

Primula maguirei (Maguire primrose)

5-Year Review: Summary and Evaluation



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**U.S. Fish and Wildlife Service
Utah Field Office - Ecological Services
West Valley City, Utah 84119**

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5-YEAR REVIEW

Primula maguirei (Maguire primrose)

1. GENERAL INFORMATION

1.1 Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (FWS) is required by Section 4(c)(2) of the Endangered Species Act (ESA) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether 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 ESA. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making including public review and comment.

1.2 Reviewers

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1.3 Methodology Used to Complete the Review

On October 6, 2008, we published a Notice of Review in the Federal Register (FR) (73 FR 58261) soliciting any new information on the *Primula maguirei* (Maguire primrose) that may have a bearing on its classification as endangered or threatened. One comment was received from the U.S. Forest Service (USFS). This comment summarized all work completed for this species by the USFS and independent researchers from 2003-2008; the information is incorporated into this review. This 5-year review was primarily written by the Utah Field Office with substantive contributions and review by the regional office. It summarizes and evaluates information provided in the recovery plan, current scientific research, and surveys related to the species. All pertinent literature and documents on file at the Utah Field Office were used for this review (see section 5 for a list of cited documents). We interviewed individuals familiar with *P. maguirei* as needed to clarify or obtain specific information.

1.4 Background

1.4.1 FR Notice Citation Announcing Initiation of This Review

73 FR 58261, October 6, 2008

1.4.2 Listing History

Original Listing

FR Notice: 50 FR 33731, August 21, 1985

Entity Listed: Species

Classification: Threatened range-wide

1.4.3 Review History

On November 6, 1991, we initiated a 5-year review of all species listed prior to 1991 (56 FR 56882). This national notice summarized the status of all Threatened and Endangered species listed under the ESA prior to January 1, 1991, but did not further discuss species status nor did it propose or change the status of any species, including *Primula maguirei*. The species' status also was considered in the 1990 Maguire Primrose (*Primula maguirei*) Recovery Plan (FWS 1990).

1.4.4 Species' Recovery Priority Number at Start of 5-year Review

At the start of the 5-year review, the Recovery Priority Number for *Primula maguirei* was 5. This number indicated: 1) the plant was listed as a full species; 2) populations face a high degree of threat; 3) recovery potential is low (see TABLE 1); and 4) that the species is not in conflict with development or other forms of economic activity

DEGREE OF THREAT	RECOVERY POTENTIAL	TAXONOMY	PRIORITY	CONFLICT
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

TABLE 1. The above ranking system for determining Recovery Priority Numbers was established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

1.4.5 Recovery Plan

Name of plan: Maguire Primrose (*Primula maguirei*) Recovery Plan (hereafter referred to as the "Recovery Plan").

Date approved: September 27, 1990

2. REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment Policy

This section of the 5-year review is not applicable to this species because the ESA precludes listing Distinct Population Segments (DPSs) for plants. For more information, see our 1996 DPS policy (61 FR 4722, February 7, 1996).

2.2 Recovery Planning and Implementation

2.2.1 Does the species have a final, approved recovery plan?

Yes. The species has a final approved recovery plan (FWS 1990).

2.2.2 Adequacy of Recovery Plan and the Recovery Criteria

The recovery plan and the associated recovery criteria have not been updated since the plan was released in 1990. Thus, the plan no longer reflects the best available and most up-to-date information on the biology of the species and its habitat. Section 4(F)(1)(B)(ii) defines “objective, measurable criteria” as those that when met, would result in a determination that the species be removed from the ESA. In order to determine whether a species is endangered or threatened, or has improved to the point of reclassification or delisting, the ESA requires an explicit analysis of the five listing/delisting factors. The recovery objectives and criteria found in the 1990 Recovery Plan do not reference the five listing/delisting factors.

The Recovery Plan sets three objectives: 1) ensure that the location and biological status, including monitoring information, of all populations are known to all management parties; 2) habitat is afforded protection; and 3) the species is protected from over-collection and commercial exploitation.

Even though the Recovery Plan does not contain objective and measurable criteria, it is still referenced in our 5-year review to the extent that it provides useful information on the species’ conservation needs.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

Criterion 1: Ensure that the location and biological status, including monitoring information, of all populations are known to all management parties.

Status: The majority of known locations of *Primula maguirei* have been mapped in databases maintained by the Utah Natural Heritage Program (UNHP), a program of the Utah Division of Wildlife Resources (UDWR). Therefore, the UNHP has historically provided the primary mechanism for managing and distributing location and trend data for rare species throughout the State, including *P. maguirei*. However, in June 2011 the UDWR reorganized, in the process eliminating its sole botanist position

and, therefore, the botany data management functions formerly provided by the UNHP. At present there is no established mechanism for maintaining or distributing location data for rare plant species in the State of Utah, including *P. maguirei*. The FWS is engaged in conversations with other partners about assuming this function; however, to date no mechanism has been agreed upon.

This data management challenge represents not just the mere maintenance and distribution of historical data, but rather a need to amend older data with more recent information gathered through additional survey and monitoring efforts. With respect to *Primula maguirei*, new data do exist that have yet to be incorporated into the databases of the UNHP. Specifically, in recent years, additional locations of the species have been discovered by persons not affiliated with or funded by the USFS, FWS, or UNHP; these locations have not yet been provided to these agencies nor have they been captured in the existing UNHP databases. The USFS also is funding ongoing monitoring activities at previously known locations; these activities also provide new information regarding the status of the species at known sites. Because *P. maguirei* occurs in such close (within a few meters) proximity to established and popular climbing routes, and because of the potential for climbing activities to change in the future (either in location, intensity or both), there is a continual need for periodic monitoring of *P. maguirei* populations. Therefore, the lack of an established repository to manage and distribute updated data represents a significant barrier to effective communications among relevant management interests as well as the ability of these entities to protect *P. maguirei*. This criterion has not been met.

Criterion 2: Habitat is afforded protection.

Status: The primary threat at the time of listing and writing the Recovery Plan was rock climbing and rappelling (see section 2.3.2.1). Since listing, the USFS has worked to address these threats through a combination of efforts including education, physical barricades and site-specific climbing closures (U.S. Department of Agriculture (USDA) 2003). Subsequent field observations also have revealed that *Primula maguirei* tends to occupy moist to perennially saturated habitats that are typically avoided along preferred climbing routes, suggesting that climbing activities may pose less of a threat to this species than previously assessed. Since 2006, the USFS has funded a monitoring program to assess the proximity of *P. maguirei* plants to climbing routes and apparent correlations between plant survival or growth and climbing activities (Sibul 2006; Torti 2008, Torti and Schen 2009; Torti 2010, 2011a). To date, this monitoring effort has failed to detect climbing-related impacts to the species. This primarily appears due to the degree of spatial separation between plants and climbing routes, the effectiveness of existing climbing closures at deterring entry into occupied habitats, or some combination of these

factors. However, at one location, *P. maguirei* has been found to persist in close proximity (2–3 meters (m)) to well-known climbing routes within a larger area visited by thousands of climbers per year (Torti 2010). These preliminary results suggest that climbers may be avoiding the specific microsites occupied by *P. maguirei*. To the extent that this is true, this pattern of recreational use may pose even less of a threat than currently believed. However, verification of this assumption would require additional, and more detailed, data collection than is occurring at the present time.

Additional protections to *Primula maguirei* and its habitat are afforded by the designation of substantial parts of Logan Canyon as a Botanical Special Interest Area (USDA 2003). This designation directs the USFS to manage the habitat of *P. maguirei* in a manner consistent with the needs of that species and other sensitive botanical resources (see section 2.3.2.4).

