Huachuca water umbel
(*Lilaeopsis schaffneriana* ssp. *recurva*)

5-Year Review:
Summary and Evaluation

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U.S. Fish and Wildlife Service
Arizona Ecological Services Tucson Sub-Office
Tucson, Arizona

August 21, 2014

5-YEAR REVIEW
Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest Region, Region 2, Albuquerque, NM
Susan Jacobsen, Chief, Division of Classification and Restoration, 505-248-6641
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1.2 Purpose of 5-Year Reviews:

The United States Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species once every five years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review:

The Service conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CRF 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act (Act) (16 U.S.C. 1531 *et seq*.). We provided notice of the status review for this taxon via the Federal Register on February 11, 2009 (74 FR 6917), requesting information on the status of *Lilaeopsis schaffneriana* ssp. *recurva* (Huachuca water umbel). No comments from the public were received. This 5-year review was completed by the lead biologist for the taxon from the Arizona Ecological Services Tucson Sub-Office. This review was conducted through a comprehensive review of all documents pertaining to *L. schaffneriana* ssp. *recurva* on file at the Arizona Ecological Services Field Office (AESFO). Interviews with individuals familiar with *L. schaffneriana* ssp. *recurva* were conducted by the AESFO, as needed, to clarify or obtain specific information. Additional sources of information included the Draft *L. schaffneriana* ssp.

recurva Recovery Plan (2011), section 7 consultations, telephone and e-mail conversation records, letters from researchers providing anecdotal field observations, unpublished field surveys and notes, monitoring reports, peer reviewed publications, reports of research projects, and various documents published by the Bureau of Land Management, the Forest Service, Fort Huachuca, Pima County, The Nature Conservancy, and their contractors. In addition, four field trips took place in November, 2013 and March, 2014, documenting the current status of 12 *L. schaffneriana* ssp. *recurva* occurrences. Representatives from the San Bernardino and Leslie Canyon National Wildlife Refuges, the Forest Service, the Bureau of Land management, and Fort Huachuca provided comments on portions of the document pertaining to their management areas and their edits were incorporated into this document.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review:

74 FR 6917, February 11, 2009

1.4.2 Listing history:

Lilaeopsis schaffneriana ssp. *recurva*, then under the name *L. recurva*, was included as a category 2 candidate in the November 28, 1983 (45 FR 82480), and September 27, 1985 (50 FR 39526), plant notices. It was included under its present name as a category 2 candidate in the February 21, 1990 (55 FR 6184). On June 3, 1993, we received a petition, dated May 31, 1993, from a coalition of conservation organizations requesting the listing of *L. schaffneriana* ssp. *recurva* as an endangered species pursuant to the Act (62FR 665, p. 669). In the September 30, 1993, candidate notice of review, the taxon was listed as a category 1 candidate (58 FR 51144) and was included as proposed endangered in the February 28, 1996 (61 FR 7596), notice.

On January 6, 1997, *L. schaffneriana* ssp. *recurva* was listed as endangered (62 FR 665); 83.2 kilometers (km)(51.7 miles (mi)) of streams or rivers in Cochise and Santa Cruz Counties, Arizona, were designated as critical habitat on July 12, 1999 (Figure 2; 64 FR37441). A draft Recovery Plan, written by contractors, was sent for review to the Service on October 28, 2011; it has not been finalized. The taxon has no legal status in Mexico.

1.4.3 Associated rulemakings: None.

1.4.4 Review History: None.

1.4.5 Species' Recovery Priority Number at start of 5-year review: 3C.

The listed entity is a subspecies, the level of threat is high, and there is a conflict with some form of economic activity (groundwater withdrawal for mining, agriculture, Fort Huachuca, municipality use, and private wells).

1.4.6 Recovery Plan or Outline: A recovery plan is not finalized at this time.

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate? No.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? No.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

Lilaeopsis schaffneriana ssp. *recurva* is a semi-aquatic to fully aquatic herbaceous perennial in the carrot family (Apiaceae). The root system is comprised of both long horizontal rhizomes and connected shorter vertical rhizomes. Hollow linear leaves that taper to a point are produced singly or in clusters at the top of short rhizomes. The leaves vary greatly in length from 2.5 to 33 centimeters (cm) (0.98 to 12.99 inches (in)) depending on their habitat, with shorter leaves typically found in dryer environments and longer when submerged in water (Coulter and Rose 1902, p. 125; Affolter 1985, p. 51; Service 2014a, p. 4). Umbels (umbrella-like flower structures) are born on stalks shorter than the leaves and contain three to ten 1.0 to 2.0 millimeters (mm) (0.04 to 0.08 in) wide perfect flowers with five white to slightly maroon tinted petals and maroon anthers (Affolter 1985, p. 51). Fruits are spherical and dry, 1.6 to 2.3 mm (0.6 to 0.09 in) long by 1.2 to 2.0 mm (0.04 to 0.08 in) broad, with five distinct spongy ribs that make the seed buoyant and easily dispersed by water (Affolter 1985, p. 57). Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren *et al*. 1991, p.15). Although we do not know the pollinator(s) of this taxon, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of *Lilaeopsis schaffneriana* ssp. *recurva* flowers along the San Pedro River in both 2012 and 2013; he believes this may be an important pollinator for the taxon. Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3). The taxon reproduces both sexually via seed and asexually through rhizomes (see section 2.3.1.1 below).

Lilaeopsis schaffneriana ssp. *recurva* is restricted to cienegas, rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content (64FR 37441, pp. 37441-37442). The taxon is generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods (62FR 665 p. 667; 64FR 37441, p. 37442). Through both rhizomes and seeds, the taxon can survive short periods without water, though is generally considered a taxon of perennial water environments. Found between 855 and 2,170 meters (m) (2,805 and 7,120 feet [ft]) in elevation, the range of the taxon crosses the Sierra Madrean Region of southeastern

Arizona and adjacent portions of Sonora, Mexico (Titus and Titus 2008c, p. 459; Vernadero Group and the Desert Botanical Garden 2012, p. 1).

Terminology
Because this taxon is clonal in nature and it is not practicable to identify individuals, the term "occurrence" is used herein to denote concentrations of this taxon within a distinct locality that are relatively distant from other concentrations and are hydrologically separated. Within these occurrences, clusters of individuals are denoted herein as "patches".

2.3.1.1 New information on the species' biology and life history:
Although the taxon is capable of reproducing both sexually, through seed, and asexually, through rhizomes, vegetative reproduction is likely the primary form of reproduction in this taxon (Vernadero Group and the Desert Botanical Garden 2012, p. i). Nevertheless, natural seed banks are important for the persistence of rare species, and observations in the field suggest *L. schaffneriana* ssp. *recurva* seed may remain viable for five to ten years, an important survival strategy during times of drought (Titus and Titus 2008a, p. 319; Titus and Titus 2008b, p. 398; Titus and Titus 2008c, p. 463). Another important survival strategy of *L. schaffneriana* ssp. *recurva* are its rhizomes, which enable occurrences to rapidly expand or contract in size between years, seasons, or both, in response to local environmental conditions, including temperature and water availability (62FR 665, p. 667; Vernadero Group 2011b, p. 3). Results from recent genetics work indicate that *L. schaffneriana* ssp. *recurva* occurrences found in near proximity to one another were typically most similar genetically, though there were some differences among occurrences and among watersheds. In two instances, geographically distant occurrences were found to be most similar to one another, with long-distance dispersal of seeds or rhizomes by birds or other vectors thought to be responsible for this connectivity.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:
Although we now are aware of many more occurrences of *L. schaffneriana* ssp. *recurva* in both the United States and in Mexico, there are no occurrences that appear to be increasing in size and many are reported from single patches among competing vegetation or in aquatic habitat that is in danger of being lost to groundwater pumping or drought. Many other occurrences have not been relocated in many years and are believed extirpated due to changes in suitability of habitat.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
Establishment of new clones either through sexual reproduction or dispersal of clumps during flooding events may be important for maintaining diversity in the taxon (Vernadero and The Desert Botanical Garden 2012, p. i). A recent genetics

study found that occurrences in close geographic proximity to one another were typically most similar genetically, although some distant occurrences exhibited similarity (Vernadero and The Desert Botanical Garden 2012, p. i). This indicates that there is either current or historical connectivity among occurrences. These results suggest that maintenance of large occurrence sizes is necessary to avoid the effects of genetic drift and that maintenance of dispersal pathways and reduction of habitat fragmentation are important to the long-term viability of this species. In addition, these findings show the need to exercise caution in introducing new occurrences.

2.3.1.4 Taxonomic classification or changes in nomenclature:
There have been no changes in classification since the taxon was listed.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):
Since the time of listing, *L. schaffneriana* ssp. *recurva* has been documented at several new sites, has been transplanted to several sites, and has disappeared from several others. We are now aware of 30 naturally occurring locations in the United States and 21 in Sonora, Mexico, that currently support or have historically supported this taxon within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds. Many of these locations were documented after the plant was listed under the Endangered Species Act and extended the known range, including the elevational range, at which this taxon was known to occur. For example, the Bingham Cienega occurrence discovered in 2001 was roughly 60 km (37.3 mi) north of, and 295 m lower in elevation than known *L. schaffneriana* ssp. *recurva* sites, and was many miles downstream of other known San Pedro River occurrences (Titus and Titus 2008c, p. 459). Furthermore, a herbarium specimen discovered at the Desert Botanical Gardens herbarium in 2002 documented a historical record of *L. schaffneriana* ssp. *recurva* near Winkelman on the lower San Pedro River (Crutchfield 1967, entire). Currently both the Bingham Cienega and Winkelman occurrences are believed extirpated.

The discovery of *L. schaffneriana* ssp. *recurva* at Ojos de Agua within the Rio Sonora drainage in 2005 illustrated the potential for this taxon to occur farther south and west into Sonora and in an, as yet, poorly explored watershed, botanically (Anderson 2006, p. 9). Likewise, the discovery of *L. schaffneriana* ssp. *recurva* in the Rio Cocospera, a tributary of Rio Magdalena/Concepción, at Rancho El Aribabi raises further questions about the known distribution of *L. schaffneriana* ssp. *recurva* in drainages west and south of Nogales, including possibly canyons that drain to the Río Magdalena in Arizona. Four localities are known in the Río Yaqui drainage of Sonora, but none farther south than Arroyo El Tigre. However, in the Yaqui drainage in Chihuahua, Rorabaugh (2013, entire) reported six *Lilaeopsis* sp. localities in the Río Papogochic and associated

drainages during 2007 surveys. A 215 km (134 mi) straight-line distance gap occurs between the Arroyo El Tigre locality and the nearest locality in the Río Papogochic region. The distance along rivers is much greater. Although *Lilaeopsis* sp. has not been found in the intervening area, it is a poorly explored area, botanically. Whether that gap is real or simply represents a lack of survey effort, and whether the Río Papogochic specimens represent *L. schaffneriana* ssp. *recurva* or *L. schaffneriana* ssp. *schaffneriana* will require future study.

In the United States (U.S.), *L. schaffneriana* ssp. *recurva* occur on lands administered by the United States Army Fort Huachuca, the Forest Service, the Bureau of Land Management, the Service, Arizona State Parks, Pima County, The Nature Conservancy, and private landowners. The majority of *L. schaffneriana* ssp. *recurva* occur along the San Pedro River, in the Huachuca Mountains, and along Cienega Creek in the San Pedro River and Santa Cruz River Watersheds. In Mexico, most *L. schaffneriana* ssp. *recurva* occur on private lands of the San Pedro River and its tributaries in the San Pedro River Watershed (Anderson 2006, entire). The current status and trends of the occurrences within the United States are summarized in Table 1 and discussed in detail in the sections below. A map indicating the general locations of all known occurrences in the United States and Sonora, Mexico can be found in Figure 1.

United States Army Fort Huachuca:
Lilaeopsis schaffneriana ssp. *recurva* occurs in four canyons on Fort Huachuca, all of which are monitored regularly by Fort Huachuca personnel and discussed individually below. Inventory, monitoring, and management of this taxon have been implemented on Fort Huachuca since 1999 (Brewer pers. comm. May 2, 2014). In addition, Fort Huachuca has conducted an inventory of all potential *L. schaffneriana* ssp. *recurva* habitat on the installation every four years. The inventory encompasses 16 marshland sites (inventory segments), originally identified during the 1999 installation-wide inventory of potential water umbel habitat, which are surveyed to determine presence, distribution, and percentage of critical habitat occupied by *L. schaffneriana* ssp. *recurva* using Service approved methodology (Vernadero Group 2010, p. iii). Inventory surveys were conducted in 1999 and subsequently in 2002, 2005, 2009 (Vernadero Group 2010, pp. iii-1), and 2013 (Brewer pers. comm. January 17, 2014). Monitoring surveys have been conducted in 2000, 2001, 2003, 2004, 2006, 2008, and 2011 (ENRD 2012, p. 1). Although occurrences were last inventoried in 2013 following a heavy monsoon season, no report was completed at the time of this review (Brewer pers. comm. January 17, 2014). The most recent monitoring report identified that the percent of transect occupied generally increased between 2008 and 2011 (the dates for which data comparison is possible). Although the percentage of occupied habitat has decreased over the years, the general distribution has been consistent since 1999 (Vernadero Group 2009, p. 2; Directorate of Public Works 2013, p. 2). Monitoring results suggest that water umbel has become either less prevalent or more difficult to detect as time passes (or perhaps some combination of the two) (Vernadero 2010).

