

MUSSENTUCHIT GILIA

Gilia (Aliciella) tenuis

By Certified Mail

May, 2003

IN THE OFFICE OF ENDANGERED SPECIES

U.S. FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

Southern Utah Wilderness Alliance	)	Petition for a Rule to List Mussentuchit gilia
1471 South 1100 East	)	(<i>Gilia tenuis</i>)
Salt Lake City, Utah 84105	)	as Threatened or Endangered under the
(801) 486-3161	)	Endangered Species Act,
	)	16 U.S.C. § 1531 <u>et seq.</u> (1973 as
	)	Amended) and for the designation of Critical
Center for Native Ecosystems	)	Habitat;
P.O. Box 1365	)	Petition for listing
Paonia, CO 81428	)	under the Endangered Species Act,
	)	16 U.S.C. §§ 1533(b)(1)(c)(iii) and
Utah Native Plant Society)	1533(b)(7) and 50 C.F.R. § 424.20.
1564 Wasatch Drive)	
Salt Lake City, Utah 84108)	
)	
)	
)	
Petitioners)	

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I. Introduction

Gilia tenuis (Mussentuchit gilia) is a rare upland forb species, endemic to Utah and restricted to the western slope of the San Rafael Swell, in eastern Sevier County, northern Wayne County, and western Emery County, Utah. This extremely rare species is currently enjoying little to no conservation attention even as the threats of oil, gas, and mineral extraction, grazing and trampling by livestock, off-road vehicle (ORV) use, noxious weeds, collection, climate change, and land exchanges have grown in magnitude in the San Rafael region. This extremely rare species has long been neglected by the Bureau of Land Management (BLM) and the Fish and Wildlife Service (FWS). *Gilia tenuis* must be granted Endangered Species Act (ESA) protection to prevent its extinction and ensure its persistence. Petitioners hereby petition the Secretary of the Interior and the FWS to list *G. tenuis* as threatened or endangered pursuant to the ESA, 16 U.S.C. § 1531, *et seq.* and regulations promulgated thereunder, and the Administrative Procedure Act, 5 U.S.C. § 553(e).

II. Petitioners

Southern Utah Wilderness Alliance (SUWA) is a non-profit environmental membership organization dedicated to the sensible management of all public lands within the State of Utah, to the preservation and protection of plant and animal species, and to the preservation of Utah's remaining wild lands. SUWA members and staff use and enjoy public lands in and throughout Utah for a variety of purposes, including scientific study, recreation, wildlife viewing, hunting, aesthetic appreciation, and financial livelihood. SUWA members and staff call for FWS to immediately list *G. tenuis* under the ESA.

The Utah Native Plant Society is dedicated to the preservation and understanding of Utah's native flora and habitat. There is a multitude of threats to the viability of the Mussentuchit gilia in the San Rafael swell but the recent dramatic increase in the number of ORVs, including dirt bikes and all-terrain vehicles, in the area could well spell

extinction for one of Utah's most beautiful species. The Society therefore calls for the immediate listing and protection of this species under the ESA.

Center for Native Ecosystems (CNE) is a non-profit advocacy organization dedicated to conserving and recovering native and naturally functioning ecosystems in the Greater Southern Rockies and Plains. We value the clean water, fresh air, healthy communities, sources of food and medicine, and recreational opportunities provided by native biological diversity. We also passionately believe that all species and their natural communities have the right to exist and thrive. CNE uses the best available science to forward its mission through participation in policy, administrative processes, legal action, public outreach and organizing, and education.

III. *Gilia tenuis* deserves ESA listing under four out of five listing criteria

A. The present or threatened destruction, modification, or curtailment of the species' habitat or range

Oil, gas, and mineral extraction, livestock trampling, ORV use, and noxious weeds all threaten to destroy or degrade *G. tenuis* habitat.

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

Oil, gas, and mineral extraction, livestock trampling, ORV use, and collection all can extirpate isolated *G. tenuis* populations during the pursuit of commercial or recreational activities. In addition, collection of individual plant by hobbyists serve as an additional threat to individuals and very small populations.

C. Disease or predation

Neither disease nor herbivory by native grazers is considered a significant threat to *G. tenuis* at this time, but there is some evidence that they may pose a threat.

D. Inadequacy of existing regulatory mechanisms

Federal agencies, the species' dominant landowner, have largely failed to conduct comprehensive monitoring for this species, and to adequately protect it from overgrazing, ORV use, and encroaching oil and gas exploration and development. Additionally, no regulations pertaining to *G.tenuis* apply to state and private lands.

E. Other natural or man-made factors affecting the species' continued existence

The small size of most *G. tenuis* occurrences makes them extremely vulnerable to extirpation. Sensitivity to drought, climate change, and potential disruptions to plant-pollinator interactions are other causes for concern.

F. Summary

We contend that at least four out of five listing criteria apply to *G. tenuis* and that the FWS possesses adequate information to list this species under the ESA, yet it has failed to do so. FWS should list *G. tenuis* under the ESA so that this species might finally derive the benefits of legal protection that listing provides and begin to move toward recovery.

IV. Taxonomy and Nomenclature: *Gilia tenuis* Smith and Neese

Mussentuchit gilia (*Gilia tenuis*) Smith and Neese, originally named by F.J. Smith and E.C. Neese in 1989 (Smith and Neese 1989), belongs to the Polemoniaceae family and to the (former) *Gilia* section of the genus *Giliandra* (the formerly recircumscribed genus *Aliciella*), which is comprised of between 19 and 23 species (Porter and Heil 1994). The remainder of (former) *Gilia* (a polyphyletic assemblage), portions of which are neither related to each other nor to *Giliandra*, contains between 75 and 103 species in both North and South America.

Recent phylogenetic analyses within Polemoniaceae have provided evidence that the current circumscription of *Gilia* recognizes and gives taxonomic status to a polyphyletic assemblage of species. As a first step to rectifying this problem, Porter (1998) resurrected the genus *Aliciella* and recircumscribed it to include the *Gilia* section *Giliandra*. The recircumscription of *Aliciella* was part of a larger reorganization of the family Polemoniaceae as a result of recent genetic work (Porter and Johnson 2000). While the recircumscribed genus *Aliciella* is likely to be adopted by the Botanical Congress (personal communication, Mike Windham) and included in the next revision of *A synchronized checklist of the vascular flora of the United States, Canada and Greenland* (Kartesz 1994) as the true, global nomenclature (rather than *Gilia*), for the purposes of this status review the original name given the species (*Gilia*) is retained. This is in keeping with the current policies of the Utah Department of Natural Resources' Natural Heritage Program and the Salt Lake Office of the FWS, which are, for now, retaining *Gilia tenuis* at the state level for monitoring and management purposes (personal communication, Ben Franklin and Larry England).

According to Thorne (1992), the overall taxonomy of *Gilia tenuis* is listed as the following: Class Angiospermae; Subclass Dicotyledoneae (Magnoliidae); Superorder Solananae; Order Solanales; Suborder Polemoniineae; Family Polemoniaceae. It is likely that none of the existing classifications accurately reflect the inter- and intra-phylogenetic relationships of Polemoniaceae, which have been difficult for taxonomists to classify. Gene sequence data has provided evidence that Polemoniaceae is part of a lineage of "Ericalean" groups (Olmstead et al. 1992) closely related to Diapensiaceae and Primulaceae (Chase et al. 1993, Porter and Heil 1994).

A preliminary analysis of phylogenetic relationships within *Gilia* section *Giliandra* provides evidence that *Gilia tenuis* is most closely related to *G. caespitosa* (Porter 1993, personal communication, Porter, 2002), a narrow endemic species of Wayne County, Utah. The distribution of these two species relative to other *Gilia* section

Giliandra species shows that these two rare species are at the northwestern extreme of the distribution of this monophyletic lineage of the species (Figure 1). There is also evidence that these two species share a more recent common ancestor than with other *Gilia* section *Giliandra* species, and this represents recently diverged lineages that are geographically adjacent to populations of their closest relative, *G. subnuda* (Porter and Heil 1994).

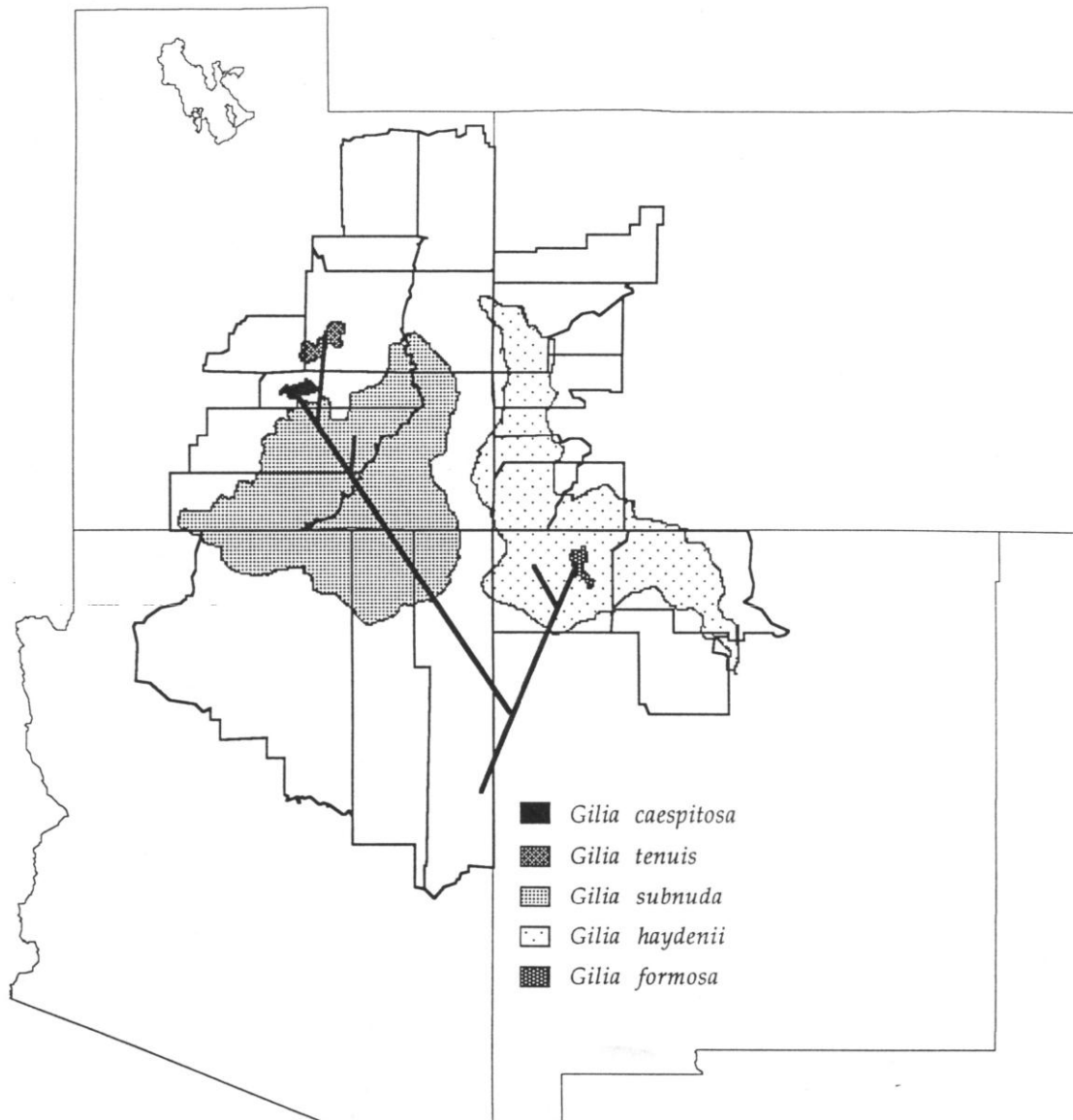


Figure 1. The geographic range of *Gilia tenuis* (per Porter and Heil 1994), and the other members of the monophyletic groups referred to as the *Gilia subnuda* Clade (Porter and Heil 1993). The phylogeny of the group is superimposed over their ranges, showing that *G. tenuis* is both a relatively more recently derived species, and part of an extension of the overall range of this clade to the northwest (Porter and Heil 1994).

A. History of knowledge of taxon

As far as is known through the literature, *Gilia tenuis* was likely first collected in 1932 by Walter P. Cottam, in the San Rafael Swell, and identified only as *Gilia*. Cottam's specimen(s) were subsequently re-analyzed by botanists in the 1950's and 1960's and were recognized as being related to either *G. subnuda* A. Gray or *G. leptomeria* A. Gray. What was likely to be *Gilia tenuis* was not collected again until 1980 when Duane Atwood and Robert Thompson found the plant near Last Chance Creek (Smith and Neese 1989). They also suggested it was closely related to *G. subnuda*. During a Threatened and Endangered plant survey in the BLM Richfield Field Office District in the 1980's, this species was again collected along Mussentuchit Creek (a tributary of Last Chance Creek) by Frank Smith. Within three years of Smith's Mussentuchit collections, additional collections were made both near Last Chance Creek and near Muddy Wash at the west base of the San Rafael Swell. As a result, *G. tenuis* was described as a new species (Smith and Neese 1989). The type specimen was collected on May 14, 1987 at the head of Mussentuchit Creek, 0.9 miles west of the Emery County line, and 6.8 air miles south of Fremont Junction, T25S, R5E, Sect 1, NW ¼, at 1900 m. elevation.