The USFS' combined program of education, physical barriers, selective use of climbing closures and the designation of Logan Canyon Botanical Special Interest Area have collectively and substantively reduced threats to *Primula maguirei* and its habitat from rock climbing. However, as discussed below, continued monitoring is needed to verify that patterns of climbing use (location and intensity of routes) are stable, and that *P. maguirei* is persisting in areas not subject to formal site closures. In addition, additional threats unrelated to rock climbing remain in the form of accelerated climate change. The magnitude and intensity of these threats is poorly understood, and would be informed by additional analyses (e.g., climate vulnerability analyses) recommended later in this document. Therefore, this criterion has been partially met.

Criterion 3: The species is protected from over-collection and commercial exploitation.

Status: We no longer believe over-collection and commercial exploitation is a threat to the species (see section 2.3.2.3). This recovery objective is obsolete.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 Biology and Life History

Primula maguirei is a perennial, herbaceous plant 50-100 millimeters (mm) (2-4 inches (in.) high, with showy reddish-lavender flowers. Leaves are oblong and 50 mm (2 in. long and 12 mm (0.5 in.) wide. *P. maguirei* has two types of flowers, the pin and thrum—this is referred to as heterostyly (Davidson and Wolf 2009). On the pin form flower, the female reproductive organs (pistil—produces ovules which become seeds) are higher than the male reproductive organs (stamen—produces pollen). The thrum form is the opposite (Davidson and Wolf 2009).

The different lengths of the pin and thrum flowers are adapted for pollination by different pollinators or different body parts of the same pollinator (Davidson 2010). These flower forms thus promote outcrossing (reproducing with non-related individuals) through sexual reproduction (Darwin 1877 in Bjerregaard and Wolf 2008). Bees, moths, and hummingbirds pollinate *Primula maguirei* flowers (Davidson 2010). *Primula maguirei* also can reproduce asexually, using underground rhizomes or horizontal plant stems to produce new shoots. Rhizomes allow storage of water in times of drought. This clonal growth pattern (genetically identical individuals growing together) allows recovery after periods of dormancy, such as during drought conditions (Kelso et al. 2009). The clonal nature of this species also makes it difficult to identify individual plants in the field (Sibul 2006).

Primula maguirei is distributed across a linear reach (ca. 16.5 kilometers (km) (10 miles (mi))) of Logan Canyon, with occurrences aggregated in upper and lower portions of the canyon that are separated by some 9.6 km (6 mi) of unoccupied habitat (see section 2.3.1.2). The upper and lower portions of the canyon are characterized by differences in several environmental parameters likely to influence the species' life history. The average temperature over the flowering period is 5°C (9°F) warmer in the lower canyon than it is in the upper canyon (Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). The average relative humidity also is lower (15-20%) in the lower canyon than in the upper canyon (Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). Generally, flowering occurs between mid-April and early June, but due to these environmental differences, plants in the lower canyon may begin blooming 2 to 3 weeks earlier and tend to dry out faster than those in the upper canyon (Bjerregaard and Wolf 2008; Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009).

It is unknown if there is sufficient cross pollination between the lower and upper canyon sites (Wolf and Sinclair 1997; Bjerregaard and Wolf 2008) (see section 2.3.1.3 for genetic discussion). Some investigators have noted a period of overlap (10–17 days) where both the lower and upper canyon sites are in flower, but the number of flowering individuals is low during this period (Bjerregaard and Wolf 2008; Davidson and Wolf 2009). However, observations since 2006 have revealed little to no period of overlap, suggesting a very limited potential for gene flow between these two portions of the species' very limited geographic range (Torti 2011b).

2.3.1.2 Distribution, Abundance, and Trends

Primula maguirei occurs solely within Logan Canyon, east of the city of Logan, in Cache County, Utah. The distribution of the species, like Logan Canyon itself, is linear and largely east-west in orientation (FIGURE 1). The total range of the species is narrowly distributed along a 16.5 km (10.3 mi) swath straddling highway 89 (see FIGURE 1). The elevation

gradient is between 1,400 m (4,800 feet (ft)) to roughly 1,800 m (6,000 ft). Land ownership is primarily the USFS. The range has not changed since we listed the species.

Primula maguirei occurs on cool, moss-covered dolomite cliff tops, notches and boulders where some soil has accumulated. The species may be physiologically dependent on the calcium and magnesium carbonates within its soil substrate. Generally, the species occurs on north-facing cliffs, with distribution limited by favorable temperature and moisture microhabitat conditions (FWS 1990). Snowmelt is likely an important source of moisture due to the extent of spring seepage present in the cliff habitat (IHI Environmental (IHI) 1995).

The distribution and abundance of *Primula maguirei* within Logan Canyon is not well known because it is difficult to safely gain access to the vertical, wet cliff faces even with climbing equipment; as a result, a considerable amount of suitable habitat has yet to be surveyed (Duncan 2011; Torti 2011b). Even when plants are found, the clonal habit of *P. maguirei* makes it difficult to define an individual, a primary means of assessing abundance (see section 2.3.1.1). Clumps of leaves occurring several inches apart (or more) can be physically connected along a rhizome and, therefore, part of the same genetic individual. In *P. maguirei*, rhizomes up to 9 centimeters (cm) (3.5 in.) in length have been observed connecting plants bearing the same flower type (and therefore assumed to represent a single genetic individual) (Davidson 2010). Because excavating plant material to determine whether physical connections exist increases the risk of mortality from desiccation (drying out), monitoring protocols do not recommend excavating plants. In the case of *P. maguirei*, excavation also is physically difficult because plants are rooted in rock crevices. Regardless, as with most clonal plants, the rhizome tends to deteriorate in sections as plants age, erasing evidence that clumps of leaves were once connected. Given all of these factors, it is nearly impossible to assess the number of individuals present in a given area without genetic data. In *P. maguirei*, the number of individuals that can successfully mate with one another is likely to be even smaller than the total number of genetically different individuals (e.g., genotypes) in a given population, because (as with most members of the genus *Primula*) the species is heterostylous – producing two flower forms, a pattern generally thought to encourage outcrossing (see also section 2.3.1.1). In *P. maguirei*, pollination experiments have shown reduced viability in crosses among flowers of the same type (Davidson 2010). Available data on distribution and abundance are summarized below but should be interpreted with these limitations in mind.

The current and historic distribution of *Primula maguirei* has been mapped in the database of the UNHP as 12 Element Occurrences (EOs) (UNHP 2008) (FIGURE 1; TABLE 2). Following standardized methods

used by the national network of Natural Heritage Programs, an EO represents a site-specific location in which a given species has been mapped, but may not represent a discrete population of that species (e.g., a population may consist of multiple EOs). In *P. maguirei*, EOs represent groups of plants generally separated by 0.8 km (0.5 mi) or more. *P. maguirei* currently occurs at 9 of the 12 EOs mapped by the UNHP (TABLE 2). One of the three remaining EOs may be extirpated (recent surveys have failed to find *P. maguirei* at this location despite credible earlier surveys), a second EO was mapped from an historic and obscure record dating to the 1930s that has not been relocated, and the third EO represents a case of misidentification (e.g., earlier reports of *P. maguirei* at this location were in error). The species' overall distribution has not changed since the time of listing, in that it remains known only from Logan Canyon in Cache County, Utah. However, in recent years the species has been discovered at some additional sites within Logan Canyon (Davidson and Wolf 2009; Torti and Schen 2009). These site-specific locations have yet to be incorporated as EOs in the UNHP database.

With regard to overall abundance, the 1985 listing rule estimated that all known populations collectively contained approximately 340 plants (50 FR 33731, August 21, 1985). The 1990 Recovery Plan increased this estimate to 3,000 plants, based on additional survey data (Padgett 1986; FWS 1990).