Believed Extirpated	Believed Extant	Unknown	Location	Jurisdiction
	2 occurrences; scattered patches / mats (2013)		Garden Canyon	Fort Huachuca
1 occurrence – 2002	1 occurrence; 1 patch (2013)		Sawmill Canyon	Fort Huachuca
	1 occurrence; 1 patch (2013)		McClure Canyon	Fort Huachuca
	1 occurrence; ? patches (2013)		Huachuca Canyon	Fort Huachuca
	multiple occurrences; multiple patches (2013)		Scotia Canyon	U.S. Forest Service
	multiple occurrences; multiple patches - 2013		Sunnyside Canyon	U.S. Forest Service
	multiple occurrences; few patches /singles (2013)		Bear Canyon	U.S. Forest Service
	1 occurrence; multiple patches (2014)		Lone Mt Canyon	U.S. Forest Service
	1 occurrence; 1 large patch (2014)		Wakefield Mine springbox	U.S. Forest Service
		1 occurrence; one patch (2007; not relocated in 2014)	Parker Canyon Lake	U.S. Forest Service
1 occurrence; ? patches (2003; not relocated in 2013)			Freeman Spring	U.S. Forest Service
	1 occurrence; 1 patch (2013)		Sycamore Spring	U.S. Forest Service
	1 occurrence – multiple patches (2014)		Mud Spring	U.S. Forest Service
	multiple occurrences; multiple patches (2013)		Las Cienegas NCA	U.S. Bureau of Land Management
	multiple occurrences; multiple patches (2010)		San Pedro River	U.S. Bureau of Land Management
	1 occurrence; multiple patches		Leslie Canyon NWR	U.S. Fish and Wildlife Service
1 occurrence; ? patches (1990)			San Bernardino NWR house pond	U.S. Fish and Wildlife Service
1 occurrence; 4 patches (1991)			San Bernardino Black Draw	U.S. Fish and Wildlife Service
1 occurrence; 2 patches (2002)			Bingham Cienega	Pima County
1 occurrence; 1 patch (2001; not relocated in 2013)			Lower Cienega Creek	Pima County
		multiple occurrences; ? patches (2001; not relocated in 2013)	San Rafael Ranch SNA	Arizona State Parks
	1 occurrence; 1 patch (2008)		Sonoita Creek NA	Arizona State Parks
		multiple occurrences; ? patches (2002; not relocated in 2013)	O'Donnell Creek	The Nature Conservancy and U.S. Forest Service

		multiple occurrences; ? patches (1989; not relocated in 2013)	Turkey Creek	Private
		3 occurrences; multiple patches (2002; not relocated in 2014)	Joaquin Canyon	Private and U.S. Forest Service
	2 occurrences; multiple patches (2013)		Upper Sonoita Creek	Private
		1 occurrence; ? patches (1977)	Monkey Spring	Private
	2 occurrences – 8 patches (2006); 1 patch (2013)		Babocomari River	Private
1 occurrence; ? patches (1967; not relocated in ~2002)			Winkelman	Private
1 occurrence; ? patches (1881)			Tucson	Private
		unknown (2007)	Arroyo el Tigre	Private; Sonora, Mexico
		numerous patches (2006)	Arroyo los Fresnos	Private; Sonora, Mexico
		abundant (2006)	cienega near the Casa Grande	Private; Sonora, Mexico
		1occurrence; sparse small patches (2006)	Las Nutrias	Private; Sonora, Mexico
		1 occurrence; small patches (2006)	Las Pamitas	Private; Sonora, Mexico
		1occurrence;1 very small patch (2006)	Ojo de Aqua	Private; Sonora, Mexico
		occurs sparingly along 6 km (3.7 mi) of river (2014)	Rancho el Aribabi along the Rio Cocospera	Private; Sonora, Mexico
		1occurrence;1 small patch (2006)	Arroyo los Alisos	Private; Sonora, Mexico
		uncommon (2006)	Cienega Los Fresnos	Private; Sonora, Mexico
		1occurrence;1 small patch (2006)	La Cieneguita	Private; Sonora, Mexico
		1occurrence;1 small patch (2006)	Portrero del Alamo	Private; Sonora, Mexico
		1occurrence; frequent patches (2006)	Rio Casa Blanca	Private; Sonora, Mexico
		1 occurrence; patchy (2006)	Rio San Pedro	Private; Sonora, Mexico
		1 occurrence; scattered plants (2006)	Rio San Rafael	Private; Sonora, Mexico
		1occurrence; dense patches (2006)	Villa Verde	Private; Sonora, Mexico
		uniknown (1990)	Arroyo el Tapiro	Private; Sonora, Mexico
		uniknown (1990)	La Cienega la Atascosa	Private; Sonora, Mexico

		unknown (1990)	La Sauceda	Private; Sonora, Mexico
		numerous plants (1994)	Mababi Spring	Private; Sonora, Mexico
1 occurrence; 2 small patches (1988)			Rio San Bernardino	Private; Sonora, Mexico
		unknown (2005)	Santa Cruz River south of the town of Santa Cruz	Private; Sonora, Mexico

Table 1. Status of *Lilaeopsis schaffneriana* ssp. *recurva* occurrences and patches from locations in the United States and Sonora, Mexico, along with the year they were last seen. Observations from Mexico were primarily from one-time surveys; the current status of *L. schaffneriana* ssp. *recurva* at these locations is unknown.

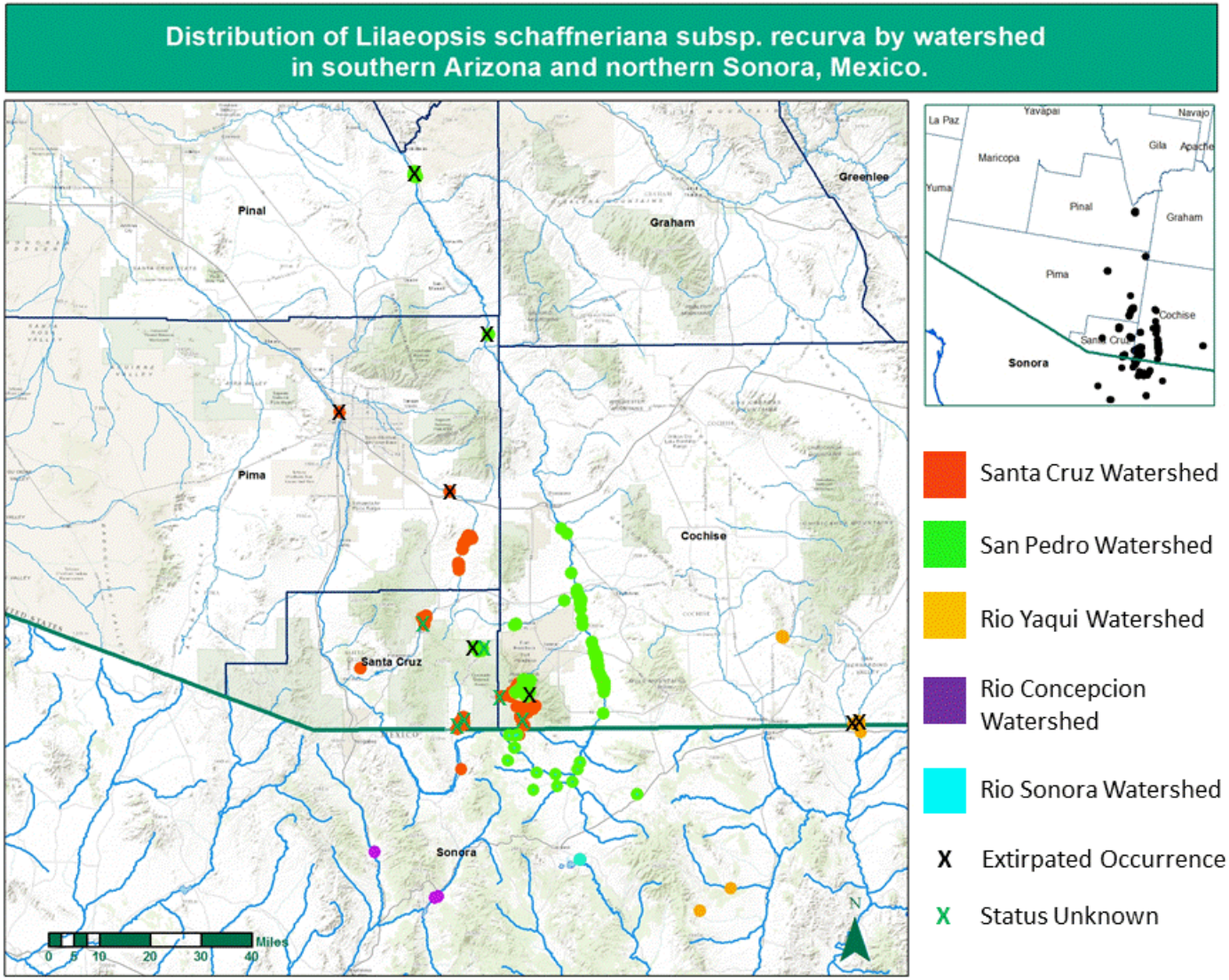

Figure 1. General locations of current and historical *Lilaeopsis schaffneriana* ssp. *recurva* occurrences in Arizona and Sonora, Mexico as of August, 2014.

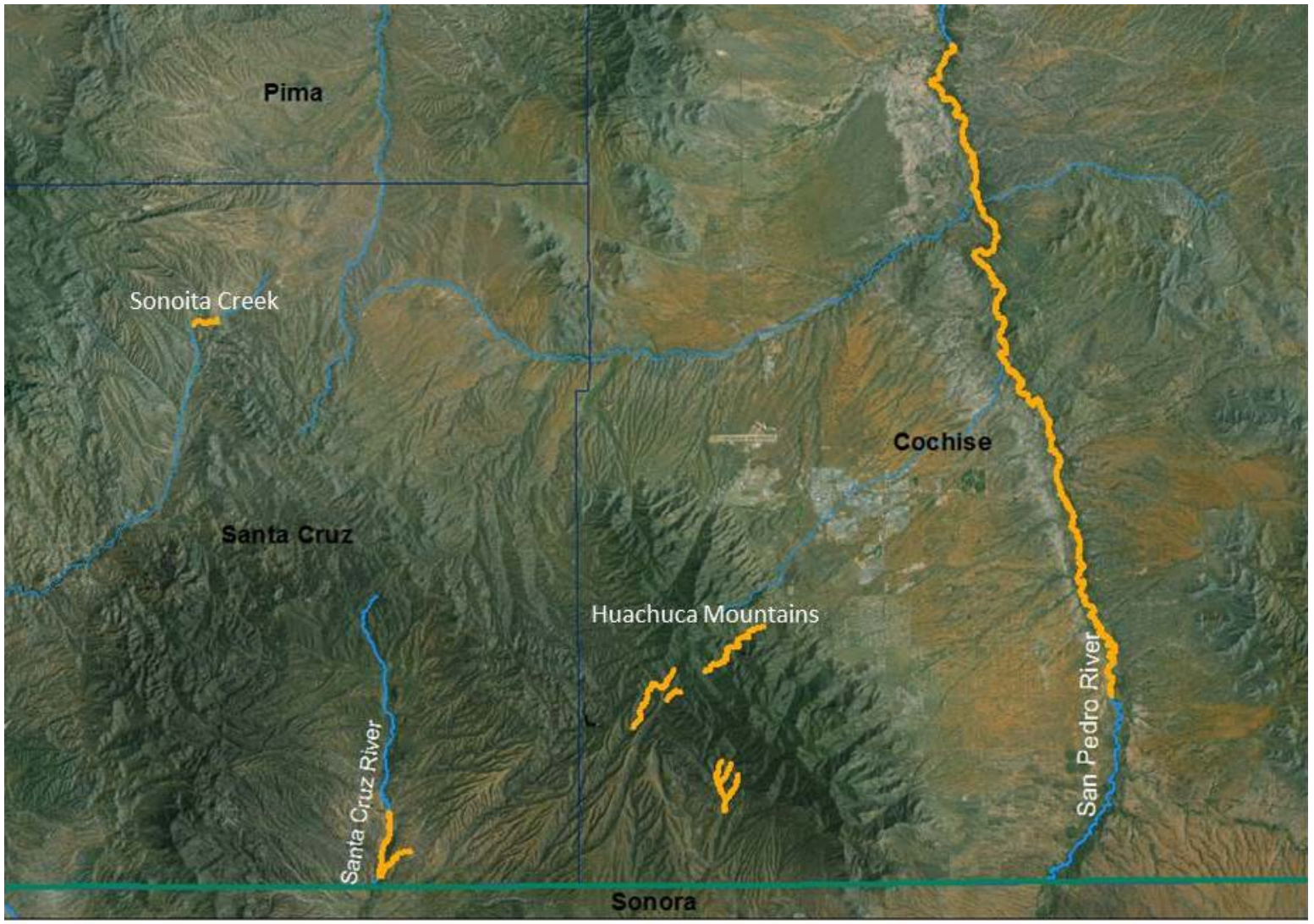

Figure 2. Orange depicts general locations of designated *Lilaeopsis schaffneriana* ssp. *recurva* critical habitat in Arizona.

Garden Canyon – *Lilaeopsis schaffneriana* ssp. *recurva* was first noted in Garden Canyon in 1958 (Gooding 1958, entire). Warren et al. (1991, p. 19) noted two separate occurrences in this canyon; one having widely scattered patches, the other, thick mats. Multiple patches of *L. schaffneriana* ssp. *recurva*, primarily located between upper Garden Canyon pond and the upper Garden Canyon picnic area, are monitored regularly (e.g. EEC 2001, entire; EEC 2002, entire; ENRD 2005, entire; Vernadero Group 2009, entire; Vernadero Group 2010, entire; Directorate of Public Works 2013, entire). Areas below middle Garden Canyon Picnic area do not contain suitable habitat for *L. schaffneriana* ssp. *recurva* (Vernadero Group 2010, p. 10). Much of the Canyon contains high cover of bunchgrasses and marshland species, including the invasive exotic *Nasturtium officinale* (watercress), making detection difficult and some historical occurrences have not been relocated in recent years (Vernadero Group 2009, p. 10). This canyon supports the greatest extent of *L. schaffneriana* ssp. *recurva* on Fort Huachuca (ENRD 2012, p. 8). In July 2014, a monsoon-related flood within Garden Canyon removed 2 of 14 monitored patches of *L. schaffneriana* ssp. *recurva* along with nearby competing vegetation (Brewer pers. comm. July 17, 2014).

Sawmill Canyon – A single occurrence of *L. schaffneriana* ssp. *recurva* was documented in this tributary of Garden Canyon in 1979 (Yatskievych 1979, entire). In 1991, Warren et al. (p. 19) reported this occurrence contained five small patches. In 2000, the staff at Fort Huachuca set up a permanent monitoring transect in the Sawmill Canyon *L. schaffneriana* ssp. *recurva* occurrence. In 2004, EEC (p. 4) reported Sawmill Canyon supports a Madrean montane marshland dominated by deergrass. In 2009, this occurrence was reported to have a patch size of 4.15 by 2.7 m (13.6 by 8.9 ft) (Vernadero Group 2009, p. 6). As of the 2013 surveys, this occurrence was 4.62 by 1.24 m (15.2 by 4.1 ft) (Directorate of Public Works 2013, p. 2; Brewer pers. comm. May 2, 2014). A second occurrence was detected in 2002, but has not been detected since (EEC 2004, p. 9; ENRD 2006, p. 3; Vernadero Group 2009, p. 13).

