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

Draft

RECOVERY PLAN

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

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Renee Van Buren, PhD.

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Additional copies of the draft document can be obtained from:

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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) and *Astragalus ampullarioides* (Shivwits milk-vetch) are endemic to the Mojave Desert around St. George, Utah. 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, the Service proposed to designate approximately 8,896 acres of critical habitat for two the federally endangered plants. For the purpose of recovery, each species comprises six extant populations located in Washington County, Utah, with one *A. holmgreniorum* population extending into Mohave County, Arizona. This also represents the known historic distribution, although it is probable that both species occupied more habitat in the past.

Habitat Requirements and Limiting Factors: *A. holmgreniorum* occurs at elevations between 756-914 meters (2,480-2,999 feet) 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 is less than 20% of the landscape. *A. ampullaroides* is found in isolated pockets of Chinle and Moenave soils around St. George. Occupied sites are small, and populations are found between 920-1,330 m (3,018-4,363 ft) in elevation in sparsely vegetated habitat with an average 12% cover. *A. holmgreniorum* is thinly and discontinuously distributed within its habitat; *A. ampullarioides*s 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.

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 **reclassify** these species from endangered to threatened status,the following recovery criteria must be met:

- Population trends for four out of six extant *A. holmgreniorum* and *A. ampullarioides* recovery populations are primarily stable or improving, as indicated by species presence, mean occupied habitat, density of occupied habitat, and demographic 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 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 Utah State plant conservation agreement.
- Adverse population-level effects from herbivory, if any, are identified and abated within *A. ampullarioides* recovery populations.
- For at least four recovery populations of each species, effective measures are in place to control invasive nonnative species that harm these milk-vetches and/or their habitats.
- The protected habitat base for at least four recovery populations 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.

Delisting can be considered 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, eight recovery populations will be needed to delist each species.
- The 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, mean 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 the extant and two additional milk-vetch recovery populations, such that ESA protection is no longer needed to compensate for regulatory inadequacies.

- Adverse population-level effects from herbivory, if any, are identified and abated within all *A. ampullarioides* 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 establishment 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 THOUSANDS)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**TOTAL**
FY1	424	15	78	161	20	0	8	7	10	2	-	725
FY2	416	20	28	81	28	0	6	4	10	2	-	595
FY3	536	20	28	89	8	0	8	7	10	2	-	708
FY4	522	30	28	36	0	0	6	4	10	2	-	638
FY5	536	30	28	34	40	40	8	7	10	2	25	735
FY6-30	9,418	424	840	400	0	400	134	136	250	50	100	12,159
TOTAL	11,852	539	1,030	801	96	440	170	165	300	60	125	15,578

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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 to 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 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 when 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, world-wide in distribution, 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). As a genus *Astragalus* are believed to be

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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.

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

A. holmgreniorum is a stemless 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 4.0-13.0 centimeters (1.5-5.1 inches) long and have 9-15 leaflets that are 0.8-1.6 cm (0.3-0.6 in.) long and broadly obovate (egg-shaped). Flowers of *A. holmgreniorum* are 1.8-2.4 cm (0.7-0.9 in.) long and 0.6-0.9 cm (0.2-0.4 in.) 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 2.0-8.5 cm (0.8-3.6 in.) 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 3.0-5.0 cm (1-2 in.) long and 0.6-0.9 cm (0.2-0.4 in.) wide. The pods retain seeds even after they are 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 20-50 cm (8-20 in.), although ungrazed flowering stems may attain a height of 1 m (40 in.). The leaves are pinnately (arranged opposite) compound, 4-18 cm (1.6-7.1 in.) long, and have 11 to 23 elliptical leaflets. Each plant produces approximately 45 small cream-colored flowers about 2.0 cm (0.8 in.) 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 0.8-1.5 cm (0.3-0.6 in.) long and 0.6-1.2 cm (0.2-0.5 in.) wide.

The species was originally 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 species 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 *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 plants,

(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 (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 listed as full species in 2001 (66 FR 49560).

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).

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 populated areas that are sufficiently discrete to be considered populations for recovery purposes by the U.S. Fish and Wildlife Service (USFWS); however, 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.

[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.

These *Astragalus* populations are distributed across a limited range. Known populations of *A. holmgreniorum* occur within approximately 10 miles (16 kilometers) of St. George in Washington County, Utah, and Mohave County, Arizona (Figure 3; 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 populated areas--State Line, Gardner Well, and Central Valley. Two populated areas, South Hills and Stucki Spring, are found south of the City of Santa Clara Butte. An isolated population called Purgatory Flat is associated with a limestone outcrop found west 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 2003).

All known locations of *A. ampullarioides* occur within Washington County, Utah (Figure 4; 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 another, Pahcoon Spring Wash, is 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 populated area is located south of Quail Creek and contains two main areas of occupancy, Harrisburg Bench and Cottonwood; these populations occur within a mile (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 2003, 71 FR 15979).

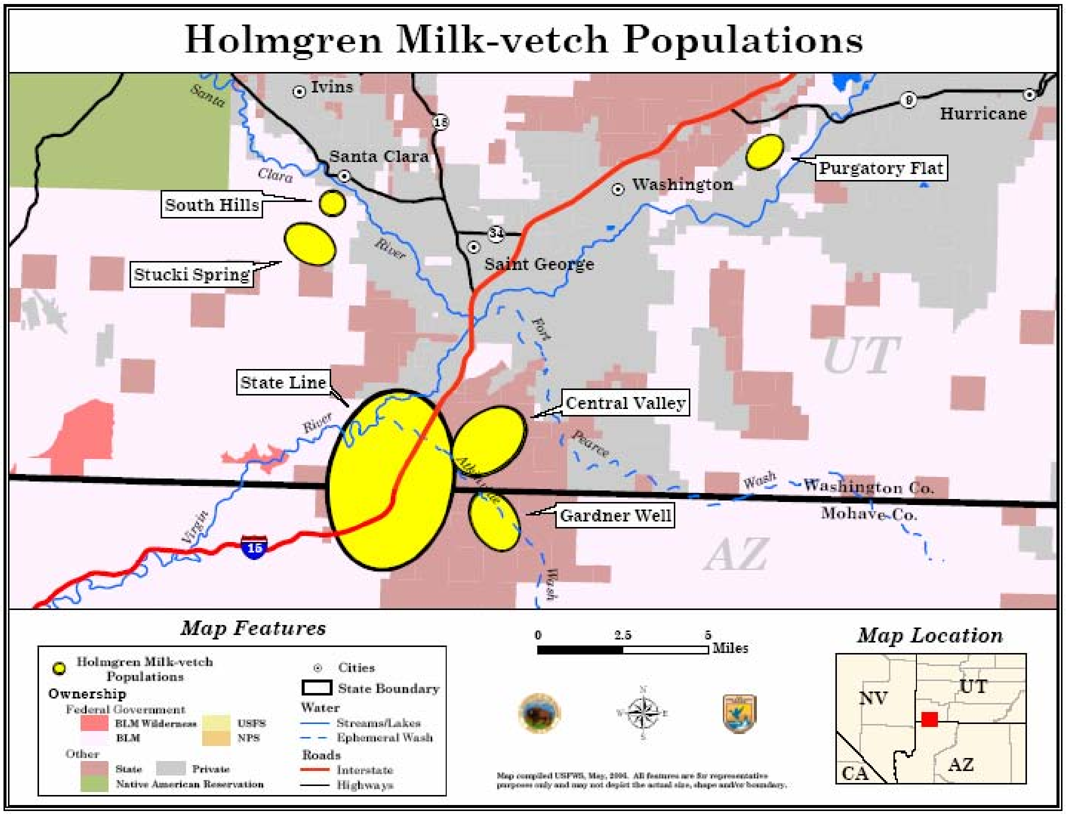

Figure 3. Distribution and range of *A. holmgreniorum*.

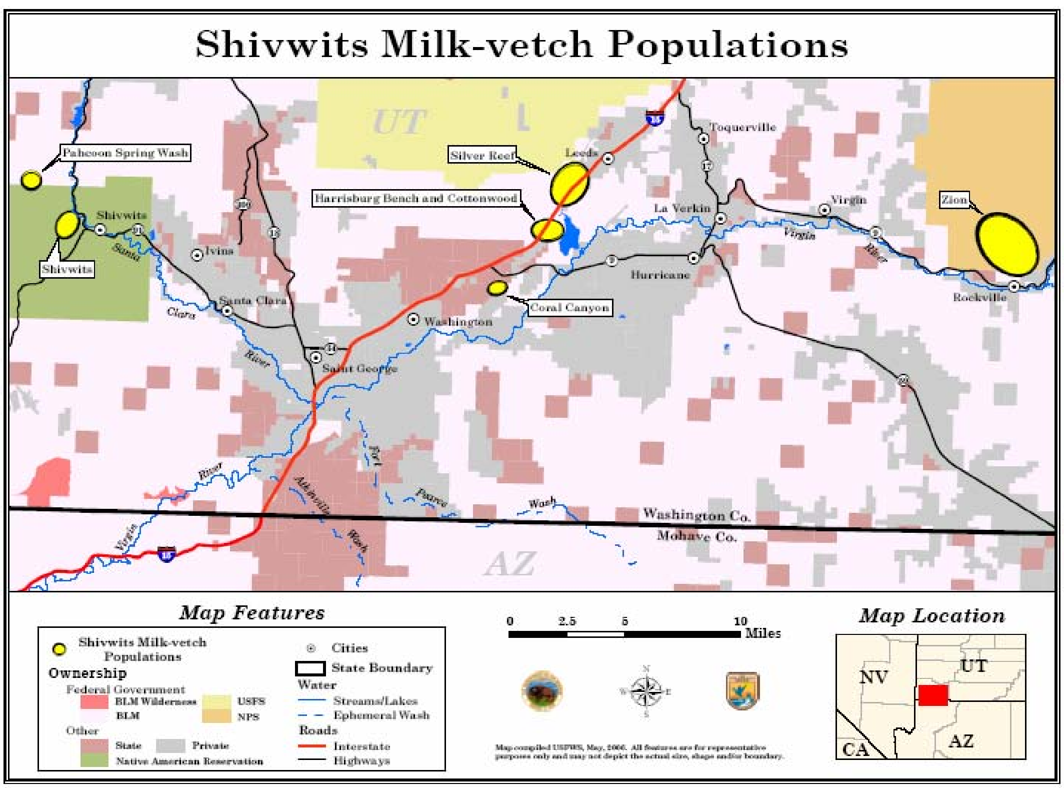

Figure 4. Distribution and range of *A. ampullarioides*.

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; however, there is no way to verify such inferences. 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).

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 tracked in 1993 lived into their fourth growing season (Van Buren and Harper, 2001a). 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 have been seen 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 2003).

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 (2003) found an average of 16.4 flowers per plant. Differential rates of flowering may be attributed to varying amounts of precipitation involved in these different years of study (Western Regional Climate Center Web Cite, www.wrc.dri.edu, May 2006).

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). Native 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). Additionally sufficient quantity and density of flowering plants is needed to attract bees and support their survivorship (Harper and Van Buren 2001); likewise, optimal pollination occurs when there is an abundance of bees (Greenleaf 2005).

A. holmgreniorum does not appear to be capable of vegetative reproduction; therefore, 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; ultimately, this 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 which after fertilization becomes seed (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 (2003) found an average of 11.1 fruits per plant.

The landscape holds an unknown quantity of seeds, referred to as a seed bank. Although initial results of an ongoing study indicate a good *A. holmgreniorium* seed reserve (Van Buren, pers.comm. 2006), high mortality of seedlings, in some years, limits the number of adults that contribute to future seed banks (Van Buren and Harper 2004). 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 plants may shift from one area to another 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 2004). 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 2003). 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 2003). 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 (2003) found an average of 86.7 flowers per plant. The number of seeds per pod is not documented. From 1992 to 2000, Van Buren and Harper (2003) found an average of 22 fruits per plant; however, due to the time of year the information was collected, this number may not indicate all fruits produced.

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;* and the nonnative honeybee *Apis mellifera* (Tepedino 2001). Like *A. holmgreniorum, A. ampullarioides* relies solely on the production of seeds for reproduction; therefore, pollination is highly linked to the survival of both species. Although flowers on *A. ampullarioides* plants can produce fruit (Tepedino 2001), automatic self-pollination produces significantly lower seed per fruit ration than pollination or insect visitation (Tepedino 2005). Overall, Tepedino (2005) found that pollinator visitation both increases the total number of fruit and seed produced, resulting in more genetically diverse offspring.

Although no methods of *A. ampullarioides* seed dispersal are documented, water patterns, landscape erosion, and soil slumping may contribute to the development of appropriate habitat sites and may move seeds within sites (Van Buren and Harper 2003). The disjunct populations of *A. ampullarioides* also imply bird dispersal (S.L. Welsh pers. comm. 2005). *A ampullarioides* seed bank viability and longevity are just beginning to be examined. Van Buren and Harper (2003) data suggest that *A. ampullarioides* maintains a long-lived seed bank, which probably enhances genetic diversity. Bench (2005) found that 68.2% of seed collected in the top 4 cm (1.6 in.) of soil from Pahcoon Spring Wash and Coral Canyon was viable. Average seed bank density at the 2 sites was 49.8 seeds/m^2 (536 seeds/$feet^2$)--79.2 seeds/m^2 (852 seeds/$feet^{2)}$ found at Pahcoon Spring Wash and 20.37 seeds/m^2 (219 seeds/$feet^2$) at Coral Canyon (Bench 2005).

Regarding genetic diversity, Stubben (1997) found that *A. ampullarioides* plants from the Shivwits population exhibited only 64.1% similarity with samples from the Coral Canyon and Harrisburg Bench and Cottonwood populations, which are over 30 km (18.6 mi) away. However, owing to limited sampling these results were deemed inconclusive by the researcher; at most, the study indicated some variance between populations but did not provide any information concerning genetic variation among individuals.

HABITAT CHARACTERIZATION

Astragalus holmgreniorum

A. holmgreniorum populations occur at elevations between 756-914 m (2,480-3,000 ft) 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 a large portion of the soil surface is nonvegetated and 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 4.3 cm (16.9 in.) (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 series (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 series 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. Although similar data points are lacking for Arizona, known sites from reconnaissance work done in the late 1980s and early 1990s indicates sites may be associated with the following soil series (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).

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 2003, 2004).

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), *K. parvifolia* (white ratany and range ratany), *Lycium andersonii* (Anderson wolfberry), and *Gutierrezia microcephala* and *G. sarothrae* (threadleaf and broom snakeweed). Native forbs and grasses include *A. nuttallianus* (small flowered milk-vetch), *Chaenactus carphoclina* and *C. sterioides* (pincushion spp.), and *Hilaria rigida* (big galleta).

Because of historical and ongoing land disturbance, dominant forb associates include the introduced weedy species *Bromus rubens* (foxtail 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 2003(a), 2003(b), 2004). Nonnative annuals make up the highest percentage of living cover in *A. holmgreniorum* habitat, and they tend to emerge prior to *A. holmgreniorum*, thus competing for soil moisture and nutrients. Interestingly, Stubben (1997) did not find *A. holmgreniorum* presence to be positively correlated with introduced annuals.

Astragalus ampullarioides

A. ampullaroides populations are found at elevations between 920-1,330 m (3,018-4,367 ft), typically on purple-hued patches of soft clay soil associated with isolated outcrops of the Petrified Forest Member of the Chinle Formation (Armstrong and Harper 1991, Harper and Van Buren 1997, Stubben 1997) and the Dinosaur Canyon Member of the Moenave Formation (M. Miller, U.S. Geological Survey [USGS], pers. comm. 2006). This substrate, which is light, airy, and unstable when dry (Van Buren and Harper 2003), 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 can persist on Chinle soils (Harper 1997). Within Zion National Park (M. Mi unpubl. data), known sites of *A. ampullarioides* may contain materials from later geologic formations such as the Dinosaur member of the Moenave Formation (M. Miller, USGS, pers. comm. 2006).

Because *A. ampullarioides* sites are small and unique, milkvetch presence can be associated only at a landscape-level scale with soil series and plant community information (USFWS unpubl. data 2005). There are site-specific soil and plant community distinctions at occupied sites, which are currently being analyzed. *A. ampullarioides* is documented from the following soil series types 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 2003).

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).

A. ampullarioides habitat is sparsely vegetated with an average 12% cover (Van Buren and Harper 2003, 2004). Due to soil shrinkage and expansion, native plant species found with *A ampullarioides* are generally herbaceous; native forbs and grasses include *Calochortus flexuosus* (sego lily), *Dichelostemma pulchellum* (bluedicks), *Hilaria rigida* (galleta), and *Lotus humistratus* (hill lotus). Other native species occurring nearby include trees and perennial shrubs such as *Pinus edulis* (pinyon pine), *Gutierrezia microcephala* (broom snakeweed), *Colegyne ramosissima* (blackbrush), and *Atriplex canescens* (fourwing saltbrush).

As with *A. holmgreniorum*, the most frequently found forbs associated with *A. ampullarioides* are introduced invasive species such as cheatgrass, foxtail brome, 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 2003, 2004).

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. The proposed units and population subunits for each species are described below, and maps are provided in Appendix 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 6,586 acres (2,665.35 hectares) 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 – 4,026 ac (1629.32 ha)
> >
> > Subunit 1b: Gardner Well – 564 ac (228.25 ha)
> >
> > Subunit 1c: Central Valley – 1,291 ac (522.46 ha)

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 (166.73 ha)

Subunit 2b: South Hills – 115 ac (46.54 ha)

Unit 3: Purgatory Flat. This unit, found east of St. George, contains a single population and 177 ac (71.63 ha) of occupied habitat.

Astragalus ampullarioides

Proposed critical habitat for *A. ampullarioides* encompasses 2,759 ac (1116.56 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 (54.22 ha) of occupied habitat.

Unit 2: Shivwits. This unit, on the Paiute (Shivwits band) Indian Reservation, contains a single population occupying 240 ac (97.12 ha).