Following the description of *G. tenuis*, additional field surveys for the plant were conducted between 1989 and 1993 by Ron Kass (Kass 1990a, 1990b) and J. Mark Porter. In 1994 a status review of *G. Tenuis* was conducted by J. Mark Porter and Kenneth Heil (Porter and Heil 1994). Since the status review was completed, Debra Clark, working for both the National Park Service (NPS) and the BLM, has conducted recent surveys for the species in the San Rafael Swell and Capitol Reef National Park.

Based on the various survey work detailed above, there are no alternative taxonomic treatments at present for *Gilia tenuis*. Indeed, there is no question that *G. tenuis* is sufficiently distinct from other members of the *Gilia subnuda* lineage (*G. subnuda* A. Gray, *G. caespitosa* A. Gray, *G. haydenii* A. Gray, *G. formosa* Greene ex

Brand), based on both morphology, and genetic work (Wolf and McCracken 1998, McCracken 2001, personal communication Mark Porter, personal communication Carrie McCracken).

V. Description: *G. tenuis* is distinct from other *Gilia* species

A. Non-technical description

Gilia tenuis is a flowering plant with 1 to 5 or more stems which have a cluster of small leaves at the base (Figure 2). The stems are either naked or have very small leaves. Both the stems and the leaves have small, sticky hairs that can cause sand to adhere to them - in some cases making the plant appear to be almost white. Anywhere from two to five tube-shaped flowers cluster at the end of each stem. Flower color varies from white to deep blue, but it is usually pale blue (Porter and Heil 1994).

G. tenuis looks very much like a dwarf *G. subnuda*, but with pale blue flowers rather than red. Likewise, the tendency to have more entire leaves and more perennial habit will cause one to confuse this plant with *G. caespitosa*, but *G. tenuis* has pale blue flowers rather than red.

B. Technical description

Perennial herb from taproots and a commonly branched caudex, this clothed with brownish, marcescent leaves; stems 0.5-2 dm tall; herbage densely glandular-puberulent and typically with adhering sand grains; becoming stipitate-glandular above; basal leaves 0.4-5 cm long, 0.1-0.9 cm wide, spatulate to narrowly oblanceolate or obovate, merely toothed or pinnately lobed to entire, the blade much broader than the length of the teeth or lobes; inflorescence paniculately cymose, inconspicuously bracteate, the flowers typically solitary or few near branch ends, calyx 4-6 mm long, the triangular to lance-attenuate lobes mainly shorter than the tube; corolla pale blue, the tube 9-13 mm long, the limb 3-10 mm wide; stamens equally inserted, the anthers exerted from the corolla tube or

barely included; capsules included in the calyx; seeds few per locule, slightly mucilaginous when wet; $2n=16$ (Welsh et al 1987).

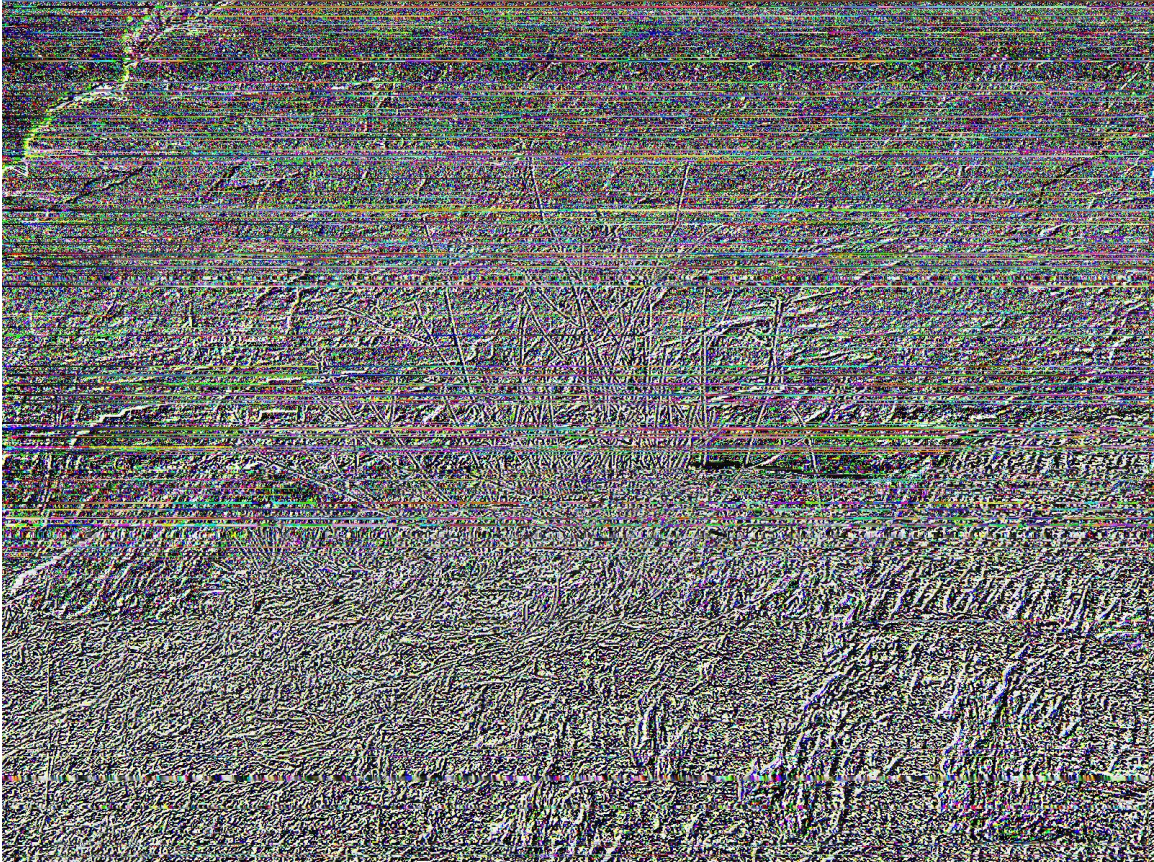


Figure 2. The Mussentuchit gilia (*Gilia tenuis*)

IV. Geographic distribution: The San Rafael Swell in southeast Utah

G. tenuis is endemic to Utah and restricted to the western slope of the San Rafael Swell, in eastern Sevier County, northern Wayne Country, and western Emery County, Utah. Within this general range the plant is found between 5,200 and 6,800 feet elevation on the appropriate geologic substrates known to contain the plant. The species ranges from near the intersection of Interstate 70 across the San Rafael Swell in the north to the Waterpocket Fold in the south.

A. Potential Habitat

The known populations of *G. tenuis* are outlined below. Potential habitat could occur in many locations throughout the San Rafael Swell, including northern Capitol Reef National Park to possibly as far north as the Wedge overlook region along the western exterior slope of the Swell. Because of the nature of *G. tenuis*, new locations of the plant are likely to be isolated from one another as well as from known populations. The most likely areas to contain populations of *G. tenuis* that are not yet discovered would include areas where the principle geologic strata that are known to support the plant (i.e. Dakota, Curtis and Navajo formations) emerge (Figure 3). In particular, areas adjacent to places already containing known populations of the plant are the most likely places to find new populations; D. Clark reported in her 2000 and 2001 survey reports that up to approximately 675 additional acres of potential habitat exists in the areas adjacent to where surveys were conducted (Clark 2000, 2001). As documented later in this petition, it is likely that much of this additional habitat is at risk.

VII. Biology, life history and population dynamics

A. Competitive interactions, and herbivory

Competitive interactions between *G. tenuis* and other plants are seldom observed, as the plant has such narrow habitat requirements and thus resides in areas where not many other species would be expected to establish (personal communication, Ron Kass, personal communication Stan Welsh, personal communication Duane Atwood). That said, if an aggressive, exotic species of plant were to become established and spread through the areas of the San Rafael Swell that contain *G. tenuis*, it would certainly be conceivable that *G. tenuis* would suffer from competition with this species (personal communication, Mark Porter). Again, the level of competition between *G. tenuis* and other species is an avenue of research that has not been studied.

(insert MS Word doc “Figure 3” here)

Figure 3. The potential range of the Mussentuchit gilia, based on suitable geologic substrates.

Similarly, very little is known about the role herbivory or seed predation may have in the life history of this plant. It is not likely that this species would be very palatable to herbivores because of the sand that is nearly always attached to the sticky stems of *G. tenuis* (personal communication, Mark Porter). Moreover, the individual that has spent perhaps the most time surveying for this species, Debra Clark, has never seen any sign of herbivory on any individuals (personal communication, October 2002). There is known herbivory on the species by an unidentified species of caterpillar (personal communication, Mark Porter). While Duane Atwood agrees that herbivory by native herbivores is likely not to be a problem for the plant, grazing by domestic livestock is likely to have more of an impact than grazing by native herbivores (personal communication, Duane Atwood). Ron Kass further pointed out that many other species of *Gilia* are readily eaten by deer (personal communication, October 2002). Stan Welsh doubts the importance of this species in the diet of any large herbivores but points out that if it is determined that *G. tenuis* is an important food source for a rare or unnamed moth or butterfly, this would pose an additional reason to protect *G. tenuis*.

B. Pollination, reproduction and seed dispersal

G. tenuis is a self-incompatible, obligate out-crossing species, pollinated by a suite of vectors, including bee, beefly, and hawkmoth (Smith and Neese 1989, Porter 1993). This is a very different situation than that of its close relatives, which are primarily pollinated by hummingbirds (Porter and Heil 1994). This phenomenon indicates a significant evolutionary shift in pollination mechanisms within the *Gilia* genus. However, very little information exists on the specific pollinators for this plant. Until detailed studies are conducted to ascertain the chief pollinators and the status of those species, there is a possibility that unidentified threats to *G. tenuis* pollinators may be jeopardizing the persistence of *G. tenuis* (Tepedino 2000).

Flowering phenology can vary slightly from year to year based on weather patterns, but generally flowering begins in mid to late May, and continues through June.

Setting of fruit closely tracks flowering, and also begins in late May. The plant overwinters as a basal rosette of leaves. In the spring, the primary axis elongates to prepare for flowering. After the plant flowers and sets fruit, axial buds of the lower leaves of the rosette develop into new basal rosettes of leaves, which must again overwinter.

Flowering may not occur every year (personal communication, Duane Atwood). Rather, it is likely induced to flower when the individual attains a certain size or carbohydrate storage level (Kass 1990b, citing Werner 1975). When Debra Clark revisited the Coal Wash population / Secret Mesa population (see *Known, Current Occurrences* section below) in May 2000, she estimated that 100% of the individuals were second year plants. This means that flowering would be expected from all individuals, but only 5% of them were flowering (Clark 2000). This erratic flowering is potentially problematic because it limits reproduction to those individuals that do flower in a given year. It also makes it uncertain whether a population has been extirpated or is simply not flowering in a given year because the plants are more inconspicuous when not in flower, and are also harder to identify¹ (personal communication, Duane Atwood; personal communication, Ken Heil; personal communication, Stan Welsh). Moreover, less reproduction occurs in dry years because fewer flowers are produced (personal communication, Ron Kass, personal communication, Duane Atwood). Of additional note is the fact that *G. tenuis* produces many fewer ovules than does its closest relatives, *G. caespitosa* and *G. subnuda* (Porter and Floyd 1993). This combination of erratic flowering and low fecundity translates into low reproductive rates, and, combined with other natural and unnatural stressors, makes *G. tenuis* vulnerable to extirpation of small populations.

Little is known of the means of seed dispersal, nor exact germination requirements, for *G. tenuis*. It is not known what role seed banks play in recruitment of this species. It is likely dispersed through wind and rain activities. However, unlike

¹ Though skilled surveyors familiar with the growth form and preferred geologic strata of the plant should

nearly all members of the Polemoniaceae family, *G. tenuis* and other members of the *Gilia* section *Giliandra* lacks a densely mucilaginous seed coat, which likely aids in seed dispersal (Grant 1959), and which is also probably helpful with binding water to the seed coat thus aiding in germination (Porter and Heil 1994). Therefore, the germination requirements for *G. tenuis* are likely different from those of other members of the Polemoniaceae which do have the mucilaginous seed coat. Overall, potential dispersal distance for this species may be quite limited. This is supported by the general isolated nature of known, extant populations.