McClure Canyon – A single occurrence containing a single patch of *L. schaffneriana* ssp. *recurva* 3.62 by 2.76 m (11.9 by 9.1 ft) across was documented in McClure Canyon in 1997 (Vernadero Group 2009, p. 3). The patch has been documented in subsequent years of survey, including 2013 (Vernadero Group 2009, p. 9; Directorate of Public Works 2013, p. 2). This occurrence is near McClure Spring in a small pool surrounded by *Muhlenbergia rigens* (deergrass - a native, warm-season, perennial bunchgrass, and a possible competitor), *Carex ultra* (Cochise sedge), and *Eleocharis* sp. (spikerush) (Vernadero Group 2009 p. 2). The exact location of the *L. schaffneriana* ssp. *recurva* patch has shifted downslope; the previous site now is filled with sediment (Vernadero Group 2010, p 12).

Huachuca Canyon – A single occurrence of *L. schaffneriana* ssp. *recurva* that likely dispersed from transplanted plugs (small containerized plants with roots

encased in potting soil) was documented in Huachuca Canyon in 2013 (see Introduced and Augmented Populations section below; Directorate of Public Works 2013, p. 2).

United States Forest Service:
Lilaeopsis schaffneriana ssp. *recurva* occurring on Forest Service lands are monitored periodically by Forest Service personnel. The last monitoring in Scotia, Sunnyside, and Bear Canyons occurred in the fall of 2013; no report was completed at the time of this review (Kraft pers. comm. November 22, 2013). While some Forest Service occurrences seem to be stable, others are in decline or are now considered extirpated.

Scotia Canyon – *Lilaeopsis schaffneriana* ssp. *recurva* was first noted in Scotia Canyon in 1988 where it was documented from an upper and lower portion of the canyon, separated by a dry middle section (Gori et al. 1990). Monitoring of permanent transects began in 1989 along the upper section (Gori et al. 1990); in 1995, the Forest Service began monitoring plants in both the upper and lower sections and this continued in 2013. In 2003, *L. schaffneriana* ssp. *recurva* was found throughout reach 2 of this canyon where there were reported marshy areas and shallow pools, though the banks were lined with *M. rigens* (Stefferud and Stefferud 2004, p. 511). Significant flows from the 2013 monsoon season scoured this canyon and because of this, larger patches of *L. schaffneriana* ssp. *recurva* were not as prevalent in the lower canyon portion as in previous years of survey; the flood also removed competing vegetation (Kraft pers. comm. February 26, 2014). Patches were found at roughly the same frequency in 2013 as in past surveys (Kraft pers. comm. November 22, 2013). In late August, 2014, severe monsoon flooding again caused scouring within Scotia Canyon. At the time of writing, the impact to the patches of *L. schaffneriana* ssp. *recurva* in Scotia Canyon is unknown. Plants in this canyon have historically represented some of the densest occurrences of *L. schaffneriana* ssp. *recurva* known (Service 2001, p. 7; Falk 1998, p. 1).

Sunnyside Canyon – *Lilaeopsis schaffneriana* ssp. *recurva* was first noted in Sunnyside Canyon in 1991 (McLaughlin 1991, entire); the plants were surveyed in 2000, followed by every other year through 2007, then again in 2013 (Service 2001, p. 2; Deecken pers. comm. September 7, 2013). In 2013, significant flows from the monsoon season scoured this canyon, although larger patches of *L. schaffneriana* ssp. *recurva* were found, the overall extent of *L. schaffneriana* ssp. *recurva* in this canyon is believed to have contracted from previous years (Kraft pers. comm. November 22, 2013). In late August 2014, severe monsoon flooding again caused scouring within Sunnyside Canyon. At the time of writing, the impact to the patches of *L. schaffneriana* ssp. *recurva* in Sunnyside Canyon is unknown. In 2003, the Stefferuds reported competition from *M. rigens* was moderately high (Stefferud and Stefferud 2004, p. 542); in 2013, it was said to be high in a few places (Kraft pers. comm. November 22, 2013).

Bear Canyon – *Lilaeopsis schaffneriana* ssp. *recurva* was first collected in Bear Canyon in 1949 (Gooding 1949, entire). In 1989, Warren et al. (p. 60) noted that *L. schaffneriana* ssp. *recurva* occurred in two small patches within Bear Creek and was not doing as well as in its tributary canyons that contained less rocky habitat with a lower stream gradient. In 2013, *L. schaffneriana* ssp. *recurva* was found in Bear Canyon where there was substrate for rooting, both as a few large patches and as singular plants in several instances (Kraft pers. comm. November 22, 2013). In 2013, *M. rigens* competition was high in portions of the canyon (Kraft pers. comm. November 22, 2013).

Lone Mountain Canyon – A single *L. schaffneriana* ssp. *recurva* occurrence of medium to high density was reported at the confluence of Lone Mountain Canyon and Bear Creek in 1988, 1990, and 1997 (Gori et al. 1990, p. 65; Warren et al. 1989, p. 60). The winter of 1999 was very dry; heavy use by congregating cattle on *L. schaffneriana* ssp. *recurva* habitat in Lone Mountain Canyon and associated tributaries was observed (Service 2002b, p. 146). This same year, the Forest Service proposed the creation of a livestock exclosure fence encompassing 2.8 hectares (ha) (7 acres [ac]) of canyon bottom near the confluence with Bear Canyon to protect the plants (Service 1999, p. 240). The Forest Service also decided that winter grazing outside of the exclosure in this canyon would be permitted only when sufficient water was available to promote cattle dispersal (Service 1999, p. 240).

The timing of when the Lone Mountain Canyon exclosure was erected is not known by this author, however a 2003 Grazing Authorization and Allotment Management Plan for the Lone Mountain Allotment indicates an exclosure *would be* established on behalf of *L. schaffneriana* ssp. *recurva* in Lone Mountain Canyon at the confluence with Bear Canyon (USFS 2003, p. 5). In 2004, Stefferud and Stefferud (p. 335) reported the exclosure fencing around the *L. schaffneriana* ssp. *recurva* in the wetted area of Lone Mountain Canyon near the confluence with Bear Creek was torn down and extensive cattle grazing occurred. They reported many areas that were completely denuded of vegetation and littered with fecal material; green plants in the riparian area were mostly grazed to the root crown or trampled (Stefferud and Stefferud 2004, p. 335).

In 2014, areas both inside and outside of the (intact) exclosure were visited and *L. schaffneriana* ssp. *recurva* was found in both locations. Inside the exclosure, it occurred in multiple small patches in slow-moving shallow water along a narrow waterway and growing among moss and other aquatic and semi-aquatic wetland vegetation (Service 2014a, p. 5). Approximately 250 m (829 ft) upstream and outside of the exclosure, approximately 10 small patches of *L. schaffneriana* ssp. *recurva* were found growing among the river cobble in an area containing other aquatic habitat indicators, but which was drying out and had no water or wet soil present. Approximately 10 m (33 ft) further upstream from this location, four additional patches were located growing on the slumping edges of a heavily utilized water-filled mud hole (Service 2014a, p. 6). These plants were small in

stature and the patches very sparse, occurring within the hoof-prints of cattle and adjacent cow pies and slumping stream banks (Service 2014a, p. 6). In July, 2014, this site was revisited following monsoon-related flooding. The mud hole had been filled with sediment and no *L. schaffneriana* ssp. *recurva* were discovered, though it is possible they could grow through the sediment (Kraft pers. comm. July 30, 2014).

Wakefield Mine springbox – An occurrence was discovered by US Forest Service personnel in 2008 at the springbox of the Wakefield Mine and was revisited in 2014 (Kraft, pers. comm. July 30, 2014). The springbox overflows creates two shallow pools and a perennial "stream" approximately 50 m (164 ft) in length. In 2014, *L. schaffneriana* ssp. *recurva* occurred in the pools and along the "stream" in one large patch.

Parker Canyon Lake – First collected in 1968, this occurrence was not visited again until 2007 when some small plants were noted near the inlet channel with Merrit Canyon along the lake margin (AZGF Heritage 2011, entire; Rorabaugh 2013, p. 1). In March of 2014, researchers combed the inlet channels of both Merrit Canyon and Collins Canyon (Service 2014a, pp. 1-2). Although no *L. schaffneriana* ssp. *recurva* was detected at this time, other aquatic habitat indicators were found among the thick thatch of dried aquatic vegetation. Because the winter of 2013-2014 was particularly warm and dry and the lake level was down, it is probable *L. schaffneriana* ssp. *recurva* still occurs at the Merrit Canyon inlet, and possibly the Collins Canyon inlet as well. Further searches should be conducted in a wet year.

Freeman Spring – In September 1998, *L. schaffneriana* ssp. *recurva* was discovered at Freeman Spring (Service 1999, p. 241). In October 1998, the site was reported to be severely overgrazed, with utilization over 70% and the spring site trampled with little vegetative growth on the banks; the site was fenced from cattle in 1998 (Service 1999, p. 242). In 1999, the *L. schaffneriana* ssp. *recurva* occurrence at Freeman Spring was thought to be small and the habitat reported to be primarily exposed bedrock with a lack of soil, not capable of supporting a large stable occurrence of *L. schaffneriana* ssp. *recurva* (64FR37441, 1999 p. 34777; Lefevre 1999, entire). This occurrence was deemed important, though not essential to the conservation of the taxon (64FR 37441, p. 34777).

In 2004, Stefferud and Stefferud noted Freeman Spring was a seep with *L. schaffneriana* ssp. *recurva* present. They noted the reach likely once had cienega attributes before erosional downcutting of the channel (Stefferud and Stefferud 2004, p. 249). In 2007, Ehret et al. (2007, p. 1) noted the presence of cienega habitat from Freeman Spring downstream for approximately 48 m (157 ft). In 2008, Freeman Spring was reported to be completely dry due to the drought (Ehret 2008, p. 1). Although these biologists were focused on quantifying fish habitat, they did note vegetation in their reports and no *L. schaffneriana* ssp. *recurva* were mentioned in either 2007 or 2008. In 2010, personnel from the

National Audubon Society's Appleton-Whittell Ranch communicated that Freeman Springs tends to dry every year during the early summer (Robinson 2010, p 6). A December site visit in 2013 revealed a single small pool at Freeman Springs with no *L. schaffneriana* ssp. *recurva* present and no potential habitat available (Service 2013a, p. 4; see Threats section below).

Sycamore and Mud Springs – In 1993, a herbarium specimen was collected from the outlet of Sycamore Spring; associates included *Muhlenbergia* sp. and *Juncus* sp., but no *Cynodon dactylon* (Bermudagrass), a non-native, invasive species, was listed (Fishbein 1993, entire). No specimens have been collected from Mud Spring. In 1999, the *L. schaffneriana* ssp. *recurva* occurrences at Sycamore and Mud Springs were thought to be small and the habitat not capable of supporting a large stable occurrence (64FR 37441, 1999 p. 34777). These occurrences were deemed important, though not essential to the conservation of the taxon (64FR 37441, p. 34777). In 2003, reach 2 of Sycamore Canyon, containing Sycamore Spring, supported *L. schaffneriana* ssp. *recurva* along with *C. dactylon*, *M. rigens*, *Carex* spp. and other riparian vegetation that was badly damaged, hedged, and cropped by past and present livestock grazing (Stefferud and Stefferud 2004, p. 557). This same survey found the exclosure fence around Mud Spring that was intended to protect *L. schaffneriana* ssp. *recurva* was in disrepair (Stefferud and Stefferud 2004, p. 558). At Mud Spring, cattle heavily impacted the area, and the only riparian plants found were grasses, *Eleocharis* sp. and *Carex* spp. (Stefferud and Stefferud 2004, p. 558).

L. schaffneriana ssp. *recurva* has been seen regularly in visits by the Forest Service to Sycamore Spring (Kraft pers. comm. February 26, 2014). The area is noted to have had intensive grazing in the past, but this has improved in recent years (Kraft pers. comm. February 26, 2014). In 2014, a survey of Mud Spring revealed many patches of *L. schaffneriana* ssp. *recurva* occurring outside and inside of an erect bullfrog fence. Patches outside the exclosure occurred in two separate spring runs, one of which was heavily impacted by livestock trampling (Service 2014a, p. 3). These patches were small in stature and sparse, but appeared healthy otherwise. Patches within the exclosure on the south and southeast edges of the spring pool were small and sparse, growing among thick *C. dactylon* (Service 2014a, p. 4). Patches on the north and northwest edges of the spring pool and within the water there were dense, over 30 cm tall (11.8 in), and healthy with little competition from other vascular plants (Service 2014a, p. 3).

O'Donnell Canyon – see The Nature Conservancy below.

Joaquin Canyon – In July 2001, Deecken (2002, entire) surveyed Joaquin Canyon as part of the Lone Mountain Land Exchange. He noted that no *L. schaffneriana* ssp. *recurva* were observed in the portion of the canyon north of FS61, however he did find two new occurrences, each containing several patches, in an area to the south of FS61 and east of FS196 (Deecken 2002, p. 2). These occurrences are north of the Cave Canyon confluence occurrence now in private ownership (see

Private –Joaquin Canyon section below). The site was described as intermittent riparian stream bottom with a few perennial small pools with less than ten percent canopy cover of riparian trees. Tom Deecken recalls these plants were mostly in areas where water was quite shallow and were most susceptible to drought conditions (Deecken pers. comm. February 2014a, b). In 2003, this area was described as having surface water in wide shallow glides, pools, and marshy areas, with sparse vegetation that was severely hedged by livestock; no *L. schaffneriana* ssp. *recurva* was noted at that time (Stefferud and Stefferud 2004, p. 293). In 2014, this site was revisited and two locations containing species of aquatic habitats were located (Service 2014a, pp. 2-3). A single puddle of water approximately 10 cm (4 in) across was found, but no *L. schaffneriana* ssp. *recurva* was detected (Service 2014a, pp. 2-3). The winter of 2013-2014 was very warm and dry; it is likely *L. schaffneriana* ssp. *recurva* still occurs at these locations within Joaquin Canyon and a survey in a wetter year should be conducted.

United States Bureau of Land Management:
Lilaeopsis schaffneriana ssp. *recurva* occurring on Bureau of Land Management lands are monitored regularly by Bureau personnel. Both the Las Cienegas National Conservation Area and the San Pedro River represent two of the densest occurrences of *L. schaffneriana* ssp. *recurva* known.