Unit 3: Coral Canyon. This unit contains a single population with 87 ac (35.2 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 (120.19 ha)

Subunit 4b: Silver Reef – 462 ac (186.97 ha)

Unit 5: Zion. This unit is located within Zion National Park boundaries and encompasses a single population occupying 1,201 acres (486.04 hectares) 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 of these is an occurrence of several individuals located north of Atkinville Wash (and north of the State Line subunit) on private lands held by Sun River; this area is now under development and the occurrence is presumed extirpated. The second is an occurrence of several individuals east of the State Line subunit that was documented in 1993 by Ben Franklin, Botanist, Utah Natural Heritage Program (pers. comm. 2006) but has not been relocated in subsequent surveys (Van Buren 2004, R. Van Buren pers. comm. 2006). It is important to note that suitable habitat occurs outside the proposed unit boundaries and future surveys may locate additional populations.

POPULATION ABUNDANCE AND TRENDS

The populations of both *A. holmgreniorum* and *A. ampullarioides* fluctuate widely from year to year, due primarily to extreme variations in local precipitation. Despite variable numbers, both species at the time of listing in 2001 were considered in decline (66 FR 49560). Surveys and monitoring efforts for both milkvetches have been ongoing since the early 1990s.

Both plants have sites where demographic studies have been conducted. These studies involve tagging individuals and categorizing these plant species by age class. Health statuses, such as evidence of herbivory, diameter of basal rosette, number of flowers/fruit each year, and in the case of *A. ampullarioides* flowering stem height, number of stems also are reported for each plant within demographic sites. Additionally, 100 m (328 ft) transects provide estimates of population density, percent cover, associated plant species, frequency of nonnatives, and other site characteristics. Population counts and plant density are discussed below for each species. As part of the recovery planning process, a preliminary examination of precipitation data 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 importance is the summarization of demographic trend information, such as age class survivorship for these species in Van Buren (2005). Although this information has not been analyzed, it could provide the basis for modeling of current and long-term population trends for the milk-vetches.

Astragalus holmgreniorum

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

- Utah-Arizona Border (State Line, Gardner Well, Central Valley) - 9-10,000 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.

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 since 2003, at the Central Valley site 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, as well as 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 in 2004 and 2005 within the State Line site, in 2003 at the Central Valley site, and in 2005 at the South Hills site (Santa Clara population) are summarized in Table 1. Field reconnaissance also was conducted in 2006, but results are not yet available. Available survey results indicate that in years with above-average precipitation, plant numbers are higher than the 2001 estimates above. Survey efforts over 3 years covered approximately 2,500 ac (1,011.75 ha), with a total of 39,679 individuals counted at the 3 study sites. Out of this total, 92% was seedlings and only 8% was adult plants. An estimated 5,143 plants returned the following growing season, for a 14% survival rate. However, except for South Hills in 2005, a disproportionately high number of the plants counted were seedlings, e.g., 99.7% seedlings in 2003 and 99.4% in 2004. Population mortality rates also are high, e.g., 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 seed bank and future recruitment, but some preliminary inferences can be drawn from the available research. 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. Further, using a conservative estimate of 11 fruits per plant with an average of 25 seeds, individuals from Central Valley population surveyed in 2003 would provide a return of approximately 29,975 seeds in 2004, and the 2005 estimated seed return from plants on SITLA lands surveyed in 2004 would be 157,850 seeds. Uncertainties, such as percentage of seed loss, are not estimated. 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.

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. Number of plants per m^2 (~1 $yard^2$)was measured at each site by counting individuals within a 4 m^2 (~4 $yard^{2)}$ plot at 20 random points along a permanent transect (Harper and Van Buren 1996, 1997, 1998, 1999; Van Buren 2005).

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

THREE POPULATIONS DESCRIBED IN FINAL RULE	RECOVERY PLAN POPULATED AREAS	YEAR OF INTENSIVE SURVEY	APPROX ACREAGE SURVEYED	LANDOWNER	TOTAL PLANTS	FLOWERING ADULTS	SEEDLINGS	EST DENSITY PER ACRE	EST SURVIVORSHIP NUMBERS*
UTAH-ARIZONA BORDER	State Line	2004	600	SITLA	15,902	1	15,819	56.5	2,735
		2005	1,100	BLM	11,254	2,338	8,462	10.2	1,857
	Gardner Well	-	-	State	-	-	-	-	-
	Central Valley	2003	700	SITLA	12,315	6	12,290	17.5	517
SANTA CLARA	South Hills	2005	80	BLM	208	157	24	2.6	34
	Stucki Spring	-	-	BLM	-	-	-	-	-
PURGATORY FLAT	Purgatory Flat	-	-	BLM	-	-	-	-	-
		TOTALS	**2,500**		**39,679**	**2,502**	**36,595**	**15.8**	**5,143**

* Of all individuals. Years 2003 and 2004 based on survivorship measured at Atkinville demography plot (4.2%, 17.2% respectively). Year 2005 based on the average over 6 years, 2000-2006, 16.5%.

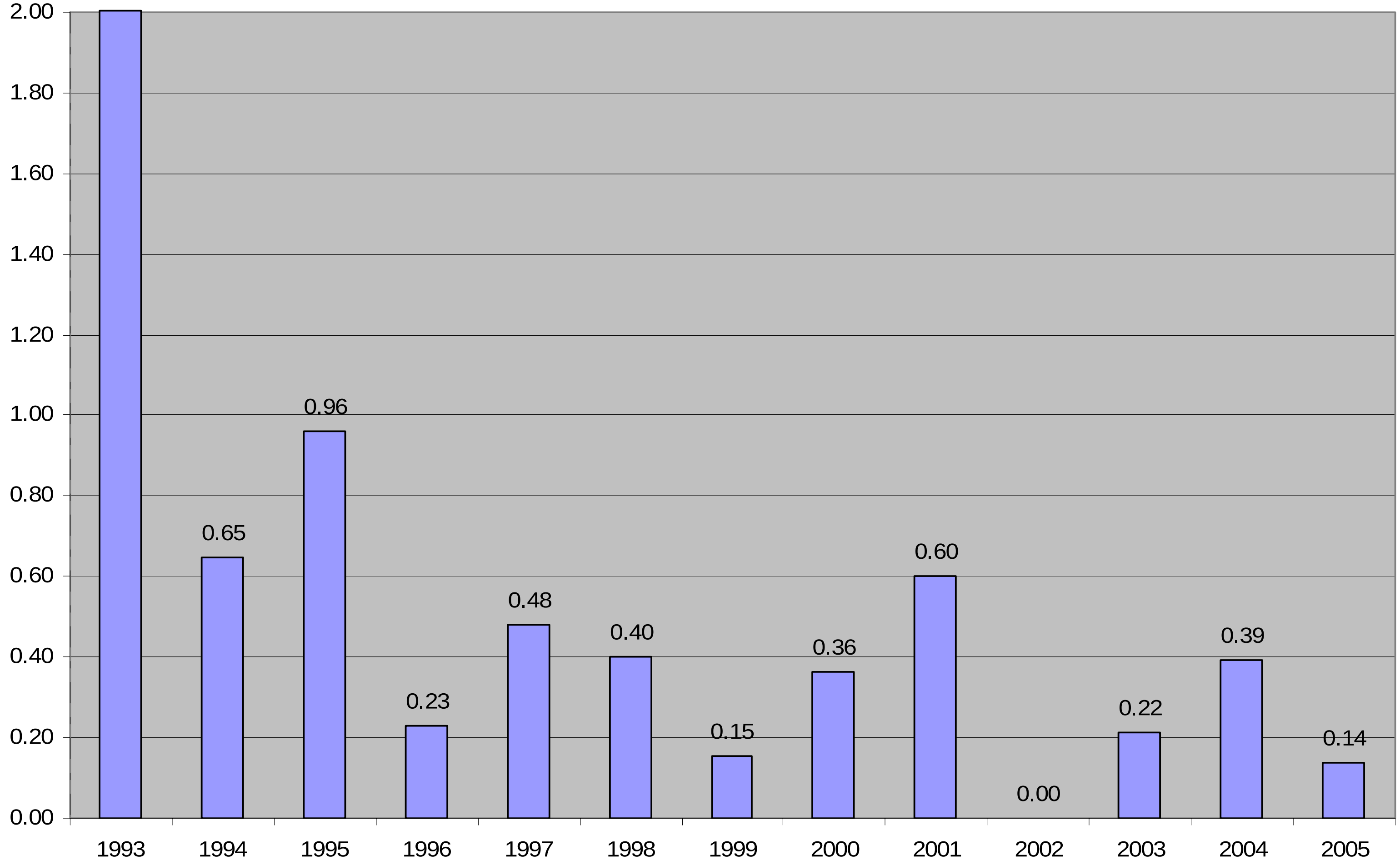

Figure 5. Average *A. holmgreniorum* density (per m^2) at six study sites from 1999-2005.

A. holmgreniorum seedling density is positively correlated with precipitation in the months January through April (Van Buren and Harper 2003a); see Table 2. Precipitation in the months of January-April ranges from 0.2 in. in 2002 to 8.35 in. (0.5-21.2) in 1993. Density data shows a lack of *A. holmgreniorum* individuals in 2002 with a high density of individuals in 1993. From 1993-2005, three of the four lowest *A. holmgreniorum* density years (1996, 1999, 2002) correspond to less than 4 in. of rainfall in the first 4 months of the year. The notable exception is 2005, which, although data are missing for a few days, appears to be the highest rainfall since 1993. In 1993 precipitation occurs mainly in January, February, and March, with April among the lowest rainfall for the timespan examined, while in 2005 April rainfall is the highest. The reason for the difference in performance of *A. holmgreniorum* in 2005 is unknown; however, it may be associated with an exceptionally wet April in an exceptionally wet beginning of the year. Further statistical investigation is warranted on this topic.

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

YEAR(S)	JAN	FEB	MAR	APR	MONTHLY TOTAL	ANNUAL TOTAL	AVERAGE DENSITY (m^2)
1993	4.74	2.69	0.83	**0.09**	8.35	11.09	**2.00**
1994	0.1	1.62	0.63	1.45	3.8	8.91	0.65
1995	2.4	0.76	3.34	1.04	7.54	11.03	0.96
1996	0.41	0.74	0.47	0.11	1.73	6.48	**0.23**
1997	3.86	0.61	0	0.36	4.83	10.68	0.48
1998	0.9	3.11	0.93	1.12	6.06	13.97	0.40
1999	0.34	0.49	0.13	0.85	1.81	5.52	**0.15**
2000	0	1.87	0.56	0.09	2.52**	6.70	0.36
2001	0.79	1.17	1.45	0.86	4.27	6.41	0.60
2002	0.01	0.06	0.13	0	0.2	3.18	**0.00**
2003	0.1	2.09	0.98	0.55	3.72*	5.80	0.22
2004	0	3.02	0.15	1.3	4.47**	10.98	0.39
2005	2.69	2.49	0.92	**2.24**	8.34*	9.17	**0.14**
2006	0.38	0.02	5.09	0.47	5.96**		

*missing < 5 days of data
**missing > 10 days of data

Available data on total monthly precipitation for St. George, Utah, from 1893 to present was preliminarily examined to consider the length necessary for data collection. The sum of the first 4 months of precipitation was rounded to the nearest whole number, as was the total of all months within the year for the following discussion. Average precipitation in January-April is 10.2 cm (4 in.). Early season precipitation (January-April) that equaled 5.1 cm (2 in.) or less, we considered low precipitation and that of 15.2 cm (6 in.) and above as high precipitation. Within the same span (1893-2005), average precipitation for the year is roughly 20.3 cm (8 in.). To be conservative yearly precipitation that which equaled or fell below 15.2 cm (6 in.), we defined as low precipitation and that which equaled or exceeded 25.4 cm (10 in.), we defined as high precipitation. Years with low precipitation that also have low precipitation in the first 4 months overlap roughly 55% of the time, while years with high precipitation overlap 67% of the time with the first 4 months. Based on the largest gaps seen between precipitation cycles, we believe a minimum of 20 years of data collection is necessary for an exhibition of most trends for *A. holmgreniorum.*

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. 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 2. At the time of listing, the total number of *A. ampullarioides* 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 more recent and higher number of seedlings is influenced by more extensive surveys in Zion National Park, as well as yearly variation in precipitation and the effect on new recruitment (i.e., production of seedlings). Additionally survey numbers are influenced by the date of survey, climatic conditions, and early seedling mortality. For example, at the Zion Hilltop site, early monitoring of 130 seedlings indicated that a die off 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, leads to a predicted reduction of close to 400 individuals if the timing of the survey differs by 30 days.

Field reconnaissance was conducted in 2005 and 2006 at all *A. ampullarioides* populations. Individual counts were not provided for Pahcoon Spring Wash and Cottonwood. Numbers at Silver Reef have at other times been estimated at 150 individuals. Actual acreage surveyed was not provided; in fact individual plant counts involved visiting known sites without further reconnaissance work in other areas. Out of the total number of individual plants counted, approximately 40% were seedlings (M. Miller and R. Van Buren, pers. comm. 2006).

Information about the characteristics of the seed bank is preliminary. Soil sampling at Pahcoon Springs Wash resulted in 35 seeds, while 9 were found at Harrisburg Bench. Overall the amount of soil sampled and number of seeds found indicated an average density of 50 seeds/m^2. Within the study of seeds in the top 4 cm (1.6 in.) of soil, 68.2% of the seeds found to be viable. This may suggest that the rate of seed return is sufficient to maintain future recruitment (A. Bench, Utah Valley State College, unpubl rep. 2006).

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 5. Number of plants per m^2 (~$feet^2$)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 (Van Buren, pers. comm. 2006). These numbers represent current data and corrections that may differ from prior reporting (Van Buren, pers. comm. 2006).

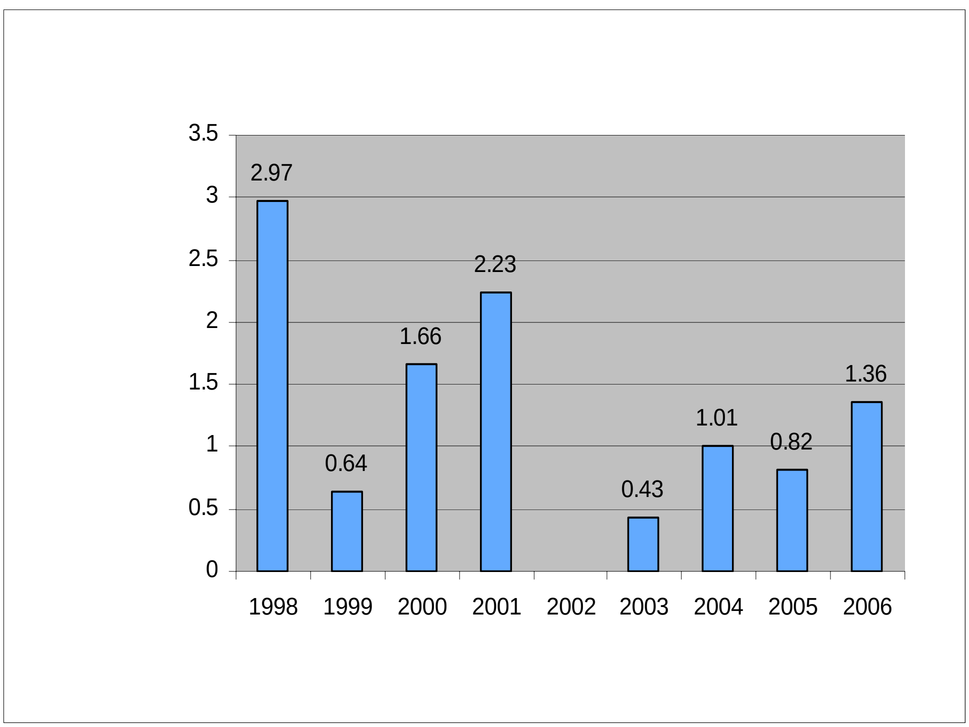

Figure 6. Average *A. ampullarioides* density at two study sites (Pahcoon Spring Wash and Harrisburgh Bench).

Like *A. holmgreniorum*, the germination, survival, and nature of mortality for *A. ampullarioides* is believed to be highly influenced by moisture relations and are equally in need of examination in better to define the correlation, if any, between precipitation and biology. Van Buren and Harper (2003) state that precipitation arriving at the beginning of the year is thought to trigger new seedlings (Van Buren and Harper 2003). Additionally, moisture during the growing season for *A. ampullarioides* influences plant mortality, which becomes apparent in the following year. Simply put, a late spring and summer of drought is thought to reduce plant numbers.

Although Van Buren and Harper (2003) do not provide months, for the purpose of determining long-term trends we will consider the first 4 months of the year for germination and seedling numbers and the months of March, April, May, and June as most important for plant mortality, as plants die back by the end of June (Van Buren and Harper 2003a). As in the discussion for *A. holmgreniorum* (above) for the months of March-June we rounded the sum of precipitation and found the average precipitation for these months is 5.1 cm (2 in.). We considered precipitation rounded sum equivalent of 0 in. as extreme low precipitation, which occurred 5 times during 1893 to 2006, 1 of which was in 2002. On average this occurred every 20 years with the largest gap in extreme drought being 49 years. For low precipitation we considered the rounded value of 1 in. or less, whereas for high precipitation we examined the rounded sum of 4 or higher. Although we recognize that this examination of precipitation needs further refining and analysis, we consider a minimum span of 20 years sufficient to span most trends.