C. Niche and rarity

G. tenuis is an important member of a very unusual vegetation association of the desert scrub community. Interestingly, it came to be a part of its current desert community via radiation from more mesic, high-elevation montane habitats into hot, low-elevation deserts.

G. tenuis is a member of a closely related group of species which display a reoccurring pattern of endemism and rarity. As noted above, *G. tenuis* and its most closely related sister species (*G. caespitosa*) are at the northwestern extreme of the distribution of the *Gilia* section *Giliandra*. There is also evidence that these two species represent recently diverged lineages that are geographically adjacent to populations of their closest relative (*G. subnuda*, personal communication, Mark Porter). This recent speciation event, combined with perennial life-history and mode of dispersal, may all contribute to the causes of rarity of *G. tenuis*. As a member of the *Gilia* section *Giliandra*, this species is helpful in understanding the origin and evolution of this unique group, as well as providing possible explanations for the high frequency of rarity in *Giliandra*. Similarly, *G. tenuis* is a member of a group that shows considerable variation in life history, suggesting that this species and its congenics may provide insight into shifts between annual and perennial habits among taxa.

still be able to identify the plant – even when not in bloom (personal communication, Duane Atwood).

In his 1990(b) survey report, Ron Kass explains that *G. tenuis* meets all the criteria for being classified as a rare taxon: 1) its small and probably fluctuating population size, 2) its edaphic specialization, and 3) its narrow geographic range (Kass 1990b). Being a perennial plant, the species is relatively long-lived (personal communication, Duane Atwood). At any rate, longevity is a trait that has been connected to rarity. Longer-lived species that are relatively slow to reproduce and have lower reproductive rates, such as *G. tenuis*, may be somewhat more susceptible to extinction (Nelson et al. 2002) because they cannot recover quickly following a population decline (Beissinger 2000). Both theory and applied research support the general conclusion that low rates of reproduction and “slow life histories” render species more at risk of extinction (Wilson and Willis 1975; Marzluff and Dial 1991).

D. Summary: these life history traits are associated with risk of extinction.

In summary, the knowledge we have on the natural history and ecology of this species paints a picture of a unique and narrow endemic. Though limited, the knowledge that we do have on the reproductive ecology of *G. tenuis* informs us that this species may flower rather erratically, produces relatively few seeds compared to its closest relatives and other desert forbs, and does not appear to disperse across long distances. These factors increase the extinction risk faced by the Mussentuchit *gilia* – especially in light of natural and human-caused disturbances in the San Rafael region. In general, the overall lack of available information on natural history and basic ecology is alarming, and strongly underscores the great need for much more ecological research on this plant.

VIII. *G. tenuis* Habitat

A. Geography, geology, and abiotic factors

G. tenuis is restricted to the sandstone outcrops and sandy detrital slopes between 5,000 and 7,000 feet elevation on the west slope of the San Rafael Swell

on the Colorado Plateau. The San Rafael Swell occurs in a relatively arid, temperate region characterized by arid to semi-arid climates where potential evaporation greatly exceeds precipitation. Mean annual precipitation, which arrives as both summer and winter precipitation, ranges from 12 cm to 25 cm. Mean annual temperatures also vary depending on elevation, and range from winter lows between -8°C and 0°C and summer highs between 30°C and 37°C (Loope 1977, Kass 1990). This region is also characterized by very low average relative humidity, which contributes to great fluctuations between diurnal and nocturnal temperatures.

G. tenuis can occur at any aspect and is most frequently associated with light-colored, coarse-textured sandstone (Porter and Heil 1994). The original paper by Smith and Neese (1989) describing the species describes it as occurring on “sparsely vegetated, fine-textured, pale, poorly cemented, Jurassic and lower Cretaceous sandstones.” It frequently occurs on cliffs, ledges and other exposed outcrops, where it grows in detritus, eolian sands or cracks in the sandstone bedrock. The plant is not restricted to a specific geological formation, but rather it is associated with a class of formations which share similar characteristics such as the Dakota, Curtis and Navajo sandstone formations (Clark 2000 and 2001), and which can range from calcareous substrates to pure sand. In all cases, *G. tenuis* is found on fine to coarse textured, easily erodible, light colored sandy substrates. Although described by other authors as occurring on limestone (Smith and Neese 1989, Atwood et al. 1991), this has been shown to essentially be incorrect (Porter and Heil 1994).

B. Floristic associations

G. tenuis occurs on the San Rafael Swell, which lies within the Canyonlands section of the Colorado Floristic Division of the Intermountain Region (Cronquist et al. 1972). The Canyonlands section is characterized by broad desert plains dissected by deep canyons, low structural upwarps and laccolithic mountains. The flora of the Canyonlands

section has its origins with both montane and desert floras (Welsh 1978), with close floristic relationships with the Mojave, Navajoan and Great Basin deserts, as well as with the montane flora from the Wasatch and Utah High Plateau ecoregions.

G. tenuis is associated with a rather unusual mixture of mountain brush, pinyon-juniper (PJ) woodlands, and cushion plants of the desert shrub association. It is most usually found in association with open pinyon pine (*Pinus edulis*) and Juniper trees (*Juniperus ostersperma*), which are in turn often mixed with some elements of Mountain Brush communities such as *Chrysothamnus nauseosus* and *Cercocarpus intricatus* (Porter and Heil 1994; Clark 2000, 2001). Multiple species of desert cushion plants are also commonly associated with *G. tenuis*. This makes the habitats containing *G. tenuis* aberrant, as most PJ woodlands are not known to contain cushion plants. Other species often associated with *G. tenuis* include *Cercocarpus montanus*, *Amelanchier utahensis*, *Shepherdia rotundifolia*, *Atriplex confertifolia*, *Ephedra toreyana*, and *Wyethia scabra*. In general, *G. tenuis* is never a dominant species in the communities where it occurs; rather it is considered an occasional to infrequent member of those communities.

There are a number of endangered plants and candidate species that have been found in association with, or nearby populations of, *G. tenuis*. These include despain footcactus (*Pediocactus despainii*), Barneby thelypody (*Schoenocrambe barnebyi*), Wright's fishhook cactus (*Sclerocactus wrightiae*), and Maguire's daisy (*Erigeron maguirei*, Kass 1990a, 1990b, personal communication, Larry England). Of these, *E. maguirei* is found significantly more often with *G. tenuis* than with almost any other forb (personal communication, Ron Kass).

C. Moisture requirements

Like all members of the *Gilia* sect. *Giliandra*, *G. tenuis* occurs in habitats associated with reoccurring, if not constant, wind and water erosion. Erosion may be largely responsible for the presence of the type of habitat *G. tenuis* prefers, which is characterized by cracks in sandstone often filled with eolian sand and detritus. These

sand-filled cracks, while seeming to be a transitory habitat, may actually offer a rather stable and relatively mesic micro-habitat (Porter and Heil 1994). In addition, *G. tenuis* has been documented at least twice on arroyos (Kass 1990, Clark 2000, 2001). Arroyos experience periodic, often annual, water-driven erosion associated with spring runoff and summer thunder showers.

While considered an upland plant, the habitats where *G. tenuis* occurs are often somewhat mesic. Arroyos, washes and other areas with eolian deposits are deposition zones - situated beneath places that receive high runoff, such as natural washes, gullies, and flow zones beneath large areas of slick rock. Water that flows into these areas and fills cracks, crevices and ledges with sand, also bring water and leaves these eolian soils moist for considerable periods (personal communication, Mark Porter).

IX. Status

A. Status of known *G. tenuis* populations

Gilia tenuis occurrences are usually widely scattered populations of a few to a few hundred individuals. *G. tenuis* has been found in only 17 locations in the world (Figure 4).² All of these are in Utah, within the western slope of the San Rafael Swell, in extreme eastern Sevier county, western Emery County, and northern Wayne County. The largest and apparently healthiest populations have been found at Prickly Pear Bend, Chimney Canyon, and the Lost and Found population site in the northern vicinity of the Last Chance Desert (Kass 1990b, Clark 2000, Clark 2001). To our knowledge, one population, in Capitol Reef National Park, has been nearly extirpated recently. Specific descriptions of each known occurrence follow below, and the numbers of the occurrences correspond to Figure 4.

² At the time this report was written, the 2002 survey report was not yet written and so the four new populations discovered in 2002 by D. Clark are not featured in this status review

(insert MS Word doc “Figure 4” here)

Figure 4. Known population locations of the Mussentuchit gilia.

1. Last Chance population. T25S, R5E, Sect 1, Willow Springs, Utah 7.5' Quad. This population occurs in Sevier county, 11 km south of Freemont Junction, and 1.5 km west of the Emery County line, at the head of Mussentuchit Creek, on the road to Last Chance Canyon. The elevation of the site is estimated to be 6000 ft (1900 m). It occurs on a parcel of land owned by the School Institutional Trust Lands Administration (SITLA).

This location is both the type, and paratype location (Smith and Neese 1989). The type location is described as “a semi barren minor ridge of fine pale sand, Dakota formation, with scattered pinyon, juniper, and other ‘mound plants’” (Smith and Neese 1989). The collectors of the type were E. Neese, F. Smith and L. Shaw, and the collection was made in May of 1987. Most of the paratype locations were also collected at the Last Chance population site, and were collected by the same individuals mentioned above, plus K. Thorne, D. Atwood, and B. Thompson.

It is possible that the Last Chance population, along with the nearby Split population (see #7, below) comprises a single meta-population, as these populations are within one mile of one another.

When this population was visited by Ron Kass in the late 1980's (Kass 1990a, 1990b), it was estimated to be around 200 individuals. Debra Clark revisited this population in May of 2000 and estimated its population to be 53 individuals. She rated the population as having the highest possible vulnerability rating (1), meaning that the population is at high risk, and that the plants may be in danger of being trampled by people or ORVs, flowers picked, and the population is within a ¼ mile of a maintained primary road (Clark 2000). Because of this perceived threat, the population was rated as marginal for defensibility in the 2000 survey - meaning that there is a low likelihood of this population being protected from extrinsic human factors. Frank Smith, one of the botanists who originally named the plant, has expressed considerable concern over these threats to the type population (personal communication, January 2003).

Another potential threat to this population, detailed in the management section below, is that the BLM land containing this population is not currently covered by any management plan.

2. **Chimney Canyon population.** T25S, R8E, Sect 22, Frying Pan 7.5' Quad. This population occurs on the northern rim above chimney Canyon, at 1800 m elevation. This population is managed by the BLM. This population was one of the original paratype populations in Smith and Neese's (1989) original naming paper for the species. This population was not revisited by D. Clark during her 2000 and 2001 surveys. Therefore, there are currently no data available on population numbers at this site. It is imperative that surveys be done soon at this site, to ascertain if individuals still exist there, and if so, in what numbers.
3. **Seger's Hole population.** T25S, R8E, SE ¼ of SE ¼ of Sect 34, Frying Pan 7.5' Quad. This population occurs in Emery County, northwest of Seger's Hole, west of Muddy Creek and north of the County line with Wayne County. It occurs on a parcel of land owned by the School Institutional Trust Lands Administration (SITLA). This population was mentioned in Porter and Heil's (1994) status report, and was visited by Ron Kass during his surveys in the late 1980's (Kass 1990b), but his survey report does not comment on population status or numbers of individuals at this site.

In 2000 Debra Clark documented 160 plants at the site, and 100% of them were flowering at the time (Clark 2000), probably because of the timing of her visit (late May). She rated the population as having a moderate vulnerability rating (2), meaning that the population is at moderate risk, that the plants may be in danger of being trampled, flowers picked, and the population is within a ½ mile of a road (Clark 2000). Clark also documented ORV activity in the area, as well as tracks from foot traffic. Because of these perceived threats, the population was rated as marginal for defensibility in the 2000 survey - meaning that there is a low likelihood of this population being protected from extrinsic human factors. Clark

revisited the site in 2001 (the only one of the 2000 sites revisited in 2001), and this time she documented only 103 plants (Clark 2001).

It is possible that the Seger's Hole population, along with the nearby Seger's Road, Bighorn Pocket, Erin's Flat, Gypsum Theory, and Seger's Overlook South populations (see #9, #10, #11, #12, #17 below) comprise a single meta-population, as these populations are within one mile or so of one another.

4. **Coal Wash population / Secret Mesa population.** T22S, R9E, Sect 24, the Blocks 7.5' Quad. This population occurs about ½ mile south of Coal Wash, and about ½ mile NW of Secret Mesa, at 6400 - 6500 ft. elevation. This population is managed by the BLM. A survey in 1989 by Ron Kass split this population into two adjacent populations that together consisted of only 10 or 20 individuals (Kass 1990a, and unpublished data provided by Larry England). Kass found the population growing on eroded sandstone slopes of the Navajo formation, in the pinyon-juniper/mountain shrub zone, in a shaded, sandy wash bottom. It was growing chiefly on north-facing slopes, and slope inclination was estimated to be 15 degrees (Kass 1990a).