Las Cienegas National Conservation Area – There are multiple occurrences of *L. schaffneriana* ssp. *recurva* from Empire Gulch, Gardner Canyon, Mattie Canyon, and Narrows Powerlines Road areas in Cienega Creek that have been detected as early as 1991, though these were not considered in the critical habitat designation of 1999 (Figures 1 and 2; Rebman 1991, entire; Warren pers. comm. April 4, 1996; 64FR 37441, entire). In addition, there is one occurrence nearby the Narrows in Fresno Canyon on State Land. All of these occurrences are monitored regularly by personnel of the Bureau of Land Management and were last measured in full in 2011 when approximately 100 patches were detected over a 12.9 km (8 mi) section of creek (Bureau of Land Management 2011, entire). In 2014, a partial survey was conducted with similar results, though the area was reported to be drier than in the past (Radke pers. comm. June 16, 2014). This area may be impacted in the future through groundwater draw-down from the proposed Rosemont Mine adjacent Cienega Creek on the west (see Threats section below).

San Pedro River – In 1878, the St. David area of the San Pedro River was described as marshy, though an earthquake in 1887 dried some marshy areas and created new springs (Geraghty and Miller 1995, p. 9). Severe flooding began as early as 1881 and by 1908, the San Pedro River channel was entrenched up to 10 m (33 ft) below the former floodplain; river channel expansion decreased after 1955 (Hereford 1993, p. iv). From 1957 to 1967, daily rainfall was above average, improving conditions for growth and establishment of vegetation (Hereford 1993, p. iv). Despite this, the two occurrences at Zinn Pond in the St.

David along the San Pedro River that were first detected in 1951 were last seen in 1953 and are believed extirpated (Gooding 1951, entire; Warren and Reichenbacher 1991, p. 18; Johnson et al. 1992, p. 6; 64FR 37441, p. 37443).

There are multiple occurrences of *L. schaffneriana* ssp. *recurva* for roughly 55 km (34 mi) along the San Pedro River near Sierra Vista in the San Pedro Riparian National Conservation Area. Personnel of Fort Huachuca monitor these occurrences. They were last measured in 2010, when it was noted that most occurrences were sparsely populated, that competitive exotic plants threatened *L. schaffneriana* ssp. *recurva*, and that erosion was noticeable between the dry 2009 and wetter 2010 (Vernadero Group 2011a, pp. 11, 21, 22). They also noted that the greatest quantity of *L. schaffneriana* ssp. *recurva* occurred south of Hwy 90 and that areas of higher concentrations remain higher from one monitoring period to the next (Vernadero Group 2011a, p. 21). This area is impacted through groundwater draw-down from the Cananea Mine in Sonora, Fort Huachuca, the city of Sierra Vista, and agriculture use (see Threats section below).

U.S. Fish and Wildlife Service:
Lilaeopsis schaffneriana ssp. *recurva* occurring on U.S. Fish and Wildlife Service lands are monitored periodically by Service personnel. The last monitoring occurred in 2013 when a few plants were relocated on Leslie Canyon National Wildlife Refuge and no plants were relocated on the San Bernardino National Wildlife Refuge.

Leslie Canyon National Wildlife Refuge – Haas and Frye (1997, p. 6) reported a single natural occurrence of *L. schaffneriana* ssp. *recurva* in Leslie Canyon National Wildlife Refuge. The refuge manager at that time does not recall this occurrence, but reports transplanting plugs into two locations within Leslie Canyon (Cobble pers. comm. April 14, 2014; see Introduced and Augmented Occurrences section below). Drying of Leslie Creek during the summer of 2002 led to the disappearance of some previously existing, large, healthy patches of *L. schaffneriana* ssp. *recurva* on the refuge, though some patches likely persisted until 2012, during which the streambed became completely dry and no plants were seen. This changed in 2013 when groundwater levels rose enough so that flow resumed in Leslie Creek, and individual plants (probably sprouting from an existing seedbank rather than from surviving rhizomes) were documented at scattered locations along Leslie Creek during an October 31 refuge-conducted survey for the taxon. (Radke pers. comm., April 22, 2014).

San Bernardino National Wildlife Refuge – In 1981, a single occurrence of *L. schaffneriana* ssp. *recurva* was discovered at House Pond located on the privately owned Slaughter Ranch adjacent to San Bernardino National Wildlife Refuge, but is believed to have been destroyed when the pond was dredged around 1990 (Warren et al. 1991, p. 7; Johnson et al. 1992, p. 6). Former Refuge Manager Kevin Cobble reported finding *L. schaffneriana* ssp. *recurva* in wet areas of Ramsower Draw at the upstream side of this pond in the 1990s and suspects it

might still be present (pers. comm., April 14, 2014). He also reports finding *L. schaffneriana* ssp. *recurva* at Mesquite Pond and Evil Twin Pond following rehabilitation of these sites, as well as at a fourth pond, possibly Cienega Pond, and Cottonwood Spring (pers. comm. April 14, 2014). In working on these ponds, Cobble suspected a seedbank was responsible for these occurrences, stating that "it just took putting permanent water on bare soil and they would appear." However, multiple surveys of these aquatic habitats by refuge staff since 2003 have not documented the taxon, likely due to resulting plant succession and competition with other species (Radke pers. comm., April 22, 2014).

One occurrence of *L. schaffneriana* ssp. *recurva* at Black Draw comprising four patches was first noted in 1989, co-occurring with *Sorghum halepense* and surviving with 4-6 months per year of zero surface flow (Haas and Frye 1997 p. 6). This occurrence was last documented in 1991 (Warren et al. 1991, p. 7; Warren and Reichenbacher 1991, p. 18) and was, at that time, considered unstable due to human-induced watershed deterioration and climate-induced periodic drying (Johnson et al. 1992, pp. 3, 4, and 6). Johnson et al. (1992, p. 6) also noted that the occurrence of *L. schaffneriana* ssp. *recurva* along the San Bernardino River in Mexico was extirpated. Here, on the Rio San Bernardino side of the border, the river became incised, with streamside cienegas drained and much watershed deterioration occurred due to cattle grazing by the 1960s (Service 1999, p. 291). However, Jim Rorabaugh photographed *L. schaffneriana* ssp. *recurva* in Sonora near the confluence of the Rio San Bernardino and Cajon Bonito during April 2008 (Rorabaugh pers. comm. April 29, 2008), and Peter Warren stated that *L. schaffneriana* ssp. *recurva* "is common along the Rio San Bernardino" (Warren pers. comm. April 28, 2008). Much restoration work has been done in both the United States and in Mexico in the past few decades to reduce scouring floods and headcutting, resulting in increased water-holding capacity and positive riparian vegetation response (Radke pers. comm. October 21, 2013).

Pima County:
Lilaeopsis schaffneriana ssp. *recurva* occurring on Pima County lands are monitored periodically by County personnel. No plants have been found in recent years and are presumed extirpated from both Bingham Cienega and Lower Cienega Creek.

Bingham Cienega – In 2001, two patches of *L. schaffneriana* ssp. *recurva* in one occurrence were discovered at Bingham Cienega (Titus 2001, entire); by 2002, the plants were no longer present due to the drought (Titus and Titus 2008c, p. 458). The cienega has fluctuated in discharge and extent over the years, with it being reduced to a small mud hole during the 1952 to 1953 drought (Fonseca 1998 p. 113). Although 11.3 ha (28 ac) of wetlands were reported to occur at Bingham Cienega in 1998 (Fonseca 1998, p. 113), the area has remained mostly dry since 2003 and has undergone repeated fires and resulting sediment deposition (Titus and Titus 2008c, p. 460; Fonseca pers. comm. January 17, 2014). This occurrence is now considered extirpated.

Lower Cienega Creek in Cienega Creek Preserve – A single *L. schaffneriana recurva* occurrence was detected in lower Cienega Creek in 2001 when researchers noted a few leaves that did not persist beyond the season in which they were discovered (EEC 2001, p. 9). A survey in June 2006 revealed no *L. schaffneriana* ssp. *recurva* at this site and a deeply entrenched stream channel 2.1 to 2.7 m (7 to 9 ft) below the former marsh (Titus and Titus pers. comm. June 20, 2006). A 2013 survey indicated no plants at this location and *L. schaffneriana* ssp. *recurva* is believed to be extirpated (Powell pers. comm. October 1, 2013).

State Parks:
Lilaeopsis schaffneriana ssp. *recurva* occurring on State Parks lands are not monitored and have not been seen in recent years.

San Rafael Ranch State Natural Area – Historically, *L. schaffneriana* ssp. *recurva* has occurred in low densities at Sheehy, Sharp, and Heron Springs, as well as along the Santa Cruz River near the border with Mexico (McGill 1978, entire; Warren et al. 1991, p. 7). All three springs are reported to support similar cienega habitat and have slow moving water in marshy drainages (Warren et al. 1991, p. 12). In 2013, these sites were visited and while habitat exists for this taxon at each location, only a few plants were found at the Santa Cruz River occurrence (Service 2013b, entire). All locations likely still support *L. schaffneriana* ssp. *recurva* in small quantities, but they were undetectable due to quantity of competing understory vegetation and possibly due to the time of year when the survey was conducted. Johnson et al. (1992, p. 7) note that *L. schaffneriana* ssp. *recurva* appears to grow year-round in the absence of killing frost, while other aquatic plants tend to die off during the winter allowing this plant to more effectively colonize open space following low-level disturbance (Johnson et al. 1992, p 7). Throughout much of its range, however, killing frosts are common and *L. schaffneriana* ssp. *recurva* becomes difficult to detect after the first frost (Service 2011, p. 1; Service 2013a pp. 2-3; Service 2013b pp. 1, 3).

Sonoita Creek Natural Area – Fresno Canyon supported one small occurrence of *L. schaffneriana* ssp. *recurva* near the confluence with Coal Mine Canyon. This occurrence was discovered in 2008 and has not been revisited (Rorabaugh 2013, p. 1).

The Nature Conservancy:
Lilaeopsis schaffneriana ssp. *recurva* occurring on The Nature Conservancy's Canelo Hills Preserve historically were monitored by Conservancy personnel. No plants have been reported there or in the adjacent O'Donnell Creek since 2002.

O'Donnell Creek – *Lilaeopsis schaffneriana* ssp. *recurva* had been found historically in a spring-fed cienega near the bunkhouse at the old Ewing Ranch, now The Nature Conservancy's Canelo Hills Preserve (Titus pers. comm. February 27, 2014a). Priscilla Titus (pers. comm. February 27, 2014) remembers

this as a well-known and large patch situated among a few small willows and in close proximity to another well-known patch occurring on adjacent private property. At this location in the fall of 2013, the soil was dry to the touch and a nearby dying cottonwood and field of *Juncus* sp. stood testament to historical water availability (Service 2013a, p. 3). No *L. schaffneriana* ssp. *recurva* were present (nor were there any *Spiranthes delitescens* (Canelo Hills ladies' tresses orchid), which historically co-occurred with *L. schaffneriana* ssp. *recurva* at this site), and it is doubtful this area could support these species again without intervention.

Historically, there were multiple occurrences of *L. schaffneriana* ssp. *recurva* both on private and Forest Service lands within O'Donnell Creek (Correll 1970a, entire). On February 14, 2002, Priscilla Titus noted one occurrence was a very small clump in flowing water near, or within, the Forest Service boundary (Titus pers. comm. February 27, 2014a). In the fall of 2013 on lands in O'Donnell Creek administered by The Nature Conservancy and the Forest Service, there were pockets of suitable habitat for *L. schaffneriana* ssp. *recurva*, though no plants were found (Service 2013a, p. 3). Further surveys are recommended.

Private Lands:
Lilaeopsis schaffneriana ssp. *recurva* occurring on private lands are not monitored and, with the exception of Upper Sonoita Creek where umbel has been seen recently, their current status is unknown.

Turkey Creek – First detected in 1989, the *L. schaffneriana* ssp. *recurva* occurrence within Turkey Creek was thought to be small and the habitat not capable of supporting a large stable occurrence (Gori et al. 1990, p. 64; Warren et al. 1991, p. 7; 64FR37441, 1999, p. 37444). Although, historically, Turkey Creek was considered habitat for a number of native fishes, on a few occasions in recent years this creek has gone dry or mostly dry (see Robinson 2010, p.5). In the fall of 2013, Turkey Creek was intermittent with a few small pools; there was extensive understory cover, including the exotic *S. halapense*, and no *L. schaffneriana* ssp. *recurva* was found (Service 2013a, p. 2). Because habitat does still occur here, the plant may also still occur in this creek, though in low frequency and cover, making detectability among the grasses and sedges difficult (Service 2013a, p. 2). Further surveys are recommended.

Joaquin Canyon – In 1998, the Service proposed a 0.64 km (0.4 mi) reach of Joaquin Canyon managed by the Forest Service as critical habitat for *L. schaffneriana* ssp. *recurva*; this reach began at the confluence with Cave Canyon and ran north (Map Unit 7; 63FR 71838, p. 71842). Because the stream channel in this reach is largely bedrock and not easily disturbed, the Service considered this area as not requiring special management consideration or protection, and the area was removed from consideration for designation as critical habitat (64FR 37441, p. 37445). In August 2001, a Biological Opinion for the Lone Mountain Land Exchange noted that most of Joaquin Canyon had perennial flow and

supported 922 m (0.57 mi) of stream bottom occupied by *L. schaffneriana* ssp. *recurva* that was disposed of by the Forest Service and placed into private ownership (Service 2001, pp. 6-7). Due to the private status of the land, this occurrence has not been revisited and the status remains unknown.

Upper Sonoita Creek – There are two occurrences of *L. schaffneriana* ssp. *recurva* in Upper Sonoita Creek. In 1988, the upper *L. schaffneriana* ssp. *recurva* occurrence was reported at low density across a 0.8 km (0.5 mi) stretch of creek (Gori et al. 1990, p. 65). In 1994 and 1996, transects in the upstream and downstream occurrences revealed *L. schaffneriana* ssp. *recurva* was more abundant upstream in the more stable site (Holdsworth and Gori 1996, p. 1). Yearly conservation easement site visits by personnel of The Nature Conservancy between 2006 and 2013 detected *L. schaffneriana* ssp. *recurva* easily and abundantly in this upstream location, with greater abundance in the northern area of the occurrence (Killeen pers. comm. October 25, 2013).

The downstream occurrence, which begins at Cottonwood Spring and extends downstream, was characterized as having a high density of plants in 1988, prior to a flood which removed *L. schaffneriana* ssp. *recurva* below Hog Canyon (Gori et al. 1990, p. 65). By 1989, the taxon had recolonized the area and was once again found to support a high density of plants (Gori et al. 1990, p. 65). In 1992, the Service, The Nature Conservancy, and the property owner of Cottonwood Spring began a cooperative project under the Partners in Wildlife Program. This project involved excluding domestic livestock from Cottonwood Spring and the riparian area, which had been grazed since the late 1800s, and stabilizing two active headcuts (Holdsworth and Gori 1996, p. 1).

