of these species will remain federally listed in perpetuity and, further, that a model that can accurately predict anything for 100 years is impossible to construct.

Response — Models are a conceptual representation of phenomena. Science today offers a growing collection of methods, techniques, and theory for scientific models. Predictive models, such as a population viability analysis (PVA), have been proven to be accurate when sufficient data are available to build the model (Brook et. al 2000). Given the data shortfall for developing a PVA for this planning effort, the recovery plan calls for a survival probability of at least 95% over 100 years, a standard currently in general use by USFWS and academic communities (see Shultz and Hammond 2003, as an example).

Comment — For a given species, *A. holmgreniorum* or *A. ampullarioides*, are all recovery populations weighted equally in the recovery criteria?

Response — We recognize that for both of these species, recovery populations vary in land size and amount of individuals found per site; however, at this time, we conclude that each site is of equal value and equally necessary for recovery.

Comment — For any given larger recovery population, it is possible that monitoring could show that a portion of the population is declining, while other sites are stable and/or improving. Under these circumstances, could the species be still considered for reclassification?

Response — To ensure the most accurate and applicable results and evaluation of monitoring data, we have recommended--(1) the development of a rangewide monitoring plan and protocol for each milk-vetch (recovery action 3.1); (2) the analysis of available data and data collection needs for evaluating population trend (recovery action 4.1); and (3) population modeling (recovery action 4.3.8). Until these activities are underway, it is premature to conclude how potential difficulties presented by hypothetical situations might be resolved.

THREATS AND THREATS ABATEMENT

Comment — Given the current threats, one reviewer stated that, at best, the recovery strategy will allow maintenance of current populations only after fencing; this reviewer further suggested that elevating the inventory of potential sites and related efforts to a higher priority.

Response — Recovery actions 1.2.2 and 1.5 address protective fencing and delineation of appropriate potential habitat areas and are listed as Priority 1 actions in the Recovery Implementation Schedule.

Comment — One reviewer found it impossible to believe that 2005 was the first year in which fire consumed areas containing *Astragalus ampullarioides.*

Response — Based on feedback from species experts and land managers with a strong familiarity with the fire history in the vicinity of the milk-vetches, fires have come near lands containing *A. ampullarioides* and *A. holmgreniorum* in recent years; however, 2005 is the first year in which a fire is documented at a site containing either *A. ampullarioides* or *A. holmgreniorum* site. In the past, the sparse vegetation of the Mojave Desert (where the milk-vetches are found) did not contain continuous fuel loads that carried fire over distances; therefore, burns occurred on very limited sites. If additional or more accurate information is available in this regard, we will update the relevant sections of the plan.

Comment — Should drought caused by climate change be considered a threat? These plants have persisted with drought cycles over a much longer period of time than we have recorded climate data.

Response — Drought is anticipated in the future and is known to decrease population numbers. For example, no data were collected in 2002 for *A. ampullarioides* due to the absence of plants (Van Buren and Harper 2004), and few adults returned after that year (R. Van Buren, pers. comm. 2006). In the case of both species, drought is an existing natural stress, and as their status becomes more precarious, any prolonged drought (whether or not part of a broader climatic trend) could threaten them with extinction.

RESEARCH AND MONITORING

Comment — In general, plants respond to soil moisture (and soil temperature) rather than to precipitation patterns directly. Linkages between precipitation and soil moisture depend on the timing, size, form, and intensity of precipitation events, as well as on soil and vegetation properties that affect the partitioning of precipitation events and precipitation between runoff and infiltration. Because understanding of plant-environment relations and among-year variations in population numbers can best be improved by relying not upon monthly precipitation characteristics (event timing, size, and intensity), soil moisture, and soil temperature, it is recommended that a data-logging meteorological station with soil moisture/temperature probes and/or a precipitation gage be installed at all current demographic sites for both species.

Response — Although the recovery plan bases the length of time (20 years) needed for data collection on patterns found within the precipitation data gathered at the St. George, Utah, weather station (number 427516), we recognize the value of this comment and will recommend further research on this topic (See recovery action 4.3.3).

Comment — Concerning monitoring methods, one respondent indicated that permanent transects with permanent quadrats be used rather than random transects and quadrats, unless it can be demonstrated statistically that none of the among-year variation in plant counts is attributed to variation in quadrat placement. Additionally, use of randomly placed quadrats may reduce the power of the sampling design to detect trends over time.

Response — We will keep this consideration in mind when recovery actions 3.1, 4.1, and 4.3.8 are initiated.