D. Clark revisited this population in May 2000, and she estimated its population to be 57 individuals. She determined that 100% of the individuals were second year plants (so, neither mature, nor immature plants), and that only 5% of them were flowering. She noted in her 2000 survey report that an ORV trail is sited just below (120 yards away from) the Secret Mesa/Coal Wash population site (Clark 2000). This is the popular Eva Connover trail, and the significance of this threat is detailed in the threats section below.

5. **Prickly Pear Bend population.** T24S, R8E, South half of Sect 28, Ireland Mesa 7.5' Quad. This population occurs near Prickly Pear Bend on Muddy Creek, on lands managed by the BLM. When this population was documented by Ron Kass in the late 1980's (1990b), it was separated into the North Prickly Pear Bend occurrence and South Prickly Pear Bend occurrence but was determined to

constitute a single population. He estimated the total population to be around 500 individuals. At the time Kass conducted the survey, he stated that, “to date, this is the largest population in the San Rafael Swell” (Kass 1990b).

Deb Clark revisited this population in 2000. A nearby occurrence was named “Gilia Canyon”, and the Prickly Pear Bend occurrences were surveyed separately and summarized on separate data sheets, though the two sites are thought to comprise one population (personal communication, Debra Clark). Clearly, Clark’s Gilia Canyon and Prickly Pear sites correspond with Kass’s north and south Prickly Pear occurrences. Clark estimated the “Prickly Pear” population to be comprised of 134 individuals, and the Gilia Canyon population to be comprised of 64 individuals, for a total combined population of 198 individuals at the Greater Prickly Pear Site. Overall, she did not feel that either occurrence that comprises the greater Prickly Pear population was significantly threatened by human activities or impacts (Clark 2000).

6. **Capitol Reef Population.** T27S, R5E, Sect 25, Cathedral Mountain 7.5’ Quad. This population was documented in the Waterpocket fold, south of the Cathedral Valley Road, at the mouth of Trail Canyon at an elevation of 6170 feet, in Capitol Reef National Park. It was documented by Carrie McCracken of Utah State University in 1997 (McCracken 2001).

D. Clark revisited this population during her 2000 survey and found no trace of a population (Clark 2000). She suspects that the population was wiped out by a flood, in either the spring of 1999 or 2000 (Clark 2000, personal communication, October 2002). However, additional surveys performed by National Park Service staff in recent years have found a few plants in the vicinity of where the original population was, and so the Capitol Reef population is not considered to be completely extirpated (personal communication, Debra Clark). The NPS has not released the exact location of these individuals, nor the exact number, but the number is assumed to be very small.

7. **Split population.** T25S, R5E, SE1/4 of SW ¼ of Section 1, Willow Springs, 7.5' Quad. Debra Clark discovered this population in May of 2001, near the type locality (Last Chance population), north of the Last Chance desert. The site is at 6060 ft elevation, and it is estimated to contain 104 individuals. This population is managed by the BLM. The population was determined to be at high risk due to proximity to a maintained road. It is possible that the Split population, along with the nearby Last Chance population (see #1, above) comprises a single meta-population, as these populations are within one mile of one another. A potential threat to this population, detailed in the management section below, is that the BLM land containing this population is not currently covered by any management plan.

8. **Lost & Found population.** 25S, R5E, SE ¼ of NW ¼ of Sect. 11, Willow Springs, Utah 7.5' Quad. Debra Clark discovered this population in May of 2001, near the type locality (Last Chance population), northeast of the Last Chance desert. The site is at 6520 ft elevation, and is managed by the BLM. It is estimated to be over 1300 individuals. Currently, this is the largest population of *G. tenuis* ever documented. A potential threat to this population, detailed in the management section below, is that the BLM land containing this population is not currently covered by any management plan. There are also indications that the area where this population is found is very overgrazed, posing a considerable risk to this population.

9. **Segers Road population.** T26 S, R8E, SW ¼ of NW ¼ of Sect 2, Frying Pan 7.5' Quad. Debra Clark discovered this population in May of 2001, northwest of Seger's Hole, west of Muddy Creek and north of the County line with Wayne County. The site is at 6560 ft elevation, and is estimated to be 50 individuals. This population is managed by the BLM. Clark reported a road traversing directly through the population site.

It is possible that the Seger's Road population, along with the nearby Seger's Hole, Bighorn Pocket, Erin's Flat, Gypsum Theory and Seger's Overlook

South populations (see #3, #10, #11, #12, #17) comprise a single meta-population, as these populations are within one mile or so of one another.

10. **Bighorn Pocket population.** T25 S, R8E, NE ¼ of SE ¼ of Sect 34, Frying Pan 7.5' Quad. Debra Clark discovered this population in May of 2001, northwest of Seger's Hole, west of Muddy Creek and north of the County line with Wayne County. The site is at 6550 ft elevation. It is estimated to be 40 individuals, and is managed by the BLM. Clark reported that the site was accessible to ORVs, and that 6 plants were found dead.

It is possible that the Bighorn Pocket population, along with the nearby Seger's Road, Seger's Hole, Erin's Flat, Gypsum Theory, and Seger's Overlook South populations (see #9, #3, #11, #12, #17) comprise a single meta-population, as these populations are within one mile or so of one another.

11. **Erin's Flat population.** T25 S, R8E, SW ¼ of NW ¼ of Sect 34, Frying Pan 7.5' Debra Clark discovered this population in May of 2001, northwest of Seger's Hole, west of Muddy Creek and north of the County line with Wayne County. The site is at 6440 ft elevation. It is estimated to be comprised of only three individuals. This population is managed by the BLM. Yet, she estimated that over 100 acres of additional potential habitat exists in the immediate area. The importance of adequately protecting this remaining habitat, in the hopes of this tiny population expanding, cannot be over-emphasized.

It is possible that the Erin's Flat population, along with the nearby Seger's Road, Seger's Hole, Bighorn Pocket, Gypsum Theory, and Seger's Overlook South populations (see #9, #3, #10, #12, #17) comprise a single meta-population, as these populations are within one mile or so of one another.

12. **Gypsum Theory population.** T25 S, R8E, SW ¼ of Sect 34, Frying Pan 7.5' Debra Clark discovered this population in May of 2001, northwest of Seger's Hole, west of Muddy Creek and north of the County line with Wayne County.

The site is at 6640 ft elevation. It is estimated to be comprised of 60 individuals. This population is managed by the BLM. Clark found ORV tracks 20 yards from some of the plants. The BLM has recently installed a watering trough for cattle in the area, and is commonly used by cattle. This trough, filled up regularly by tanker truck deliveries, is within $\frac{3}{4}$ of a mile from the Gypsum theory population and is easily accessed by cattle.

It is possible that the Gypsum Theory population, along with the nearby Seger's Road, Seger's Hole, Bighorn Pocket, Erin's Flat, and Seger's Overlook South populations (see #9, #3, #10, #12, #17) comprise a single meta-population, as these populations are within one mile or so of one another.

13. **Horsefly Hell population.** T24S, R8E, SW $\frac{1}{4}$ of NW $\frac{1}{4}$ of Sect 18, Ireland Mesa 7.5' Debra Clark discovered this population in June of 2001, upstream from Prickly Pear Bend, on Muddy Creek. The site is at 5320 ft elevation, and is managed by the BLM. It is estimated to be comprised of 175 individuals. 50% of the population was determined to be immature, and 50% mature.

14. **Lost Wash population.** T25S, R8E, NW $\frac{1}{4}$ of NW $\frac{1}{4}$ of Sect 10, Ireland Mesa 7.5' Debra Clark discovered this population in September of 2001, near John's Hole Overlook, north of Chimney Canyon and west of Muddy Creek. The site is at 6140 ft elevation. It is estimated to be comprised of 75 individuals. This population is managed by the BLM. Plants were documented in the wash, and so these individuals are at risk of being extirpated by a flood (like the Capitol Reef population nearly was).

It is possible that the Lost Wash population, along with the nearby Keyhole and South of Slaughter populations (see #15 and #16, below) comprise a single meta-population, as these populations are within one mile of one another.

1. **Keyhole population.** T25S, R8E, SW $\frac{1}{4}$ of SW $\frac{1}{4}$ of Sect 10, Ireland Mesa 7.5' Debra Clark discovered this population in September of 2001, near John's Hole

Overlook, north of Chimney Canyon and west of Muddy Creek. The site is at 6480 ft elevation. It is estimated to be comprised of 25 individuals. This population is managed by the BLM.

It is possible that the Keyhole population, along with the nearby Lost Wash and South of Slaughter populations (see #14 and #16) comprise a single meta-population, as these populations are within one mile of one another.

2. **South of Slaughter population.** T25S, R8E, SW ¼ of Sect 10, Ireland Mesa 7.5' Debra Clark discovered this population in September of 2001, near John's Hole Overlook, north of Chimney Canyon and west of Muddy Creek. The site is at 6120 ft elevation. It is estimated to be comprised of 89 individuals. This population is managed by the BLM.

It is possible that the South of Slaughter population, along with the nearby Lost Wash and Keyhole populations (see #14 and #15) comprise a single meta-population, as these populations are within one mile of one another.

3. **Seger's Overlook South population.** T25 S, R8E, SE ¼ of Sect 34, Frying Pan 7.5' Debra Clark discovered this population in May of 2001, northwest of Seger's Hole, west of Muddy Creek and north of the County line with Wayne County. The site is at 6720 ft elevation. It is estimated to be comprised of 21 individuals. This population is managed by the BLM.

It is possible that the Seger's Overlook South population, along with the nearby Seger's Hole, Seger's Road, Bighorn Pocket, Erin's Flat, Gypsum Theory and Seger's Overlook South populations (see #3, #9, #10, #11, #12, above) comprise a single meta-population, as these populations are within one mile or so of one another.

A. Summary: Current status

Currently there are a total of 2,353 individual *G. tenuis* plants thought to exist. Of the 17 known occurrences of *G. tenuis*, only 25 percent (four occurrences) may be considered even of moderate size (over 100 individual plants, which is certainly not large by any standard other than comparison with most known populations). Of all the remaining known populations, 19 percent (three occurrences) are extremely small - less than 25 individual plants confirmed at each location. The population size is unknown for two of the occurrences (Chimney Canyon, and the nearly extirpated Capitol Reef population) and so these sites should be resurveyed in the near future. Overall, this means that many of the known populations of *G. tenuis* are quite small compared to other forbs in similar environments; therefore they could be additionally vulnerable to disturbances. The specific disturbances to which this species is known to be susceptible to are outlined in detail below.

D. Clark's recent survey (2000) that sought to document and report on the status of previous known populations found only 510 individuals out of a previously known 720 individuals. Further, in 2000 no plants were found at the previously recorded site in Capitol Reef National Park, due to a large flood that washed out this small population (Personal communication, Debra Clark). While the 2001 surveys were more intensive (the person/search hours were more than quadrupled), and did result in a number of new populations being discovered, the survey report states, "this is the most amount of time spent searching for a species resulting in the least number of plants found" (Clark 2001). The intrinsic rarity of this plant can certainly be deduced from this statement alone.

Another important point to consider when determining status of a plant species is its general reproductive success from year to year. Most of the previous surveys for *G. tenuis* have not adequately collected demographic data on the species. Many assessments (i.e. Shultz and Shultz 1984; Kass 1990a, 1990b) suggest that the presence of rosettes of leaves denotes high seedling establishment and survival. However, reproductive success

cannot really be assessed in this fashion, as these rosettes may be juveniles, or persisting rosettes from old, senescent individuals - not actively reproducing plants. Furthermore, *G. tenuis* is expected to germinate in the spring (as do all other members of *Gilia* section *Giliandra* for which information exists), and most surveys for *G. tenuis* are conducted in the spring. However, apparent reproductive success in the spring doesn't necessarily mean there is good recruitment into the population if there is high summer mortality, which can often be the case.

According to the best available knowledge, *G. tenuis* is limited to the 17 occurrences discussed above which have been inventoried at a total of around 2,350 individuals, but no estimate is given for two of these sites. In comparison, a review of the first ten ESA-listed plant species (in alphabetical order) that occur in Utah reveals that at least five of the ten species had larger estimated total populations when they were listed than *G. tenuis* does currently. These five listed species are: *Asclepias welshii* (Welsh's milkweed), listed as Threatened in 1987 with 11,000 individuals; *Astragalus desereticus* (Deseret milkvetch), listed as Threatened in 1999 with between 5,000 and 10,000 individuals; *A. holmgreniorum* (Holmgren milkvetch), listed as Endangered in 2001 with between 10,030 and 11,030 individuals; *A. montii* (heliotrope milkvetch), listed as Threatened in 1987 with 10,500 individuals; and *Cycladenia jonesii* (Jones cycladenia), listed as Threatened in 1986 with 7,500 individuals. Clearly, *G. tenuis*, with a total estimated population size of fewer than 2,400 individuals, is in good company with these other listed species found in Utah.