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. In general, *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 (66 FR 49560), threats to these species were categorized into the five factors set forth in section 4(a)(1) of the ESA, i.e., (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 the probability of extinction of *A. holmgreniorum* and *A. ampullarioides* included--(1) habitat loss and fragmentation caused by land development and urban expansion in the St. George area; (2) habitat degradation caused by ORV use, mineral exploration and development, and cattle trampling; (3) overcompetition and displacement by exotic weeds, with associated fires; (4) loss or restriction of pollinators; and (5) herbicide and/or 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 affect the long-term survival prospects of the milk-vetches. Disscussion under each listing factor, below incorporates newly identified and predicted threats, in the near future (i.e., 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 and Stubben 1997). Human population in and around St. George is estimated at 130,000 and is growing rapidly with an approximately 1,000 new residents each month (St. George Area of Commerce, Demographics website http://www.stgeorgechamber.com/EcDev/demographic_overview.htm, 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 changing current open land use for increased urban development. Current and planned land-use development for housing and community amenities affects the State Line, Gardner Wells, South Hills, and Purgatory Flat recovery populations.

Up to an estimated 50% of occupied and supporting habitat for Holmgren milk-vetch is in areas targeted for development on Arizona and Utah State trust lands, whose prime responsibility is to plan for and dispose of these lands for their maximum value. Housing and community development plans exist for the entirety of two of six *A. holmgreniorum* populations: Central Valley (SITLA) and Gardner Well (ASLD), as well as parts of the State Line population (Northwest Economic Associates, 2006).

Since listing in 2001, private housing development 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 the all *A. holmgreniorum* individuals, is within Utah's School and Institutional Trust Lands Administration (SITLA) "South Block" lands, which are planned to be developed into 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 Arizona State Land Department, such as Gardner Well and parts of the State Line population. Real estate development on these properties will result in direct individual loss, loss of genetic diversity, and accelerate loss and fragmentation of plant habitat, reducing plant population viability, which limits the potential for the species' recovery. Because private, State, or other non-Federal funding is involved, land development is likely to continue.

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 asserts the ability to exchange or sell land to State or private interests if the exchange or transfer results in acquisition of better habitat 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, the net result would be a global loss for the species. Nonetheless, Federal land sales and/or disposals constitute a serious future threat to the South Hills and Stucki Spring *A. holmgreniorum* populations.

Additionally recreational development is affecting the species. Within the Purgatory Flat recovery unit, lands are leased by BLM, St. George for a shooting range which Washington County wishes 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. At this time, no regular monitoring program exists.

Many activities associated with urbanization that were of threat to *A.holmgreniorum* at the time of listing remain today. These activities include the construction of new roads, highways, electric power transmission lines, pipelines, airports, and maintenance of existing roads (66 FR 49560).

Information on pipelines and their potential threat to the species is lacking and, therefore, considered nominal. A utility corridor exists within the State Line and a substation and transmission lines exist at Central Valley, while powerlines are found within other units such as the Stucki Spring and Purgatory Flat. However, utility maintenance is low and no new impacts to species and/or species habitat are known or projected at this time. Previously proposed airport location south of Price City Hills would have conflicted with the milk-vetch; however, the new proposed alignment east of White Dome is outside of known locations.

Many new surface roads will come into being with the expanding housing market and the creation of highway corridors around St. George is under consideration. Section 7 consultation for the Southern Corridor, a proposed 4-lane, limited-access highway, originating near milepost 2 of I-15 and connecting with State Route 9 near Hurricane, mitigated impacts for *A. holmgreniorum.* This included 2.3 ac of milk-vetch within the highway right-of-way near Atkinville Wash (5:1 mitigation ratio) and an additional 2.0 ac of indirect impact near the Atkinville interchange (3:1 mitigation ratio), associated with induced development adjacent to the highway. The USFWS' biological opinion on the Southern Corridor recommended that "Federal Highway Administration (FHWA) should 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." In this regard, the FHWA has committed to provide approximately 17 ac of mitigation for *A. holmgreniorum* through land acquisition in the Central Valley for a plant preserve (Utah School and Institutional Trust Lands Administration et al. 2005).

Future transportation planning by Dixie Metropolitan Planning Organization is examining 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 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 for Stucki Springs and South Hills populations.

Regular road maintenance activities for I-15 that are expected within the Holmgren milk-vetch State Line population include refurbishing signs, pavement rehabilitation, upgrading guardrails and crash attenuators, replacing delineators, installing rumble strips, placing buried conduit for electronic traffic management systems (P. West, UDOT biologist, pers. comm.2006). Another related road threat 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 occur regularly and some of these activities are potential, rather than actual threats.

Maintenance of river corridors may present a new, temporary threat. In response to the 2005 Virgin River flooding, stabilization efforts in 2006 resulted in construction of a haul road along the same Southern Corridor alignment. Concerns then arose that this haul road may have affected a larger and/or different area of landscape than that of the Southern Corridor. To determine actual habitat reduction for the Central Valley population, it may be necessary to further examine and substantiate these claims. Future control along river corridors could potentially impact habitat areas in the State Line population.

Further the final listing indicated that mining might have habitat-related problems for several of the populations. Mining activities are unknown in the past 3 years and are believed to not be indicative of future threats for *A. holmgreniorum.*

Accompanying habitat loss is habitat fragmentation, which is often a consequence of land development and urban expansion. However, 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 pollinator crossing the roads face potential mortality in collisions with oncoming cars.

In 2001, habitat degradation from ORV use was a listing factor for *A. holmgreniorum.* Registered off-highway vehicles, within the State of Utah, has risen 195% in Utah since 1998, with an increase in numbers by 437% in Washington County, Utah (Fred Hayes, Utah Division of Parks and Recreation, pers. comm. 2005). This is a serious 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 soils that maintain soil stability. Hydrologic patterns can be affected, which may unnaturally restrict population size and seed dispersal. The ORV activities also lead to further habitat fragmentation and create favorable conditions for invasive plant species. The ORV use currently degrades or has the potential to degrade habitat for both plant species for nearly all known *A. holmgreniorum* populations.

Milk-vetch habitat degradation also is caused by cattle trampling, recreational trail use, and military operations, which disturbs the soil surface and seed banks for these species. This is an issue for the State Line and Gardner Well *A. holmgreniorum* populations. It was noted in the 2001 listing that habitat degradation resulted from military training operations conducted by the Utah Army National Guard on State lands within the occupied habitat of *A. holmgreniorum* between the current urbanized center of St. George and the Utah Arizona border (66 FR 49560). The Utah Army National Guard has redirected training to areas outside of habitat (L. England, USFWS, pers. comm. 2006).

Finally, a growing widespread phenomenon is the increased likelihood of fires associated with invasive species. In particular, invasive annual grasses such as *B. tectorum* and *B. rubens* grow in sufficient densities and become dry enough to carry a fire over large areas. The native Mojave Desert vegetation is not adapted to a frequent fire regimen (R. Bolander, BLM, pers. comm. 2005); therefore, this has the potential to cause permanent changes in vegetative communities that harbor the milk-vetches.

Astragalus ampullarioides

Like *A. holmgreniorum, A. ampullarioides* experiences habitat loss due to the growing pressures of the City of St. George and surrounding areas (see above). Residential and commercial development is taking place or further anticipated at the Coral Canyon population and to a lesser degree for Gardner Wells and Harrisburg Bench and Silver Reef populations. It is unknown the degree the construction of new roads, highways, electric power transmission lines, and pipelines will alter *A. ampullarioides* habitat in the future, as many of the associated impacts have occurred prior to listing. No projects are foreseen to impact the species at this time. The construction of highway I-15 likely altered the Cottonwood site within the Harrisburg Bench and Cottonwood population areas. Additionally, current and future highway maintenance (see *A. holmgreniorum* above for description of potential threatening activities) is a potential threat.

Most *A. ampullarioides* populations and their habitat occur primarily on Federal and Tribal lands (~90%). These areas are not receiving pressure from development. 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 now occurs 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 is projected across the road, further reducing the natural landscape, on which native pollinators may exist. No land development is currently predicted at the Shivwits 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 is an immediate threat to individuals and habitat. The frequency of direct plant loss arises and habitat disturbance is unknown. Research on user impact is suggested so that Zion National Park can better manage and assess continuing threats of this species on their lands.

In the final listing, electric power transmission line development 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 were conducted which 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 occupancy.

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

Habitat degradation from ORV use was a listing factor for *A. ampullarioides* and is a serious continuing threat, given the increasing popularity of ORV activities in Washington County (see above for more details). The ORV activities in *A. ampullarioides* are particularly damaging as localized clay habitat lack soil stability and are easily impacted by transgressions. As with *A holmgreniorum*, ORV activities lead to associated plant loss, habitat degradation, and changes in native plant communities. Fencing at Pahcoon Spring Wash, Harrisburg Bench and Cottonwood, and Silver Reef populations will reduce this direct threat to *A. ampullariodes* sites on BLM lands. However, fencing will not abate all ORV use with *A. ampullarioides* habitat. Currently, the Silver Reef population experiences the highest levels of ORV use.

Milk-vetch habitat degradation also is caused by cattle trampling, which disturbs the soil surface and seed banks for these species. This is an issue the Pahcoon Spring Wash, Shivwits, and Silver Reef *A. ampullarioides* populations. In particular, the habitat for the Pahcoon Spring Wash population 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. These 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.

Finally, St. George, Utah and surrounding areas are facing an increase in fires due to exotics grasses such as *B. tectorum* and *B. rubens*. In 2005 fire ran through the Harrisburg Bench site of the Harrisburg Bench and Cottonwood population. Site visits in 2006 proved species presents and indicated a healthy return. Timing of the 2005 fire coincided with annual plant dormancy patterns, which appears to have reduced detrimental affects (Dr. R. Van Buren, pers. comm. 2006). Fires in past years and in this year are occurring 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* and efforts will be made to protect the plant locations.

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, although *A. holmgreniorum* is occasionally susceptible to herbivory, *A. ampullarioides* is extremely palatable to both wildlife and domestic livestock. 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 this threat at that site.

Overgrazing by livestock can eventually cause a shift in the plant communities that favors faster growing invasive plants to the detriment of both *A. holmgreniorum* and *A. ampullarioides* (see Factor E). Recent herbivory at the BLM *A. ampullarioides* demography study site near the Shivwits Reservation is tentatively attributed to rabbits (Van Buren 2005); however, it is not known if the level of herbivory negatively affects the plants at the population level. Some level of natural herbivory occurs every year in *A. ampullarioides* populations (Van Buren 2005).

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 indicates aphid infestations associated with *A. ampullarioides* populations. Also, an outbreak of white moths, which visited flowers in April 2005, may have restricted production of offspring. 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 need to be further examined.

Factor D. The inadequacy of existing regulatory mechanisms.

In Utah occupied *A. holmgreniorum* habitat occurs on BLM and National Park Service (NPS) lands, State lands, Tribal lands, and privately owned lands. In Arizona, *A. holmgreniorum* is restricted to BLM and State lands immediately adjacent to the Utah border. Aside from the ESA, which protects listed plants that occur on Federal lands, there are limited other existing regulations or laws, which directly protect these milk-vetches or their habitat. Under the Arizona Department of Agriculture website (2005) the Native Plant Law of 1993 requires "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." The State of Utah does not have any plant protection laws. Some policy-level protection from BLM is afforded through the "Dixie Resource Area Proposed Management Plan and Final Environmental Impact Statement" (BLM1998); nonetheless, the location of these species in areas valued for future urban expansion makes the long-term security of their habitat, even on BLM lands, uncertain. There is no legal protection for either species on State lands in Utah or Arizona or on private property and unconstrained species and habitat loss is likely to continue.

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 plants, and annual exotics 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 concern.

Pollination of *A. holmgreniorum* and *A. ampullarioides* is a long-term concern. Both species 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 *A. ampullarioides*, a lack of pollinators would result in a gradual decrease in the number of seeds in the seed bank (Tepedino 2005). Additionally, a loss of pollinators could lead to low amounts of pollen, which has been shown to reduce seed production in other rare *Astragalus* (Karron 1987).

Finally, 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 seed bank longevity, the affected populations could become extirpated (R. Van Buren pers. comm. 2006). Given that drought events occur at a regional level (Miller 2005), this could prove to be a serious factor for both species (Western Regional Climate Center 2006). Frost kill also affects both species and could become a more prevalent problem with long-term seasonal changes (R. Van Buren, pers. comm. 2006).

THREATS ASSESSMENT

Recovery of *A. holmgreniorum* and *A. ampullarioides* will require reducing 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 their continued survival. 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, using the ranking criteria below:

- **Exposure -** The extent to which the species and the threat (i.e., 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 is assigned to this category.

- **Immediacy -** The action time frame of the threat, e.g., the stressor is present and acting on the species now, is anticipated in the future, or the impact 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 -** The intensity or strength of the threat <u>where it occurs</u>.

  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)

[3] This 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).

- **Recovery/Management Potential -** How possible it will be to reverse and abate the threat , based on technical expertise and 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)

The matrices used to assess the threat to each milk-vetch and a summary of the results and their implications are provided below. The threats assessment covers only those listing factors that have a foreseeable effect on each species. In particular, Factor B, overutilization, is not applicable to these species, and Factor D, inadequacy of regulatory mechanisms, is not amenable to assessment as a direct threat to the 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. Truly pervasive threats to this species include land development/urban expansion, deleterious effects of 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 concern 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 cause 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 portion of the extant population, and there are doubts about the long-term continued viability of this population unless additional habitat preserves can be secured. Habitat conservation through land acquisitions and easements is costly due to sharply increasing prices in the St. George vicinity. However, the acquisition of land and its protection would directly thwart population loss and highly improve recovery scenarios.

Introduction of invasive plants is one of the fastest growing concerns for many rare and endangered species, and bringing invasive species under control once they are established has proven to be a difficult issues; however, as long as the soil substrate and seed bank 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 that are 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. For example, fire recently burned 1,214 ha (3,000 ac) in the nearby Red Cliffs Desert Reserve, negatively altering habitat conditions for an array of Mojave desert species including the threatened desert tortoise.

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--that would outlast the period over which the species can withstand consecutive years of reduced reproductive output and seed bank depletion. Thus, while climate change is viewed as a potential rather than current threat, drought years bear close watching for effects on each population, and measures to mitigate loss of reproductive adults and seed output may be warranted both on an emergency and ongoing basis.

Natural resource utilization for outdoor recreation, particularly ORV use, affects all but the Purgatory Flat population, where access has been effectively controlled with fencing. Other human uses in milkvetch 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/or persist with effective management controls, the enforcement efforts needed over time 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.

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 trampling	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
	Impacts on pollinators & associated loss or restriction of gene flow caused by impacts on pollinators		x		x	x	x	3	2	1
	Herbicide use	x						2	1	3
	Prolonged drought caused by climate change	x	x	x	x	x		2	2	1

Cattle trampling is limited to two populations, State Line and Gardner Well, and the effects on these populations are considered to be of low severity. Herbicide use is anticipated to affect only the State Line population, and use is currently infrequent. These two threats are 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.

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 trampling
- 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 within the Mojave Desert ecosystem, prolonged droughts caused by climate change, and, herbivory. Although land development poses a threat to three of the six *A. ampullarioides* populations (Coral Canyon, Harrisburg Bench and Cottonwood, and Silver Reef), it is not as pervasive a threat for this species as it is for *A. holmgreniorum*; nonetheless, the possibility of irrevocably losing any of the known *A. ampullarioides* populations constitutes a significant extinction risk for this plant.

The ORV and other recreational uses affect all *A. ampullarioides* populations except, possibly, the Shivwits population. As with *A. holmgreniorum*, 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. The long-term management needed to control unauthorized access is substantial and may become even more of a challenge as the demand for recreational access grows in the future.

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 & recreational access (including road/trail development & use)	x			x	x	x	3	3	2
	Illegal dumping/waste disposal				x	x		1	1	2
	Cattle trampling	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
	Loss or restriction of gene flow caused by impacts on pollinators	x	x	x	x	x		3	3	1
	Pesticide/herbicide use			x				2	2	3
	Prolonged drought caused by climate change	x	x	x	x	x	x	2	2	1

As with *A. holmgreniorum*, 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 seed bank remain intact, it is possible that an effective management remedy will be found. The threat of fire associated with invasive exotics is increasing. Recently, in 2005, a fire ran through occupied habitat at the Harrisburg Bench site (east of I-15) within the Harrisburg Bench and Cottonwood population. Data from 2006 indicate that the milkvetch 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 positive result. Nor can we ascertain if fire under different conditions would produce different 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 seed bank is viable. Although the listing of this species indicated livestock grazing at Pahcoon Spring Wash and Shivwits populations (now largely excluded at Shivwits and to be excluded at Pahcoon Spring Wash), all *A. ampullarioides* populations are susceptible to the effects of overgrazing by livestock and other setbacks to survival or productivity caused by adverse environmental conditions.

Any prolonged drought, whether part of a broader climatic trend or not, that outlasts seed bank 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, 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, of low concern for the Shivwits *A. ampullarioides* population, and uncertain to the degree at the Silver Reef population. Silver Reef, along with the Harrisburg Bench population, also is affected by illegal waste disposal activities, and Coral Canyon, due to its proximity to a golf course, is potentially threatened by herbicide use; however, these threats are localized and of minor concern to the rangewide population.

In terms of *A. ampullarioides* populations that are affected by more or less threats, Silver Reef appears the most affected by a 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.

Finally, 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:

- ORV use and other recreational land uses
- Invasive plant species and the potential for associated wildfires
- Land development/urban expansion
- Impacts on pollinators
- Cattle trampling
- 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 both before 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 qualitatively 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 Utah's School and Institutional Trust Land Administration, TNC, USFWS, BLM, UDOT, and FHWA. Accomplishment of the goals established within this document may take several years, and a 10-year time limit (until January 1, 2015) on holding land for inclusion in future plant preserves is in effect. The letter expresses the intent to acquire a 166-ac (67.18-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's 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. However, the BLM stewardship of *A. holmgreniorum* habitat does come with a caveat. According the Dixie Resource Management Plan (1999), public lands supporting federally-listed or sensitive plants are to be retained in public ownership unless the exchange or transfer results in acquisition of better habitat or provides for suitable management by another qualified agency or organization. This leaves the door open for the sale or transfer of lands supporting populations of this milk-vetch. However, administrative land actions are subject to section 7 consultation under the ESA.