Between 1994 and 2005, surface water in the stream channel, the number of pools, and presence of *L. schaffneriana* ssp. *recurva* were monitored post-restoration (Holdsworth and Gori 1996, p. 1). Results indicate a decrease in both water availability and presence of *L. schaffneriana* ssp. *recurva* between 1994 and 2005 (The Nature Conservancy1994-2005, entire). Although not monitored since, in 2013, the downstream portion of Cottonwood Spring was dominated by *M. rigens* and *L. schaffneriana* ssp. *recurva* was difficult to detect (Killeen pers. comm. October 25, 2013). Continuation of this monitoring is highly recommended by the Service. In addition, in February 2014, the Service was informed that in 2013, a private land owner with a back hoe may have altered the habitat at this spring; impacts to *L. schaffneriana* ssp. *recurva* and a variety of other listed species are unknown and should be investigated (Killeen pers. comm. February 6, 2014).

Monkey Spring – Herbarium collections were made five times between 1965 and 1977 documenting the occurrence of *L. schaffneriana* ssp. *recurva* in Monkey Spring (Minckley 1965 and 1967, entire; Pinkava 1967, entire; Correll 1970b, entire; Reeves 1977, entire). Warren et al. (1991b, p 18) were unable to relocate this occurrence and concluded *L. schaffneriana* ssp. *recurva* had been extirpated

from the spring. Although this site has not been revisited by botanists in recent years, in February of 2010 and again in June of 2012, fish researchers collected Gila topminnow (*Poeciliopsis occidentalis)* from this spring (Marsh and Associates 2010, entire; Marsh and Associates 2012, entire). Their memoranda of the trips included photographs of Monkey Spring which show potential *L. schaffneriana* ssp. *recurva* habitat, including slow-moving water and hydrophytic plants. Therefore, as of 2012, the site still held some potential of supporting *L. schaffneriana* ssp. *recurva* and should be visited to look for *L. schaffneriana* ssp. *recurva* if this can be arranged with the land owner.

Babocomari River – In May of 2006, a single occurrence containing seven patches of *L. schaffneriana* ssp. *recurva* was discovered on the Babocomari River within the Babocomari Ranch (Titus and Titus 2006a, p. 1). These patches were re-visited in October, 2006, following a significant flood event resulting in intense scouring and sediment deposition. All but one patch was relocated and appeared in good condition, and two additional patches were discovered (Titus and Titus 2006b, p. 1). Herbarium collections were made of *L. schaffneriana* ssp. *recurva* from this location in 2008 (Titus 2008, entire; Titus and Anderson 2008, entire). A site visit to the Babocomari Ranch is planned in the fall of 2014, as continued monitoring of this occurrence is warranted.

An unpublished note in the Service files states that, in 1998, *L. schaffneriana* ssp. *recurva* was possibly seen in Lyle Canyon (a tributary of the Babocomari) by the then manager of the Audubon Research Ranch, Bill Brannon. This potential occurrence has not been revisited or confirmed.

In 2013, an employee of the Bureau of Land Management discovered a single, small patch of *L. schaffneriana* ssp. *recurva* during one of several five-mile river surveys. The employee noted the plant was found in a heavily grazed area, roughly 6.4 km (4 mi) from the confluence with the San Pedro River.

Winkelman area – A 1967 herbarium specimen collected from the edge of a drying pool in the San Pedro River, 9.7 km (6 mi) south of Winkelman, documents an historical occurrence of *L. schaffneriana* ssp. *recurva* (Crutchfield 1967, entire). Prior to 2003, on several occasions, Priscilla Titus and others surveyed the Dudleyville Preserve, an area roughly 9.7 km (6 mi) south of Winkelman on the San Pedro River with aquatic habitat present; no *L. schaffneriana* ssp. *recurva* were found (Titus pers. comm. February 27, 2014b). In 2013, The Nature Conservancy published a Water Budget map (entire) which clearly shows the area 9.7 km (6 mi) to the south of Winkelman has perennial flow. Additional surveys are needed.

Tucson area – An 1881 herbarium collection from somewhere along the Santa Cruz River in Tucson documents the oldest known occurrence of *L. schaffneriana* ssp. *recurva* (Warren et al. 1991, p. 5). Because the Santa Cruz River in the

vicinity of Tucson is now dry, this occurrence is presumed extirpated (Warren et al. 1991, p. 5; Johnson et al. 1992, p. 3).

Mexico:
The distribution of *L. schaffneriana* ssp. *recurva* in Mexico is not well studied or understood. Affolter (1985) reported only two localities from Chihuahua and none from Sonora; Hendrickson et al. (1980, pp. 96-97) reported *Lilaeopsis* sp. from one locality in northeastern Sonora at Rancho Mababi and from La Junta, Chihuahua. Our current understanding of the distribution in Mexico comes from two primary sources: a section-6 funded survey for *L. schaffneriana* ssp. *recurva* from 2004-2005 conducted by Greta Anderson and a 2007 Service study of gartersnakes (*Thamnophus* sp.) by Jim Rorabaugh, in which locations that supported *Lilaeopsis* sp. were documented (Anderson 2006, entire; Rorabaugh 2013, entire). These two studies indicate that *L. schaffneriana* ssp. *recurva* is currently known only from the state of Sonora in Mexico. *Lilaeopsis* species are found in Chihuahua, but they are not known to be *L. schaffneriana* ssp. *recurva.*

Sonora – From these two studies (Anderson 2006, entire; Rorabaugh 2013, entire) we have confirmed observations of *L. schaffneriana* ssp. *recurva* from the following 15 locations in Sonora: (1) Arroyo el Tigre; (2) Arroyo los Fresnos (numerous patches; also noted by Warren et al. 1991, p. 13); (3) cienega near the Casa Grande (abundant); (4) Las Nutrias (one occurrence with sparse small patches); (5) Las Pamitas (one occurrence with small patches); (6) Ojo de Aqua (one occurrence with a very small patch; also noted in Gori et al. 1990, p. 64); (7) Rancho el Aribabi along the Rio Cocospera (occurs sparingly along 6 km (3.7 mi) of river; also recently noted by T. Van Devender in 2009, K. Fehlberg in 2010 [SEINET observations], and J. Rorabaugh in 2014 [Rorabaugh pers. comm. April 9, 2014]); (8) Rancho Los Fresnos including: Arroyo los Alisos (one occurrence with one small patch), (9) Cienega Los Fresnos (uncommon), (10) La Cieneguita (one occurrence with one small patch), and (11) Portrero del Alamo (one occurrence with one small patch); (12) Rio Casa Blanca (one occurrence with frequent patches); (13) Rio San Pedro (patchy occurrence); (14) Rio San Rafael (one occurrence with scattered plants; also noted by Warren et al. 1991, p. 13); and (15) Villa Verde (one occurrence with dense patches).

From other studies in Sonora, there are observations of five additional occurrences (numbered below) of *L. schaffneriana* ssp. *recurve*. Observations were reported by Esther Saucedo Monarque (1990, pp.48-54) from: (1) Arroyo el Tapiro, (2) La Cienega la Atascosa, and (3) La Sauceda in Sonora. Tom Deecken observed numerous *L. schaffneriana* ssp. *recurva* at (4) Mababi Spring west of Presa Cuquiarichi in Sonora (Deecken 1994, entire). Warren et al. (1991, p. 10) found an occurrence with two small patches along the (5) Rio San Bernardino in Sonora in May of 1988; both were destroyed in an August 1988 flood. Phil Jenkins collected *L. schaffneriana* ssp. *recurva* along the (6) Santa Cruz River south of the town of Santa Cruz in Sonora in 2005 (Jenkins, 2005, entire).

Chihuahua – From the two studies mentioned above (Anderson 2006, entire; Rorabaugh 2013, entire) we have also confirmed observations of *Lilaeopsis* sp. from the following 7 locations in Chihuahua: Arroyo Rincon (two patches); La Junta; Rio Casas Grandes (one occurrence with a few patches); Rio Conchos tributary (moderately abundant); Rio Papogochic (several occurrences); Rio east of Cusarare (moderately abundant); and the Rio Santa Clara (one occurrence with two patches). It is unknown if the *Lilaeopsis* from Chihuahua are *L. schaffneriana* ssp. *recurva* or *L. r*ecurva ssp. *schaffneriana*. No collections were made from these observations, however, photographs were taken. Historically, it was thought that *L. r*ecurva ssp. *recurva* only occurred on the west side of the Continental Divide, and that ssp. *schaffneriana* occurred on the east (64FR 37441, p. 37442). It is currently not believed that hybridization occurs between these subspecies.

Introduced and Augmented Occurrences:
In recent decades, a variety of efforts have been initiated in order to determine if planting clumps of *L. schaffneriana* ssp. *recurva* propagated in a greenhouse setting, or transplanted directly, could serve as a viable tool with which to establish new occurrences, restore lost occurrences, and to serve as reserves in which *L. schaffneriana* ssp. *recurva* would be preserved in the event that naturally occurring occurrences were subjected to catastrophic loss.

Audubon Research Ranch – In December 2003, a total of 128 100 cm^2 (39.4 in^2) *L. schaffneriana* ssp. *recurva* plugs were planted in four spring runs at Finley Tank on the Audubon Research Ranch (Titus and Titus 2008a, p. 314). This area was chosen because it is located in the San Pedro watershed but is hydrologically isolated from extant *L. schaffneriana* ssp. *recurva* sites, thus preventing potential contamination by differing genetic stock. Prior to the transplant, *L. schaffneriana* ssp. *recurva* was propagated in a greenhouse using plugs obtained from the Desert Botanical Garden in Phoenix that had originated in Sonoita Canyon. *Lilaeopsis schaffneriana* ssp. *recurva* established quickly at Finley Tank and, by 2004, many of the plugs had merged and formed contiguous patches in two of the spring runs. These transplants are still flourishing to date, although *L. schaffneriana* ssp. *recurva* no longer appears to be present in drier portions of the site or within two of the spring runs with greater interspecific competition. In 2014, Kennedy (pers. comm. February 3, 2014) noted *L. schaffneriana* ssp. *recurva* was doing well in north Finley Spring, but that the non-native, aggressive invasive, *Rubus discolor* (Himalayan blackberry), was a problem in the south spring and will become a problem in the north spring, unless it is controlled or removed.

Leslie Canyon National Wildlife Refuge – Haas and Frye (1997, p. 7) report two transplanted plugs of *L. schaffneriana* ssp. *recurva* taken from the San Bernardino Black Draw occurrence and placed into Leslie Canyon. One plug was placed above a U.S.G.S. stream gauge along a pool; the second plug was placed near large *Juglans major* (walnut) trees at the end of permanent water in the creek downstream from the weir (Cobble pers. comm., April 14, 2014). The plug near

the pool reportedly became very robust, spreading to cover between 9.1 and 12.2 m (30 and 40 ft) of pool edge (Cobble pers. comm., April 14, 2014). The previous Refuge manager, Kevin Cobble, reported that, in 1999, this occurrence was thriving. However, a drought period during 2001 and 2002 eliminated the occurrence near the walnut trees (Radke pers. comm., April 22, 2014). Additionally, a more severe drought beginning in 2009 and extending through 2012 eventually completely dried Leslie Creek and all remaining occurrences disappeared until October, 2013, when individual plants were found scattered upstream from the U.S.G.S. stream gauge during a systematic survey for the taxon, responding to a resumption of flow in Leslie Creek (Radke pers. comm., April 22, 2014).

In 2003, an estimated 27.11 m^2 (90 ft^2) of *L. schaffneriana* ssp. *recurva* occupied Leslie Canyon (Malcom 2004, p. 2), and a formal monitoring program for the taxon was initiated at Leslie Canyon NWR in 2004. Monitoring of the plant's introduced occurrence along Leslie Creek occurred seven times between 2004 and 2013 (Malcom 2007, entire; Malcom 2008, entire; Lohrengel 2010, entire; Perkins 2011, entire; Terry 2012, entire; Mendoza 2013).

In 2004, 59 m^2 (194 ft^2) of *L. schaffneriana* ssp. *recurva* occupied Leslie Canyon. By 2007, this number had dropped to 45 m^2 and by 2010 it had dropped to 23.5 m^2 (77 ft^2). During the annual surveys conducted from 2011 through 2013, *L. schaffneriana* ssp. *recurva* was not found in Leslie Canyon. The decline in *L. schaffneriana* ssp. *recurva* in Leslie Canyon is directly related to insufficient amounts of precipitation and a subsequent lowering of the water table (Terry 2012, entire). Due to extended drought, and with the exception of periodic seasonal flood events, surface water availability in Leslie Creek has been sustained only through a series of disconnected pools and did not exist as a flowing stream between November, 2009, and about November, 2012 (Radke pers. comm., April 22, 2014). The resumption of surface flow in Leslie Creek during 2013 may not be sustainable due to continuing drought conditions.

San Bernardino National Wildlife Refuge – In a transplant study at San Bernardino National Wildlife Refuge during 1990-1991, 12.7 cm (5 in) plugs of *L. schaffneriana* ssp. *recurva* attained from Black Draw exhibited excellent growth and vigor in a pond, newly-created by using flow from Cienega Spring, which was relatively free of competing vegetation (Warren 1991, p. 4). However, at Cienega Spring *L. schaffneriana* ssp. *recurva* was eventually eliminated in one location that exhibited intense competition with spike-rush (*Eleocharis* sp.) and bulrush (*Schoenoplectus* sp.), and it failed to thrive in a second Cienega Spring location that had a moderate amount of competing native and non-native vegetation (Warren 1991, p. 5). At a third transplant site on the north side of the pond, *L. schaffneriana* ssp. *recurva* expanded in size and vigor (Warren 1991, p. 5).