Currently, all known sites for this plant are on federal or state lands, primarily on lands managed by the Price and Richfield Field Offices of the BLM, with two locations on State-held lands, and one (nearly extirpated) occurrence in Capitol Reef National Park (Clark 2000 and 2001). While some would consider a plant where the majority of the species occurs on federal lands to be secure, the opposite is in fact true, and this species is quite threatened. As detailed below in the "Threats section," the nature of the San Rafael Swell, where all extant populations are found, is such that much of the area is

considerably threatened by overgrazing, ORV activities, and oil and gas exploration and development.

1. Past and Present Conservation Efforts

Since most of the occurrences of *G. tenuis* are on BLM land, the BLM has been responsible for much of the monitoring and study of the species to date. The Richfield District of the BLM conducted surveys for plant species of concern in the San Rafael Swell, including *G. tenuis*, in the late 1980's (Kass 1990a, 1990b). As discussed above, D. Clark has been surveying for the species in recent years.

As explained below, there are several current, and imminent future threats to the current *G. tenuis* populations, but so far only some of these have been given the research attention they deserve. In addition, very no direct action has been taken to protect known *G. tenuis* populations from threats or disturbances.

There have been numerous conservation efforts proposed to preserve all or portions of the San Rafael Swell. This includes: the original six (and part of a 7th) Wilderness Study Areas (WSAs) the BLM designated in the region as a result of their original 1982 wilderness inventory on BLM lands; a counter proposal by the Utah Wilderness Coalition for additional wilderness units - many of which are located in the San Rafael Swell; a short-lived effort to designate a portion of the Swell as a National Park in the mid 1980's; a recent (1999) failed Congressional effort to designate the area as a National Conservation Area; and an unsuccessful push to designate much of the Swell as a National Monument. The interest shown by Congress, the state of Utah, Emery County, native Utahans and local environmental groups underscores the fact that most of these interests acknowledge the biological and ecological importance of this part of Utah. This includes its role as a storehouse for what is largely considered to be one of the greatest concentration of rare endemic plants in the state (personal communication Mike Windham, personal communication Stan Welsh). Unfortunately, even with these past

conservation efforts in the region, *G. tenuis* is still at significant risk.

X. *G. tenuis* meets at least four of five criteria for listing

Habitat loss and degradation, overutilization, livestock grazing, inadequate regulatory mechanisms, small population size, drought, and an unstudied pollination system all threaten the persistence of *G. tenuis*.

A. The present or threatened destruction, modification, or curtailment of the species' habitat or range

Oil, gas, and mineral extraction, livestock trampling, ORVs, and noxious weeds are causing *G. tenuis* habitat loss, degradation, and fragmentation.

1. Oil, gas, and mineral extraction threaten much of *G. tenuis* occupied and potential habitat

One of the most severe threats facing *G. tenuis* occupied and potential habitat is expanded and expedited oil and gas exploration and development in the San Rafael Swell. In fact this threat may very well constitute the principle present or future threat of destruction, modification, or curtailment of habitat available within the range of *G. tenuis*. All forms of oil, gas, and mineral extraction are associated with surface disturbances that may result in destruction of *G. tenuis* and/or its habitat. Access roads, pipelines, well pads, and mines all may destroy habitat for this species.

There are multiple layers of habitat disturbance that are widely known to accompany oil and gas development. Access roads permanently reduce and fragment habitat and provide additional long-term opportunities for ORV intrusions into sensitive habitats. The amount of road development per well pad constructed is partly a factor of well density, but recent estimates include one mile of road per oil well (USFS Bridger-Teton National Forest 2000), 0.4 miles of road per conventional natural gas well (BLM, Pinedale Field Office 2000), and 0.3 miles of road per coalbed

methane well (BLM, Buffalo Field Office 2002). Comer (1982) explains that after an oil or gas field is developed, it experienced increased recreation activities, particularly by ORVs. New powerlines, pipelines, and railroad tracks are often constructed, further reducing and fragmenting habitat (Weller et al. 2002). Ground disturbances may introduce noxious weeds (Shuman and Whicker 1986), eliminate mycorrhizal fungi (Knapp 1996), and destroy biological soil crusts (Belnap 1995). Waste products contaminate habitat (Clarren 1999; Clifford 2001). Particularly insidious for species like *G. tenuis*, oil and gas mining can remove rock outcrops that provide important habitat for specialized species (Weller et al. 2002, citing BLM 1999).

Seismic exploration involving the use of vibroseis, or “thumper trucks” (Figure 5) is the precursor to oil and gas drilling, and is very destructive to sensitive plants and their habitats, and fragile desert soils. Seismic activities crush large swaths of vegetation, destroy biological soil crusts, compact soils, bury vegetation, decrease nitrogen fixation activity, introduce noxious weeds, and increase soil erosion by wind and water, (Boyle and Connaughton 2002; BLM, Moab Field Office 2002). Exploration conducted by shot hole explosives also requires the use of vehicles such as drilling rigs and recording trucks (Evans 1997). The effects of seismic exploration are long-lasting, and may persist for 50-300 years after activity ceases (BLM, Moab Field Office 2002; Belnap 2002). Routes used for seismic exploration often turn into established roads (McLellan and Shackleton 1989; Crawford 2001; Zimmermann 2001; Belnap 2002; BLM, Moab Field Office 2002; Conway 2002). In fact, the BLM has acknowledged that tracks from seismic exploration conducted in the 1970’s remain visible in 2002, and are often used as roads and trails by motorized vehicles (BLM, Moab Field Office 2002).



Figure 5. Vibroseis trucks on the West Pinedale 2D Geophysical Exploration Project Area, Green River Basin, Wyoming. Photo by Scott Groene.

There have been very limited scientific studies of the impacts of vibroseis trucks on desert soils, but one study completed by Menkens and Anderson (1985) in Wyoming reported that soil compaction within the vibroseis truck tire tracks was significantly higher than in untracked areas, and remained so 14 months after the study was completed. An even later visit to the site (two years after the study was completed) revealed that vegetation within the tire tracks had yet to recover. Only one vibroseis truck was used in the Wyoming study - but typically multiple trucks are used in seismic exploration (Evans 1997; BLM, Moab Field Office, 2002).

Few detailed scientific studies have been made of the effects of soil compaction on plant form and function. Such studies of single passes of tanks on maneuver in the Mojave Desert, however, show that such effects are certain to occur (D. Prose, unpublished data). Prose's studies show long-term effects of both soil compaction and surface disturbance caused by a single pass of a tank on typical Mojave Desert soil. These effects include larger numbers of annual plant species growing within tracks compared to adjacent undisturbed areas, but the plants in the tracks are much smaller and provide less cover for the soil than individuals of the same plant species in control areas. Further, the species composition shifts so that annual plants with lateral root spreading grow more easily within the tracks than those with vertical tap

roots, because a veneer of sediment accumulates in the track depressions resting on a zone of compacted soil less than a centimeter below the surface. These studies of tanks, which are not as heavy as vibroseis trucks, indicate that profound alternations of the desert plant community can ensue as the result of seismic exploration.

Currently, conventional oil and gas leasing on Utah BLM lands is increasing at an accelerated rate. From 1999 to 2001, the BLM sold 556 oil and gas leases involving almost 750,000 acres of public lands in Utah, primarily in eastern and southeastern Utah. These expedited lease sales are also resulting in more permits to drill; between 1999 and 2001, the Utah BLM approved over 900 of the Applications for Permit to Drill (APDs) that it received. The surge of oil and gas exploration and development that is underway in the San Rafael Swell will have a considerable impact on *G. tenuis* populations and populations of other rare desert plants in this fragile region.

In addition to the expedited threat of new oil and gas exploration and development in Utah, and in the San Rafael Swell specifically, wells are spaced closer now than ever before. In Colorado, for example, wells are permitted to be spaced every 10 acres currently (CNE 2002), while 40 years ago 640 acre spacing was the maximum permitted (Clarren 1999). The proposed Nebulous/Shenendoah oil and gas development in the Uinta Basin in Utah will use spacing of less than 40 acres (personal communication, Ed Forseman, BLM, personal communication Bob Lopez, BLM,). In general in Utah, spacing varies between 40 and 160 acres (personal communication, Diana Mason, Utah Division of Oil, Gas and Mining). In addition, now new wells are being drilled in existing oil and gas fields to take advantage of more relaxed spacing regulations, thus making it harder to avoid impacts to sensitive species. In the past ten years, advanced technology has allowed for year-round drilling, which has also increased the rate of oil and gas development (CNE, 2002).

In 2002 the national BLM office in Washington, D.C. instructed all Field Offices to include a new Threatened, Endangered and Sensitive Species stipulation, which effectively defers all analysis and consultations on these species to the APD phase for all lease sale parcels (Bisson 2002). The consequence of this is that even lands with

known populations of sensitive and listed species may be leased for oil and gas development with no habitat analysis or consultation until an APD is filed. Restricting development at the APD phase is notoriously difficult because of the monetary investment that the lessee has already made.

Further, by its own terms the Bisson memo does not apply to all sensitive species, as the ambiguous wording of the memo leaves the agency broad discretion to disregard sensitive species in the path of oil and gas development:

“The lease may now or hereafter contain plants, animals or their habitats determined to be threatened, endangered, or **other special status species**. BLM **may** recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activity that will contribute to a need to list such a species or their habitat. BLM **may** require modifications to or disapprove proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species...” (emphasis added)

In terms of the impacts of oil and gas exploration to *G. tenuis* specifically, current federal oil and gas leases overlap with the Last Chance Population (the type locality), as well as the nearby Split population, and Lost & Found population (Figure 6). In addition to the threats that oil and gas wells and current and future leases pose to known populations of *G. tenuis*, these activities pose a considerable threat whenever they are sited in the known range of the species (Figure 6). Currently, there are 10 wells (both active and shut-in with the possibility of becoming active again) that overlap potential *G. tenuis* habitat. But what is far more disturbing is the acreage of current and future oil and gas leases that overlap predicted *G. tenuis* habitat. About 30,000 acres of land are already leased within the plant’s habitat, and over 13,000 additional acres were just leased in this the November, 2002 lease sale (Figure 6). In addition, an April 2003 lease offering on SITLA lands threatens both the Split population, and Lost & Found population (Figure 6). These leased areas are of critical concern, as there are still many places that may contain new populations of *G.*

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Figure 6. Oil, gas, and mining impacts to known Mussentuchit gilia populations, and *G. tenuis* habitat.

tenuis that have not yet been surveyed, and there are untold amounts of federal and state lands that could very well be offered for lease in the very near future. Other than the occasional surveys that documented the original six (extant) populations that were discovered before 2000, anything resembling extensive surveys for new populations were not conducted until very recently. There are likely undiscovered populations in the region, and with the acreages being leased for oil and gas exploration and development, one or more of these unknown populations might be in the path of future seismic exploration and oil and gas development.

a. Mineral extraction results in habitat loss

The chief form of mineral extraction that is ongoing in the San Rafael Swell is gypsum mining (Figure 6 – most active mines are gypsum). The removal of gypsum from the soil requires the complete removal of topsoil. This impacts not only the area where soil is removed, but also a larger area that includes soil spoil mounds, vehicle work areas, and access routes.

The Last Chance (Type locality), Split and Lost & Found populations all exist on a portion of the Curtis formation that is particularly rich in gypsum deposits. The Resource Management Plan (RMP) for the San Rafael states that over 290,000 acres on the west side of the resource area near the Last Chance population and squarely within the potential range of *G. tenuis* are open for mining claims and have high potential for occurrence of gypsum (BLM 1991). Furthermore, and as is described in more detail below, the actual locations of the Last Chance, Split and Lost & Found populations are just west of the Sevier/Emery county line, and are within a small sliver of BLM land that is not currently covered by any active land use plan (BLM 1991; San Rafael Resource Area RMP Record of Decision 1991; personal communication, Tom Gnojek, BLM; personal communication, Frank Erickson, BLM; personal communication, Tim Finger, BLM). This lack of management direction provides less protection of known populations of *G. tenuis* and less intensive or no additional survey requirements for the plant in the event of new gypsum mining operations in this area.

Other minerals taken out of the San Rafael Swell include bentonite and zeolite. The active mine immediately adjacent to the Last Chance, Split and Lost & Found populations, owned by Western Clay Company, is currently producing bentonite and zeolite (Figure 6). All mining involves various degrees of surface disturbance. Access roads and transportation corridors must be constructed, waste rock must be disposed of, and processing facilities must be built. While mineral extraction is less widespread in *G. tenuis* habitat than oil and gas exploration and development, this sort of mining has the undeniable potential to cause population-specific habitat loss and degradation. Operating mines have impacted thousands of acres of desert land in Utah and threaten even more.