Additional surveys conducted since the 1990 Recovery Plan suggest that the total number of plants across all known populations is somewhere between 4,000 and 20,000 (Sibul 2006; Torti 2008; UNHP 2008; Torti and Schen 2009; Torti 2010, 2011a). As noted above, this rather imprecise estimate in abundance reflects the fact that a considerable amount of suitable habitat has yet to be surveyed (thus the higher estimates reflect extrapolations of available counts to these areas) as well as the inability to define an individual or a standard counting unit (e.g., clumps, rosettes, stems). Despite these limitations in available estimates, the species' populations have been qualitatively assessed as stable in a series of recent surveys contracted by the USFS (Sibul 2006; Torti and Schen 2009; Torti 2011a). However, although this monitoring effort has documented little evidence of mortality, it also has not reported any evidence of recruitment. These conclusions are largely based upon 3 years of observations at 4 of the 9 EOs, supplemented by 2 years of observation at a 5th EO. In all cases, the primary investigator has noted the preliminary nature of these data, and recommended that monitoring be continued so that the long-term viability of these populations can be better understood.

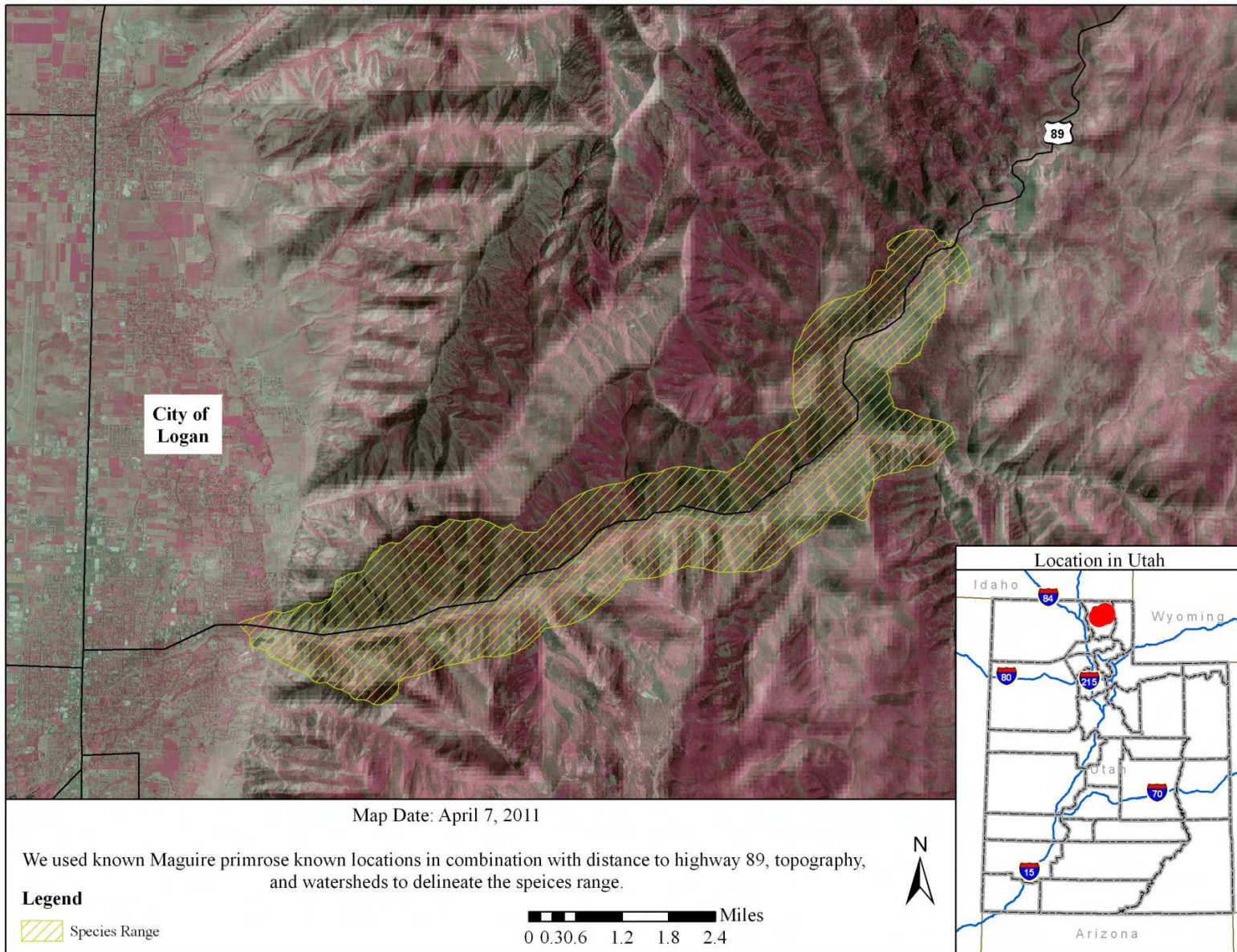


FIGURE 1. Maguire primrose range.

TABLE 2. Element Occurrences (EOs) for *Primula maguirei* as Mapped by the UNHP (2008).

EO SITE NAME	EO#	EO STATUS (as inferred by FWS)	LAST SIZE ESTIMATE (Source)	STATUS OF CLIMBING RELATED THREATS	SOURCE OF LAST CLIMBING IMPACT ASSESSMENT
Mouth of Logan Canyon Red Bridge	001	Extant	55 clumps (Sibul 2006)	No – plants close to routes, but persisting	Torti 2008, 2009, 2010, 2011a, 2011b
Lower Logan Canyon South	002	Extant	1,000-2,000 clumps (Torti 2010)	No – climbing not occurring (due to closure)	Torti 2008, 2009, 2010, 2011a, 2011b
Lower Logan Canyon North	003	Possibly extirpated	none (Sibul 2006)	No – species not present	Sibul 2006
Bierdneau Hollow	004	Historic/obscure record	none (Sibul 2006)	No – climbing not occurring (not suitable)	Sibul 2006
Clark Hollow	005	Extant	174 clumps (Sibul 2006)	No – plants not located along climbing routes	Torti 2008, 2009, 2010, 2011a, 2011b
Lower Logan Canyon South - 2nd Dam	006	Extant	110 clumps (Sibul 2006)	No – climbing not occurring (not suitable)	Sibul 2006
Right Fork Logan Canyon	007	Extant	21 clumps (Sibul 2006)	No – plants not located along climbing routes	Sibul 2006
Logan Canyon	008	In error (misidentified)	n/a (Sibul 2006)	No – species not present	Torti 2010
Woodcamp Campground	009	Extant	36 clumps (Sibul 2006)	No – plants not located along climbing routes	Torti 2008, 2009, 2010, 2011a, 2011b
Heartland	010	Extant	>600 clumps (Sibul 2006)	No – plants not located along climbing routes	Torti 2008, 2009, 2010, 2011a, 2011b
Card Canyon	011	Extant	4 clumps (Torti 2010)	No – climbing not occurring (due to closure)	Torti 2010
No name	012	Presumed extant	none (Sibul 2006)	Not assessed	Sibul 2006

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

When we listed the species and wrote the Recovery Plan, we knew that *Primula maguirei* was a rare endemic plant found within a single canyon with few individuals. No genetic information was known.

We now know that *Primula maguirei* has a relatively high level of genetic diversity for a narrow endemic. The greatest genetic differentiation occurs between the lower and upper canyon sites located roughly 10.5 km (6 mi) apart (Wolf and Sinclair 1997; Bjerregaard and Wolf 2008). However, within the upper canyon sites, even the Right Hand Fork population demonstrates genetic differences from the other upper canyon sites (Wolf 2010, pers. comm.). The species is not inbred (Wolf and Sinclair 1997).

Reasons for genetic differentiation between the upper and lower canyon sites are thought to be due to long-term separation, possibly after a period of glaciation (Bjerregaard and Wolf 2008). Alternatively, the genetic differentiation may be due to more recent divergence in microclimatic conditions at each of the sites, which has led to the upper sites flowering later than the lower canyon sites and, therefore, a lack of gene exchange between these portions of the species' range (Bjerregaard and Wolf 2008) (see section 2.3.1.2).