Ongoing efforts to reestablish *L. schaffneriana* ssp. *recurva* in aquatic habitats at San Bernardino National Wildlife Refuge took place during 2005, 2007, 2008, 2010, and 2014 (Radke pers. comm. April 22, 2014). Transplants into pond edges during the July 2005 reintroduction effort were ultimately outcompeted and eliminated by other plants of aquatic habitat (Service 2009a, p. 18). During 2007, additional transplants were made at the Minckley Pond Outflow and the Evil Twin Pond Outflow (Malcom 2008, entire). During 2008, transplants were made at the Evil Twin Pond Outflow, Minckley Pond Outflow, North Pond Outflow, and Hay Hollow Wash Pond Outflow (Malcom 2008, entire). The transplant at Evil Twin Pond Outflow persisted until at least September, 2012, but ultimately did not succeed (Radke pers. comm., April 22, 2014). As of 2013, the transplants at Minckley Pond outflow consisted of 8 m^2 (26.2 ft^2) down from 12.3 m^2 (40.4 ft^2) in 2007 (Lohrengel 2010, p. 1; Mendoza 2013 p. 1). The transplant at Hay Hollow Wash Pond Outflow was thriving during March, 2009, but was negatively impacted by flooding later that summer (Radke pers. comm., April 22, 2014). The current status of *Lilaeopsis* occurrence at North Pond Outflow is unknown.

During 2010, additional transplants were placed in Hay Hollow Wash at the pond outflow. While the *Lilaeopsis* transplants initially responded very well in Hay Hollow Wash, they eventually failed after being covered by tons of sediment following several floods during 2009 and 2010 (Lohrengel 2010, p. 3; Radke pers. Comm., April 22, 2014). Multiple transplants during March 2014 into Snail Spring run on Slaughter Ranch and into Hay Hollow Wash at the pond outflow on San Bernardino National Wildlife Refuge are currently thriving (Radke pers. comm. April 22, 2014). Work to document and evaluate the success of transplanted plugs on San Bernardino National Wildlife Refuge was conducted during 2007, and showed that transplants appeared to be most successful in areas where water saturation levels remained constant, where herbaceous competitors were rare, and where water velocity was low (Radke pers. comm. April 22, 2014).

Las Cienegas National Conservation Area – In June, 2013, representatives of the Bureau of Land Management and the Service, aided by school children, collected 50 plugs from Cienega Creek and planted them directly into a newly dug pond at Cienguita (Rorabaugh pers. comm. June 26, 2013). These plugs were planted at a dry time, but gained hold after monsoon rain came (Simms pers. comm. July 18, 2013).

The Desert Botanical Garden – The Desert Botanical Gardens maintains a sizable occurrence of *L. schaffneriana* ssp. *recurva* in an artificial pond in the botanical garden that is useful for educational purposes. The Desert Botanical Gardens also maintains living collections in pots in the greenhouse for use in research and for potential use in reintroduction efforts. The greenhouse material originated from Sonoita Creek, Scotia Canyon, San Pedro River, and Garden Canyon. The collections are labeled and propagated separately in order to retain the genetic integrity of each collection.

The Arizona Sonora Desert Museum – The Arizona Sonora Desert Museum in Tucson maintains 25, 20.3 cm (8 in) nursery pots of *L. schaffneriana* ssp. *recurva* in a greenhouse on the museum grounds, and two 20.3 cm (8 in) pots on the grounds in a public display (Montgomery 2012, entire). These plants were cultivated using material obtained from the Desert Botanical Garden. The Museum planted some material in a marsh exhibit in the spring of 2012, and periodically includes living specimens in an educational display at the museum entrance that highlights Threatened and Endangered plants. Eight potted plants grown at the Desert Botanical Garden will be transferred to the Arizona Sonora Desert Museum later in 2014.

Sonoita Creek – In 1995, representatives of The Nature Conservancy installed a total of 57 10 cm (3.9 in) diameter *L. schaffneriana* ssp. *recurva* plugs into 4 different habitats in Sonoita Creek, within the Sonoita-Patagonia Preserve, using material collected at Cottonwood Springs, a perennial stretch of Sonoita Creek approximately 16 km (10 mi) upstream from the transplant location (Warren 1996, p. 4). The four habitats consisted of the main Sonoita Creek channel, a sand bar, an unnamed tributary stream, and a spring on the north side of the canyon (Warren 1996, p. 4). Initially, *L. schaffneriana* ssp. *recurva* grew vigorously, but when the sites were revisited in 2002 and 2006, the taxon could not be relocated, and it is presumed extirpated from all four habitats at this location. The two nearest the stream were lost to flood scour, one spring site dried up and the other spring site was anaerobic and did not sustain *L. schaffneriana* ssp. *recurva* (Warren pers. comm. February 6, 2014).

San Pedro Riparian National Conservation Area – Fort Huachuca has implemented two *L. schaffneriana* ssp. *recurva* transplant efforts in recent years. These efforts were undertaken in compliance with the 2007 Biological Opinion for proposed ongoing and future military operations and activities at the Fort (Service 2007, entire). The Biological Opinion stipulated that efforts should include off-post activities including *L. schaffneriana* ssp. *recurva* collection, propagation and planting in suitable habitat along the San Pedro Riparian Natural Conservation Area, and assisting the Bureau of Land Management, the Coronado National Forest, and other land owners/managers responsible for *L. schaffneriana* ssp. *recurva* (Service 2007, p. 65).

In December, 2010, Fort Huachuca representatives in partnership with the Bureau of Land Management transplanted 32, 16, and 16 *L. schaffneriana* ssp. *recurva* plugs respectively, in Murray Spring, Horse Thief Canyon, and Frog Spring within the San Pedro Riparian Natural Conservation Area (Simms pers. comm. October 26, 2011; Vernadero Group 2011b, p. 3). Plugs for the transplant effort were propagated by the Desert Botanical Gardens using material obtained from within the San Pedro Riparian Natural Conservation Area in 2007. In August of 2011, the Bureau of Land Management noted in visits to the Horse Thief Draw site that *L. schaffneriana* ssp. *recurva* was scoured by floods, but was re-sprouting from the root at most locations (Simms pers. comm. October 26, 2011). The most

recent monitoring of these plugs, in 2013, revealed that percentage of occupied habitat continues to expand three years post-transplant in both Horse Thief Draw and Murray Springs (Directorate of Public Works 2013, p. 1). The extent of occupied habitat at Frog Spring has decreased in each year since the transplant (Directorate of Public Works 2013, p. 2).

Fort Huachuca – In 2009, Fort Huachuca staff transplanted 64 *L. schaffneriana* ssp. *recurva* plugs (material grown from two plugs each from the Garden Canyon Picnic area and McClure Canyon) into 6 locations within Huachuca Canyon Creek, McClure Canyon, and Cave Spring. The purpose of the transplant was to establish *L. schaffneriana* ssp. *recurva* in suitable habitat outside of known locations in order to increase the number of occurrences and decrease the likelihood of a stochastic event, such as flood or drought, eliminating the currently existing occurrences (Brewer, pers. comm. February 18, 2009). As of the most recent monitoring of these plugs in the spring of 2013, all but one of these locations showed continued expansion of occupied habitat. While one location in Huachuca Canyon Creek has shown a decrease in percentage of occupied habitat since 2012, occupied habitat remains higher than in 2010 (Directorate of Public Works 2013, p. 2).

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

Lilaeopsis schaffneriana ssp. *recurva* is a species of wetted lands in the dry landscape of southeastern Arizona and northern Mexico; its presence is completely dependent upon the availability of wet habitat. Across its range, the taxon is either stable or in decline; many occurrences have been extirpated due to groundwater pumping and drought, in combination with other lesser threats such as livestock grazing and habitat degradation. Many threats to this limited habitat continue and are projected well into the future as a result of increased human population growth, climate change to a warmer and drier environment, increases in wildfire and sedimentation, increases in invasive exotic plants, and increases in mining and recreation activities.

2.3.1.8 Conservation Measures:

Introduction and Augmentation of occurrences

There has been success in establishing *L. schaffneriana* ssp. *recurva* into locations with suitable habitat within the historical range of the taxon (e.g. Audubon Research Ranch, Las Cienegas National Conservation Area, Fort Huachuca, and on the San Pedro Riparian National Conservation Area). Other attempts to establish this taxon have ultimately failed (e.g. Leslie Canyon National Wildlife Refuge and Sonoita Creek). Still other attempts have had mixed results (e.g. San Bernardino National Wildlife Refuge).

Easements

Since 1990, the Nature Conservancy has held a conservation easement on one private property on Sonoita Creek which supports *L. schaffneriana* ssp. *recurva*

(Killeen pers. comm. April 29, 2014). Although the easement was created for a purpose other than the protection of *L. schaffneriana* ssp. *recurva*, the taxon benefits from this land protection. Several additional conservation easements on the Babacomari River are held by The Nature Conservancy, Fort Huachuca, and the Bureau of Land Management; collectively these easements protect several miles of perennial water in the Babocomari River (Duncan pers. comm. April 29, 2014). In 1999, Arizona State Parks purchased 1,440 ha (3,557 ac) of land in the San Rafael Valley including the Santa Cruz River which supports small occurrences of *L. schaffneriana* ssp. *recurva*. One management goal of the San Rafael State Natural Area is to protect, preserve, and enhance habitat for federally listed threatened and endangered species (Arizona State Parks 2013, p. 9). The land is rested from livestock grazing, protected from development through an easement, and is managed to minimize the impacts of non-native species. In 2013, the Arizona Land Trust protected 3.2 km (2 mi) of Sonoita Creek on the Circle Z Ranch, including perennial stretches. Although no *L. schaffneriana* ssp. *recurva* have been surveyed for or documented on this property, the taxon has been found upstream and potential habitat exists for the taxon on this protected ranch.

In Sonora, Mexico, Rancho El Aribabi is a federally designated private reserve, which recognizes ecological values and also precludes mineral entry. The Ranch, which contains *L. schaffneriana* ssp. *recurva*, is managed for its ecological values and ecotourism. Similarly, Rancho los Fresnos, which also supports an occurrence of *L. schaffneriana* ssp. *recurva*, is owned and managed for its ecological values by the conservation organization Naturalia. Livestock have been removed from the property and management includes the use of prescribed burning. At Rancho San Bernardino, in Sonora, the Cuenca los Ojos Foundation actively manages lands known to have historically supported and may currently support *L. schaffneriana* ssp. *recurva*. Management includes extensive restoration of grasslands and waterways, resulting in the many-fold increase in extent of perennial water in Rio San Bernardino creating habitat for the taxon.

Conservation and Management Plans

There are three conservation plans currently in place that provide some benefit to *L. schaffneriana* ssp. *recurva*. First, the 2008 Malpai Borderlands Habitat Conservation Plan ensures that no cattle grazing occurs within San Bernardino National Wildlife Refuge, thereby protecting *L. schaffneriana* ssp. *recurva* from trampling and overgrazing impacts (MBHCPTWG and Lehman 2008, p. 105). Second, the 2009 Leslie Canyon Watershed Safe Harbor Agreement incorporates management actions related to the recovery of the taxon, including its propagation and establishment in existing aquatic habitats, the maintenance of wetland levels, and the exclusion of humans and livestock that may excessively trample the taxon (Service 2009b, p. 7). Lastly, although most *L. schaffneriana* ssp. *recurva* occur outside of Pima County, the Draft Pima County Multi-Species Conservation Plan includes monitoring of a) *L. schaffneriana* ssp. *recurva* every two to three years,

b) habitat conditions at Bingham Cienega, and c) post restoration efforts (Pima County 2012, pp. 70, 81).

Fort Huachuca participates in water conservation efforts, effluent reuse or recharge, the purchase of conservation easements, and storm water recharge; all which benefit *L. schaffneriana* ssp. *recurva* and its habitat (Service 2014b, p. 21). In addition, Fort Huachuca personnel monitor *L. schaffneriana* ssp. *recurva* both on the Fort and on the San Pedro National Conservation Area regularly (Service 2014b, p. 20). There is no livestock grazing allowed on Fort Huachuca, eliminating the threat *L. schaffneriana* ssp. *recurva* of overgrazing and measures are taken to ensure recreational trampling does not occur (Service 2014b, p. 21). In addition, transplanting of plugs has occurred in the past and may continue in the future (Service 2014b, p. 21).

Conservation Areas

The Bureau of Land Management manages the Las Cienegas National Conservation Area which encompasses much of the upper Cienega Creek watershed, an area supporting multiple patches of *L. schaffneriana* ssp. *recurva*. The area was set aside to conserve, protect, and enhance this resource and is managed under a comprehensive management plan which includes assurance that riparian and wetland sites are properly functioning (Bureau of Land Management 2003, pp. 7-9). The Bureau of Land Management also conducts periodic monitoring of *L. schaffneriana* ssp. *recurva* along upper Cienega Creek and has plans for introducing plugs at up to 11 locations over a 10 year period (Service 2008, p. 3). In addition, to protect these sensitive riparian and wetland habitats, the Bureau of Land Management designated this area as the Empire-Cienega Area of Critical Environmental Concern. The goal of the designation is to protect and enhance watershed, grassland, and threatened/endangered wildlife resources, emphasizing total ecosystem management (Bureau of Land Management 2003, p. A6-1).

Section 7

Between February, 1997, and April, 2014, there have been 46 section 7 consultations involving *L. schaffneriana* ssp. *recurva*. Biological opinions resulting from the consultations included measures to reduce adverse effects on the taxon and resulted in non-jeopardy determinations.

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

Threats to the taxon identified through research and consultations that could potentially impact *L. schaffneriana* ssp. *recurva* include: aquatic habitat degradation; wildfire and resulting sedimentation; invasive, non-native plant competition; livestock grazing; and recreation (Factor A) and the effects of drought and climate change (Factor E).

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

Aquatic Habitat Degradation

Human activities such as groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, agriculture, mining, sand and gravel operations, road building, non-native species introductions, urbanization, wood cutting, wildfires, and recreation all contribute to aquatic habitat loss and degradation within the historical range of *L. schaffneriana* ssp. *recurva* (Hendrickson and Minckley 1984, p. 161; Bahre 1991, pp. 177-178; Hereford 1993, p. 2). Flood control projects that permanently alter stream flow characteristics may reduce or eliminate stream sinuosity and associated pool and backwater habitats that are critical to *L. schaffneriana* ssp. *recurva.* Such activities are widespread in Arizona.

Ground water pumping may lead to perennial reaches becoming intermittent or ephemeral and to springs drying out, resulting in the loss of *L. schaffneriana* ssp. *recurva* occurrences (Warren et al. 1991, p. 7; 60FR 16836, p. 16838; Service 2014b, pp. 148-149). Along the upper San Pedro River, Stromberg et al. (1996, pp. 124–127) found that wetland herbaceous species are the most sensitive to the effects of a declining groundwater level. Webb and Leake (2005, pp. 302, 318–320) described a correlative trend regarding vegetation along southwestern streams from historically being dominated by marshy grasslands to currently being dominated by woody species that are more tolerant of declining water tables due to their deeper rooting depths.