Secondary impacts of mineral extraction may be the most severe. ORV and passenger vehicle use on old mining roads are a common secondary impact. Livestock grazing use of rangelands increases in areas where mining roads now offer vehicle access to install grazing facilities and manage livestock. The management stipulations for mining rarely call for post operation closure and restoration of mine sites or access roads.

2. Livestock trampling destroys *G. tenuis* habitat

Decreases in native plant species diversity, cover and density as a result of livestock grazing have been observed in a wide variety of arid ecosystems in the western U.S, including those of the Colorado Plateau of southern Utah. Moreover, these kinds of alterations to the vegetative community can in turn lead to significant repercussions for successional trajectories, the abiotic environment, and wildlife (Jones 2001).

One of the chief ways cattle grazing affects vegetative communities is by altering species composition of plant communities. This happens in two ways: 1) active selection by herbivores for, or against a specific plant taxon, and 2) differential vulnerability of plant taxa to grazing. Grazing can also delay plant phenology, which in turn can have dramatic effects on communities of pollinators and seed dispersers

(Fleischner 1994), thereby further disrupting the composition of a vegetative community. Studies that have documented significantly greater native plant species richness in ungrazed areas compared to those that are grazed include Brady et al. (Arizona - 1989), and Floyd-Hanna et al. (New Mexico - 2000).

While cattle grazing has been shown to decrease species richness in arid communities, it similarly affects species evenness, with considerable secondary effects. Long-term cattle grazing has been shown to decrease the abundance of perennial grasses and forbs and increase the amount of annual grasses and weeds in western U.S. deserts (in northern Arizona-Schmutz et al. 1967; the Great Basin-Rice and Westoby 1978; central Utah-Brotherson and Brotherson 1981; California-Hanley and Page 1981; and Nevada-Medin and Clary, 1990). Any significant grazing-induced changes in cover, densities or relative abundances of certain plant species or guilds can in turn have profound implications at the community level, as these changes can translate into major conversions of community organization, for example, transforming grassland to desert (Schlesinger et al. 1990).

One particularly insidious result of cattle grazing in arid western ecosystems is the spread of exotic grasses and weeds. Grazing aids the spread and establishment of alien species in three ways: 1) dispersing seeds in fur and dung; (2) opening up habitat for weedy species; and 3) reducing competition from native species by eating them (Fleischner 1994). Studies that have found increased densities, cover or biomass of exotic plant species in grazed versus ungrazed sites include Green and Kaufman (Oregon -1995), Drut (Oregon - 1994) and Harper et al. (Utah - 1996).

Table 1 illustrates grazing density in the allotments known to contain populations of *G. tenuis*. As discussed above, high densities of cattle would be considered most detrimental to populations as higher densities of cattle may result in cattle feeding on what is likely not a preferred source of forage (*G. tenuis*) and may also force cattle to forage further from water sources, thus exposing populations to potential trampling.

Table 1. BLM Grazing Allotments known to contain populations of the Mussentuchit gilia, and season of use, permitted AUM's, and estimated grazing density for those allotments.

Allotment	Season of use	AUM by season	total permitted AUMs	allotment acres	acres/AUM
Wood Hollow	3/1 - 6/15 11/15 - 2/28	102 150	252	17,023	67.6
Lone Tree	11/1 - 4/15 11/1 - 4/15 11/1 - 4/15 11/1 - 4/15 11/1 - 4/15	2369 98 1337 284 1157	5245	120,580	23.0
Mussentuchit	3/1 - 5/31 11/1 - 2/28	865 1128	1,993	58,921	29.6
Hondo	11/1 - 5/31	223	223	117,494	526.9
Harnet	11/1 - 5/31 10/16 - 5/31 11/1 - 5/31 11/1 - 5/31 10/15 - 5/31	35 195 35 1331 196	1792	95,955	53.5

There are certain factors regarding grazing management within the San Rafael Resource Area that are also of concern. One is the fact that all of the allotments known to contain populations of *G. tenuis* are grazed during the critical spring growing season (Table 1), widely viewed as the worst possible time of year to graze sensitive desert grasses and forbs (Cook and Child 1971, Miller and Donart 1981, Holecheck et al. 2001). Of equal concern are the over-inflated stocking rates on the Lone Tree allotment, which contains the Prickly Pear Bend population and Horsefly Hell population, and the Mussentuchit allotment, which houses the Last Chance, Split, and Lost & Found populations (Table 1). With only 23 acres per Animal Unit Month (AUM) on the Lone Tree allotment, and only 29.6 acres per AUM on the Mussentuchit allotment, the density of cattle is over twice what is typically recommended for arid rangelands in the West (Holechek et al. 2001). The land use

plan's ecological condition description for these two allotments confirm that they are indeed overgrazed. The Lone Tree statistics reveal that fully 74% of the vegetation is classified as mid-seral, or fair condition- the 2nd worst condition class. And the land use plan reports that 49% of the vegetation in the Mussentuchit allotment to be in mid-seral condition and 14% to be in early seral, or poor condition (BLM 1991).

In terms of on-the-ground, specific grazing impacts that are noteworthy, the BLM has recently installed a watering trough for cattle in Seger's Hole. This trough, filled up regularly by tanker truck deliveries, is within $\frac{3}{4}$ of a mile from the Seger's hole and Gypsum theory populations, and these two populations, topographically, are easily accessed by cattle (personal communication, Tim Finger, BLM). Furthermore, the entire area occupied by the Last Chance, Split, and Lost & Found populations is very overgrazed (personal communication, Ray Bloxham, field inventory leader, Utah Wilderness Coalition). As pointed out earlier, one likely reason for this is the high stocking rates in the Mussentuchit allotment (Table 1). In addition the range that supports all three of these populations is well-watered for cattle, and a private ranch is close to the Lost & Found population. Lastly, the Horsefly Hell and Prickly Pear populations are also at risk from overgrazing, as these populations occur in one of the allotments (Lone Tree) with very high stocking rates (Table 1), and these populations either occur directly within the Muddy Creek floodplain, or within easy access of it, and thus see substantial cattle use/traffic. Muddy Creek is one of the chief water sources for cattle in this area.

3. Recreational and Off-road vehicle use threatens *G. tenuis* habitat with destruction

a. General recreation, hiking

The San Rafael Swell is an increasingly popular recreation area because of its proximity to large population centers along the Wasatch Front. The easy access, network of roads, and scenic landscape provide virtually unlimited recreational opportunities for people traveling from nearby population centers like Denver, Las

Vegas, and especially the greater Salt Lake City area.

Human traffic is a considerable threat to *G. tenuis*, especially in light of the increased popularity of the San Rafael Swell for vacationers and recreationists. Because many of the places where *G. tenuis* has been discovered have already been developed for human access (within one kilometer of a road) the need for careful assessment of the risks that human traffic may pose is all the greater.

b. Off-road vehicle use threatens *G. tenuis* habitat with destruction

The San Rafael Swell region has shown greatly increased ORV use in recent years and those populations near roads and popular ORV routes are at considerable risk. The increase in user-days in the San Rafael Swell is indicative of a recent, massive upswelling in ORV use in the state of Utah. Recent years have seen ORV registrations and sales dramatically increase throughout Utah, with state registration for ORV's and dirt bikes up a startling 375% in just five years; climbing from 34,000 machines registered in 1997 to over 127,600 in 2002 (Salt Lake Tribune, May 12, 2003).

ORV use presents a serious, substantial casue of disturbance to *G. tenuis* habitat. Documented ORV impacts on vegetation range from complete denudation of large staging areas to selective kill-off of the most sensitive plants. Ultimately, web-like networks of ORV trails coalesce into broad areas largely denuded of vegetation. Indirect impacts include the upsetting of water storage, soil infiltration rates, and thermal structure of soils; these are all ORV related deficiencies that can disrupt seed germination and seedling growth (Davidson and Fox 1974).

While the potential impacts of ORVs to plants is perhaps more obvious, it is the indirect effects these vehicles can have on desert soils that may be more insidious to *G. tenuis*. Initial physical impacts of ORVs result in stripping the surface of small plants and mechanical crusts, which stabilize the soil (Wilshire 1983, Belnap 1995). At the same time that the land is denuded, soils are compacted. Maximum

compaction of typical sandy loam soils of western arid lands is attained in only 10 passes of a motorcycle on a dry, level surface (Webb 1983). Soil compaction takes place in a cylinder beneath the tracks, reaching depths of 30 cm, and soil loosening (by shear) takes place in shallow zones on both sides of the cylinder of compaction. Loss of the insulating effects of plant cover and changes in the heat capacity of compacted soils causes soil temperatures to increase by as much as 10° C in daytime and decrease by as much as 3° C in nighttime (Webb et al. 1978, Wilshire et al. 1978). Soil compaction further reduces infiltration of water, resulting in ponding in tracks and rapid evaporation, or shedding of incident precipitation by runoff. Either way, the shallow subsurface soil biota are denied their normal moisture supply. As with soil compaction, the reduction of infiltration rates quickly reaches a maximum after only 10 or so passes of a motorcycle (Webb 1983). Most southwest desert soils are susceptible to the above documented effects of ORVs. The USGS conducted an 18 month study on 200 ORV sites in California, Utah and Nevada, and found that all soil types examined were vulnerable to ORV damage, except certain dry lake deposits and clay rich soils with <10% slopes (CEQ 1979). *G. tenuis* is not known to inhabit any of these (dry lake deposits, clay rich soils) soil types.

In terms of the impacts of ORV use to *G. tenuis* specifically, some of the documented populations are near frequently traveled roads (Figure 7). Debra Clark noted in her 2000 survey report that an ORV trail is sited just below (120 yards away from) the Secret Mesa/Coal Wash population site (Clark 2000). This trail, the extremely popular “Eva Conover” trail, probably sees as much if not more ORV use than any other route in the San Rafael Swell (personal communication Tom Gnojek, BLM). Even though the ORV use designation in this area is “limited to designated routes and trails” (BLM 1991), there is currently some illegal use coming off of this popular route (personal communication, Tom Gnojek, BLM) and the BLM’s own monitoring shows this. This is problematic, as any illegal use coming from a trail that typically sees an average of over 600 vehicle passes/day by the vehicle counter on the route³ is

³ This is an average amount of vehicle passes per day, averaging across all months of the year. The number of passes is much greater per day in the spring-fall. Additionally, the Price BLM Field Office reports that

likely to be fairly substantial, simply by virtue of that many vehicles using the route.

ORV activity has also been observed at the type locality (Porter and Heil 1994). In fact, a road used by ORV users runs right through the Last Chance population, thus dissecting it in two (Figure 7). The Split population, also in this area, was also determined to be at “high risk” by D. Clark during the 2001 survey, because it was very close to a maintained road (Clark 2001). In fact the name given to this population likely reflects that the road dissects this population into two. Additionally, the entire area containing the Last Chance, Split, and Lost & Found populations is designated as open to cross country vehicle use, and discussed elsewhere in this document, is not covered under any active management plan. The Mussentuchit dunes - clearly in an area of suitable *G. tenuis* habitat - are designated as an open ORV play area in the San Rafael Land Management Plan.

Segers Hole is currently seeing some of the biggest increases in ORV activity in the San Rafael Resource Area (personal communication Tom Gnojek, BLM). One of the chief roads that the ORV users travel to access this area runs right by the Seger’s Hole *G. tenuis* population (where D. Clark found ORV tracks very near plants), and goes directly through the Seger’s Road population site (Clark 2001). Other nearby *G. tenuis* populations are accessible via this road, such as Bighorn Pocket and Gypsum Theory, where D. Clark found ORV tracks within 20 yards of some of the plants (Clark 2001). Even though the ORV use designation in this area is “limited to existing routes and trails” (BLM 1991), there is currently a great deal of illegal use coming off of Seger’s Road.

the vehicle counter is not very dependable – and will usually count wildlife and tumbleweeds, etc. as a vehicle.

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Figure 7. Existing roads impacting known Mussentuchit gilia populations, and potential *G. tenuis* habitat

In summary, ORV use threatens nearly all potential habitat of *G. tenuis*. Even though the San Rafael RMP designated most ORV use to “limited to existing roads and trails” (BLM 1991), in reality the BLM does not have the man-power to police the entire Resource Area, and only routes clearly signed have any chance of limiting use to existing trails. This means that perhaps only 1% of routes in the San Rafael Swell really have any chance of seeing use limited to those trails. In general, unregulated and abusive ORV use in the San Rafael Swell is likely to constitute one of the principle present or future threats of destruction, modification, or curtailment of habitat available within the range of *G. tenuis*. Larry England of the USFWS Field Office in Salt Lake City believes that ORV activity may in fact represent the most important threat to *G. tenuis* at this time (personal communication 2002).

