

Results of a Conservation Agreement and Strategy for Rabbit Valley Gilia (*Gilia caespitosa*)

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Abstract: *Gilia caespitosa* Gray (Rabbit Valley gilia) is a rare species restricted to scattered occurrences from the northern Waterpocket Fold to Thousand Lakes Mountain and Rabbit Valley in Wayne County, Utah. This species is a very narrow endemic, known only from unstable and faulting soils of detrital Navajo Sandstone. Species occurrences are often found with limited numbers of plants and minimal potential for increasing. Information available regarding historic abundance, ecology, biology, and demographics is limited. These factors contribute to the need to develop a Conservation Agreement and Strategy to provide the initial direction for conservation. Initial objectives of the strategy were to survey for additional occurrences and identify and establish management guidelines that would ensure the overall long-term survival of the species. Through an interagency effort, most of the initial conservation measures have been achieved. Results from these efforts include greatly expanded numbers of known population occurrences, refined monitoring protocols, and increased public awareness efforts.

Rabbit Valley gilia (*Gilia caespitosa*) is a rare species that occurs in scattered locations within a very limited range in Wayne County, Utah. It is currently recognized as a candidate for listing by the USDI Fish and Wildlife Service (USDI 1997). Additionally, it is recognized as a sensitive species by the USDI Bureau of Land Management and Capitol Reef National Park, and the USDA Forest Service.

Prior to 1996, little information regarding life history, abundance, and general demographics of the species was known. In an effort to enhance species information and establish management protocols to ensure the survival of *Gilia caespitosa*, the Bureau of Land Management, Capitol Reef National Park, the National Forest Service, and the Fish and Wildlife Service developed a Conservation Agreement and Strategy in 1996 (USDA and USDI 1996). This strategy is a commitment by each of the cooperating agencies to address protection measures designed to achieve long-term conservation of the species and to ensure that management actions will not result in the need to list *Gilia caespitosa* as threatened or endangered. Management actions resulting from implementation of the *Gilia caespitosa* strategy will also benefit other sensitive species that occupy the same habitat sites as Rabbit Valley gilia.

Efforts taken as a result of the strategy have greatly expanded the knowledge base regarding *Gilia caespitosa*. The results of these efforts have led

to better species management, further enhancing each agency's ability to protect Rabbit Valley gilia. Cooperation by each of the agencies has proven to be a vital factor in the ability to accomplish measures as outlined in the strategy.

Species Status Background

Gilia caespitosa has been documented in Federal Register Notices as rare since the 1975 Smithsonian Institution report to Congress. In 1976 it was listed as proposed endangered on the Fish and Wildlife Service mass listing proposal (USDA 1976); it was withdrawn in 1979. In the 1980 Notice of Review, the status of *Gilia caespitosa* was categorized as Category 1 Candidate (C1) (USDI 1980). The supplementary Notice of Review in 1983 listed *Gilia caespitosa* as a Category 2 Candidate (C2) (USDI 1983a, 1983b). Notice of Reviews from 1985 through 1993 listed *Gilia caespitosa* as a C1 species (USDI 1985, 1993). Changes in terminology in the 1996 Notice of Review resulted in categorizing *Gilia caespitosa* as a candidate, and it remains as such today.

On December 15, 1992, a settlement agreement was signed in the case *Fund for Animals et al. v. Manuel Lujan et al.* in which "by no later than September 30, 1996, defendants agree to propose for listing all species that were officially categorized as C1 as of September 1, 1992 or make a finding that the species no longer warrants listing published in the Federal Register" (*Fund for Animals*

1992). *Gilia caespitosa* is one of the species addressed in the lawsuit. Development of a conservation agreement and strategy satisfied the requirements with regard to the lawsuit settlement agreement.

Nomenclature and Description

Gilia caespitosa was first collected in 1875 by Lester F. Ward, in Rabbit Valley, near Teasdale, Utah. The specimen was identified and described the next year by Asa Gray (1876) as a member of the genus *Gilia*. The recognition of this species as a rare member of Polemoniaceae was brought to light in 1975 by James Reveal, who compiled a list of rare species for Utah for the Smithsonian Institute report to Congress in accordance with Section 12 requirements of the Endangered Species Act (Reveal 1976, USDI 1983a). Further discussion of the nomenclature of *Gilia caespitosa* is available in a status report for *Gilia caespitosa* prepared by J. Mark Porter and Kenneth D. Heil (1994). A name change has been proposed transferring this species, along with all other members of *Gilia* section *Giliandra*, to the genus *Aliciella* Brand. However, it is still recognized as *Gilia caespitosa* in "The Utah Flora" (Welsh et al. 1993) and in the conservation agreement and strategy, so this paper uses the name of *Gilia caespitosa*. The common name "Rabbit Valley gilia" comes from the original collection record.