The letter of intent also addresses the Central Valley *A. holmgreniorum* population, a large population on roughly 1,150 ac (465.4 ha). Conservation efforts are being pursued for this area include a small plant preserve (approximately 17 ac or 6.87 ha) and discussions with SITLA, the landowner, about incorporating open space or corridors in the planned community that would 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 destroyed will affect recovery success. Conservation of more than the 17 ac (6.87 ha) being set aside is essential to maintaining the diversity and viability of this *A. holmgreniorum* population, and this issue remains under active negotiation.

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 with parking and trailheads to be relocated 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. Although plant monitoring has been sporadic, periodic observations confirm the continuing presence of *A. holmgreniorum*. The fence remains intact and no ORV use is currently seen. A fenceline along a BLM access road near South Hills and Stucki Spring has partially reduced ORV use; however, 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 fences are 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 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, location of authorized actions, implementation of post-wildland fire Emergency Stabilization and Rehabilitation activities, and design of pre-planned 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, return interval to 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 early 1990s (Armstrong and Harper 1991, Van Buren 1992; Hughes 1992). Potentially occupied habitat that has not been surveyed in recent years includes the areas are between South Hills and Stucki Springs and between Stucki Springs 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, demographic and trend monitoring has been conducted at three *A. holmgreniorum* study sites, as described in

Population Abundance and Trends. Data collection techniques 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 1.2-km (0.75-mi) 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.* Rangewide distribution and abundance of *A. ampullarioides* and associated invasive exotic plants in relation to soil properties, geomorphic setting, and plant community composition will be described. 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 seed bank studies also will be conducted to evaluate effects of exotic plants on seed bank composition of plant communities in which *A. ampullarioides* occurs. 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, Band Chairman, pers. comm. 2005). Some individuals occur outside this protective fence. Construction of a fence to protect all individuals and habitat resources has been discussed.

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 impacts like soil disturbance and plant trampling. Further funding to provide fence monitoring and timely maintenance and repair is a high conservation need if these fences are to be effective.

Inventory efforts occurred for *A. eremeticus* var. *ampullarioides* (later elevated to *A. ampullariodes*) in the early 1990s (Armstrong and Harper 1991, Van Buren 1992). Onsite counts or estimation of individuals occurred at all sites in 2006 (see Table 2). Zion National Park began conducting extensive surveys in 2001, increasing known localities and numbers, with additional surveys in potential habitat 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

The purpose of this section is 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 seed banks, 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.

Astragalus holmgreniorum and *Astragalus ampullarioides*

A. holmgreniorum and *A. ampullarioides* are perennials that thrive in Mojave Desert conditions, under an irregular moisture regime. The persistence of seeds in the soil through unfavorable germination conditions, i.e., the seed bank, as well as adult plant dormancy (for *A. ampullarioides*) are survivorship mechanisms that represent a biological constraint, as an unknown percentage of genetic heritage is dormant within the soil (R. Van Buren, pers. comm. 2006). For plants with seed banks, 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; however, due to recurring drought patterns, the importance of protecting these species' seed bank is indisputable. Monthly precipitation records from 1893 indicate that both species have co-evolved with drought (Western Regional Climate Center web site http://www.wrcc.dri.edu, May 2006); however, reduction and loss of habitat and seed bank may reduce overall resiliency. Therefore, the quality and condition of habitat and soils are high priorities. Retention of suitable habitat adjacent and near 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.

Droughts trigger dormancy and loss of reproductive activity, and late-season frosts can cause flower and fruit damage in both species. 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). Although species-level actions cannot protect against climatic extremes, off-site 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 habitat. 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. Research is needed to elucidate and substantiate this biological constraint. 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 *Bromus rubens* (red brome) and *B. tectorum* (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 (B. 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 (Van Buren, pers. comm. 2006). Additionally, fires may produce intense heat that can kill latent seed embryos and reduce seed bank 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). 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 seed bank (Tepedino 2005). Even with a sufficient pool of pollinators, in years of low plant presence (as seen with *A holmgreniorum*) pollen exchange may be reduced by the number of individual plants and the lack of plant density within the landscape. Studies indicate that reproductive processes such as seed output diminish as plants become more thinly dispersed across the landscape (Harper et al. 2000).

Astragalus holmgreniorum

A. holmgreniorum biological constraints center on the transition from seedling to reproductive adult. 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). Long-term drought would severely impact seedling and adult presence. Survivorship of the species to reproductive adults is low, which further places emphasis on the need to reduce or eliminate ground-disturbing activities, which can lead to species trampling in *A. holmgreniorum* habitat.

As habitat and population numbers decrease due to urban expansion, efforts to improve the seedling survivorship rate need attention, as the transition from seedlings to adulthood appears to be a limiting factor in reproductive success.

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. If the presence of *L. tridentata* indicates a biological constraint producued by *L. tridentata* presence, then the potential encroachment of *L. tridentata* into *A. holmgreniorum* habitat may be 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 formations during precipitation events (Van Buren and Harper 2003a); however, natural soil erosion, wind, birds and small ground animals also may play a role in seed movement. Similar dispersal mechanisms are thought to be associated with *A. ampullarioides,* although dispersal also may result from soil movement, since these plants are found on high clay-bearing soils that swell and shrink depending on their moisture content. Additionally, the distance between populations indicates that animal vectors may play a prime role in dispersal of *A. ampullarioides.* Given this, the protection of natural habitat processes and connectivity within the landscape is needed to allow natural dispersal over time, indicating that efforts to reduce overall habitat fragmentation are necessary.

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. This project will describe the distribution and abundance of *A. ampullarioides* and associated invasive exotic plants in relation to soil properties, geomorphic setting, and plant community composition. Experimental studies will be conducted in a field setting 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*. To inform restoration planning, soil seed bank studies also will be conducted to evaluate effects of exotic plants on seed bank composition of plant communities in which *A. ampullarioides* occurs, as well as adult plant dormancy (for *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. Accordingly, 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 *Bromus rubens* (red brome) and *B. tectorum* (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 (B. 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 (Van Buren, pers. comm. 2006). Additionally, fires may produce intense heat that can kill latent seed embryos and reduce seed bank 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.

Despite the amount of Petrified Forest Member of the Chinle and Dinosaur Canyon Member of the Moenave geological formation layers that are exposed, *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 this species and substrate as it relates to the milk-vetch's limited distribution needs further research. Until parameters pertaining to this 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, 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 as it relates to recovery needs and opportunities, a general vision to provide direction to the recovery process, and broad solutions to problems that are affecting these species' 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 in previous sections, 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 staunch 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 (NMFS 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 historical 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 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.

Full recovery will thus 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 seed banks), 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 will need to be sustained in order to reach full recovery are designated as “recovery populations;” this will include extant and, if feasible, introduced populations of each species. Where currently found, *A. holmgreniorum* is divided into six recovery populations: State Line, Gardner Well, Central Valley, South Hills, Stucki Spring, and Purgatory Flat. *A. ampullarioides* is divided into 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, land development and, to a large extent, 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 as well as to other disturbances such as 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; nonetheless, the recurring drought cycles that occur in the region provide a dynamic context for conservation, and recovery actions will take this context into account. For instance, during periods of drought, more aggressive management 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 seed banks through dry periods.

Although population viability analyses for these species is not yet feasible, studies for other rare plants suggest a general need for retaining and possibly increasing the population size and distribution of rare and declining species. 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 possibly 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 off-site 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. Thus, in order to exercise caution, no introductions will be conducted until a rangewide repatriation strategy has been developed for each species, and initial 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.

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 its 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.

Finally, 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, cooperative efforts will be pursued with BLM, Arizona Strip, the Arizona State Land Department, the City of St. George, SITLA, and USFWS. Additionally, 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 maintaining the current number of populations at a size and distribution indicative of the species' population dynamics and known range and 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. *A. holmgreniorum* is likely to have occurred in more locations historically than it now does, since the past loss of areas with habitat conditions similar to occupied habitat for this plant could be indicative of a long-term, rangewide decline that needs to be reversed in order to achieve full recovery. Conversely, it is unlikely (while not impossible) that additional natural populations will be found, given the negative search results since the six known populations were discovered.

There is some basis for optimism regarding the possibility of artificially establishing new populations; however, 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. This elevates the importance of conserving all extant populations through the foreseeable future.

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, pointed at 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 need to be addressed. The most imminent threats to *A. holmgreniorum* will be addressed on a site-specific basis. Recovery will be promoted by conducting mutual problem-solving discussions centering on habitat protection, by tracking and alleviating threats, and by building a mutual understanding of recovery needs vis-à-vis projected land uses.

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. In particular, the following two priorities will be addressed.

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, isolated due to both natural patchiness and human-induced habitat fragmentation, and -- despite all these limitations -- 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 population losses, recovery will hinge on conservation of extant populations to the maximum extent possible and recognize the potential need to find or create 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 as necessary.

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 is achieved, (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 the continuation of natural selection.

RECOVERY OBJECTIVES

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

- Ensure that these rare plant species remain distributed throughout their current ranges;
- Ensure adaptive management of the species' habitat, taking into account environmental changes and new insights;
- Ensure that population trends and emerging threats to the species are effectively monitored and that monitoring results indicate that the species are no longer imperiled;
- Ensure that needed off-site measures are in place to avert any 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 double set of recovery criteria: population-based criteria and threats-based criteria. All criteria must be met in order to propose reclassification or delisting. Although the criteria have been developed jointly to 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 over the course of the recovery process, if and when important new information becomes available: recovery criteria must always be based on the best available information.

Population-Based Criteria

The term "recovery population" will apply 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, in 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. Population trends for *A. holmgreniorum* and *A. ampullarioides* recovery populations are shown to be stable or improving as indicated by the following parameters:

***A. holmgreniorum*:**

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

b) Mean occupied habitat at all recovery population sites is primarily stable or increasing for the 10-year period immediately prior to reclassification, and

c) Density of occupied habitat is shown to be primarily stable or improving, as measured by annual plant counts at permanent and/or random transects based on a standardized monitoring protocol, at a minimum of four recovery population sites over a 20-year period, and/or

d) Demographic modeling, using data from a 20-year period collected in accordance with a standardized monitoring protocol, provides a preliminary indication of demographic stability as determined through recovery action 4.3.8.

***A. ampullarioides*:**

a) Species presence is maintained at all recovery population, and

b) Mean occupied habitat at all recovery population sites is primarily stable or increasing for the 10-year period immediately prior to reclassification, and

c) Density of occupied habitat is shown to be primarily stable or improving, as measured by annual plant counts at permanent and/or random transects or census counts taken every 3-5 years, using a standardized monitoring protocol in either case, at a minimum of four recovery populations over a 20-year period, and/or

d) Demographic 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 for a minimum of four recovery populations.

P-2. 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 needed gene flow within and, where possible, among populations. Habitat size and connectivity parameters will be set through recovery actions 4.3.2, 4.3.5, 4.3.6, and 5.

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 located or are introduced to habitat in proximity to extant populations and 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 habitat base for each new 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, where possible, among populations. Habitat size and connectivity parameters will be set through recovery actions 4.3.2, 4.3.5, 4.3.6, and 5 .

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 parameters.

A. holmgreniorum:

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

a) Mean occupied habitat at all recovery population sites is primarily stable or increasing for the 10-year period immediately prior to delisting, and

b) Density of occupied habitat is shown to be primarily stable or improving, as measured by annual plant counts at permanent and/or random transects based on a standardized monitoring protocol, at all eight recovery population over an additional 10-year period, and/or

c) Demographic modeling, using data from an additional 10-year period collected in accordance with a standardized monitoring protocol, indicates a pattern of demographic stability as well as a survival probability of at least 95% over 100 years for all eight recovery populations.

A. ampullarioides:

In addition to continuing to meet the presence parametersfor reclassification,

a) Mean occupied habitat at all recovery population sites is primarily stable or increasing for the 10-year period immediately prior to delisting, and

b) Density of occupied habitat is shown to be primarily stable or improving, as measured by annual plant counts at permanent and/or random transects <u>or</u> census counts taken every 3-5 years and using a standardized monitoring protocol in either case, at all eight recovery population over an additional 10-year period, and/or

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

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 for ensuring adequate long-term funding for conservation must be identified.

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 through recovery actions 4.3.2, 4.3.5, 4.3.6, and 5. Protection can be achieved via fee acquisition, conservation easement, and/or long-term management agreements.

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 seed bank 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.

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* 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, 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 Utah and, in the case of *A. holmgreniorum*, Arizona 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 *A. ampullarioides* recovery populations and/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 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 actions 4.3.2, 4.3.5, 4.3.6, and 5.

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 4.3.5.

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 recovery actions 4.3.2, 4.3.5, 4.3.6, and 5. Protection can be achieved via fee acquisition, conservation easement, and/or long-term management agreements.

Factor C. Disease or predation.

T-12. Adverse population-level effects from herbivory, if any, are identified and, as needed, are abated within *A. ampullarioides* 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 off-site 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 by the year 2035.

STEPDOWN 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 Tribal and 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.
     - 1.2.3 Implement effective ORV use control measures.
     - 1.2.4 Enforce existing regulations preventing unauthorized land uses.
   - 1.3 Effectively manage livestock grazing activities in *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 seed banks for each species.
     - 1.6.1 Protect the *in situ* (onsite) seed bank for 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 Develop standardized, rangewide survey procedures for each species
   2.2 Implement *de novo* (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 *A. holmgreniorum* and *A. ampullarioides* sites for population information and trends.
   3.1 Develop a rangewide monitoring plan and protocols 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 a post-delisting monitoring plan.

Research

4. Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers.
   4.1 Develop standard procedures for setting annual research priorities and evaluating proposals.
   4.2 Establish protocols for protecting milk-vetch populations during the course of field studies.
   4.3 Conduct needed investigations and identify recovery applications of research results.
      4.3.1 Nonnative weeds.
      4.3.2 Pollinators.
      4.3.3 Habitat substrates and soil conditions.
      4.3.4 Fire effects.
      4.3.5 Genetic variation within and among populations.
      4.3.6 Seed bank viability and longevity.
      4.3.7 Parasitism and/or disease.
      4.3.8 Modeling.
5. Develop and implement a rangewide strategy for augmentation and/or establishment of milk-vetch populations.
   5.1 As needed identify potential population establishment sites for each species.

5.2 Develop population augmentation and establishment 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 ORVand other interest groups.

   7.4 Develop 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

The 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.

PROTECTION

1. **Conserve known extant *Astragalus holmgreniorum* and *A. ampullarioides* populations and their habitat.** For *A. holmgreniorum*, there are 6 known areas of occupancy, containing from 500-10,000 individuals. 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 6 known areas of occupancy, containing about 1,500 individuals. Plants are clustered in high densities on intermittently distributed purplish-red, clay Chinle outcroppings. To preserve the integrity of the landscape and to adequately support pollinators, hydrology, and sites for seed dispersal, the acreage of recovery areas is higher than the number of acres of physically occupied habitat. The protection measures needed for individual areas should be evaluated on a site-specific basis.

   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 the size and connectivity needed for full recovery of each milk-vetch species. This action will involve Federal land management agencies such as the BLM and NPS.

   1.1.2 Work with the Shivwits Band of the Paiute Tribe to conserve the *A. ampullarioides* population on their land. The USFWS should initiate a government-to-government dialogue with the Tribe about developing and implementing a long-term management plan that has as its primary objective conservation of the milk-vetch population 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 the site into the public domain or establish plant conservation as a primary land use objective for the site. This will involve the the Shivwits band of the Paiute Tribe, Utah's State Institutional Trust Land Administration, Arizona's Trust Lands Administration, 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 the highway right-of-way to reduce habitat damage.

1.2 **Prevent human disturbance of known populations and their habitat.** Human activities such as hiking, biking, horseback riding, dog walking, and ORV travel lead to degradation of the landscape. These activities can increase erosion, change hydrology and vegetation patterns, compact soils, and cause inadvertent plant trampling. Habitat should be managed to maintain or enhance viable populations of *A holmgreniorum* and *ampullarioides*, to protect pollinators, and to allow for the functioning of natural ecosystems.

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 evaluate the need and use of the trails in relationship 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.** Where direction of human use cannot be abated by relocation and/or size of occupied sites is small, fencing is recommended to reduce immediate impacts. Maintaining fences in good-repair is a challenge in Washington and Mohave Counties, and fence repair costs should be obligated. Many nonauthorized activities exist within *A holmgreniorum* and *A. ampullarioides* landscape and habitat. Fences that have been established in the past are frequently vandalized by individuals or groups seeking unrestrained access.

1.2.3 **Implement effective ORV use control measures.** Effective control of ORV use involves designating trails and access outside of occupied or potential habitat, preparing designated trail maps, and signing to indicate where trail use is acceptable.

1.2.4 **Enforce existing regulations preventing unauthorized land uses.** Unauthorized land uses can include illegal dumping, ORV use, target practice, and fence cutting among others. For *A. holmgreniorum* and *A. ampullarioides* habitat to be protected, the goal is to raise law enforcement awareness of these species to enforce the protection of these areas.

1.3 **Effectively manage livestock grazing activities in *A. ampullarioides* habitat.** Federal lands with suitable habitat for *A. holmgreniorum* and *A. ampullarioides* should be surveyed in allotments where grazing is authorized. Effective grazing management may include the construction of fencing; moving water troughs; allowing for rest years; and revising 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. The advanced development of best management actions will aide planning actions and can be readily available for incorporation into planning documents. Actions that may occur regularly or repeatedly across the landscape should be addressed. Such 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. ampullarioide* 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; these pollinators require floral resources and a land base for their life cycles. To conserve the milk-vetches, maintaining 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). A loss in pollinators would decrease genetic diversity and population fitness of *A. holmgreniorum*. Methods of seed dispersal are unknown and may be provided by birds or small animals, as well as the natural landscape through hydrology, shifting soil, wind, etc. Requirements for germination most likely involve abiotic and biotic soil conditions. At some level, the disturbance or change of natural regimes is likely to preclude recovery. The research described below can further illuminate elements essential for recovery. Protective needs of the associated ecosystem community should be evaluated and prioritized. Evaluation of protective needs of the species' associated ecosystem should include, but not be limited to, reduction of landscape fragmentation and loss of occupied lands to development; removal of nonnative weeds; landscape restoration, especially areas where overuse has created land-scars; and determining reduction or removal of 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 9).