4. Exotic weeds degrade *G. tenuis* habitat

Exotic weeds are slowly taking over the Intermountain West (Belnap 1998). Sites become more invasible due to increased bare soils as a result of the same chief activities that potentially impact *G. tenuis*: grazing, ORV use, and mining/drilling operations. All of these activities disturb the soil, which offer greater opportunity for weed establishment, with less competition (Gelbard and Belsky, in prep, and references within). Evans and Young (1972) found that increased soil erosion (shown to be caused by both grazing and ORV use) also loosens surface soils and helps bury seeds. Exotic seeds adapted to more erosion-prone environments will benefit from this while natives most likely will not. Finally, soil disturbance can further assist weed invasions by creating warmer and drier soil microclimates through soil compaction and loss of plant, microbiotic crust and litter cover. The resulting warmer, drier microclimate reduces the competitive vigor of many native grasses (Piemeissal 1951, Archer and Smeins 1991), thus further increasing viability of aggressive exotics.

Once they are established weeds negatively impact western arid ecosystems in numerous documented ways. Weed infestations reduce biodiversity (Randall 1996), increase fire frequency (Esque 1999, Brooks et al. 1999), disrupt nutrient cycling

(Vitousek 1990), alter soil microclimate (Evans and Young 1984), reduce effectiveness of wildlife habitat (Davidson et al. 1996, Knick and Rotenberry 1997), and can expedite loss of topsoil in xeric environments (Lacy et al. 1989). All of these factors can increase endangerment of intrinsically rare, relatively slow reproducing species such as *G. tenuis*.

5. Summary: Habitat destruction, modification, and fragmentation

Stan Welsh, noted authority on rare Utah flora observed:

“The impress of man and his activities onto the natural habitats of Utah has reduced the area available to most native or indigenous plants.....With the advent of the second half of the twentieth century, there has occurred a resurgence of economic activities, mineral exploration, and a greater use of the public lands which hitherto had been considered as useful (if considered useful at all) only for grazing and watershed [purposes]....Plant species which were once remote from the impacts of civilization - industrial, agricultural, or recreational activities - are now threatened not only by the effects of ranching, construction, and off-road travel, but even by the very agencies of the government which are established by law to oversee in the public trust the proper use and protection of the public lands. At the present time, hardly a part of Utah, even that set aside as national parks, monuments, or wilderness areas, is safe from degradation by masses of people or by those seeking to exploit the very natural resources and features these areas were established to protect. Inroads into the most remote and most arid portions of the state now guarantee further reduction of the unique flora of Utah.

Naturally, those entities that will suffer the greatest from the commercialization of the state will be those which have specific and naturally restricted areas of distribution. Only the most enlightened management and protection from unreasonable exploitation will ensure the continuation of the rich indigenous flora that these plants represent...” (Welsh 1975, *emphasis added*).

Over 25 years later, the threats cited by Welsh, above, are as real as ever - indeed there are many indications that they have increased considerably. As outlined above, the chief threats facing *G. tenuis* habitat include oil and gas exploration and development, livestock grazing and ORV use. Mineral extraction – chiefly in the form of gypsum mining – may also pose a considerable threat to certain populations.

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

Because *G. tenuis* habitat is so narrowly defined, its destruction in the pursuit of commercial or recreational activities often involves the destruction of *G. tenuis* individuals as well. Therefore, many of the threats to habitat may also be regarded as sources of overutilization. Oil, gas, and mineral extraction, livestock trampling, and ORV use kill *G. tenuis* plants while destroying habitat for economic or recreational gain. Collection of plants and seeds also may threaten this species.

1. Oil, gas, and mineral extraction kills *G. tenuis* individuals

G. tenuis individuals in the path of access roads, pipelines, well pads, seismic routes, mines, and other infrastructure associated with these extractive industries are destroyed. The ability of *G. tenuis* individuals and small populations to recover from disturbances such as oil and gas exploration, development and mining have not been studied, but the likelihood of a small population (as most of the known *G. tenuis* populations are) being able to recover from such disturbances are slim (personal communication, Mark Porter). This plant is not considered to be a “pioneer” plant, and will not readily move into profoundly disturbed sites (personal communication, Stan Welsh). One of the key traits that enables a population to withstand impacts such as drilling is not the number of seeds produced by the population in its effort to recolonize, but rather the success of seedling establishment within the population after a large disturbance. With the amount of disturbance involved with oil and gas exploration and development, the chances are remote that populations would recover if these impacts were centered right near a small population of individuals, regardless of the number of seeds they produce.

1. Livestock trampling kills *G. tenuis* individuals

Most populations of *G. tenuis* occur on open range, and grazing occurs in and around these populations. *G. tenuis* is likely to be detrimentally affected by livestock trampling. If cattle do in fact graze *G. tenuis*, or even if they merely travel through its habitat and trample it incidentally, then there is a possibility that the plant is differentially

affected by such disturbance depending on the particular microhabitat or season. As both flowering and fruiting for this plant occur in late May through June, *G. tenuis* is very likely to be even more negatively impacted by grazing disturbance during that period. As mentioned above, all of the allotments known to contain populations of *G. tenuis* are grazed during the critical spring growing season (Table 1). Although cattle may be in general less interested in the particular microhabitats that contain *G. tenuis*, excessive livestock densities like those in the San Rafael Swell may force cattle further from wells to feed, thus exposing *G. tenuis* to trampling damage. Wet or dry years could compound the effects of grazing on *G. tenuis* and the arid plant community within which it dwells.

Damage to individuals due to trampling may have dire repercussions. Trampling (by people) was implicated in the decline of the listed plant *Astragalus cremnophylax* var. *cremnophylax* (sentry milkvetch) partly because damage sustained by individuals had negative effects on reproduction (Maschinski et al. 1997). Reproductive rates increased after populations were fenced off so that trampling could not occur. Not only was a greater percentage of the population reproductive after protection from trampling, fruit production also increased. The authors also noted that because damaged plants did not easily recover, the effects persisted for years even after protection (Maschinski et al. 1997).

3. Off-road vehicle use destroys *G. tenuis* individuals

ORV use contributes to overutilization of *G. tenuis* individuals for recreational purposes. ORVs run over plants and either kill the plant outright or destroy flowers and thus the ability to set fruit and seed. Seedlings, and seeds germinating within the ground, are very sensitive to ORVs and are easily killed outright or buried (Bury 1977, CEQ 1979). Additional damage occurs as soils compact and erode, exposing roots and killing more plants (Liddle 1975; Hartley 1976). Plants may be buried by sand due to increased wind erosion after disturbance (BLM, Moab Field Office 2002). When ORVs cause topsoil erosion, mycorrhizal fungi propagules may be lost, and many desert plants are obligately mycotrophic (Knapp 1996).

4. Other impacts to *Gilia tenuis* individuals

a. Collection

The genus *Gilia* has had a history of use as an ornamental cultivar, and - along with *G. caespitosa* - *G. tenuis* is probably one of the showiest and most colorful of the genus (Porter and Heil 1994). *G. caespitosa* is already sought by rock-garden enthusiasts seeking colorful, tufted plant species, and currently seeds of this plant are sold illegally (personal communication, Debra Clark). *G. tenuis* will likely be sought after when it is more widely known. Already, collection by amateurs is considered to be one of the chief threats to this species (personal communication, Lori Armstrong).

b. Sand or gravel quarrying

Because *G. tenuis* is associated with sandstone outcrops, there is the potential for use of these sites for sand or sandstone quarrying. This is particularly true for sites experiencing road maintenance or road construction where fill may be required (see Figure 7, which also depicts active sand and gravel mines). These activities could easily harm or kill individual plants.

c. Road building and maintenance

Currently, one of the known populations of *G. tenuis* (the Last Chance site) is bisected by a road. Construction of this road has impacted the habitat for *G. tenuis* and without doubt destroyed some individuals of the population. Grading could have severe impacts on *G. tenuis* (personal communication, Stan Welsh). Another population (Split population) likely derives its name from the fact that this population is also severed by a maintained road. D. Clarke, who most recently surveyed this population, maintains that the population is at “high risk” due to this road, in part because flowering plants are visible from the road and could be collected by amateur plant collectors. Indeed, collection is considered to be one of the chief threats to this species (personal

communication, Lori Armstrong). New road construction and maintenance could also potentially impact individual plants.

5. Summary: Overutilization for commercial and recreational purposes

With only an estimated total of fewer than 2,400 individuals in existence, further loss of *G. tenuis* plants must not be tolerated, and FWS should grant *G. tenuis* listing under the ESA and curtail impacts from oil, gas, and mineral extraction, livestock trampling, ORV use, and collection.

C. Inadequacy of existing regulatory mechanisms

Based on the limited and small populations of *G. tenuis* (outlined above), and the significant threats facing this species, it is clear that ongoing and existing regulatory mechanisms, primarily under the auspices of the BLM, have been, and continue to be, ineffective in conserving this species to the extent that the overall meta-population is guaranteed to be viable, well into the future.

1. Federal agencies

Currently, no federal laws specifically protect plant species that are not listed on the federal Threatened or Endangered Species List. Hence, public land agencies such as the BLM which are responsible for managing sensitive species such as *G. tenuis* lack the fundamental mechanism necessary to prevent extirpations of populations of these species - federal listing. As such, we generally see industrial development slowly spreading into areas occupied by sensitive species, harmful grazing practices remaining unchanged, and usually little or no conservation measures being taken for the sake of sensitive species.

G. tenuis was listed as a Category 2 species by the U.S. Fish and Wildlife Service until the elimination of that category several years ago (personal communication, Larry

England). This designation indicated that a threatened or endangered listing under the Endangered Species Act may be appropriate. As of today, this species has not received any formal legal protection.

a. The BLM lacks the mechanisms to prevent *G. tenuis* extirpations without listing

Nearly all known population sites for this species are on federal lands - chiefly BLM lands. *G. tenuis* is listed as a “sensitive” plant species by the BLM State Office. Under this designation, the BLM must ensure that actions authorized on BLM administered lands do not contribute to the need to list any Special Status Species (BLM Manual Section 6840.06C&E). However, the Special Status designation does not automatically confer any special management consideration or protection to the species. For example, the BLM does not have the authority to require Federal mineral lease holders to modify their on-the-ground actions to protect BLM-designated sensitive species (CNE, 2002).

Currently, the BLM State Office is in the process of conducting detailed status reviews of all plants on a newly revised BLM Sensitive Species list for Utah (personal communication, Ron Bolander), including one for the *Mussentuchit gilia*. At this time, it is unclear what the findings of this status review will do, if anything, in terms of improving management and protection of this rare and sensitive species.

The vast majority of the BLM lands known to contain populations of *G. tenuis* are managed under the San Rafael RMP, published in 1991. The RMP states that no management action will be permitted on public lands that will jeopardize the continued existence of sensitive species listed by the State of Utah (BLM 1991). Neither the Price nor Richfield Field Offices have prepared a habitat management plan for *G. tenuis*.

A very small portion of BLM land known to contain the Last Chance (type locality), Split population, and Lost & Found populations lies over the western side of the Sevier/Emery County line. Interestingly, this sliver of BLM land between the county line

and the Fishlake National Forest – known as the “Forest Planning Unit” (FPU) - is not covered by **any** Resource Management Plan at the present time (BLM 1991; San Rafael Resource Area RMP Record of Decision 1991; personal communication, Tom Gnojek, BLM; personal communication, Frank Erickson, BLM; personal communication, Tim Finger, BLM). While the original Draft Environmental Impact Statement for the San Rafael RMP did provide environmental impact analyses for the FPU, the Record of Decision and Final EIS and Management Plan did not cover this area. There was supposed to be a separate Record of Decision issued by the Richfield BLM Field Office covering this area, but in a crucial oversight by the BLM, it was never issued. The implications of this oversight include decisions on a road closure and critical wildlife habitat protection that could never be implemented (personal communication, Tim Finger). The implications of the absence of a management plan for this small area of Utah that contains the type locality, Split population, and Lost & Found population is severe, given the increase in oil and gas leasing in this area, and ORV abuse.

Currently, five of the known, extant, *G. tenuis* populations occur within BLM Areas of Critical Environmental Concern (ACECs). This includes the Seger’s Hole and Seger’s Road populations in the Segar’s Hole ACEC, the Horsefly Hell and Prickly Pear populations in the Muddy Creek ACEC and the Coal Wash population in the Sids Mountain ACEC. In addition, six *G. tenuis* populations occur within BLM Wilderness Study Areas (WSAs). This includes the Chimney Canyon population, Prickly Pear, Keyhole, South of Slaughter, and Lost Wash populations in the Muddy Creek WSA, and the Coal Wash population in the Sids Mountain WSA.