Comment — Existing monitoring data should be examined by an independent reviewer to evaluate the adequacy and power of current designs. Monitoring designs for a particular recovery criterion should be developed to satisfy specific quantitative sampling objectives.

Response — Implicit to the goals of this recovery plan is the need to complete the set of information needed to perform an accurate current and predictive assessment of range-wide population stability for both species. We will follow advice adapted from Morris et al. (2002) to--(1) heighten the level of awareness about the need to implement recovery plan actions using quantitative methods, (2) involve quantitatively trained biologists in the recovery process, and (3) fill the gap between the design of monitoring protocols and the requirements of a predictive model.

Comment — Information on reproductive biology found in Tepedino (2005) should be cited in the plan, as it provides additional information and presents differences between site and year when compared with other studies.

Response — We confirm that there is information on reproductive biology in Tepedino (2005) that supplements the information currently found in the plan. Unfortunately, due to administrative time constraints, we have been unable to add all additional and/or pertinent information found in Tepedino (2005). To remedy this, the information will be considered during recovery plan implementation.

Comment — Some comments indicated that a water year or precipitation cycle may differ from an annual year.

Response — We have revised the definition of the water year or precipitation cycle to mean moisture from October 1 to September 30. We have not updated the related discussion; however, we state clearly in the plan the methods we used in assessing annual precipitation and the length of monitoring needed to assess population trends for these milk-vetches. Our understanding of this relationship will be refined as recovery proceeds.

PARTICIPATION

Comment — One commenter expressed support for a team approach utilized during recovery plan development but also advocated direct participation of managing agencies and interested parties during the development and updating of recovery plans.

Response — Individuals from managing agencies and interested parties have participated in recovery planning efforts since 2001 and have contributed important expertise regarding the recovery issues and needs covered in this plan. The USFWS has administrative responsibility under the ESA for developing and implementing recovery plans, and an important facet of this responsibility is to provide opportunity for exchange of knowledge and participation. Open communication and a mutual understanding of agency missions and stakeholder concerns are imperative, although the USFWS must keep its focus on the overriding goal of full recovery. In the case of this plan, informal recovery meetings provided a forum for working with scientific and management experts, and interested parties.

Comment — Regarding the establishment of a “technical working group” as mentioned in the plan under recovery action 10, it was suggested that the present infrastructure in Washington County be utilized to the extent practical, including the Habitat Conservation Advisory Committee.

Response — The individual experts mentioned in the previous comment have functioned as a working group during development of this recovery plan. As recovery actions are implemented, the USFWS may appoint a more formal team, which would likely include all or most of these experts, and we also will utilize the Washington County decision-making infrastructure to assist with recovery implementation as appropriate.

USE OF SUBJECTIVE OR AMBIGUOUS TERMS

Comment — One reviewer cautioned against the use of terms such as “irreparable,” “severe,” “substantial,” “overgrazing,” and others, stating that this terminology often represents an assumption that is unsubstantiated unless documented with analyzed data.

Response — Appraisal of potential and actual threats is a central tenet of the planning process. In most cases, this is necessarily limited to a qualitative assessment, but this does not obviate the need to discern among levels of severity, substance, or ability to repair losses incurred from adverse activities. Such a lack of discrimination would significantly handicap recovery planning. Recognizing, however, the need to be as rigorous as possible as we proceed with recovery efforts, this recovery plan includes several actions related to data collection and analysis as a means of refining our understanding of greater and lesser threats.

Comment — The distinction between “weed” as described in the plan and the term “noxious weed” may need to be clarified.

Response — The term noxious weed is not used in this document, and none of the plants discussed within this document are federally listed as a noxious weed under the Federal Plant Protection Act. The Plant Protection Act, which regulates the spread of noxious weeds, defines a noxious weed as “any plant or plant product that can directly or indirectly injure or cause damage to crops . . . or other interests of agriculture , irrigation, navigation, the natural resources of the United States . . .” that is new or not widely introduced and thus is capable of being controlled. The invasive annual weeds discussed within this document meet the generally known definition of a weed as “an undesirable or troublesome plant” and are widespread.

Comment — One reviewer suggested that the use of value-laden words such as “staunch” or “bold” need not to be used in this document. The description of the current threats is sufficient to show the work that is needed.

Response — The goal of a recovery plan for endangered species is to create conditions that allow the species to be reclassified and delisted. A difficult problem needs a bold answer, defined as beyond the usual limits of conventional thought or action. We believe that these words are used appropriately and clearly in this plan, and add value.

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