1.6 Protect the seed banks for each species.

1.6.1 Protect the onsite seed bank for each species. Presumably, areas within and near plant occupancy have 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, such as 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 requires the establishment of best management practices that will ensure the protection of natural soil conditions and seeds. Further research pertaining to this topic is described below.

1.6.2 Protect seeds offsite. Seed-banking, 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-banking 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. This action will provide a protocol for seed collection that will minimize effects to *A. holmgreniorum* and *A. ampullarioides*. 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. Seed collection permits should be evaluated for need and duplication. Permit holders, at minimum, must provide documentation of activities which detail 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 small number of individuals and restricted distribution of *A. holmgreniorum* and *A. ampullarioides* make this species highly vulnerable to random environmental and human-caused events. As a protection against significant loss of genetic material, seed representing the diversity of the taxa should be collected and stored for long term conservation in at least on Center for Plant Conservation approved facility. The stored seed may 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 Develop standardized, 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 to indicate presence. Documentation practices are inconsistent. Standard survey procedures should be developed and uniformly applied to ensure consistency and accuracy across the species range. This also should facilitate a systematic search for as yet unidentified populations.

2.2 Implement new searches in potential habitat areas.

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. A determination of survey needs may be based on completing current knowledge and advancing knowledge in areas of suitable habitat that is currently considered unoccupied. The discovery of new populations would enhance future recovery options.

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 on areas where activities may affect habitat, or 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 introduction needs, a systematic approach for compiling and analyzing survey results should be developed and consistently utilized by managment entities.

2.3 **Apply the conservation measures detailed in recovery action 1 to each additional site.** Land development, land purchasing, land trades, and land disposal actions will have an impact on the species range, distribution, and rate of recovery. Measures should be implemented to conserve occupied and suitable habitats across the species range.

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

3.1 **Develop a rangewide monitoring plan and protocols for each species.** Results from past monitoring efforts exist. The quality and quantity of information required to detect populations needs to be determined. A cohesive plan would utilize the best information from past efforts to develop a rangewide plan and protocols to assess trends over the long term.

3.2 **Implement standardized monitoring on Federal lands.** Current monitoring for *A holmgreniorum* is occurring by Dr. Renee Van Buren through agreements with BLM (Utah) and Utah SITLA. Data collection sites occur the State Line, Gardner Well, and Central Valley areas. Current monitoring for *A. ampullarioides* is occurring by Dr. Renee Van Buren through agreements with BLM (Utah) at Pahcoon Wash and Harrisburg. Activities in Zion National Park include land surveys, individual counts or estimations, and current research under the direction of Mark Miller, USGS. Discussions between Federal agencies and interested parties are needed to promote joint development of monitoring needs and goals. Rangewide assessment of population trends is necessary to evaluate threat abatement measures, population health and stability, and recovery actions and results. A standardize monitoring program provides an assessment of population numbers to determine the status of populations, such as stable, improving, or in decline.

3.3 **Obtain permission from landowners and conduct monitoring on Tribal and non-Federal lands.** Non-Federal landowners are key to the long-term conservation of both species. Cooperation and respect toward these State and private lands is necessary for the development of amenable relations. Although long-term conservation agreements are desired, permission to collect and use data for population trends is relevant and important to assess rangewide conditions.

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. Participants should develop a common database for submittal of all monitoring data.

3.5 **Develop a post-delisting monitoring plan.** As goals, objectives, criteria, and actions are taken and recovery is obtained, a post-delisting plan that encompasses a minimum of 5 years of monitoring needs to be developed and completed 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 particular biological requirements of these species are known, if full recovery and conservation is expected, more must be learned. Research needed for recovery purposes will be aimed specifically at the protection and conservation of A. *holmgreniorum* and *A. ampullarioides*. The topics specified under recovery action 4.3 represent current research priorities; however, this list does not include all research possibilities, and investigations that are identified in the future as necessary for advancing the conservation of either species will be added to the plan and appropriately prioritized. In addition, studies may further reveal new techniques or actions for recovery, which will be incorporated into an updated plan as needed (see recovery action 12).

   4.1 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 and/or affect *A. holmgreniorum* and/or *A. ampullarioides* should be established. The selection/evaluation criteria should then be disseminated to all prospective investigators.

   4.2 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, seed banks, soil compaction and erosion; procedures for limiting the spread of nonnative plants via human transport; and effects of actions on pollinator and potential seed dispersal vectors.

   4.3 Conduct needed investigations and identify recovery applications of research results. The information base for each of these milk-vetches needs to be as complete as necessary to ensure the effectiveness of recovery efforts. Problematic gaps remain in our knowledge about each species' biological constraints, microhabitat requirements, genetics, and the effects of certain threats upon population viability.

      4.3.1 Nonnative weeds. Research involving nonnative weeds should evaluate factors pertaining to interaction, such as competition, between nonnative weeds and *A. holmgreniorum* and *A. ampullarioides*; determine the need for nonnative plant control; and study management measures in a controlled setting that may contain similar, but unoccupied habitat.

4.3.2 Pollinators. Conservation of pollinators and their habitats are essential toward the recovery of the milk-vetches. Maintaining visitation by an array of pollinator species is essential because bee populations fluctuate from year to year and not necessarily in synchrony with flowering or with each other (Roubik 2001; Tepedino and Stanton 1980 in Tepedino 2005; Tepedino 2005). A loss in pollinators would decrease genetic diversity and population fitness (Tepedino 2005).

Conduct and evaluate research regarding reproductive biology and essential pollinators on *A. holmgreniorum* and *A. ampullarioides*. Preliminary work has identified some insect pollinators and factors regarding their role in the sexual reproduction of *A. holmgreniorum* and *A. ampullarioides.* Further research should identify pollinator limitations and effects on these plant species. Knowledge of pollinator presence, density, preference of floral resources, and nesting substrate may be essential to the viability of the current populations and the suitability of potential introduction sites.

4.3.3 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 identify sites of unknown, but potential occupancy; and assist in assessment of sites needed for expansion and/or introduction.

4.3.4 Fire effects. Conduct and evaluate research to assess effects of fire on both species. Determine and standardize fire fighting protocols including post-fire habitat restoration.

4.3.5 Genetic variation within and among populations. The amount of variation within the gene pool of *A. holmgreniorum* and *A. ampullarioides* sites is unknown. Genetic information should be otained and evaluated in terms of resiliency, genetic drift, and inbreeding depression. Genetic diversity may indicate the health, fitness, and adaptability of a population towards natural and human-caused stresses. Genetic information should be utilized to guide site preservation, restoration, augmentation, and introduction decisions..

4.3.6 Seed bank viability and longevity. Quantify existing seed banks, investigate seed dispersal mechanisms, and determine the range and viability of seed banks for both plant species. To better understand long-term survival strategy of a species, an understanding of the soil seed bank must be taken into consideration. Fluctuations in soil seed density are unknown for *A. ampullarioides,* since soil samples were collected only once due to its rarity. Continued studies of *A ampullarioides* should be carried out in order to better understand the long-term strategies this species employs for survival. This research will support the protection of habitat resources, assist with understanding the lifecycle and survival mechanisms of both plant species.

4.3.7 **Parasitism and/or disease.** Damage of flowers and inflorescence stalks from disease and parasitism has been identified on some for *A. ampullarioides* plants. Additional effort should be employed to document disease or parasitism occurrences and collect parasites or diseased stalks. Notes should be taken in the field to describe the pattern of parasitism or disease. Investigation should determine the source of damage. Protocol should be established for the investigation of disease or parasitism outbreaks, including a record-keeping system.

4.3.8 **Modeling.** A population model provides a means of incorporating data, such as demographic processes and environmental variability, to determine population growth rates and survivorship. Population models should be developed to track recovery progress of these species. Available data can be used to develop the initial models. The quality of the models will improve over time as variables such as viable seed longevity and survivorship rates are further defined. Modeling on *A. holmgreniorum* and *A. ampullarioides* may include precipitation cycles and response, competition with invasive species, pollinator success, genetic data, and fire cycles.

5. **Develop and implement a rangewide strategy for augmentation and/or establishment 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).
- A monitoring strategy.

Population management should be conducted in coordination with the appropriate Federal and State plant management and land management agencies. If the activities will occur 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. Projects 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 the State (on behalf of private landowners), 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 preclude or readily address any threats to the site that may exist or emerge.
- In general, introductions should avoid sites with remnant populations to prevent disease spread and/or introduction of alien genes. However, there may be instances where such introductions may be considered with careful planning.
- 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 establishment protocols. Protocols should be established for augmentation of extant populations. The 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 to improve the prospects for success, protect reintroduced individuals, and modify 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 the survival, is important; intervention may be necessary in some cases. The monitoring procedures should take the following factors, as applicable, into consideration:

- Success indicators.
- Status updates.
- Refinements in techniques.
- Effects of management.
- Costs.

- Any other information that allows USFWS and reintroduction 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. These management activities may include but will not necessarily be limited to the following:

- 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.
- 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 population.
- Implement interventions (e.g., supplemental watering, horticultural aids) when necessary.
- When necessary, make decisions with regard to revision, rescheduling, or discontinuation of the project. If this happens, ensure that information from the project is not lost, 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.
- 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 engaging key parties through personal contacts, effective working relationships, and ongoing dialogues with recovery partners and stakeholders. Communications should focus on the role 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 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 for the development 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, inclusive of 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 **Develop 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. 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 disseminating informational and educational materials through school programs, exhibits, and other venues. Target audiences for these programs should 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* involves 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 serves as the best impetus for stimulating discussion about environmental issues, including the issues involved in recovering endangered plants.

8.1.1 **Integrate milk-vetch recovery into broader interpretive programs.** Although recovery of endangered plant species is the main goal of outdoor advocacy for the milk-vetch recovery program, it may be more compelling to interpret recovery within the broader natural or ecological contexts for 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 handson involvement in recovering these species, onetime 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 new 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 quality of the remarkable environment in Washington and Mohave Counties, they can become more meaningfully engaged in enjoying the natural outdoors and protecting the resources, including the 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 presentation 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

10. 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 critical. 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.

11. 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 vital 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 program(s) for *A. holmgreniorum* and *A. ampullarioides*. The group also should ensure that tracking results are documented in the USFWS' recovery implementation database.

12. 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 3 years. It is a guide for meeting recovery objectives discussed in Part II of this plan. This schedule indicates action priorities, action numbers, action descriptions, duration of actions, and estimated costs. In addition, parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the schedule. The listing of a party in the Implementation Schedule neither requires 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 5)

USFWS	=	Region Six, U.S. Fish and Wildlife Service
BLM	=	Bureau of Land Management
SITLA	=	State Institutional Trust Lands Administration
TNC	=	The Nature Conservancy
Acad Inst	=	Academic Institutions
OSA	=	Utah and Arizona State agencies other than SITLA

[others]

RECOVERY IMPLEMENTATION SCHEDULE

Action Priority	Action#	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	T-1	Protect plant populations on Federal lands	20	BLM, NPS, USFWS	no	800	40	40	40	40	40	Involved agencies to incorporate recovery actions into planning & management decisions as required by ESA; extending 20 years
1	1.1.2	T-1	Work with the Shivwits Band of the Paiute Tribe to conserve the *A. ampullarioides* population on their land	5	SB, USFWS	no	2,750	55	55	55	55	55	Cost estimates include administrative expenses, fence maintenance, & grazing management
1	1.1.3	T-2	To the extent possible, protect populations on non-Federal lands	20	USFWS, SITLA, ASLD, OSA, LJ, NGO, Private	yes	7,800	20 0	200	30 0	300	30 0	Conservation easements & fee acquisitions: 2 years at $200K, 8 years at $300K, 10 years at $500K
1	1.1.4	T-2	Minimize the effects of Federal highway projects near occupied habitat	15	FHWA, USFWS	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	Locate trails away from occupied habitat	10	USFWS, SB, BLM, NPS, SITLA, ASLD, Private	no	330	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	Protect sites with fencing	30	USFWS, SB, BLM, NPS, SITLA, ASLD, Private	no	275	20	20	20	20	20	$20K for first 5 years, $15K for next 5 years, $10K for following 10 years
1	1.2.3	P-3, T-5	Implement effective ORV use control measures	30	USFWS, BLM, NPS, SITLA, ASLD, LJ, 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 preventing unauthorized land uses	30	USFWS, BLM, NPS, SITLA, ASLD, LJ, Private	no	160	8	8	8	8	8	$8K for first 10 years, $5K for the 10 years, $3K for following 10 years
1	1.5	P-2, T-1, T-2	Protect the vegetation communities/ecosystems associated with each species	30	USFWS, BLM, NPS, SITLA, ASLD, LJ, NGO, Private	no	300	10	10	10	10	10	Repeat costs over 30 years
1	1.6.1	T-2	Protect the *in situ* seed bank for each species	30	USFWS, BLM, NPS, SITLA, ASLD, LJ, 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 & 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 & protocols for each species	30	USFWS, BLM, NPS, SITLA, ASLD, LJ, 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

Action Priority	Action#	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
1	3.3	P-1, P-6	Obtain permission from landowners & conduct monitoring on Tribal & non-Federal lands.	30	USFWS, 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 (without costs of USFWS salary)
1	4.3.1	T-6	Investigate nonnative weeds	periodic, 30	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	no	135	15	15	15	-	-	For 3 years; repeat every 10 years
1	4.3.2	T-7	Investigate pollinators	periodic, 15	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	no	60	-	10	10	10	-	$10K for 3-year period in 15 years
1	4.3.3	P-2, P-5	Investigate habitat substrates & soil conditions	3	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	no	90	30	30	30	-	-	Already initiated for *A. ampullarioides*
1	4.3.5	T-9	Investigate genetic variation within & among populations	periodic, 10	USFWS, Acad Inst	no	60	30	-	-	-	-	$15K per species, repeat for changes in 10 years
1	4.3.6	P-2, P-5	Investigate seed bank viability & longevity	10	USFWS, BLM, NPS, NGO, Acad Inst	no	30	10	2	2	2	2	$10K to initiate, "stach" seeds for longevity tests, annual for 5 years, every other year for 10 years
1	7.3	T-2	Establish communication with ORV & other interest groups	10	USFWS, SB, NPS, BLM, NPS, NGO	no	20	2	2	2	2	2	$2K/year for 10 years
1	9	T-2	Provide oversight & support for implementation of recovery actions	30	USFWS, SB, BLM, NPS, 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 the status of each species & assess the effectiveness of recovery actions	30	USFWS, SB, BLM, NPS, NGO, Acad Inst	yes	60	2	2	2	2	2	1-day meeting biannually. $2K/year
2	1.3	T-4	Effectively manage livestock grazing in suitable habitat	periodic, 30	BLM, SB, USFWS, SITLA, ASLD	no	60	6	-	-	6	-	Periodic surveys and assessed every 3 years
2	1.4	T-13	Incorporate plant protection into Federal planning documents	20	USFWS, BLM, NPS, FHWA	no	400	20	20	20	20	20	Involved agencies to incorporate recovery actions into planning & management decisions as required by ESA; extending 20 years
2	1.6.2.1	T-10	Develop seed collection & permitting guidelines	1	USFWS	yes	2	2	-	-	-	-	FWS salary
2	2.1	P-1	Develop standardized, rangewide survey procedures for each species	1	USFWS, BLM, NPS, 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 & non-Federal landowners & conduct surveys	30	USFWS, SB, NGO, Acad Inst	yes	150	5	5	5	5	5	$5K/year for 30 years

Action Priority	Action#	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
2	3.4	P-1	Create a database for long-term collection & evaluation of monitoring data	30	USFWS, BLM, NPS	yes	100	13	3	3	3	3	$10K to create database, $3K for annual updates for 30 years
2	4.2	T-2, T-5	Maintain government-to-government communications with the Shivwits Band of the Paiute Tribe	30	USFWS, SB, BIA	yes	120	4	4	4	4	4	FWS salary. $4K/year for duration of recovery process.
2	4.2	P-1, T-10	Establish protocals for protecting milk-vetch populations during the course of field studies	1	USFWS, BLM, NPS, NGO, Acad Inst	yes	4	4	-	-	-	-	FWS, BLM-AB, NPS salary plus technical working group participation
2	4.3.4	P-3	Investigate fire effects	5	USFWS, BLM, NPS, NGO, Acad Inst	no	50	10	10	10	10	10	$10K for 5-year period
2	4.3.7	T-12	Investigate parasitism and/or disease	5	USFWS, BLM, NPS, NGO, Acad Inst	no	20	4	4	4	4	4	$4K (estimated 5 years)
2	4.4	P-3	Identify recovery applications of research results	10	USFWS, SB, BLM, NPS, 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	5.1	P-3, P-4	Identify augmentation and/or repatriation needs for each species	2	USFWS, SB, BLM, NPS, NGO, Acad Inst	no	40	20	20	-	-	-	Anticiipated to be salary & travel cost of participating agencies in recovery meetings
2	5.2.	P-4	Develop population augmentation & establishment protocols	1	USFWS, SB, BLM, NPS, NGO, Acad Inst	no	8	-	8	-	-	-	Anticipated salary & travel cost of participating agencies in recovery meetings
2	5.3	P-4	Develop procedures for monitoring & evaluating success of expansion efforts	1	USFWS, SB, BLM, NPS, NGO, Acad Inst	no	40	-	-	-	-	40	Anticipated salary & travel cost of participating agencies in recovery meetings, & writing
2	6.1	P-4	Pre-establishment preparation & establishment activities	10	USFWS, SB, BLM, NPS, NGO, Acad Inst	yes	400	-	-	-	-	40	Beginning FY5 at $40K per year, 10 years
2	6.2	P-4	Post-establishment activities	10	USFWS, SB, BLM, NPS, NGO, Acad Inst	yes	40	-	-	-	-	-	Monitoring efforts; beginning FY6 at $8K annually, 5 years
2	7.4	T-2	Develop information exchange with fire management & other emergency operations	periodic, 30	USFWS, SB, BLM, NPS, SITLA, ASLD, LJ, NGO, Private	no	30	2	-	2	-	2	Salary of involved Federal agency personnel. Multi-agency effort.
2	8.2	T-2	Develop educational materials & conduct outreach	periodic, 30	USFWS, SB, BLM, NPS, SITLA, ASLD, LJ, NGO, Private	no	15	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, FHWA, ASLD, SITLA, OSA	no	100	13	3	3	3	3	$10K to create database, $3K for annual updates for 30 years