2.3.1.4 Taxonomic classification or changes in nomenclature.

Primula maguirei was recently determined to be one of four varieties of *Primula cusickiana* A. Gray (Holmgren and Kelso 2001). The classification is described as *Primula cusickiana* var. *maguirei* L.O. Williams (Holmgren and Kelso 2001). The physical features of the plant are as they were when originally classified and this taxonomic reclassification does not change its limited range and geographic restrictions. *Primula maguirei* is an endemic with unique ecological and physical characteristics; however, the features that distinguish *Primula cusickiana* var. *maguirei* from other varieties within *Primula cusickiana* are not substantial enough to warrant *P. maguirei* being classified at the species level (Holmgren and Kelso 2001). We recognize the synonymy (same identity) of *P. maguirei* = *P. cusickiana* var. *maguirei* and find this taxonomic change does not affect the listing or protection of the *P. maguirei* under the ESA. We recommend that the taxonomy be amended through a technical revision to the list at 50 CFR 17.12 (see section 4). Until that time, we will continue to refer to this species as *Primula maguirei*.

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

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

Rock Climbing

At the time of listing, we considered rock climbing and rappelling as threats to *Primula maguirei* (50 FR 33733, August 21, 1985). Climbing activities in general may significantly reduce plant density (Nuzzo 1995) or alter microclimate characteristics of cliff faces to be less suitable for the species. However, cliff faces used for climbing generally have lower species richness than unclimbed cliffs; sport climbers also may purposely choose climbs without the microtopographic habitats needed for vegetative growth (IHI 1995; Kuntz and Larson 2006). Because many of the established climbing routes in Logan Canyon existed prior to the listing of *P. maguirei*, we do not know whether climbing routes have altered vegetation patterns or if climbing routes were initially chosen because of the lack of vegetation.

The Recovery Plan recommended prohibiting rock climbing on cliffs where the species was present. In response to the Recovery Plan and interest by local climbers, the USFS evaluated climbing and rappelling impacts on natural resources in Logan Canyon (USDA 1992). Public meetings and field trips with interested local climbers, botanists, and conservationists documented known *Primula maguirei* habitat at existing and potential climbing areas (USDA 1992). Cooperative efforts between recreational users and the USFS (IHI 1995, Northern Utah Climbing 2010) resulted in increased outreach and research efforts to minimize effects of climbing to the plants. For example, an educational pamphlet and website were developed, climbing routes were established to avoid the plants, and climbers were educated to minimize impacts to vegetation. The climbers agreed to stop climbing in areas with known *P. maguirei* (IHI 1995).

The USFS has funded a number of studies to look at the interactions between rock climbing and *Primula maguirei* (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). These studies have examined climbing-related impacts at 11 of the 12 EO locations mapped for *P. maguirei* by the UNHP, and have consistently concluded that climbing-related impacts are not occurring at these sites (TABLE 2). The explanations for the apparent lack of conflict varied by site--at 3 sites, *P. maguirei* is not (and may never have been) present; of the remaining 8 sites, 1 was assessed as unsuitable for climbing; 2 have been formally closed to climbing by the USFS; another lacked any evidence of impacts despite the presence of *P. maguirei* within a few meters of climbing routes; and at the remaining 4 sites, plants are not located along or near climbing routes (Sibul 2006; Torti 2010, 2011a, 2011b; summarized in TABLE 2 this document). Short-term monitoring (1-3 years in duration)

at 5 of the 9 EOs where *P. maguirei* still occurs has indicated that plants are relatively stable, showing no significant mortality or decreased growth at any monitored location (Torti 2011a).

These studies have recommended that existing climbing closures remain in effect, but have not recommended additional closures based upon the apparent lack of conflict from existing patterns and levels of climbing activity (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). Instead, these authors recommend that monitoring of both *Primula maguirei* and climbing use continue in order to gain increased confidence in apparent trends as well as to verify the assumption that climbing routes and/or pressures will not change. We believe that the threats posed by rock climbing may be less than previously assessed, based on the preliminary data and short-term monitoring that has occurred so far, and we concur with the recommendations to continue monitoring to ensure that the species is adequately protected from habitat loss from climbing-related activities. Monitoring should include an adaptive management approach that utilizes the monitoring data to determine the necessity of continued monitoring and management actions. This recommendation is reflected in section 4.

Highway Improvements

At the time of listing, transportation and utility construction from the mouth of Logan Canyon to the Right Fork of Logan Canyon were considered threats to the species (50 FR 33733, August 21, 1985). Highway and utility construction had the potential to change the geomorphology of the canyon; we believed that construction could result in altered air patterns and the removal of vegetation to an extent that the microclimate habitat of the cliffs would become less suitable for *Primula maguirei*.

Since the time of listing, one highway resurfacing and bridge replacement (Burnt Bridge) project has occurred near the upper canyon *Primula maguirei* sites, from the Right Fork of Logan Canyon to Garden City (Federal Highway Administration 1995). *P. maguirei* occurrences along this stretch of highway are about 40-50 feet above the highway. Conservation measures were used to protect the species, such as avoiding construction activity in *P. maguirei* habitat, limiting removal of canyon-bottom trees (preserving microhabitat conditions of the cliff face), avoiding blasting during the flowering period, and minimizing dust during the flowering period (Federal Highway Administration 1995). Highway widening projects have the potential to impact the species. However, the Utah Department of Transportation (UDOT) does not have plans to improve the highway through at least 2030 (UDOT 2007). Therefore, we do not consider highway projects to be a threat to the species in the foreseeable future.

Campground Development

At the time of listing, we determined that campground and trail development within Logan Canyon area may impact the species (50 FR 33733, August 21, 1985). Furthermore, we were concerned with the indirect effects of altering the microenvironment of Logan Canyon by removing canyon-bottom trees for campgrounds (50 FR 33732, August 21, 1985). Two small campgrounds are currently within 0.25 mi of three known *Primula maguirei* locations. We are not aware of any loss of plants from campground activities. No major campground improvements have occurred since we listed *P. maguirei* and further campground development is now seen as unlikely given the limited space available in the canyon (Duncan 2010, pers. comm.). We no longer consider campground activities as a threat.

Maintenance and Improvement to Water Development

At the time of listing, we determined that utility construction was a threat. More specifically, the Recovery Plan stated that water development and maintenance or improvements of facilities such as reservoirs and water pipelines were threats to the species (FWS 1990). However, the only water facility in the canyon is the DeWitt Pipeline, which supplies 70% of Logan City's water (CH2MHILL 2007). We are not aware of any *Primula maguirei* occurrences within the DeWitt pipeline route (CH2MHILL 2007). The final biological assessment for the project also included best management practices and mitigation measures to reduce the likelihood negative impacts to the species would occur as a result of the project (CH2MHILL 2007). We are not aware of any additional water improvement projects planned within the vicinity of habitats occupied by *P. maguirei*. Therefore, we do not currently consider water development to be a threat.

Climate Change

At the time of listing, climate change was not considered a threat to *Primula maguirei*. Recent climatic changes, including increased temperatures and changes in precipitation, are important driving forces on ecosystems that affect a wide variety of organisms with diverse geographic distributions (Walther et al. 2002; Parmesan and Yohe 2003). For example, flowering is occurring earlier in the year for many plant species, and some species are moving to higher latitudes or altitudes (Walther et al. 2002).

In the southwestern United States, including Utah, average temperatures have increased ~ 0.8°C (1.5°F) compared to a 1960–1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 2 to 5°C (4 to 10°F) in the Southwest (Karl et al. 2009). Utah is expected to see longer periods between precipitation events, while those precipitation events become more intense (Steenburgh et al. 2007). Much of the Southwest remains in a 10-year drought, recently assessed as

the most severe western drought of the last 110 years (Karl et al. 2009). Snowpack and timing of snowpack melt is likely to be of particular importance to *Primula maguirei*. In a study of the western United States, including northern Utah, 10-20 day shifts in peak flow timing were assessed as common in basins less than 2,500 m (8,202 ft) in elevation (Regonda et al. 2005). All predictive models indicate a shift toward earlier snowmelt in the future (Rauscher et al. 2008). Snowmelt may provide a more critical water supply for *P. maguirei* than spring precipitation since the species often occupies cliff areas prone to spring-time seepage (IHI 1995). We do not fully understand how earlier snowmelt may impact this species, but anticipate that the changes predicted by most climate models could have significant adverse consequences upon the availability of suitable habitat.