It is questionable whether ACEC and WSA designations afford adequate protection to these populations. ACEC designation in itself does not automatically confer any additional protections to an area, and no specific management plans have been written for any of the ACEC’s known to contain populations of *G. tenuis*. While the three ACECs that contain *G. tenuis* have No Surface Occupancy Stipulation, they can still be leased (BLM 1991, personal communication, Tom Gnojek) and even No Surface Occupancy stipulations have various exceptions and modifications that may still permit

the destruction of rare plants. In addition, when the ACECs and WSAs that house *G. tenuis* were designated, no reductions were made in cattle stocking rates. In addition, ORV use remains on some existing routes and trails - most notably Sids Mountain WSA and ACEC which contains some of the most popular ORV routes in the San Rafael Swell (BLM 1991, personal communication, Tom Gnojek). The impacts these particular activities can have on *G. tenuis* populations are outlined in the threats section, above.

b. Summary of *G. tenuis* management by federal agencies

Because *G. tenuis* does not have Threatened or Endangered status under the ESA, the BLM continues to lease public lands occupied by this species, harmful grazing practices remain unchanged, ORVs are virtually given free rein throughout *G. tenuis* habitat, and above all, no monitoring is conducted. The BLM has not actively managed the Mussentuchit gilia, and with the considerable pressure from industry to continue to develop its habitat and from recreationists to have access, only the legal obligations of the ESA are sufficient to ensure its persistence. As FWS is well aware, only ESA listing will necessitate Section 7 consultation on federal actions.

2. State policies are inadequate

There is no Utah Threatened and Endangered Species law that may afford protection to special status plants that are not covered under the ESA, such as *G. tenuis*. This makes it even more likely that these sensitive species will never be adequately protected on State lands. Indeed, the State Natural Heritage Program, housed within the Utah Department of Natural Resources Division of Wildlife Resources, does not keep an official State Sensitive Plant and Species of Special Concern list (personal communication, Ben Franklin, personal communication Ron Bolander). Rather, State sensitive plant lists are only kept by the U.S. Forest Service and BLM (at the statewide level) in Utah.

G. tenuis is categorized by the Utah Natural Heritage Program as a G1 species globally and an S1 species statewide, though neither ranking offers any legal protections. These rankings indicate extreme rarity or other factor(s) making the species especially vulnerable to extinction or extirpation (typically 5 or less occurrences or very few remaining individuals or acres, Utah Natural Heritage program website 2001).

The Last Chance population and the Seger's Hole population overlap School Institutional Trust Lands Administration (SITLA) holdings. This does not confer any special protection to rare plants on those holdings. In fact, SITLA has dramatically increased its oil and lease offerings in recent years.

3. Summary, Inadequacy of existing regulatory mechanisms

In summary, current management and regulatory mechanisms, primarily under the responsibility of the BLM, are ineffective in ensuring secure populations of *G. tenuis*. Only the legal protections afforded by the ESA will result in substantive management changes that will ensure the persistence of this species on BLM lands.

D. Other natural or man-made factors affecting the species' continued existence

Other factors that may imperil *G. tenuis* include all those risks associated with small populations, and impacts due to drought coupled with a changing global climate.

1. Small populations are more vulnerable to extinction

Even in the absence of the threats listed above, *G. tenuis* is in a delicate position due to the small size of most of its populations. Stan Welsh, lead author on a Utah Flora and renowned regional expert on rare endemic plants, feels that certain (smaller) populations of *G. tenuis* may be in trouble (personal communication, 2002) due to a variety of threats (all discussed above). There is a substantial body of literature on the risks that small populations face for a wide variety of reasons (Gilpin and Soulé 1986,

Lande 1987), including environmental and demographic stochasticity (Caswell 1989, Goodman 1987, Mode and Jacobson 1987, Lande 1993), Allee effects (Allee et al. 1949), and other factors. These concerns apply to this species. In many places, *G. tenuis* faces exactly those risks because its population size is as small as 25 individuals or less. Connectivity issues may also be a serious concern. These risks need to be considered in addition to and in concert with the particular threats outlined above.

2. Drought and climate change exacerbate all other threats

Prolonged drought can also act in concert with one or more of the above threats to deal a crippling blow to rare endemic desert plants, especially those that already exist as small populations. Successive years of drought, such as the 6-year drought southeast Utah is currently experiencing, can have especially devastating consequences for perennials like *G. tenuis* which may experience population destabilization if adult mortality increases dramatically (Caswell 1986, Silvertown et al. 1993, Hunt 2001). In particularly unpredictable and stochastic environments like deserts, the sequence of good and/or poor quality seasons is important in determining the long-term dynamics of a population and the likelihood of extirpation (EDF 1995). The impacts of prolonged drought conditions will likely exacerbate the effects of all the other threats to *G. tenuis* described in this status review.

In addition to the compounding effects of drought, climate change - specifically an increase in global temperatures including those in western North America - is a very real threat to all native plants. The likelihood of warming temperatures in the next 50 years is high, and most scientists do not dispute the advent of global warming.

Different species of plants will respond to climate change in varying ways. Species that evolved together and adapted in response to one another's phenology may experience a loss of synchrony whereby natural events such as flowering and pollinator emergence that were once timed concurrently become offset because of differing responses to climatic cues. Species may therefore no longer be able to rely on the services once

provided by other species (McCarty 2001). This may have serious implications for *G. tenuis* pollination.

In general, climate change threatens to be an additional source of stress for species already threatened by local and global environmental changes, exacerbating the impacts of habitat fragmentation, for example, and increasing the risk of extinction to those species (McCarty 2001). Perhaps the best way that land managers can reduce the threat of climate change to species and communities of concern is to create a set of core areas and reserves for species and communities, through protective management of core areas and linkages, as is consistently recommended by lead conservation biologists (Noss et al. 1999, Soule and Terborgh 1999). McCarty summarized the potential impacts of impending climate change to rare species when he stated:

“Conservation scientists need to look at climate change as a current, not just a future, threat to species. Although a causal link to climate cannot yet be rigorously demonstrated, the consistent patterns indicate that the prudent course for conservation is to take these changes seriously. Certainly, cases such as the extinction of the golden toad are of immediate concern, but the changes in climate need to be taken into account as a possible factor contributing to declines in other species” (McCarty 2001).

E. Summary, threats to the *Mussentuchit gilia*

As outlined above, the chief threats facing *G. tenuis* include livestock grazing, ORV use, and most certainly expedited energy exploration in the region. Plant collection by hobbyists, and mineral extraction – chiefly in the form of gypsum mining – may also pose a considerable threat to certain populations. These chief threats, and their level of impacts to known, extant populations of *G. tenuis*, are featured in Table 2. Collection, sand and gravel quarrying, road construction and maintenance, and exotic weed infestations are considered to be lesser threats. Neither disease and predation, nor overutilization for commercial, scientific or educational purposes are considered to be considerable threats to this species at this time.

The Mussentuchit *Gilia* deserves particular attention and conservation efforts because it occurs in rare ecosystems of high biological value, it is likely sensitive to disturbance of various kinds, and it is imminently threatened by several sources of disturbance, namely future oil and gas exploration and development, overgrazing, and ORV use. As discussed above, it is clear that the species is very rare relative to the extent of habitat within which it occurs; there are only 17 known populations likely in existence that are thought to contain about 2,350 individuals. Most of these populations are very small, and many are threatened or potentially threatened by some form of disturbance. In general, *G. tenuis* is likely to be highly susceptible to these disturbances because it has narrow habitat requirements, is not a particularly “fast reproducer,” is not known to compete aggressively with associated species, and is not known to recover quickly from disturbance.

Given what is now known about the state of the Mussentuchit *Gilia* overall, the importance of the rare habitats where it is found, and the concern voiced by many prominent Utah botanists on the general status and security of some existing populations (personal communication, Stan Welsh, personal communication Mark Porter) and the species as a whole (personal communication, Ron Bolander, Frank Smith, Ken Heil, Mark Porter), it is appropriate that immediate measures be taken to protect the remaining populations, and provide for the full biological recovery, of this imperiled species. With only 17 populations of the plant known to be in existence, and the majority of those impacted or potentially impacted by a variety of human disturbances, conservationists and land managers need to implement immediate efforts to mitigate the damage already being done, develop strategies to protect known populations from future threats, and initiate aggressive recovery efforts. **This will be best accomplished with a formal listing of the species as either threatened or endangered, under the U.S. Endangered Species Act.** Multiple botanists have been sufficiently worried about the fate of this species to suggest it for listing (personal communication Frank Smith, personal communication Ken Heil). Even in cases where we lack a full understanding of the complex relationship between *G. tenuis* and some disturbances, such as cattle grazing,

(insert MS Doc “Table 2” here)

we should still respond preemptively to protect all existing populations, given the scarcity of the species.

The threats to *G. tenuis* and to all sensitive, xeric vegetative communities in the San Rafael Swell and southern Utah have been recognized for several decades. As discussed above, there has been a long list of conservation initiatives suggested for the San Rafael Swell, indicating that those who propose those initiatives appreciate the biological importance and ecological uniqueness of this region - including the myriad of rare endemic plants found here. Today this region is gravely threatened by greatly increased ORV use and expedited oil and gas exploration and development. It is clear that the impetus for listing the species, now more than ever, is strong.

There is also a clear and pressing need for more surveys of *G. tenuis* throughout the western slope of the San Rafael Swell, and possibly in additional locations, such as in the entirety of Capitol Reef National Park. Other research efforts, necessary to answer unsolved questions about the ecology of the species and demographics of specific populations, are certainly warranted and urgently needed. Further research should include studies on pollinators; seed dispersal, seed germination and establishment experiments including studies of seed longevity; and more detailed monitoring of known populations to further our understanding of demography and population stability of those populations. These additional efforts however, must be undertaken in concert with FWS's decision to list the species, and immediately afford it protection under the ESA.

XI. Recovery of *G. tenuis*

Conserving and recovering *G. tenuis* will require several steps. Activities related to oil, gas, and mineral extraction must be designed so as to avoid occupied and suitable (for recovery) *G. tenuis* habitat. Grazing management policies in *G. tenuis* habitat must be reviewed, and management should change accordingly. Occupied and suitable *G. tenuis* habitat should be closed to ORV use. The spread of noxious weeds and the activities that facilitate their spread need to be carefully managed. Population monitoring

should take place rangewide. Seeds may need to be collected and stored for conservation purposes. *G. tenuis* pollination must be investigated, and identified pollinators must be conserved as well.

Finally, the protection and recovery of sufficient habitat to ensure long-term persistence, including providing for the dispersal and movement of the species through time and for the continued unfolding of natural ecological processes, must be ensured. Listing *G. tenuis* under the ESA is a critical, necessary step toward the protection and full biological recovery of this species.

X11. Benefits of ESA listing for *G. tenuis*

The benefits of ESA listing for *G. tenuis* are substantial, as we suggest throughout this petition:

- Listing will require that federal agencies enter into Section 7 consultation with FWS, and carefully consider the potential impacts to *G. tenuis* of ongoing and proposed activities under their jurisdictions. The result will be significantly improved protection on federal lands from oil, gas, and mineral extraction, grazing and trampling damage, ORV use, noxious weeds, and other human disturbance, in the form of a proactive approach to implementing conservation actions prior to opening *G. tenuis* habitat to development.
- Projects involving a federal nexus will also require Section 7 consultation; therefore the benefits of listing will extend to populations occurring on non-federal lands as well.
- The designation of critical habitat, yet another exclusive benefit of ESA listing, will result in significant additional protection not only for occupied habitat but also for other habitat areas deemed essential to the recovery of the species, and habitat for other rare and listed species as well. The ESA prohibits adverse modification of designated critical habitat.

- Listing will result in the development of a recovery plan aimed at biological recovery (and delisting).
- Listing will help spur research (and the required funding and scientific interest) necessary to fully understand how biological recovery of *G. tenuis* can be achieved. This research may further the recovery of other imperiled species as well.
- Listing will help make *G. tenuis* management consistent across land management boundaries.
- Listing will require protections that are not occurring now and will not occur otherwise through requirements for Section 7 consultation.
- Listing is necessary to ensure the persistence of *G. tenuis* given the expedited rate of energy development within its range.
- Even given the most ambitious scenario involving the states and federal agencies adopting their own conservation measures, this would at best result in the reduction of threats to *G. tenuis*, not biological recovery. A conservation plan that involves Utah taking active and effective conservation measures seems unlikely.

XIII. Documents cited

Petitioners hereby incorporate by reference every document cited in this petition and/or cited in the References below. We are happy to provide copies of any of these documents upon request.

XIV. Critical habitat

This petition requests that critical habitat be designated for *G. tenuis* concurrent with final ESA listing.

XV. 90 day petition finding

This petition and accompanying materials provide substantial scientific and commercial information indicating that ESA listing for *G. tenuis* may be warranted. Petitioners expect to receive a formal acknowledgment of this petition and a decision within 90 days of its receipt.

Respectfully submitted,

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