Action Priority	Action#	Recovery Criterion	Action Description	Action Duration (Years)	Responsible Parties	USFWS Lead?	Total Costs (1,000s)	FY1	FY2	FY3	FY4	FY5	Comments
3	2.3	T-1, T-2	Apply the conservation measures detailed in recovery action one to each additional conservation site	30	USFWS, SB, BLM, NPS, SITLA, ASLD, LJ, NGO, Private	no	95	-	-	-	10	10	$0K first 3 years, $10K FY4-5, $5K FY6-30
3	3.5	P-1	Develop & implement a post-delisting monitoring plan	7	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	yes	-	-	-	-	-	-	Begin in FY18 at $20K/year for 7 years (2 years to develop plan & 5 years implementation)
3	4.1	T-2	Develop standard procedures for identifying annual research priorities & evaluating proposals	1	USFWS, SB, BLM, NPS, NGO, Acad Inst	yes	20	20	-	-	-	-	FWS, BLM-AB, NPS salary plus technical working group participation
3	4.3.8	P-1	Demographic modeling	30	USFWS, Acad Inst	no	80	22	2	2	2	2	$20K to examine information & build model, $2K for 30 years for updating
3	4.3.9	T-2	Investigate other topics as identified through recovery action 4.1	30, periodic	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	no	60	8	-	8	-	8	$8K every other year
3	7.1	T-2	Maintain a dialogue among Federal, State, & municipal agencies	30	USFWS, SB, BLM, NPS, SITLA, ASLD, NGO, Acad Inst	yes	120	4	4	4	4	4	$4K annually for 30 years, salary costs
3	8.1.1	T-2	Implement recovery into broader interpretive programs	30	USFWS, BLM, NPS, OSA, LJ, 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, 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 the recovery program as indicated by new information & recovery progress	periodic, 30	USFWS, SB, BLM, NPS, NGO, Acad Inst	yes	125	-	-	-	-	25	$25K every 5 years

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APPENDICES

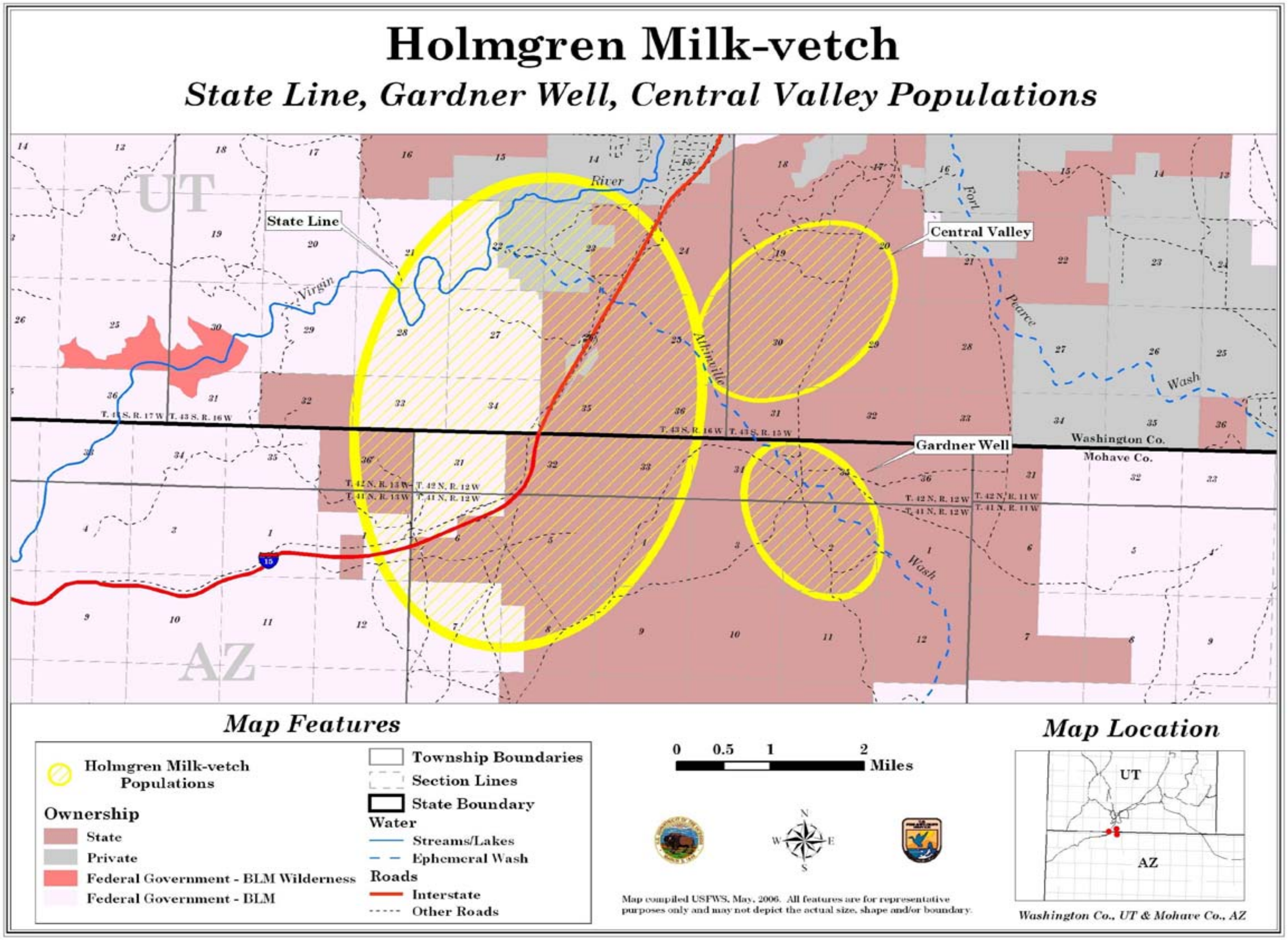
APPENDIX A. Maps of Individual *Astragalus holmgreniorum* Populations

APPENDIX B. Maps of Individual *Astragalus ampullarioides* Populations

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

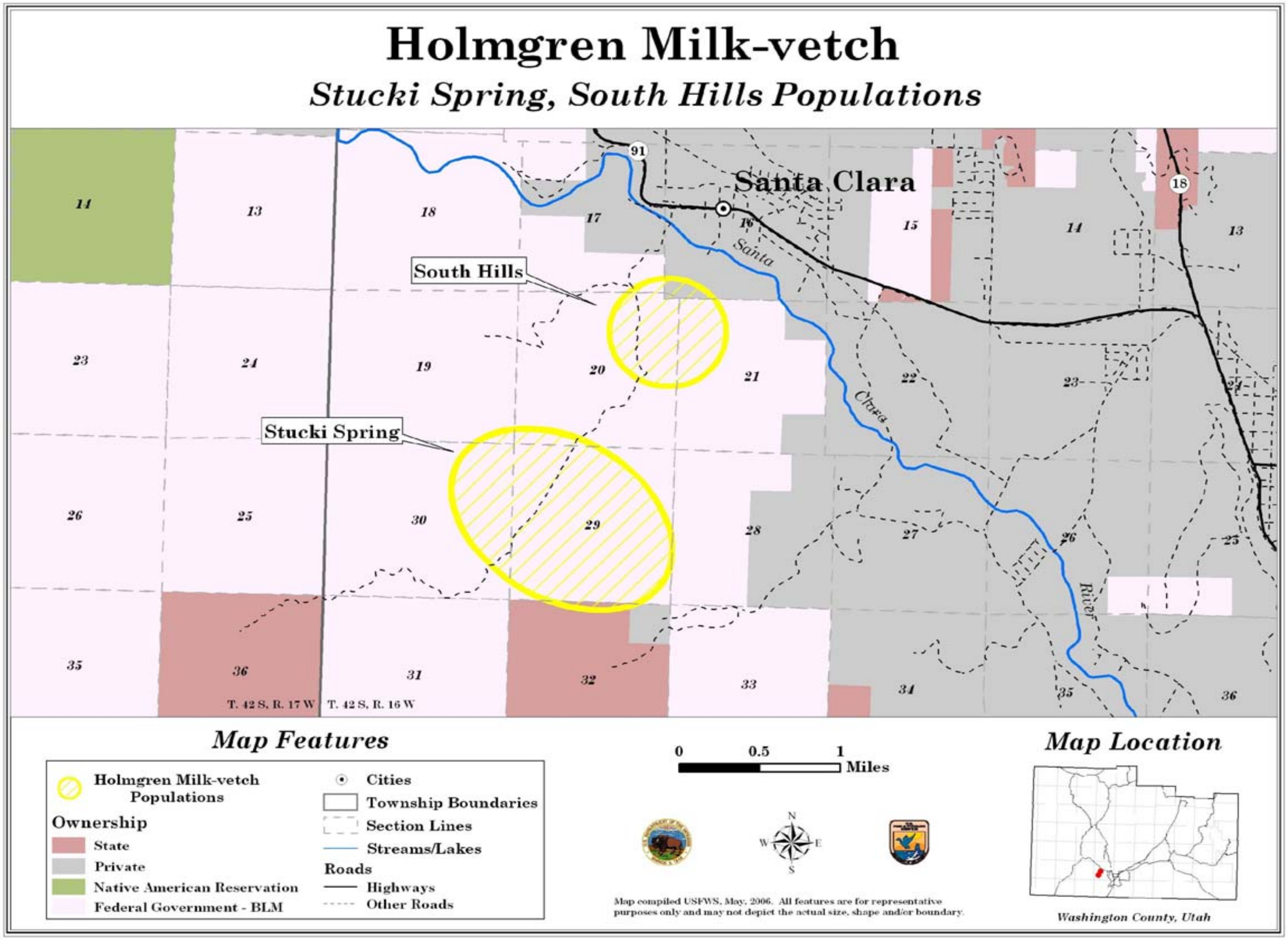
APPENDIX D. Maps of Proposed *Astragalus ampullarioides* Critical Habitat Units

APPENDIX A.



Holmgren Milk-vetch
State Line, Gardner Well, Central Valley Populations
UT
AZ
State Line
Central Valley
Gardner Well
Virgin
River
Fort
Pearce
Wash
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.



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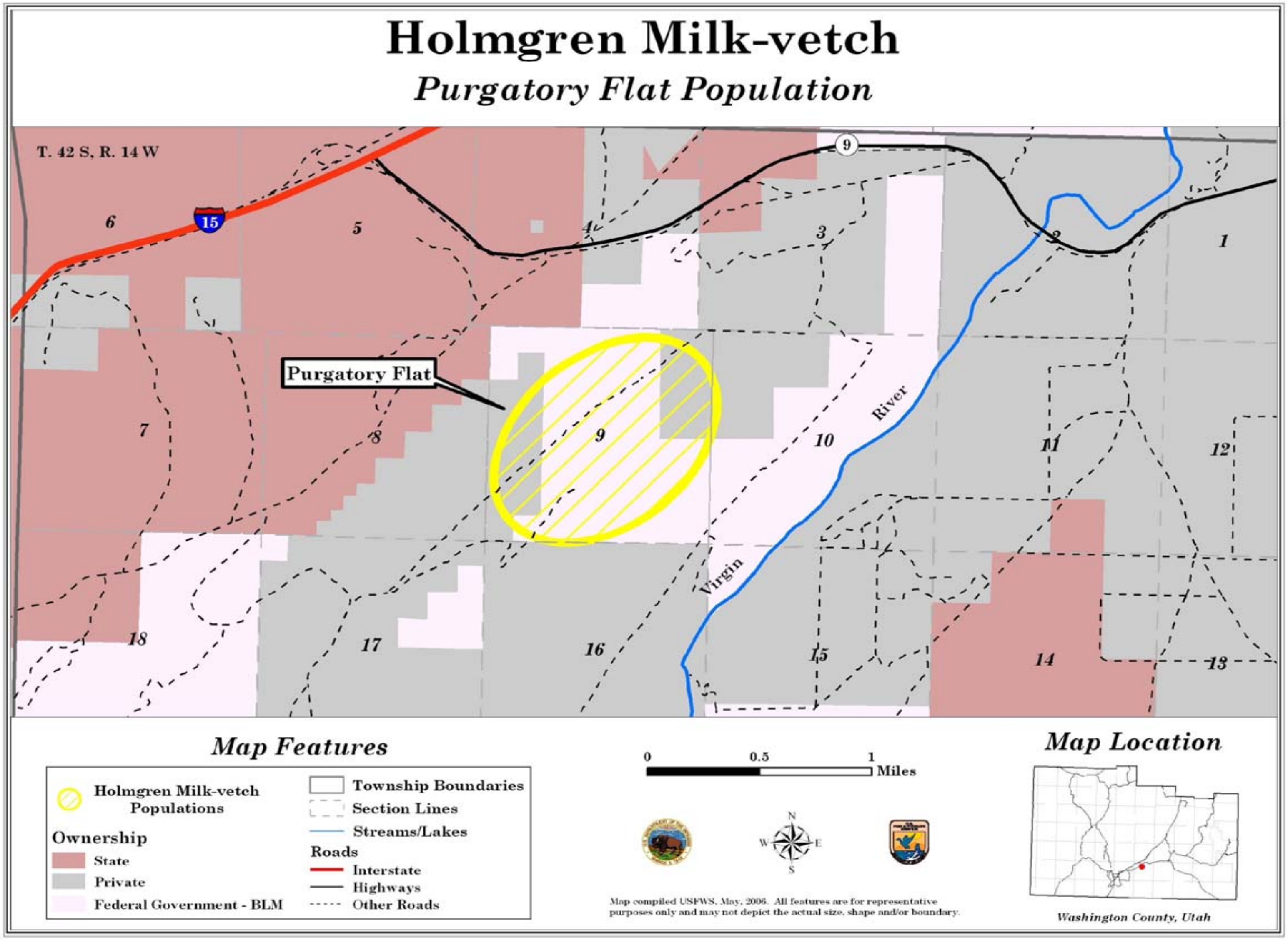
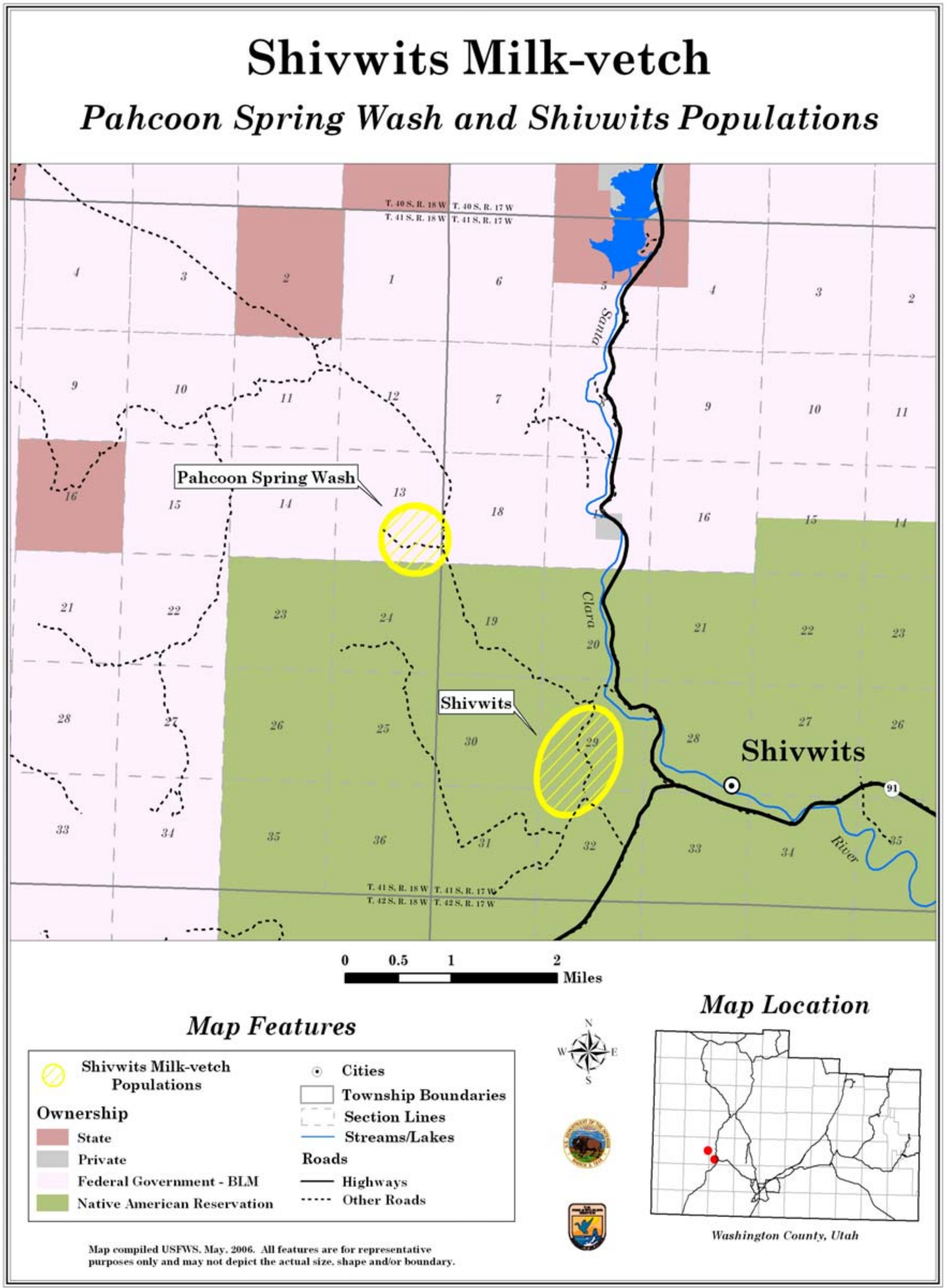
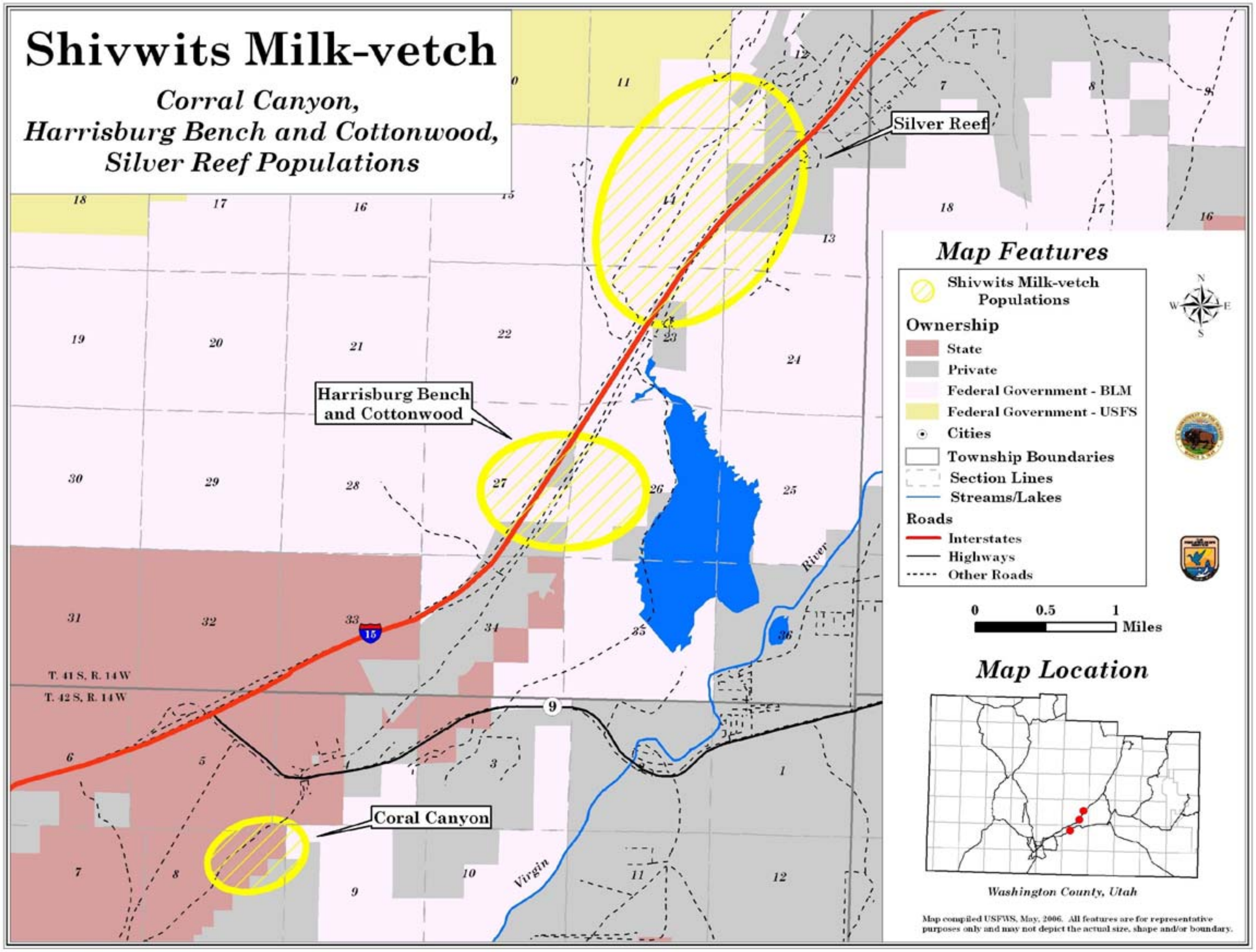