Reliable projections of climate change in the West are particularly difficult due largely to its complex topography (Smith et al. 2001). It is thus difficult to predict the long-term effects of climate change on a species such as *Primula maguirei* that occurs in a relatively small area (Wolf 2010, pers. comm.). At least one location (Right Fork, EO #007 in TABLE 2) has decreased in the number of individuals and area of coverage in apparent response to dry winter and spring conditions (Shultz 1987 in IHI 1995). Another occurrence (Lower Logan Canyon North, EO #003 in TABLE 2) was located in 1982 during a wet year, but has not been observed again since (Sibul 2006). Although rhizomes may allow *P. maguirei* to store water in times of drought (see section 2.3.1.1), extreme weather events, such as persistent or prolonged drought conditions, could ultimately exceed the drought tolerance of *P. maguirei*. In 2008, HOBO data loggers were placed at 10 sites throughout Logan Canyon and programmed to record temperature and humidity every 30 minutes (Torti 2008). Torti also established 124 permanent quadrats over the course of 2 years (2008 and 2009) to record the approximate size of clumps of *P. maguirei*, the number of stems per clump, the number of flowers per stem, the pin or thrum form of the flower, as well as the general state of the flower's phenology (Torti 2008). Follow-up surveys in 2009 and 2011 suggest that plants within permanent quadrats have been relatively stable, with no significant mortality or reductions in vegetative growth (stems) or reproduction (flowers) (Torti and Schen 2009; Torti 2011a). We recommend that this long-term monitoring effort continue in conjunction with data collection from the HOBO data loggers, so that a climate vulnerability assessment can be completed for this species (see section 4).

Summary

We believe that rock climbing may pose less of a threat to the species than previously assessed. The USFS has closed a number of climbing routes (representing two discrete locations containing the species) to provide protection to *Primula maguirei*. Where climbing activities are still

occurring in or near occupied habitat, the limited monitoring data available do not suggest the existence of climbing-related impacts (Sibul 2006; Torti and Schen 2009; Torti 2010, 2011a, 2011b). In most cases, the plants' habitat is adjacent to climbing routes and not directly impacted (Torti 2010). Only in one population are there sites where the plant is in close proximity to climbing activities (Torti 2010). Even so, these plants have persisted over the course of 3 years of monitoring (Torti 2010). However, continued monitoring will be needed to verify that patterns of climbing use are stable, and that *P. maguirei* is persisting in areas not subject to formal site closures.

Water developments, campground developments, and highway expansion were considered threats at the time the species was listed. We do not believe these activities remain threats to the species, as there are no plans for development or maintenance activities in areas occupied by *Primula maguirei* in the foreseeable future. At this time, we do not have enough information to make a decision as to how climatic conditions influence long-term survivability of *P. maguirei*. Therefore, we recommend that long-term monitoring efforts continue so that a climate vulnerability assessment can be completed for this species prior to delisting.

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

Primula maguirei is an attractive plant and could be collected illegally; however, growing the plant outside its natural habitat is not easy, and thus collectors do not favor this species (50 FR 33733, August 21, 1985; FWS 1990). For example, seeds were collected by Red Butte Gardens for the purposes of propagation, but attempts at propagation were not successful (Sibul 2006).

Given the difficulty of growing this species and difficulty in accessing its cliff habitat, we do not believe overutilization for commercial, recreational, scientific, or educational purposes is a threat to *Primula maguirei* now or for the foreseeable future.

2.3.2.3 Disease or predation.

In the listing document and Recovery Plan for *Primula maguirei*, disease and predation were not considered threats to the species (50 FR 33733, August 21, 1985; FWS 1990). Herbivory from rodents is regularly encountered (Sibul 2006; Bjerregaard and Wolf 2008; Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009), primarily from bushy-tailed woodrats (*Neotoma cinerea*) and similar species (Bjerregaard and Wolf 2008). Snails of the *Oreohelix* genus were observed directly on plant leaves (Davidson 2010). Insects also may damage fruits of the plants (Sibul 2006). The magnitude of herbivory of a single individual ranges from the single flower being eaten to the entire plant being devoured (Davidson 2010).

Herbivory from rodents, snails and insects appears to affect plants; however, we do not have information indicating that it is occurring at unnatural or unsustainable levels. We have no evidence to indicate that this factor is a threat to this species now or for the foreseeable future.

2.3.2.4 Inadequacy of existing regulatory mechanisms.

There are several Federal laws and regulations that are pertinent to *Primula maguirei*. These different statutes contribute in varying degrees to the conservation of *P. maguirei*.

Federal Endangered Species Act

The ESA is the primary Federal law that provides protections for *Primula maguirei* since its listing in 1985. The ESA provides several tools to conserve the species. These are discussed below.

- Section 7(a)(1) states that Federal agencies, in consultation with us, shall carry out programs for the conservation of endangered species.
- Section 7(a)(2) requires Federal agencies to consult with us to ensure any project funded, authorized, or carried out by such agencies does not jeopardize the continuing existence of a listed species.
- Section 9(a)(2) of the ESA prohibits any person to “remove and reduce to possession any [endangered species of plants] from areas under Federal jurisdiction [or] maliciously damage or destroy any such species on any such area.”
- Section 6 of the ESA allows for cooperation between us and the State of Utah in the management and funding of projects designed to enhance the conservation of federally listed species. However, as noted above (section 2.2.3), the State of Utah (UDWR) recently eliminated its sole botany position, and has expressed a desire to have the botany data management functions formerly served by this position be assumed by another entity. As a result, the FWS’ existing Cooperative Agreement with Utah is in a state of flux, and may need to be amended with respect to the plant species currently covered in that Agreement. At the present time, the FWS has yet to identify a partner willing to be a signatory to a Cooperative Agreement addressing these plant species. Until this issue is resolved, the authorities of Section 6 cannot be applied toward the recovery of ESA listed species such as *P. maguirei*.

In the absence of the ESA’s protections, some Federal protections of the species or consideration for the species’ biological needs would remain, as described below.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) (42 U.S.C. 4371 et seq.) provides some protections for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to

implementation of such projects with a Federal nexus, the NEPA requires an agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where the analysis reveals significant environmental effects, the Federal agency must discuss mitigation that could offset those effects (40 CFR 1502.16). These mitigations usually provide some protections for listed species. However, the NEPA does not require that adverse impacts be mitigated, only that impacts be assessed and the analysis disclosed to the public. In the absence of the ESA's protections, the USFS would still be required to analyze the effects to this species because it is expected to be retained on the USFS sensitive species list if it is removed from the Federal list of threatened and endangered species (Duncan 2011; discussed below). Because USFS also has designated a substantial portion of Logan Canyon as a Botanical Special Interest Area, the agency also is already required to include in its NEPA analyses an assessment of effects to unique botanical resources, including the distinctive dolomitic limestone cliffs occupied by *Primula maguirei* (see below).

National Forest Management Act

Prior to listing, the USFS provided some protection for *Primula maguirei* by designating it as a sensitive species under the National Forest Management Act (NFMA) (Title 2600, Chapter 2670.3(2)) (50 FR 33733, August 21, 1985). If the species is removed from the Federal list of threatened and endangered species, it is likely to once again be listed as a USFS sensitive species (Duncan 2011). The NFMA requires that the USFS prepare a Biological Evaluation for USFS sensitive species for any activity that triggers NEPA analysis. Within the Biological Evaluation, the USFS must analyze the effects of any action that may impact a sensitive species and minimize the adverse affects.