Over the past decade, Fort Huachuca has pursued a rigorous water use reduction plan to reduce groundwater consumption in the Sierra Vista subbasin (Harris et al. 2001, p. 15-5; Service 2014b, p. 27). Their efforts have focused primarily on reductions in groundwater demand both on-post and off-post and increased artificial and enhanced recharge of the groundwater system. In addition, Fort Huachuca and the City of Sierra Vista have increased the amount of water recharged to the regional aquifer through construction of effluent recharge facilities and detention basins that not only increase storm-water recharge, but mitigate the negative effects of increased runoff from urbanization. The total net effect of all the combined efforts initiated by Fort Huachuca has been to reduce the net groundwater consumption by approximately 2,272 acre feet (71 percent) since 1989 (Service 2007, pp. 41–42). Despite these efforts, residential water demand continues (Harris et al. 2001, p. 15-5) and the effect of increased water demand and withdrawals may be exacerbated by the current, long-term drought throughout the region (see Drought and Climate Change section below).

A 2007 computer model developed by the United States Geological Survey simulated the response of groundwater pumping in the San Pedro Basin from 1902 to 2003 (Pool and Dickinson 2007, entire). This model reflects a more than 100 foot drop in groundwater levels in the Sierra Vista area as a result of intensive

pumping from the Fort Huachuca, the Mexicana de Cananea (one of the largest open-pit copper mines in the world), agricultural irrigation in Arizona and Sonora, municipality use, and domestic wells in unincorporated areas (Varady et al. 2000, p. 232; Harris et al. 2001, p. 15-5; 60FR 16836, p. 16838; Pool and Dickinson 2007, pp. 2, 15, 37; Lacher Hydrologica Consulting 2012, p. 1). Lacher Hydrologica Consulting (2012, p. 2) modified the model to project future groundwater declines in the regional aquifer, finding that, without mitigation, groundwater levels would decline an addition 21.3 m (70 ft) between 2000 and 2100.

Elsewhere in *L. schaffneriana* ssp. *recurva* habitat, the Rosemont Copper Mine is proposed to be constructed in the north-eastern area of the Santa Rita Mountains in Santa Cruz County, Arizona. This mine, if actualized, will include a mine pit that will be excavated to a depth greater than that of the regional aquifer and water will drain from storage in the aquifer into the pit (Service 2013c, p. 238). The need to dewater the pit during mining operations would result in ongoing water removal via pumping of aquifer water storage. Upon cessation of mining, a pit lake would form, and evaporation from this water body will continue to remove water from storage in the regional aquifer (Service 2013c, p. 238). This aquifer also supplies baseflow to Cienega Creek and its tributaries, an area immediately east of the proposed project site which is designated as the Bureau of Land Management's Las Cienegas National Conservation Area. Cienega Creek and its tributary, Empire Gulch, support numerous occurrences and more than 100 patches of *L. schaffneriana* ssp. *recurva*. Multiple agencies and organizations have developed groundwater models to analyze potential effects from the proposed mine on groundwater withdrawals throughout the affected area; these analyses are ongoing.

Sand and gravel mining along the San Pedro, Babocomari, and Santa Cruz Rivers in the United States has occurred, and probably will continue unless regulated (60FR 16836, p. 16841). No mining occurs within the San Pedro Riparian National Conservation Area (60FR 16836, p. 16841). Sand and gravel mining removes riparian vegetation and destabilizes the ecosystem, which could cause *L. schaffneriana* ssp. *recurva* habitat or patch losses upstream or downstream from the mining (60FR 16836, p. 16841). These mines also pump groundwater for processing, and could locally affect groundwater reserves and perennial stream base flows (60FR 16836, p. 16841).

In summary, the best available scientific and commercial information indicates that, regardless of the scenario, any reduction in the presence or availability of water in occupied habitat is a threat to *L. schaffneriana* ssp. *recurva*. The *L. schaffneriana* ssp. *recurva* occurrences in Cienega Creek and the San Pedro River are two of three major strongholds for this taxon and historical, current, and potential future dewatering is a serious threat to both areas. Many more isolated occurrences of *L. schaffneriana* ssp. *recurva* have already become ephemeral or

been lost due to perennial waters becoming ephemeral or ephemeral waters drying completely.

Wildfire and Sedimentation

Fire would generally not burn the wetland habitat of *L. schaffneriana* ssp. *recurva* due to high humidity; however it has the potential to burn adjacent upland habitats causing indirect effects on *L. schaffneriana* ssp. *recurva* and its habitat throughout the range of the taxon (Service 2009a, p. 21). Effects include increased runoff of floodwaters, deposition of debris and sediment originating in the burned area, and potential for scouring of *L. schaffneriana* ssp. *recurva* individuals and habitat (Service 2014b, p. 145). Since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970 to 1986 (Westerling et al. 2006, p. 941). The timing, frequency, extent, and destructiveness of wildfires are likely to increase (Westerling et al. 2006, p. 943) and with them changes in vegetation community composition and structure, increased presence of invasive exotic plants, and alterations in the hydrologic and nutrient cycles (Griffis et al. 2000, p. 243; Crawford et al. 2001, p. 265; Hart et al. 2005, p. 167; Smithwick et al. 2005, p. 165; Stephens et al. 2014, p. 42).

Post-fire flooding and associated sedimentation can strip out, bury, or stunt growth of *L. schaffneriana* ssp. *recurva* patches, or transform habitat from wet or marshy to dry, sandy, or gravelly (Service 2009a, p. 24; Service 2013a, p. 4). For example, Freeman Spring is an area reported historically to contain springy soils and support *L. schaffneriana* ssp. *recurva* (Service 2013a, p. 4). Today, 10 years post-Ryan Fire and after subsequent flooding and deposition, the taxon and the habitat no longer exist at this location. Similarly, in 1998, a large culvert was installed by Santa Cruz County on the Cimarron Road to reduce sedimentation and alteration of habitat occupied by *L. schaffneriana* ssp. *recurva*. The mitigation measure was unsuccessful and sediment deposited at the site covering the plants and extirpating this site below the road (Service 1999, p. 235). In McClure Canyon of Fort Huachuca, an occurrence of *L. schaffneriana* ssp. *recurva* has shifted downslope due to the previously occupied habitat being covered in post-flood sediment (Vernadero Group 2010, p 12). In 2007, a flood at Evil Twin Overflow on the San Bernardino National Wildlife Refuge resulted in the covering of *L. schaffneriana* ssp. *recurva* in sediment; as of 2010, no plants had grown through or around the sediment (Lohrengel 2010, p. 3).

In 2009, the Huachuca FireScape project was created with participants from Fort Huachuca, the Coronado National Forest, and Coronado National Memorial (Huachuca FireScape 2014, entire). This group works together to reduce the extent of fires by coordinating prescribed burns and thinning on over 161,874 ha (400,000 ac) across southeastern AZ (Huachuca FireScape 2014, entire). In addition, Fort Huachuca's Integrated Wildfire Management Plan (Gebow and Hessil 2006, entire) and, elsewhere, the San Bernardino and Leslie Canyon National Wildlife Refuges Fire Management Plan (Service 2006, p. 3), provide a planning framework for reducing the risk of fire and fire suppression effects on

listed species. These combined efforts will help reduce the risk of catastrophic fire in areas containing *L. schaffneriana* ssp. *recurva* habitat.

In summary, although the direct impacts of fire are potentially reduced due to high humidity within its habitat, the indirect impact of fire on *L. schaffneriana* ssp. *recurva*, including post-fire flooding and sedimentation, may be great. High severity fire and flooding are both expected to increase in the future. Landscape managers have teamed up to help lower the risk of catastrophic fires in the sky islands of southeastern Arizona. However, it will take some time before the benefits from these efforts will be realized. For example, in 2014, the Brown Fire burned 97 ha (240 ac) on Fort Huachuca and Coronado National Forest lands within a 0.4 km (0.25 mi) of a known occurrence of *L. schaffneriana* ssp. *recurva* in Sawmill Canyon.

Invasive Non-native Plant Competition

Lilaeopsis schaffneriana ssp. *recurva* are most abundant in areas with ample sunlight and low competition with other native and non-native species (Titus and Titus 2008c, p. 459). In a clipping experiment, *L. schaffneriana* ssp. *recurva* leaf number and length, as well as, flower production increased when interspecific competition for sunlight, water, and nutrients was removed (Titus and Titus 2008c, p. 462). In a 2008 monitoring effort at Garden Canyon, researchers indicated that increased competition, with both native plants and *N. officinale* had a noticeable effect on the detectability of *L. schaffneriana* ssp. *recurva* (Vernadero Group 2009, p. 10). They also noted that *N. officinale* went from a status of "present" in 2002, to "a major threat" in 2009 when it was reported to be "now choked by a recent invasion of watercress" (Vernadero Group 2010, p. 12).

Sorghum halepense (Johnson grass) is a Mediterranean, perennial, invasive exotic grass hybrid between *S. bicolor* and *S. propinquum* (Rout et al. 2013, p. 328). With rhizomes 1.5 m (4.9 ft) deep (Stromberg 2013, p. 4), height up to 2 m (6.6 ft) tall (Gould 1988, p. 310), and leachates (solution produced by leaching) produced by the foliage and the roots which inhibit growth of native plants (Rout et al. 2013, pp. 327-328), this highly competitive species is now dominant on many floodplains in the southwestern United States (Stromberg 2013, p. 4). In the tallgrass prairie of the central United States, it has been documented to spread nearly 0.5 m (1.6 ft) every year (Rout et al. p. 327). Although considered a mesophyte (not adapted to wet or to dry conditions) by Stromberg (2013, p. 4), others consider its distribution riparian (Hendrickson and Minckley 1984, p. 136) or, most common in ecosystems with moist to mesic moisture regimes (FEIS 2004, entire). In the Ciennega Creek watershed, *S. halepense* is a common, exotic, perennial grass most often associated with cienega wetlands or along stream channels and gravel bars (Tiller et al. 2013, p. 423).

In 1996, researchers noted that in Leslie Canyon, *L. schaffneriana* ssp. *recurva* coexists with invading *S. halepense* (Haas and Frye 1997, p. 6). They also note that the removal of more aggressive stoloniferous or rhizomatous competitors to

L. schaffneriana ssp. *recurva* appears to be a principle component in stimulating plant growth (Haas and Frye 1997, p. 12). In several reports on the endangered *Spiranthes delitescens* at the Canelo Hills Cienega Preserve, a site also known to contain *L. schaffneriana* ssp. *recurva,* researchers suggest declines in *S. delitescens* may be due, in part, to an increase in *S. halepense* and have recommended control of this invasive grass (Gori 1993, pp 1-2; Gori 1994, p. 6; Gori and Backer 1999b, p. 1). The Nature Conservancy has made control of this taxon a priority, and currently there are some patches which they continue to work to eradicate, or at a minimum, keep from spreading further (Miller pers. comm. November 23, 2013).

Neighboring Turkey Creek and Freemont Springs were visited in 2013 and large stands of *S. halepense* were present in both locations; in addition, *Arundo donax* (giant reed) was discovered in one location within Turkey Creek (Service 2013a, p. 2). Also in 2013, *S. halepense* was noted to be present in large quantities in the vicinity of known occurrences of *L. schaffneriana* ssp. *recurva* in the San Rafael Valley. In one of these locations, Sheehy Spring, a patch of *R. discolor* was noted to have increased in size since first reported years ago and could become a threat to *L. schaffneriana* ssp. *recurva* in the future (Service 2013b, p. 1).

Cover of invasive exotic plants such as *C. dactylon* and *N. officinale* in streams in the Huachuca Mountains and along the banks and within San Pedro pose a threat to *L. schaffneriana* ssp. *recurva* (Vernadero Group 2011a, p. i). In 2004, monitoring of *L. schaffneriana* ssp. *recurva* found common associates included *S. halepense*, *Hordeum jubatum* (foxtail), and *C. dactylon* (EEC 2004, p. 12). In an examination of the seedbank at the Finley Tank introduction site, a large number of competing seeds were present in some of the seedbank samples, particularly those of *C. dactylon* (Titus and Titus 2008a, p. 317). At the southern spring in Finley Tank, *R. discolor* was removed prior to the introduction effort by the 2002 Ryan wildfire and, as predicted, is once again a problem in this location (Titus and Titus 2008a; L. Kennedy pers. comm. February 3, 2014). A researcher at the Appleton-Whittell Research Ranch noted that the *R. discolor* could become a problem in the north spring where *L. schaffneriana* ssp. *recurva* occurs if left untreated (Kennedy pers. comm. February 3, 2014).

In summary, the best available scientific and commercial information indicates that invasive exotic plants have increased their presence within aquatic habitat of southeastern Arizona, and this invasion and expansion of infestations are expected to continue. Because *L. schaffneriana* ssp. *recurva* is sensitive to competition from both native and non-native herbaceous plants, the continued increase in such species as *S. halepense, C. dactylon, N. officinale,* and *R. discolor* can only lead to a decrease in the presence of *L. schaffneriana* ssp. *recurva* throughout the range of the taxon.

Livestock Grazing

Lilaeopsis schaffneriana ssp. *recurva* are affected by livestock grazing in the

following ways: 1) trampling, 2) direct impacts from construction of range improvement projects, 3) changes in stream geomorphology that lead to erosion, sedimentation, and downcutting, 4) watershed degradation and resulting adverse effects to stream hydrology, and 5) consumption (Service 1999, p. 237; Anderson 2006, p. 28). Observations of *L. schaffneriana* ssp. *recurva* response to grazing indicate the taxon is capable of experiencing light to moderate grazing with negligible impact (Simms pers. comm. October 26, 2011; Anderson 2006, pp. 22, 31; Edwards pers. comm. February 21, 2001; Rorabaugh 2013, entire).

Grazing during dry periods when cattle spend a disproportionate amount of their time, if not controlled, in riparian areas, may result in harmful effects to *L. schaffneriana* ssp. *recurva* and other riparian obligates (Edwards pers. comm. February 21, 2001; Service 2002a, pp. 76-77; Krueper 1996, p. 287; Malcom and Radke 2008, p. 81; Service 2014a, pp. 3, 6-7). In such instances, severe and widespread trampling may occur; roots and soil structure can be damaged; vegetation species composition and structure can shift; soil can become compacted; stream banks can be degraded; runoff and soil erosion from storm events may increase with higher peak flows; and stream entrenchment may occur; all of which would have harmful effects on *L. schaffneriana* ssp. *recurva* habitat and existing occurrences (Service 2002a, p. 138; Krueper 1996, pp. 287-288; Simms pers. comm. October 26, 2011).