APPENDIX B.


Shivwits Milk-vetch
Pahcoon Spring Wash and Shivwits Populations
Pahcoon Spring Wash
Shivwits
Shivwits
Santa
Clara
River
T. 40 S, R. 18 W
T. 40 S, R. 17 W
T. 41 S, R. 18 W
T. 41 S, R. 17 W
T. 42 S, R. 18 W
T. 42 S, R. 17 W
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.



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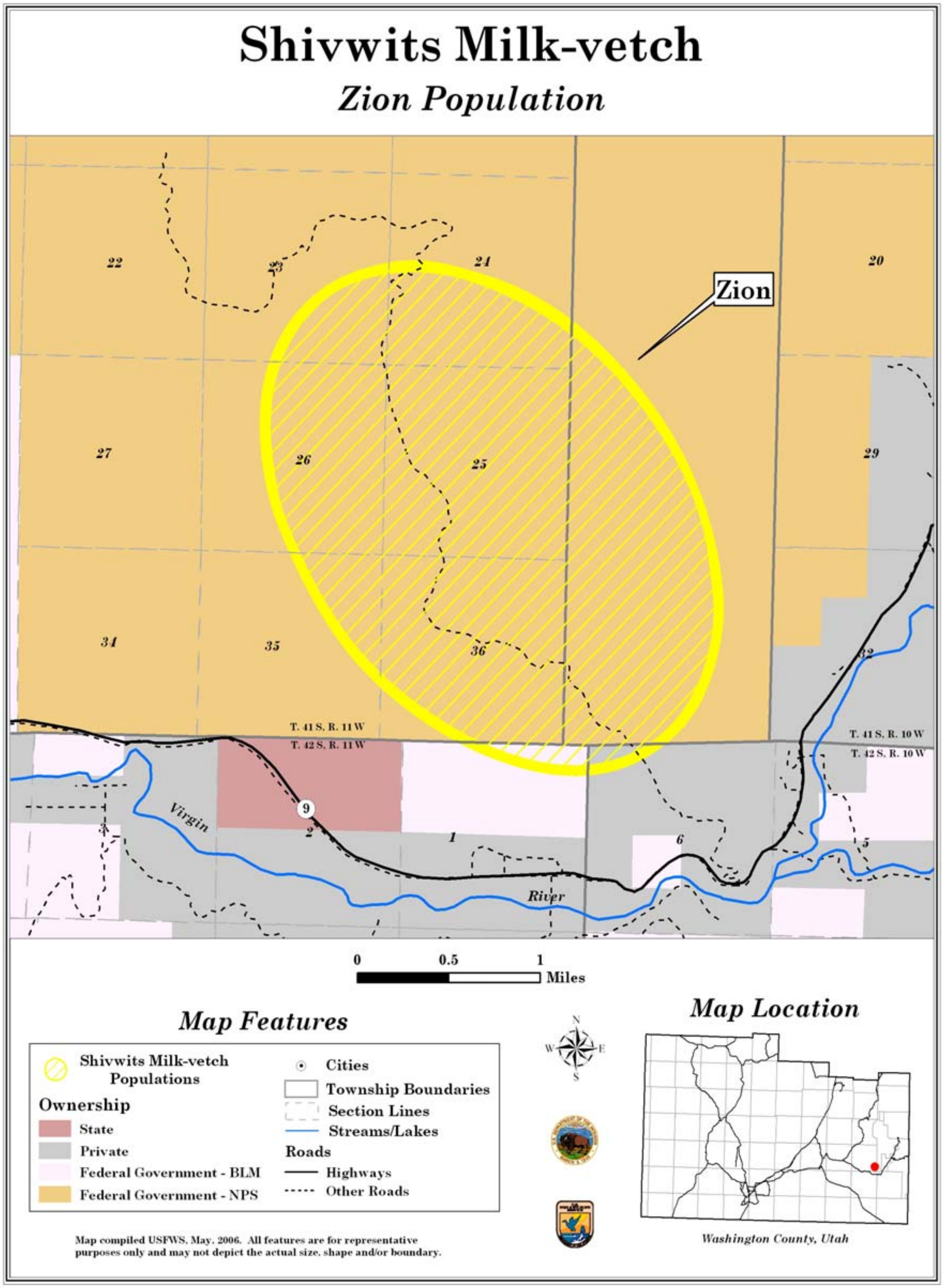
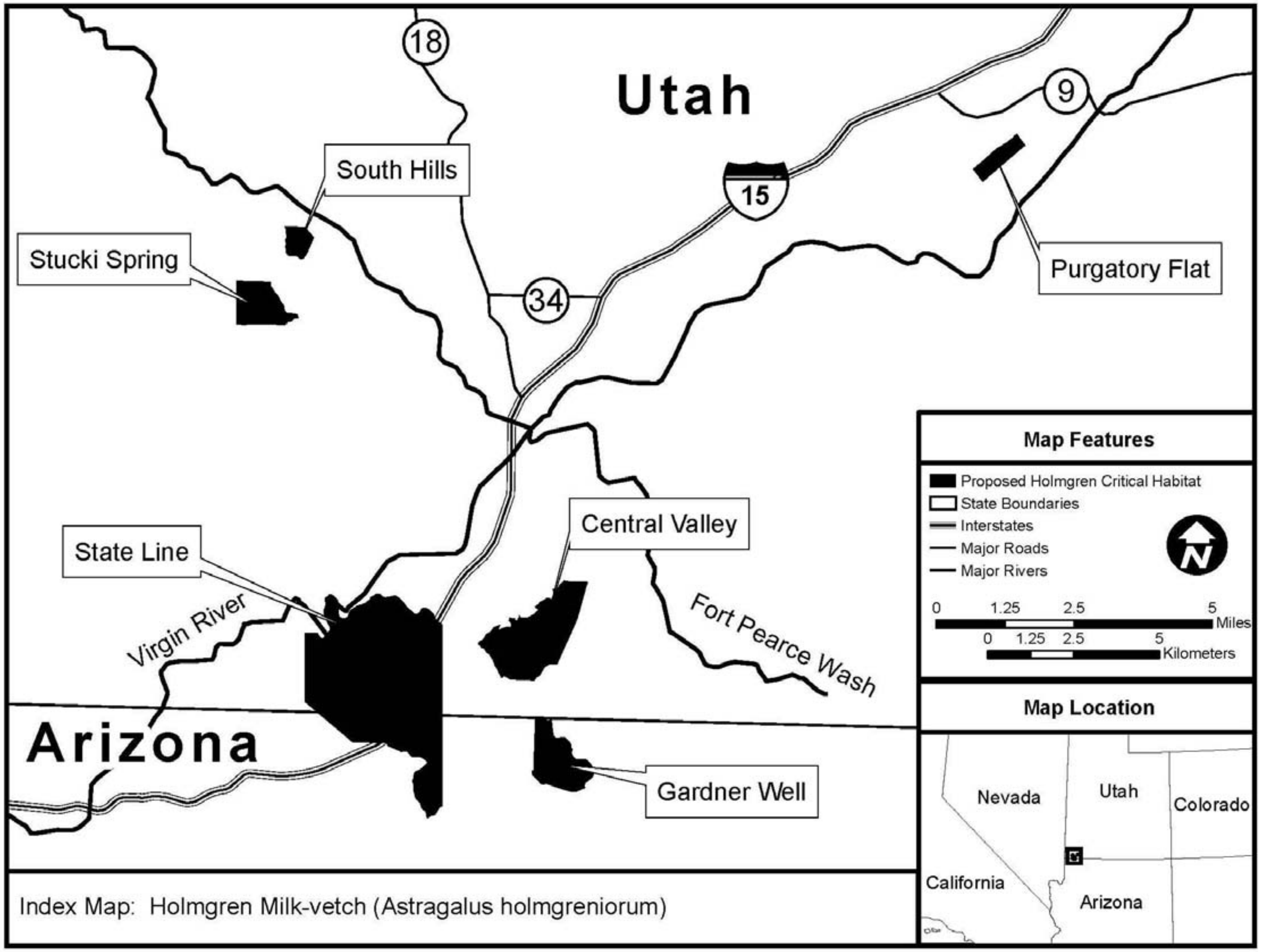
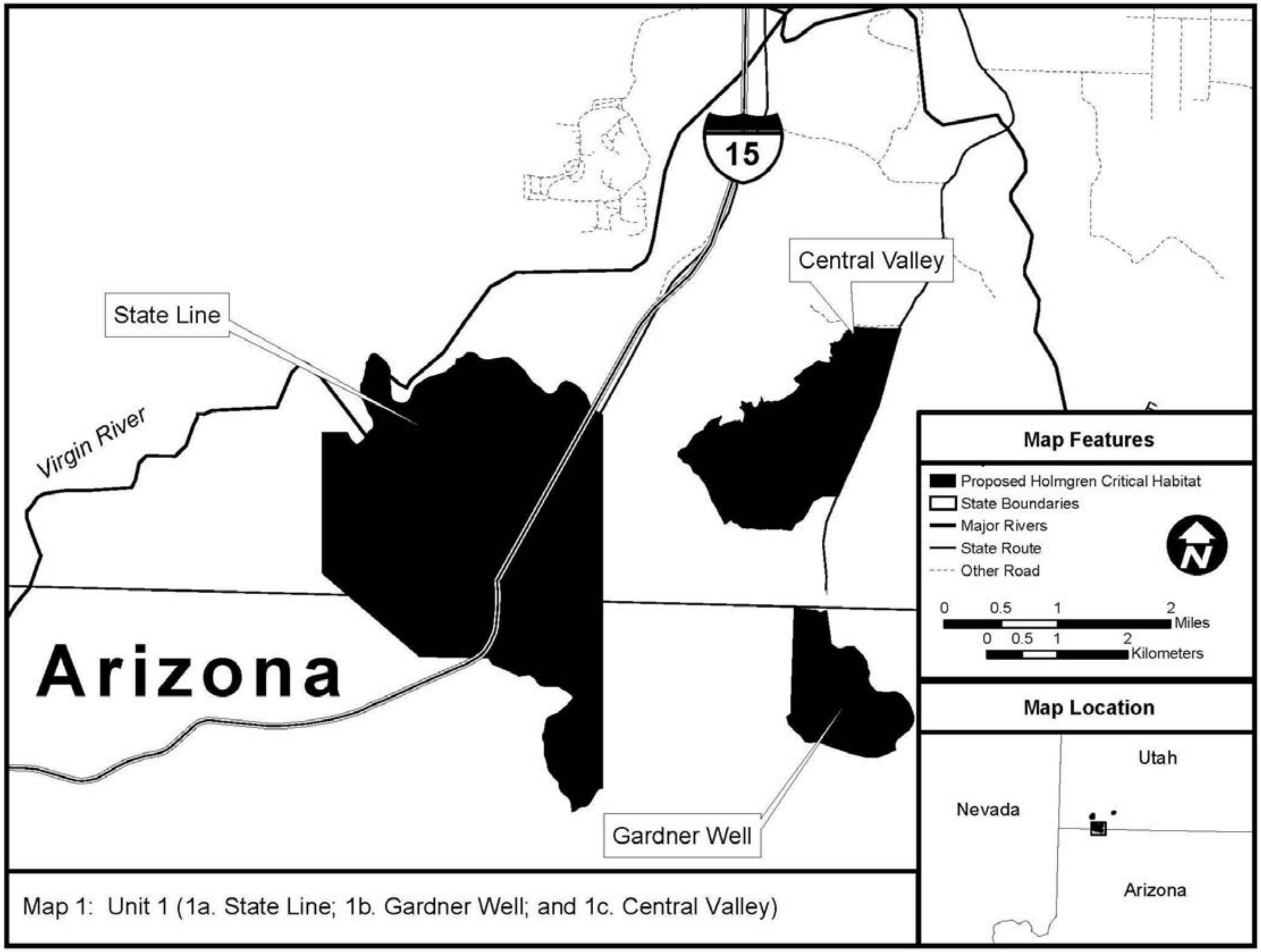