Gilia caespitosa is a long-lived perennial. Flowering plants have 1 to 20 or more stems above the ground and a woody caudex below the soil surface. Plants are 3–11 cm tall with stems forming a tufted dome with a small cluster of leaves at the base. The leaves in the basal cluster are 0.4–2.5 cm long and 0.8–4.2 mm wide, and are always covered with sticky hairs (often sand adheres to the leaves, too). Above the cluster of leaves, along the stem, the leaves are much smaller. The stems have lateral branches starting about midway up the stem, but sometimes the lateral branches may start as low as within the basal leaf cluster. All of the stems have the same kind of sticky hairs as the leaves and end in a small cluster of 1 to 5 flowers. The flowers consist of five sepals as well as five petals, both fused and forming a narrow tube; the petals are 4.0–5.7 mm long. Flower color varies from scarlet to vermilion, crimson, or pink. The flowers have five anthers attached to the inside of the tube, but not all five are attached at the same level. The fruit is a capsule, 3.0–5.5 mm long with 5–11 seeds per locule (Porter and Heil 1994).

Distribution, Habitat, and Ecology

Gilia caespitosa is restricted to scattered occurrences from the northern Waterpocket Fold to Thousand Lakes Mountain and Rabbit Valley in Wayne County, Utah. Occurrences are often found with limited numbers of plants and limited potential for increasing. Plants are found on private, Utah State Trust, Bureau of Land Management, Forest Service, and National Park Service lands.

Gilia caespitosa occurs, almost exclusively, in Navajo Sandstone associated with cliffs, ledges, exposed outcrops, and drainages of eroded or detrital sandstone. Only one occurrence is known on the Kayenta Formation amongst broken cliff ledges and in rock crevices (Clark 1999). The habitat is associated with recurring, if not constant water and wind erosion. Erosion may be largely responsible for the presence of this type of habitat, as it is often marked by cracks in sandstone that are packed with eolian sand and detritus/eolian deposits (Porter and Heil 1994). Plants occur in full sun or in shaded canyons, on exposed sandstones, cliff walls, and less commonly sandy wash bottoms. Rabbit Valley gilia grows between 5200 and 8000 feet, primarily on slopes of 60–100 percent (USDA and USDI 1996).

Gilia caespitosa is found in association with open pinyon-juniper woodlands, which are often mixed with some elements of mountain brush, sagebrush steppe or ponderosa pine forest. The most frequently associated species include ponderosa pine (*Pinus ponderosa*), Utah juniper (*Juniperus osteosperma*), little leaf mountain mahogany (*Cercocarpus intricatus*), roundleaf buffaloberry (*Shepherdia rotundifolia*), and Indian ricegrass (*Stipa hymenoides*; Clark 1999).

Preliminary data suggest that this species is a self-incompatible, obligate, outcrossing species (Porter and Heil 1994). Little is known regarding the pollination or reproductive success of this species. Although various bee species have been observed frequenting its flowers, it is unknown whether any act as pollinators. Phenological patterns vary slightly from year to year due to variable weather patterns. Flowering generally begins in early to mid June and continues through July, and occasionally to mid-August. Fruiting closely tracks flowering and begins in late June.

Gilia caespitosa overwinters as a series of loose, basal leaves. Plants maintain the same taproot year after year (Porter and Heil 1994). After vernalization, the primary axes elongate and flowering begins. A few of the axial buds of the lower leaves

of the rosette develop into new basal rosettes of leaves, which again overwinter. This annual ramification might be interpreted as a type of vegetative reproduction. However, because the same taproot is maintained year after year and adventitious roots are not produced, in a strict sense this is not true clonal reproduction (Porter 1993). Flowering plants are at the smallest 2 cm x 2 cm, and are presumed several years old. Monitoring to date has documented that plants up to 3 years in age have not flowered and seem to be several years from the potential for flowering (C. Dawson, personal communication).

Conservation Agreement and Strategy

In 1995, an interagency technical team began development of a conservation agreement and strategy for *Gilia caespitosa*. All information known regarding Rabbit Valley *gilia* was analyzed for development of the strategy. One important component in the development of the strategy was the limited information available regarding *Gilia caespitosa*. No thorough inventories, detailed monitoring, or pollination, ecological, or habitat studies had been conducted. As this was the case, the obtainment of this information was an important first component of the strategy. The conservation agreement and strategy was signed by all parties in 1996 (USDA and USDI 1996).