Wasatch-Cache National Forest Revised Forest Plan

In 2003, the Wasatch-Cache National Forest Revised Forest Plan (Forest Plan) designated Logan Canyon as a Botanical Special Interest Area. Special Interest Areas are intended "to protect and manage for public use and enjoyment special recreation areas with scenic, geological, botanical, zoological, paleontological, archaeological, or other special characteristics or unique values" (USFS Manual 2372.02). The Logan Canyon Botanical Special Interest Area was designated because of the unique flora and number of rare and endemic plants that grow there, in particular the *Primula maguirei*. The inclusion of *P. maguirei* in the Logan Canyon Botanical Special Interest Area highlights the importance of species conservation but does not create legal or regulatory requirements (USFS Manual 2372).

Over the last several years, the USFS has funded numerous research projects to better understand *Primula maguirei*. Projects include research to better understand genetic differentiation, the natural history and breeding system, taxonomic standing, status surveys, analysis to determine

impacts of climbing on the species, and a long-term monitoring effort to assess how survival, growth, and reproduction are affected by temperature and humidity.

The Forest Plan has provided an effective tool to help manage the impacts of climbing on *Primula maguirei* (see section 2.3.2.1) (USDA 2003). The Forest Plan (USDA 2003) includes the following standards and guidelines for climbing:

- Climbing areas determined to negatively impact plant species at risk will be closed (USDA 2003).
- No live vegetation can be removed from any cliff face, top or base in areas of known at risk plant populations (USDA 2003).

The Forest Plan also includes the following two conservation measures that will minimize the impact of invasive species to *Primula maguirei* (USDA 2003):

- Management activities that negatively affect pollinators (e.g., insecticide, herbicide application and prescribed burns) should not be conducted during the flowering period of any known Threatened, Endangered, and Sensitive plant populations in the application area (USDA 2003).
- Integrated weed management should be used to maintain or restore habitats for threatened, endangered, proposed and sensitive plants and other native species of concern where they are threatened by noxious weeds or nonnative plants (USDA 2003).

The Revised Forest Plan also includes area-specific desired future conditions for at-risk botanical resources (USDA 2003). The plan indicates projects are to be developed consistent with these descriptions and that while no one project is likely to achieve all of the goals, objectives and desired future conditions, the aggregate of multiple projects over time should move toward them. Specific to the Cache Box Elder Management Area, the plan says:

Rare plant habitats will be managed to maintain or restore and provide for recovery of populations of threatened and endangered species and current and proposed Sensitive plant species. Cliff, crevice, and ledge habitats will be protected and provide for the viability of a variety of cliff species along with a balance of recreational climbing opportunities. Recreational activities (rock climbing, hiking, biking, skiing) in Maguire's Primrose and Frank Smith's Violet habitats, will be at a level that maintain individuals and habitat dynamics during key life stages including flowering and fruit production. Continued interactions with the local climbing community will provide for conservation of Logan Canyon endemics and recreational enjoyment. Reconstruction activities associated with Highway 89 will meet the requirements of the Bear River Endemics Conservation Agreement [see below] and provide for the viability of the Logan Canyon endemic species. Riparian plant habitats and rare riparian

species will be protected from trampling and overuse by livestock grazing and recreational uses. Populations of nonnative plant species will be reduced or eradicated in actual and potential rare plant habitat. Habitats will be maintained to promote pollinator success and survival and to provide for nesting needs. Proper stocking levels and utilization intensities will maintain and protect rare plants and their associated habitat. Proactive efforts will educate and inform forest users of the fundamental importance of plant species to society, plant conservation, and biodiversity. Protective measures will be provided for Maguire's Primrose and Frank Smith's Violet populations in the lower portions of Logan Canyon. Wheeler's Angelica habitat will be improved through targeted noxious weed programs and riparian conservation. The USFS requirements of the Maguire's Primrose Recovery Plan and the Bear River Endemics Conservation Agreement [see below] with FWS will be met.

We concurred with a no effect determination for the Forest Plan (USDA 2003). At the time, we considered the management prescriptions, standards and guidelines contained within these documents, and the Forest Plan to effectively mitigate the potential adverse impacts from activities allowed by the Forest Plan.

Conservation Strategy and Action Plan for the Bear River Range Endemics
In 1995, the Wasatch-Cache National Forest contracted with a consulting company to write a Conservation Strategy and Action Plan (CSAP) for the Bear River Range Endemics (Bear River Endemics Conservation Agreement), including *Primula maguirei* (IHI 1995). The purpose of the Bear River Endemics Conservation Agreement is to provide for long-term conservation of the Bear River Range Endemics through informed management (IHI 1995). The Bear River Endemics Conservation Agreement took a 3-fold approach:

- (1) Summarize the available information regarding the Bear River Range Endemics and review existing and potential threats to their continued existence.
- (2) Identify a strategy to conserve the endemic plants and their habitat and enhance their chances for continued survival as viable populations. This may prevent the need to pursue Federal listing through the ESA for candidate species.
- (3) Define a plan of action for implementing the CSAP that will be acceptable to the responsible agencies.

The Bear River Endemics Conservation Agreement outlines a number of studies that should be done to gain a better understanding of *Primula maguirei* and outlines a number of actions the USFS can implement to abate the perceived threats to the species (IHI 1995). As stated previously and discussed in section 2.3.2.1 above, the USFS has funded a number of these studies and implemented climbing restrictions and monitoring to ensure *P. maguirei* and its habitat remain protected.

Summary

Prior to listing, *Primula maguirei* was afforded some protection because the USFS designated it as a sensitive species under the NFMA. This designation requires the USFS to analyze the effects of actions they fund, authorize, or carry out that may affect *P. maguirei*. In the event that ESA protections are removed, the USFS has expressed the intention to once again designate *P. maguirei* as a sensitive species, thereby reinstating these protections. The USFS also has designated substantial parts of Logan Canyon as a Botanical Special Interest Area, a designation which directs the agency to protect and manage (in part) for the unique botanical resources present, including *P. maguirei*. This designation also will remain in effect regardless of the ESA status of *P. maguirei*. In addition, the USFS has funded numerous research projects to better understand the status of this species and its vulnerability to threats, and has closed certain areas to climbing activity as a result of concerns stemming from the perceived threats. If these existing regulatory mechanisms continue to be adequately implemented, as they have been in recent years, we regard them as likely to be sufficient to provide for the long-term protection of the species in the event that it is de-listed.

2.3.2.5 Other natural or manmade factors affecting its continued existence.

At the time of listing and the Recovery Plan for *Primula maguirei*, there were no other threats known to the species (50 FR 33733, August 21, 1985; FWS 1990). Since then, we have identified two additional potential threats to *P. maguirei*.

Invasive Species

Weed infestation is a possible threat to *Primula maguirei*. Dyer's woad (*Isatis tinctoria*) is found near 8 of the 9 sites where *P. maguirei* is found (CH2MHILL 2007). Dyer's woad is primarily found in disturbed sites, such as pastures, rangeland, cropland, woodlands, and areas of disturbed soils such as housing developments (Weber County 2004). Dyer's woad also could invade lands disturbed by fire, roads, and areas associated with grazing. Because *P. maguirei* grows within the cliff face, in cracks and crevices, we do not anticipate that this infestation will directly affect *P. maguirei*. It is possible that rockslides could occur in sites occupied by *P. maguirei*, allowing Dyer's woad to gain a foothold; however, these events are rare and would not occur with great frequency. Efforts to control Dyer's woad or other invasive exotics using herbicides and/or biocontrol agents could affect *P. maguirei*; however, conservation measures contained in the Forest Plan are adequate to avoid direct and indirect effects associated with these management activities (USDA 2003). We have no evidence to suggest that invasive exotic species are currently impacting *P. maguirei*. However, because future infestations of invasive species can be difficult to predict, this threat represents a perpetual challenge that must be periodically assessed and managed

appropriately. The Forest Plan directs the USFS to manage the threat of invasive species to the sensitive botanical resources in Logan Canyon Botanical Special Interest Area (USDA 2003). At the present time, we regard this threat as foreseeable, but adequately addressed by existing regulatory mechanisms.