With the onset of earlier springtime temperatures (Cayan et al. 2005, entire) and continuing drought conditions (Weiss and Overpeck 2005, p. 2074; Archer and Predick 2008, p. 24), the period of winter vegetation dormancy and water availability has decreased in recent years. In Sunnyside Canyon, Lone Mountain Canyon and its tributaries, Bear Canyon, and Scotia Canyon, the current Coronado National Forest Grazing Management Plan recommends grazing in winter months only when adequate water is available to disperse cattle and reduce impact on riparian areas (Service 2002b, pp. 144-146). This stipulation should be amended to include more areas that support *L. schaffneriana* ssp. *recurva* and implementation enforced.

Over-grazing of riparian areas has been shown to reduce the occurrence of *L. schaffneriana* ssp. *recurva* and damage its habitat (Falk 1998, p. 2; Dupée 1999, entire). In 1998, Mima Falk (p. 2) noted that along the *L. schaffneriana* ssp. *recurva* monitoring transects, seven areas in Bear Canyon and four areas in Scotia canyon showed evidence of bank instability or trampling from livestock use. Six of seven areas containing *L. schaffneriana* ssp. *recurva* in Bear Canyon, and one of four in Scotia Canyon, no longer contained plants in 1995, providing evidence of patch extinction in localized areas. In Leslie Creek, researchers quantified the impacts of a single cow on individual *L. schaffneriana* ssp. *recurva* and concluded that even a small number of livestock left in one place could eradicate the taxon in that area (Malcom and Radke 2008, p. 81). Researchers studying the effects of livestock removal at Cottonwood Spring concluded that two years following livestock removal, streamside and aquatic vegetation, and thus channel stability,

were increased, all of which provided a benefit to *L. schaffneriana* ssp. *recurva* (Gori and Backer 1999a, p. 3). In the spring of 2014, *L. schaffneriana* ssp. *recurva* growing outside of cattle exclosures were diminished in size and quantity compared to those plants inside exclosures (Service 2014a, pp. 3-7).

In summary, the best available scientific and commercial information indicates that periodic disturbance removes competing vegetation and allows recolonization or expansion of *L. schaffneriana* ssp. *recurva* occurrences (Service 1999, p. 237). In instances where natural disturbance is low or infrequent, occasional trampling and grazing by domestic livestock could improve habitat for *L. schaffneriana* ssp. *recurva*; excessive livestock use, however, can be detrimental to the taxon and its habitat (Falk 1998, p. 2; Service 1999, p. 237; Service 2002a, p. 137; Malcom and Radke 2008, p. 81; Service 2014a, pp. 3, 6-7). Livestock grazing occurs in portions of the range of *L. schaffneriana* ssp. *recurva*, with the exceptions of Garden, Huachuca, McClure, and Sawmill Canyons of Fort Huachuca, within the boundaries of the San Pedro National Wildlife Conservation Area, where only trespass cattle have been reported in recent decades, within the State Park lands of the San Rafael Valley, and in the San Bernardino and Leslie Canyon National Wildlife Refuges.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:
While *L. schaffneriana* ssp. *recurva* is collected periodically for genetics studies, herbarium specimens, and for plugs for reintroduction efforts, these collections are monitored through a permit process to ensure over-collection is not a threat to the taxon. In addition, *L. schaffneriana* ssp. *recurva* has the ability to reproduce vegetatively and can resprout following removal of vegetative material. Therefore we find overutilization is not a threat to the taxon.

2.3.2.3 Disease or predation:
There is no evidence to suggest that disease is a threat to *Lilaeopsis schaffneriana* ssp. *recurva*. Although javelina have been observed eating *L. schaffneriana* ssp. *recurva* at San Bernardino NWR (Johnson 1991 p. 8), predation by native wildlife does not seem to have a large impact on the taxon. Grazing by domestic livestock is discussed under Domestic Grazing in Section 2.3.2.1 above. Therefore, we find disease or predation by native wildlife is not a threat to the taxon.

2.3.2.4 Inadequacy of existing regulatory mechanisms:
Lilaeopsis schaffneriana ssp. *recurva* is considered sensitive by both the Bureau of Land Management and the Forest Service. The 2008 Bureau of Land Management Manual 6840, Special Status Species Management, states, in part, that they will develop and implement plans and programs that will conserve listed species and the ecosystems upon which they depend, monitor and evaluate ongoing management activities to ensure conservation objectives, ensure that all activities affecting the occurrences and habitats of listed species are designed to be consistent with recovery needs and objectives, and ensure that all actions

authorized, funded, or carried out by the Bureau of Land Management are in compliance with the Endangered Species Act (Bureau of Land Management 2008, entire).

The 2005 Forest Service Manual chapter 2670, Threatened, Endangered, and Sensitive Plants and Animals, states, in part, that national forest system habitats and activities will be managed for listed threatened or endangered species to achieve recovery objectives so that listing under the Endangered Species Act is no longer necessary (USFS 2005, p. 4). In addition, the Forest Service, Coronado National Memorial, and Fort Huachuca are participating in the Huachuca FireScape project to reduce the risk of catastrophic fire and sedimentation impact in the sky islands of southeastern Arizona (Huachuca FireScape 2014). Other land management agencies maintain fire management plans aimed at reducing threats from catastrophic fire which would benefit listed species.

On non-Federal lands, the Arizona Native Plant Law provides some protection for this taxon within Arizona. *Lilaeopsis schaffneriana* ssp. *recurva* is protected under the Arizona Native Plant Law as a highly safeguarded plant, which makes it unlawful for any person to destroy, dig up, cut, collect, mutilate, harvest or take, and place into possession any of these plants on non-Federal lands (Arizona Revised Statutes 2009, chapter 7). However, the Arizona Native Plant Law does not prohibit landowners from removing or destroying protected plants on their property, but they are required to notify the Arizona Department of Agriculture 20 to 60 days prior to destruction of a protected native plant.

Critical habitat designation provides an added layer of protection the habitat of *L. schaffneriana* ssp. *recurva* for projects with a Federal nexus, such as Federal permitting or funding, or occurrence on Federal lands; seven critical habitat units have been designated for this taxon (Figure 2: 64FR 37441, p. 37444).

There are no protections for *L. schaffneriana* ssp. *recurva* in Mexico (CITES 2014, p. 673).

In summary, the best available scientific and commercial information indicates that the status of *L. schaffneriana* ssp. *recurva* as a listed endangered species with critical habitat designated under the Endangered Species Act, a Bureau of Land Management and Forest Service sensitive species, and a highly safeguarded plant under Arizona State Law, afford some protection to the taxon within the United States. There are no regulations in place that address threats to *L. schaffneriana* ssp. *recurva* and its habitat from drought and the effects of climate change, or from any threats throughout its range in Mexico.

2.3.2.5 Other natural or manmade factors affecting its continued existence:
Drought and Climate Change
Southeastern Arizona and much of the American southwest have experienced serious drought in recent decades (Bowers 2005, p. 421; Garfin et al. 2013, p. 3;

CLIMAS 2014) and precipitation is projected to be less in the future with climate change (Seager et al. 2007, p. 1181; Karl et al 2009, pp. 24, 33; IPCC 2013, p. 45). More than 72 percent of Arizona was experiencing severe drought and 16 percent extreme drought conditions during July of 2014, when this document was finalized (CLIMAS 2014, entire). Instrumental and paleoclimate records from the Southwest indicate that the region has a history of multi-year and multi-decade drought (Hereford et al. 2002, p. 1; Karl et al. 2009, p. 130; Garfin et al. 2013, p. 3).

Lilaeopsis schaffneriana ssp. *recurva* evolved in the Southwest and has persisted in many locations throughout its range through historical droughts such as those of the 1950s. However, given the severity and persistence of the present multi-year drought, it is unknown how long *L. schaffneriana* ssp. *recurva* will maintain viability in de-watered habitat. It has been suggested that seed from this taxon may persist for 5 to 10 years in such situations (Titus and Titus 2008a, p. 319; Titus and Titus 2008b, p. 398; Titus and Titus 2008c, p. 463).

Most climate change scenarios predict that the American southwest will get warmer during the 21st century (Overpeck et al. 2012, p. 5; Karl et al. 2009, p. 129). Winter and spring warming causes an increased fraction of precipitation to fall as rain, resulting in a reduced snow pack, an earlier snowmelt, and decreased summer base flow (Christensen et al. 2004, p. 340; Regonda et al. 2005, p. 373). Earlier snowmelt and warmer air temperatures can lead to a longer dry season. Warmer air temperatures lead to increased evaporation, increased evapotranspiration, and decreased soil moisture. These three factors would lead to decreased streamflow even if precipitation increased moderately (Garfin 2005, p. 43). Decreased streamflow causes streams become smaller, intermittent, or dry, and thereby reduces the amount of habitat available for aquatic species such as *L. schaffneriana* ssp. *recurva*. In addition, in a warmer environment, an enhanced hydrologic cycle is expected; flood extremes could be more common, resulting in larger floods (Karl et al. 2009, p. 24) which may destroy *L. schaffneriana* ssp. *recurva* patches, and even entire occurrences, if no niches in backwaters are present to ensure recolonization.

Many springs (Robinson 2010, p. 6; Ehret 2008, p.2), cienegas (Fonseca pers. comm. January 17, 2014), creeks (Bureau of Land Management 2012, entire), and rivers (Turner and Richter 2011, pp. 2-3) that have been perennial in the past are now intermittent, have more dry reaches, or have dried up entirely. As a result, many occurrences of *L. schaffneriana* ssp. *recurva* have become reduced in density or distribution, become ephemeral, or are now presumed extirpated (see the San Bernardino National Wildlife Refuge, Bingham Cienega, Freeman Spring, Leslie Canyon National Wildlife Refuge, Lower Cienega Creek, Tucson, and Winkelman sections above). Reduced water flow can reduce the ability of *L. schaffneriana* ssp. *recurva* to grow, reproduce, and expand to new locations. Even if *L. schaffneriana* ssp. *recurva* can survive long periods of drought as seeds or rhizomes (Haas and Frye 1997), at some point increasing aridity would

eliminate the plant, including seed stock and rhizomes, from intermittent reaches (Service 1999, p. 237). For example, no *L. schaffneriana* ssp. *recurva* have been seen in Bingham Cienega since 2002; similarly, the decline and loss of *L. schaffneriana* ssp. *recurva* in Leslie Canyon in recent years was directly related to the reduction in rainfall and a lowering of the water table (Terry 2012, entire).

In summary, the best available scientific and commercial information indicates that there is a reasonable likelihood that the current drought and rise in temperatures will continue for many more years throughout the range of *L. schaffneriana* ssp. *recurva*. It is unknown how long *L. schaffneriana* ssp. *recurva* can remain dormant during an extended drought. The projected drought will likely contain periods of high year-to-year precipitation variability characteristic of Southwest climate. Whether this variability will be enough to preserve occurrences *L. schaffneriana* ssp. *recurva* remains unknown.

2.4 Synthesis

Lilaeopsis schaffneriana ssp. *recurva* is a taxon of southeastern Arizona and adjacent Sonora, Mexico, that is dependent upon wet soils. The vulnerability of its aquatic habitats to the impacts of drought, degradation, and climate change make this taxon equally vulnerable. Although new occurrences of *L. schaffneriana* ssp. *recurva* have been discovered in recent years and there have been some successes with introductions and augmentations, we are aware of eight occurrences that have been extirpated and multiple occurrences that have not been relocated in recent years. Maintaining self-sustaining, watershed-scale occurrences across the full suite of watersheds within the range of *L. schaffneriana* ssp. *recurva* is important to the survival of the taxon (Service 2014b, p. 132). Although no Recovery Plan for this taxon exists to provide quantifiable recovery criteria, the loss of so many occurrences, uncertainty of so many others, and continued threats of drought, water withdrawal, and post-fire sedimentation, among others, demonstrate a continued danger of extinction throughout its range for the foreseeable future, and thus meets the definition of endangered at this time.

3.0 RESULTS

3.1 Recommended Classification: Remain as endangered.

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change is needed

3.2 New Recovery Priority Number: No change; remain as 3C.

Brief Rationale: The taxon is both highly threatened by continued threats of drought, water withdrawal, and post-fire sedimentation, along with low population occurrences; yet it has a high potential for recovery through the conservation of aquatic resources, proper land management activities which promote and conserve functional habitat, and successful introduction and augmentation of occurrences throughout the range of the taxon. The taxon receives a ranking of 3 as it is a subspecies as opposed to a species. Because the plant is an aquatic obligate, requiring perennially moist soil habitats, conflict with human activities and economic development over fresh water resources remains. Groundwater withdrawal for mining, agriculture, Fort Huachuca, municipality use, and private wells, in addition to long term trends of drought and increasing human water use are ongoing sources of conflict, and impact survival of *Lilaeopsis shaffneriana* spp. *recurva*.

3.3 Listing and Reclassification Priority Number: N/A

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- The Draft Recovery Plan should be finalized.
- Studies of dewatered and ephemeral sites known historically to support this taxon should be conducted to evaluate the impacts of water withdrawal and drought on the seedbank and rootstock of this taxon.
- Studies should be conducted to evaluate the impacts of livestock grazing, especially in periods of drought and with regard to time of year.
- Studies should be conducted to determine the pollinator(s) of the taxon and if self-pollination is possible.
- On a regular basis, there should be standardized monitoring of *Lilaeopsis* occurrences on Forest Service, Bureau of Land Management, and The Nature Conservancy lands, especially where there are existing transects that have not been measured in many years.
- On a regular basis, there should be monitoring of surface and subsurface water levels in areas known to support *L. schaffneriana* ssp. *recurva*.
- Genetics studies should be continued to better understand the relationship of occurrences within and between the United States and Sonora, Mexico. Genetic studies of *Lilaeopsis schaffneriana* on both sides of the Continental divide are needed to determine if ssp. *recurva* occurs across a larger geographic range. Samples should be obtained from smaller occurrences, such as Mud Spring and Lone Mountain Canyon, to determine if these locations offer additional genetic variability which should be preserved.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Lilaeopsis schaffneriana* ssp. *recurva*

Current Classification: Endangered with Critical Habitat

Recommendation resulting from the 5-Year Review:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: Julie Crawford, Botanist, Arizona Ecological Services Field Office

FIELD OFFICE APPROVAL:

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

Approve _____ Date 8/1/14

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Approve _____ Date 8/21/14