APPENDIX C.
Proposed *Astragalus holmgreniorum* Critical Habitat Index Map

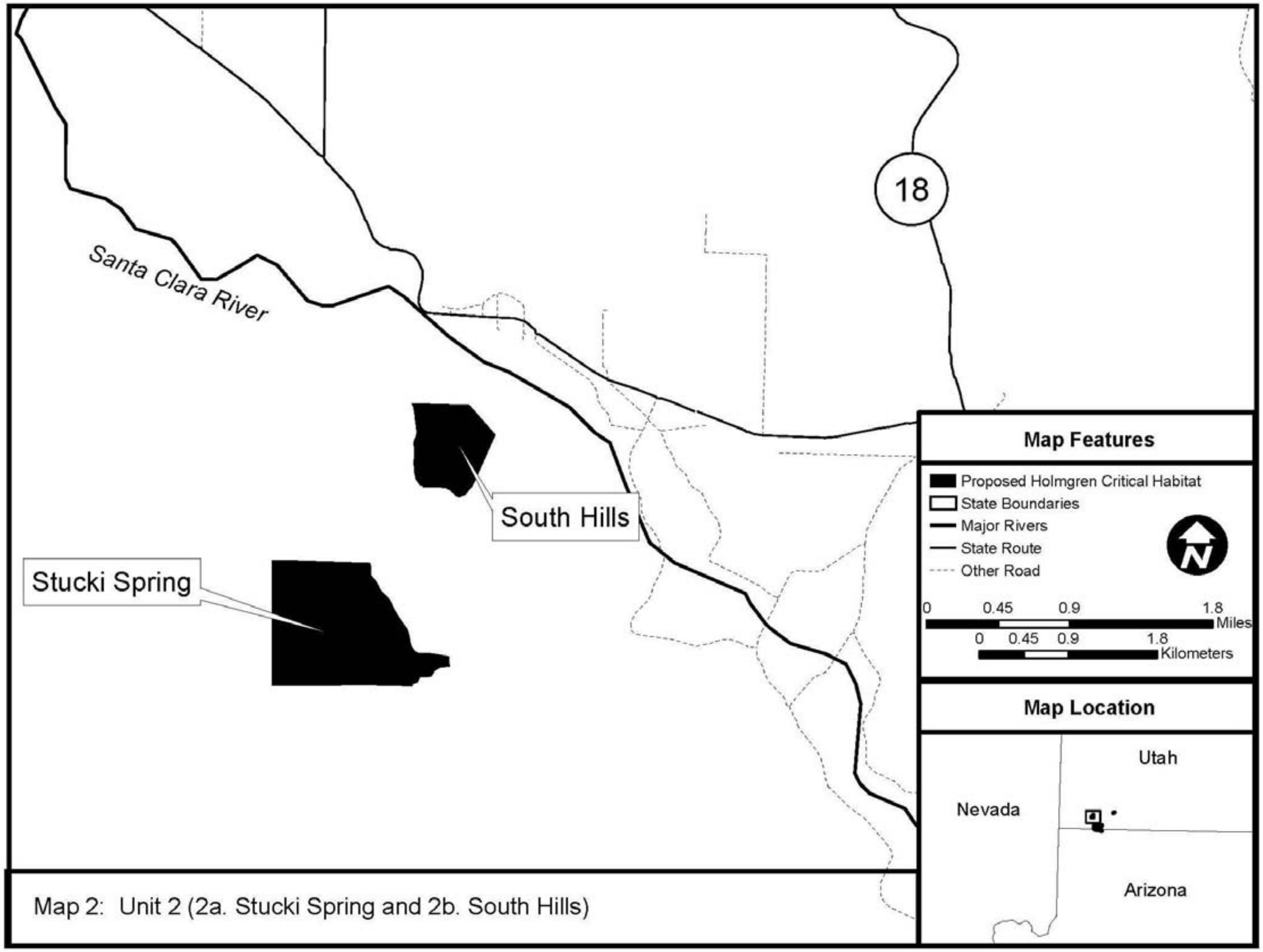


APPENDIX C cont.
Proposed *Astragalus holmgreniorum* Critical Habitat Unit 1 Map

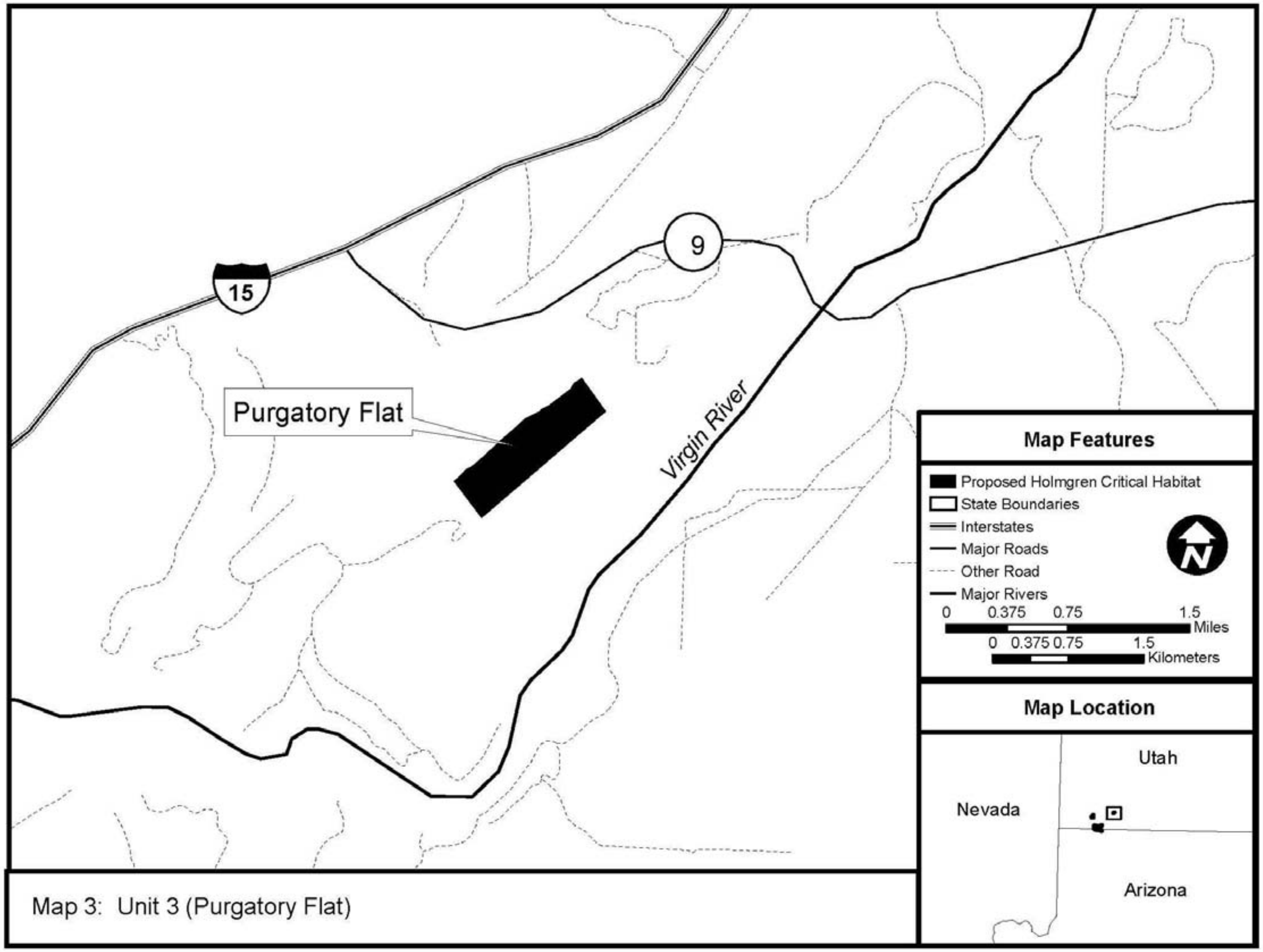


Map 1: Unit 1 (1a. State Line; 1b. Gardner Well; and 1c. Central Valley)

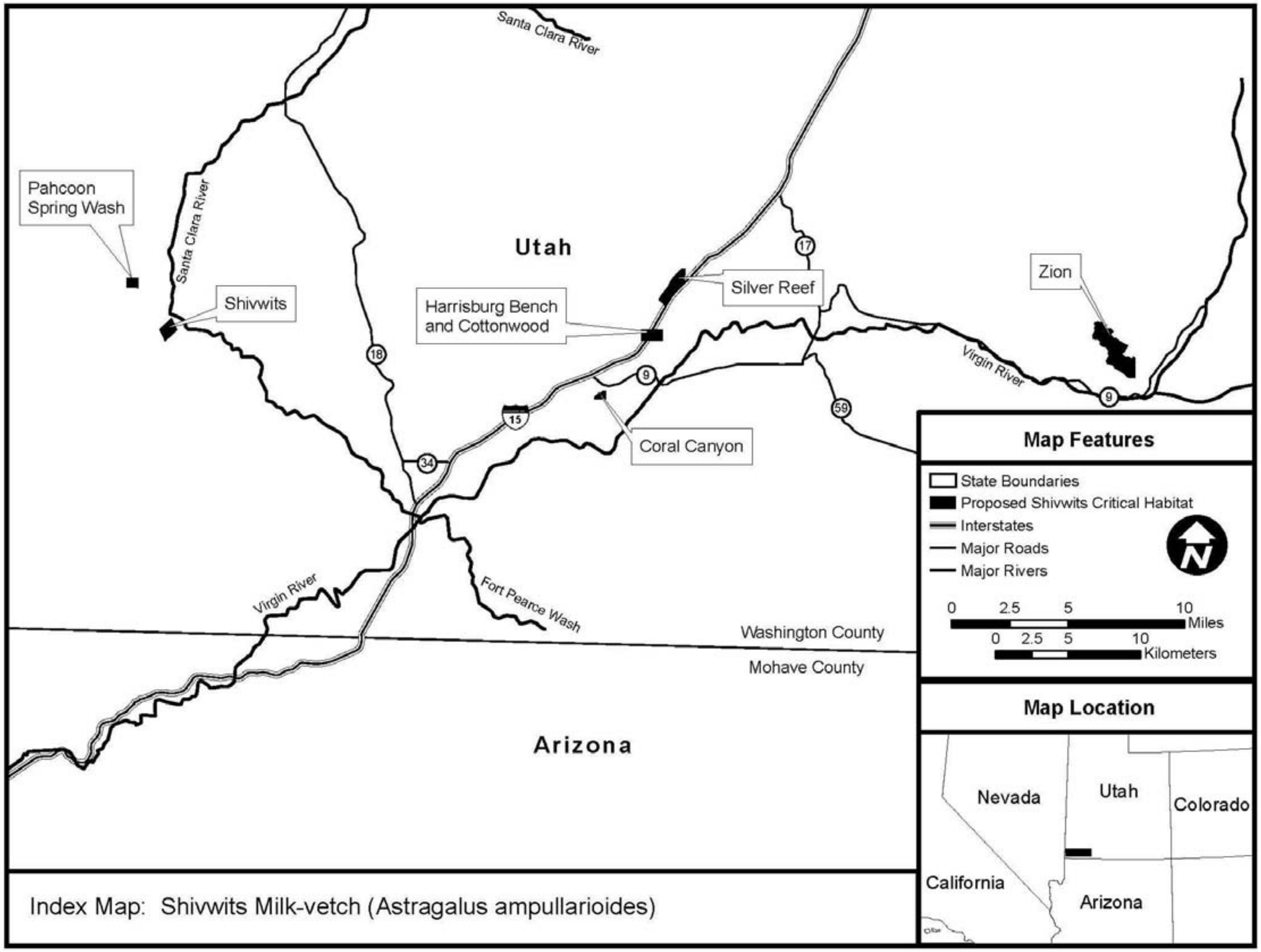
APPENDIX C cont.
Proposed *Astragalus holmgreniorum* Critical Habitat Unit 2 Map



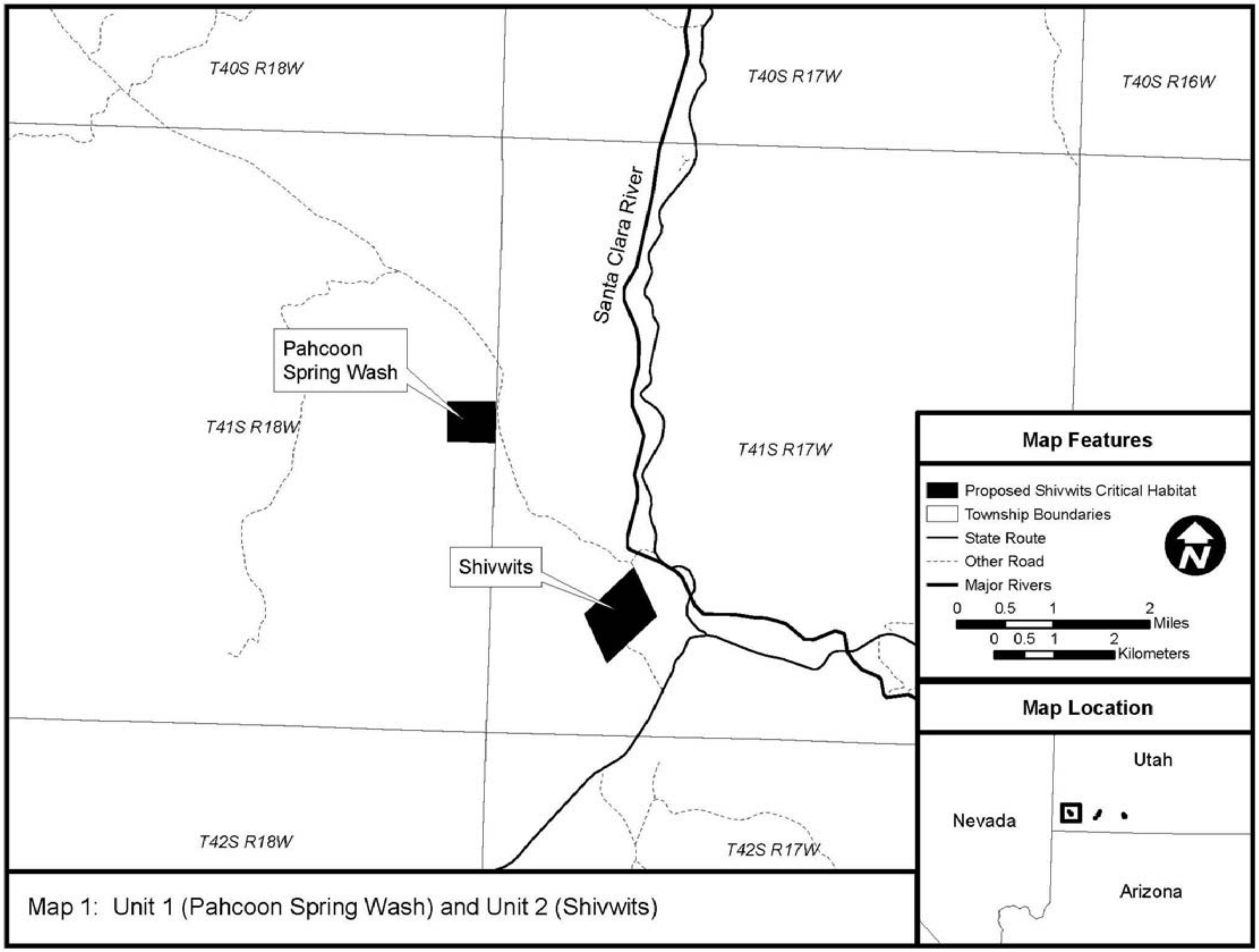
APPENDIX C cont.
Proposed *Astragalus holmgreniorum* Critical Habitat Unit 3 Map



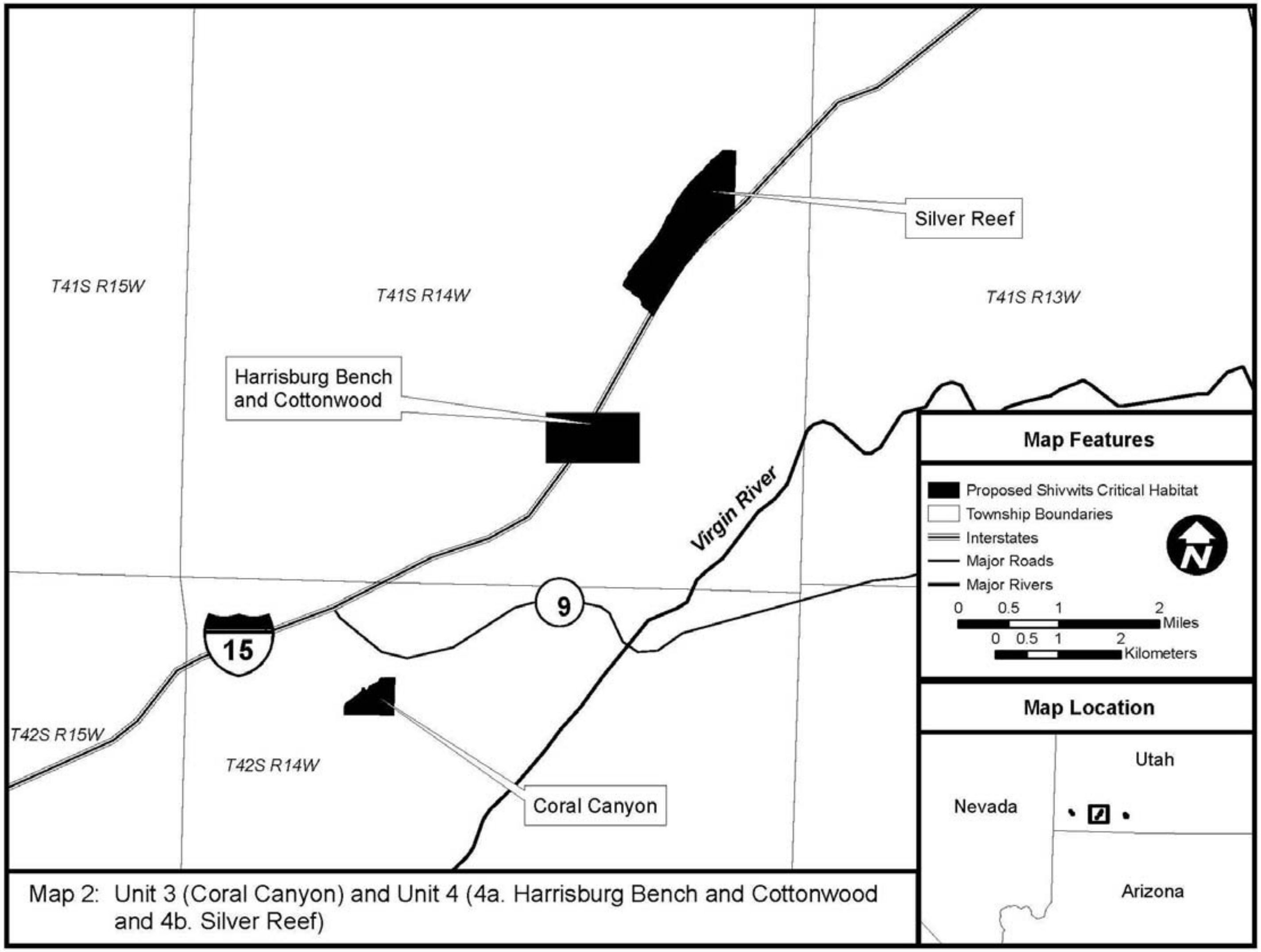
APPENDIX D
Proposed *Astragalus ampullarioides* Critical Habitat Index Map



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