Small Population Risks

Smaller numbers of plant individuals are more likely to succumb to natural catastrophes (e.g., drought, fire, and flood), environmental stochasticity (e.g., changes in weather, available pollinators, amount of predation), and demographic stochasticity (e.g., fluctuations in survival and fitness). We acknowledge that *Primula maguirei* is found in a single canyon and this limited range increases the potential for some threats to affect all known populations simultaneously. However, several factors suggest that *P. maguirei* may be less vulnerable to these risks than its limited geographic distribution otherwise suggests:

- Estimates of the total number of plants in the wild have increased from 350 (at listing) to between 4,000-20,000 clumps (see section 2.3.1.2);
- The number of locations known to support the species also has increased since the time of listing (also see section 2.3.1.2);
- The rugged and isolated habitat (i.e., moist cliff tops, notches and boulders) in which *P. maguirei* occurs appears generally unsuitable for rock climbing routes, suggesting that although climbing occurs in Logan Canyon, this threat may have less of an effect than previously thought on the habitats in which *P. maguirei* occurs; and,
- Preliminary monitoring data indicates that existing populations have been stable (low rates of mortality over the past 3 years).

These increases in abundance and the number of known locations should reduce the risk of extirpation or extinction from stochastic events. However, as noted above (section 2.3.1.2), recent estimates of abundance in *Primula maguirei* populations are either imprecise (ranging from 4,000-20,000 clumps) or speculative (the presumption of additional locations in areas that have yet to be surveyed). These estimates and assumptions need verification through additional surveys before threats from small population risk can be effectively dismissed.

Summary

At the time of listing, we did not identify any other natural or manmade factors as threats to *Primula maguirei*. We have since identified invasive species and small population risks as potential threats to the species. We have no evidence to indicate that invasive exotics are currently a threat, and existing regulatory mechanisms appear adequate to prevent this threat from impacting *P. maguirei* in the foreseeable future. Threats from small population size appear to be less substantial than the limited distribution of this species would suggest, but additional survey effort is needed to verify available estimates of the number of individuals and known locations within Logan Canyon.

2.4 Synthesis

Since listing *Primula maguirei* in 1985, we have reason to believe that the primary threat to the species (rock climbing) may be less of a threat than previously assessed, as a result of a combination of factors ranging from active management intervention (education and outreach and site closures) to improved survey data resulting in a better understanding of the location of *P. maguirei* plants relative to current climbing routes.

Based on recent field surveys and research, the population of *Primula maguirei* has remained stable since the USFS has implemented its long-term monitoring program in 2008. However, although this preliminary monitoring effort has documented little evidence of mortality, it also has not reported any evidence of recruitment. We recommend this monitoring program continue so we can fully assess patterns and levels of climbing use relative to *P. maguirei* survivorship and reproduction, as well as the ability of the species to reproduce and adapt to changing climatic conditions. The distribution of *P. maguirei* has not changed since we listed the species in 1985. Abundance estimates (now 4,000-20,000 clumps are estimated to exist across the range of the species) are greater than they were at the time of listing, due largely to increased survey efforts (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). Substantial amounts of suitable habitat have not yet been surveyed, suggesting that abundance may be greater still. Genetic variation is high within *P. maguirei*, with significant genetic differences between plants occurring in lower and upper portions of Logan Canyon. This is most likely explained by the short overlap of flowering periods and the distance (ca. 10.5 km (6 mi)) between the upper and lower canyon areas. We do not know if pollinators regularly travel the distance between *P. maguirei* sites or whether pollination between the two extreme sites provides adequate genetic connectivity.

Additional monitoring and data collection is needed to verify that rock climbing and small population size pose less of a threat to *Primula maguirei* than previously assessed at the time of listing. At the time of listing, other threats to *P. maguirei* included highway improvements, utility construction or maintenance, campground and trail maintenance, and overutilization. These threats are not expected to occur or impact the species within the foreseeable future. We also find it unlikely that *P. maguirei* is currently being impacted at the population level by herbivory (wood rats, snails, and insects) or by risks associated with small population size. Invasive exotic species are established in Logan Canyon; however, the majority of these species have not yet colonized the rocky cliff habitats occupied by *P. maguirei* and are unlikely do so in the foreseeable future. Although it will forever remain possible that these or other invasive exotic species could invade these cliff habitats, we regard the existing set of regulatory mechanisms directing the USFS to monitor and manage this threat to be adequate. Climate change is the most difficult potential threat to understand and predict how it may influence this species. Therefore, we recommend that the USFS continue to explore correlations with precipitation and humidity data in support of a climate vulnerability assessment.

3. RESULTS

3.1 Recommended Classification:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

3.2 New Recovery Priority Number

Brief Rationale

Threats were categorized as high in the past. Today we believe the combined degree of threats is low. This determination reflects that the threats for which the species was originally listed (rock climbing, highway development, campground development, and collection) have been minimized, avoided, or are not as large a threat as previously thought. In addition, we believe there is likely to be sufficient representation, resiliency, and redundancy to overcome stochastic events; however, we believe that this needs verification through additional survey effort.

A relatively low potential for full recovery was believed to exist as *Primula maguirei* is a narrow endemic reliant on micro-site habitat. Today, we believe recovery potential is high. A high recovery potential means: 1) the biological and ecological limiting factors and threats to the species' existence are well understood; 2) threats are easily alleviated; and 3) intensive management is not needed, or techniques are well documented with high probability of success (48 FR 43104, September 21, 1983). Increasing population estimates indicate that this species is not rare in its existing habitat and has likely always inhabited a restricted range. As the main known threats are relatively well understood, are being managed or could be managed with a high probability of success, we believe that a higher potential for recovery exists.

Conflict arising from construction, development projects, or other forms of economic activity for *Primula maguirei* does not occur. Taxonomic changes indicate that *P. maguirei* is a subspecies, *Primula cusickiana* var. *maguirei*. Therefore, the new recovery priority number is a **15** for *P. maguirei*. This reflects a sub-species with low threats and high recovery potential without immediate conflicts (see TABLE 1 in section 1.3.5).

4. RECOMMENDATIONS FOR FUTURE ACTIONS

- (1) Revise the species' taxonomy in the FR to reflect the best available scientific information.
- (2) Federal agencies should work with partners to resurrect the UNHP and ensure the plant portion of the database is populated and maintained.
- (3) Continue monitoring plant survivorship, growth and reproduction in *Primula maguirei* in conjunction with assessments of climbing patterns and intensities. Iteratively assess the need for changes in climbing closures and monitoring efforts.
- (4) Encourage and implement standardized and quantitative reporting of population parameters (clumps, rosettes, stems) in monitoring reports, and strengthen the use of quantitative measures to assess population (or site-specific) trends.

- (5) Conduct additional surveys in areas of potentially suitable habitat to refine and narrow the range of available estimates of total population size.
- (6) Continue collecting precipitation and humidity data (using HOBO sensors or comparable field equipment) in conjunction with monitoring plant survivorship, growth, and reproduction. Use this information to prepare a climate vulnerability assessment for this species to assess its relative vulnerability to accelerated climate change.
- (7) Encourage the USFS to iteratively assess and manage the potential for invasive exotic species to threaten sensitive botanical resources (species and habitats) in Logan Canyon, including *P. maguirei*. These activities should specifically ensure that existing infestations of Dyer's woad (*Isatis tinctoria*) have not expanded or encroached into botanically sensitive habitats.
- (8) Continue and expand prior research regarding the identity and availability of pollinators.

5. REFERENCES

- Bjerregaard, L., and P.G. Wolf. 2008. Strong genetic differentiation among neighboring populations of a locally endemic primrose. *Western North American Naturalist* 68(1):66-75.
- CH2MHILL. 2007. DeWitt Pipeline Rehabilitation/Replacement Project Biological Assessment. Prepared for USFWS on behalf of Wasatch-Cache national Forest, Logan Ranger District. August 2007. 28 pp.
- Davidson, J.B. 2010. Natural history and breeding system of Maguire primrose. Master's thesis Utah State University, Logan, UT. 64pp.
- Davidson, J.B., and P.G. Wolf. 2009. Breeding system characterization of *Primula maguirei*: a threatened, cliff dwelling, narrow endemic plant, preliminary results. Fifth Southwest Rare Plant Conference Changing Landscapes in the Southwest, Salt Lake City, UT. March 16-20, 2009.
- Duncan, M. 2010. Personal communication between Mike Duncan (Botanist with the Uinta-Wasatch-Cache Forest, Salt Lake City Utah) and Katherine Richardson (USFWS) regarding management, habitat and threats of *Primula maguirei*.
- Duncan, M. 2011. Phone conversation between Mike Duncan (Botanist with the Uinta-Wasatch-Cache Forest, Salt Lake City Utah) and Carolyn Wells (USFWS) regarding management of *Primula maguirei*. July 7, 2011.
- Federal Highway Administration. 1995. Record of Decision U.S. Highway 89 Right Fork in Logan Canyon to Garden City Final Environmental Impact Statement Cache and Rich Counties, Utah. Project No. F-021(7). Lakewood, CO. 43 pp. + appendices.
- Holmgren, N.H., and S. Kelso. 2001. *Primula cusickiana* (Primulaceae) and its varieties). *Brittonia* 53(1):154-156.

- IHI Environmental. 1995. Conservation Strategy and Action Plan Bear River Range Endemics. Prepared for USDA Forest Service, Wasatch-Cache National Forest. Purchase Order Number 48-84N8-4-0251.
- Karl, T.R., J.M. Melillo, and T.C. Peterson, (eds.). 2009. Global Climate Change Impacts in the United States. Cambridge University Press.
- Kelso, S., P.M. Beardsley, and K. Weitemier. 2009. Phylogeny and biogeography of *Primula* sect. *parryi* (Primulaceae). *Int. J. Plant Sci.* 170(1):93-106.
- Kuntz, K.L., and D.W. Larson. 2006. Influences of microhabitat constraints and rock-climbing disturbance on cliff-face vegetation communities. *Conservation Biology* 20(3):821-832.
- Northern Utah Climbing. 2010. Maguire primrose. Available on-line at <http://nuclimbing.com> [accessed January 25, 2010].
- Nuzzo, V.A. 1995. Effects of rock climbing on cliff goldenrod (*Solidago sciaphila* Steele) in Northwest Illinois. *American Midland Naturalist* 133(2):229-241.
- Padgett, W.G. 1986. Maguire primrose status report. Unpublished report prepared by Utah Native Plant Society, Logan. 15 pp.
- Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421:37-42
- Rauscher, S.A., J.S. Pal, N.S. Diffenbaugh, and M.M. Benedetti. 2008. Future changes in snowmelt-driven runoff timing over the western U.S. *Geophysical Research Letters* 35:L16703, doi:10.1029/2008GL034424. pp. 5.
- Regonda, S.K., B. Rajagopalan, M. Clark, and J. Pitlick. 2005. Seasonal cycle shifts in hydroclimatology over the western United States. *Journal of Climate* 18: 372-384, cited in: Vicuna, S. and J.A. Dracup. 2007. The evolution of climate change impact studies on hydrology and water resources in California. *Climatic Change* 82:327-350.
- Sibul, A. 2006. Final report for the 2006 survey effort for Maguire's primrose (*Primula maguirei*). Red Butte Gardens, Salt Lake City, UT. 11pp. + appendices.
- Smith, J.B., R. Richels, and B. Miller. 2001. Potential Consequences of Climate Variability and Change for the Western United States. In: *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*. U.S. Global Research Program, Washington, DC. pp. 219-245.
- Steenburgh, J., J. Horel, D. Bowling, R. Julander, T. Garrett, D. Long, R. Gillies, and T. Reichler. 2007. *Climate Change and Utah: The Scientific Consensus*. Blue Ribbon Advisory Council on Climate Change Report to Governor Jon M. Huntsman, Jr. October 3, 2007.
- Torti, S.D. 2008. *Primula maguirei*: the establishment of long-term survey quadrats. Cost-share agreement between the Forest Service and Sylvia Torti. 19 pp. + appendices.

- Torti, S.D. 2010. *Primula maguirei*: Validation of four Elemental Occurrences and co-occurrence of recreational climbing and *Primula*. Cost-share agreement between the Forest Service, and Sylvia Torti. 8 pp + appendices.
- Torti, S.D. 2011a. Long-term monitoring of *Primula cusickiana* var. *maguirei*: year four. Cost-share agreement between the Forest Service and Sylvia Torti. 8 pp. + appendices.
- Torti, S.D. 2011b. Phone conversation with Sylvia Torti (University of Utah) and Carolyn Wells (USFWS). July 7, 2011.
- Torti, S.D., and G. Schen. 2009. *Primula maguirei*: a second year survey of long-term quadrats. Cost-share agreement between the Forest Service, Sylvia Torti, and Greta Schen. 8 pp. + appendices.
- U.S. Department of Agriculture. 1992. Logan Canyon climbing and rappelling management policy. Facsimile from USDA Forest Service, Wasatch-Cache National Forests, Logan Ranger District, to Larry England, Botanist for the USFWS. Received February 18, 1992.
- U.S. Department of Agriculture. 2003. Record of Decision Revised Forest Plan Wasatch-Cache National Forest. Salt Lake City, UT. 42 pp.
- U.S. Fish and Wildlife Service. 1990. Maguire primrose (*Primula maguirei*) recovery plan. U.S. Fish and Wildlife Service, Denver, CO. 13 pp.
- Utah Department of Transportation. 2007. Long Range Transportation Plan 2007-2030: Mobility Plan for Rural and Small Urban Areas. Executive Summary. 5 pp.
- Utah Natural Heritage Program. 2008. GIS data containing exact points of plant elemental occurrences.
- Walther, G., E. Post, P. Convey, A. Menzel, C. Parmesan, T.J.C. Beebee, J. Fromentin, O. Hoegh-Guldberg, and F. Bairlein. 2002. Ecological responses to recent climate change. *Nature* 416:389-395.
- Weber County. 2004. Dyer's woad. Available on-line http://www.co.weber.ut.us/weeds/dyers_woad.php [accessed February 16, 2011].
- Wolf, P. 2010. Interview between Paul Wolf (Genetic botanist and professor at Utah State University, Logan) and Katherine Richardson (USFWS) regarding management, habitat and threats to *Primula maguirei*.
- Wolf, P.G., and R.B. Sinclair. 1997. Highly differentiated populations of the narrow endemic plant Maguire primrose (*Primula maguirei*). *Conservation Biology* 11(2):375-381.

**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Primula maguirei***

Current Classification: Threatened rangewide

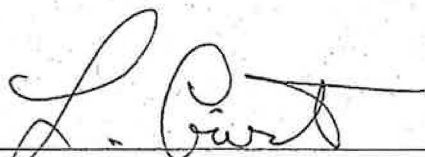
Recommendation resulting from the 5-Year Review:

At the present time, we recommend no change in status. However, this species is approaching recovery and could be delisted in the near future. Specifically, we believe delisting could move forward if sufficient progress is made on the recovery actions highlighted in section 4 above. We intend to work with the USFS to see that these actions are completed.

Review Conducted By: Utah Field Office, Ecological Services

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve 
Field Supervisor, Utah Ecological Services Field Office

Date 8/16/2011

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve 
Assistant Regional Director – Ecological Services

Date 8/18/11