The overall purpose of the strategy is "to attain the goal of long-term conservation of *Gilia caespitosa* throughout its range through proactive management of the species and the ecosystems upon which it depends" (USDA and USDI 1996). The strategy recognized that conservation of *Gilia caespitosa* would require removing threats and maintaining or expanding populations. The strategy recognized that efforts taken for *Gilia caespitosa* would also benefit other threatened, endangered, and sensitive plant species that shared the same ecosystems.

The primary objectives of the conservation agreement and strategy are threefold. The first objective is to "ensure that existing regulatory mechanisms and agency funding is available to provide for long-term management of *Gilia caespitosa*." The second objective is to "inventory for additional occurrences" and the last objective is to "identify and establish management guidelines which will ensure overall long term survivability of the species" (USDA and USDI 1996).

The strategy listed six action items and outlined which agency was responsible for conduct-

ing each of the items, as well as the budget necessary to accomplish each.

1. Assure that agencies follow existing land management policies. These policies and regulations control the collection of plants and activities that may affect its habitat. Additionally, these policies retain federal ownership of lands containing *Gilia caespitosa* and provide the feasibility of acquiring additional occupied habitat.

2. Inventory suitable habitat for *Gilia caespitosa* and determine the number of individuals in each occurrence, its habitat characteristics, and its overall distribution. Survey plans will be developed to assure that all suitable habitat is checked.

3. Establish monitoring plots to study the biology, ecology, and life history of the species. Locations and methods for monitoring are to be selected by the interagency technical team.

4. Protect *Gilia caespitosa* from international trade and commercial exploitation. Such protection includes its listing in the appendices of the Convention of International Trade in Endangered Species of Wild Fauna and Flora.

5. Fund a Center for Plant Conservation endowment for *Gilia caespitosa*. This endowment provides for seed bank collections to be made for the purpose of long-term seed storage and maintaining refuge garden populations for species that are threatened in their natural habitat. The endowment also provides for the conducting of research beneficial to the conservation and recovery of the species.

6. Develop public awareness, appreciation, and support for the conservation of *Gilia caespitosa*. This includes educating horticulturalists, specifically rock-gardeners, regarding measures needed for conservation of *Gilia caespitosa* in the wild. Some of the materials to be developed include pamphlets, audio-visual programs, and posters for use in schools, with conservation organizations, and at agency offices.

Results of the Conservation Agreement and Strategy

Agencies have taken an active role in following existing land management policies that provide protection for *Gilia caespitosa* in its natural habitat. Population occurrences have been fenced and trails have been rerouted to prevent damage from off-highway vehicle use. Federal lands occupied by *Gilia caespitosa* have been removed from potential exchange. Collection activities have been limited to those necessary for scientific study and

have been monitored by the interagency technical team.

Surveys have been completed within all conservation units, with only a few outcrops of Navajo Sandstone remaining. Prior to 1997 only 13 locations were known for *Gilia caespitosa*. These locations contained approximately 4,700 plants (Clark 1997). Surveys conducted through 2000 have documented an additional 21 population occurrences and close to 9,000 plants (Clark 1999). This has almost tripled the known number of population occurrences and plant numbers.

Surveys have provided additional information regarding the habitat characteristics of Rabbit Valley *gilia*. It is now obvious that there are more locations and individual plants at or above 7,000 feet elevation. Plants are found on all aspects and appear to have no preference for any particular exposure (Clark 1999). Additionally, one plant was found growing in cryptobiotic soil (Clark 1997), which had never before been observed.

Plant associations vary with changes in elevation. When all *Gilia caespitosa* sites are considered together (Table 1), no species occurs more than 71 percent of the time; however, when you divide the sites into two groups by elevation (Tables 2 and 3), a better representation of associated species can be seen. Indian ricegrass is the only species that occurs at more than 60 percent of all sites, regardless of elevation. Utah juniper occurs at 81 percent of all the sites below 6,800 feet, but at only 44 percent

Table 1. Associated plant species occurring at 20 percent or more of all *Gilia caespitosa* sites (n = 34).

Percent of sites with <i>Gilia caespitosa</i>	Associated plant species
80–100%	0%
60–80%	71% <i>Stipa hymenoides</i> 62% <i>Juniperus osteosperma</i> 62% <i>Cercocarpus intricatus</i>
40–60%	44% <i>Pinus ponderosa</i>
20–40%	35% <i>Artemisia</i> sp. 32% <i>Cryptantha</i> sp. 32% <i>Pinus edulis</i> 32% <i>Shepherdia rotundifolia</i> 29% <i>Arctostaphylos patula</i> 29% <i>Erigeron</i> sp. 29% <i>Poa</i> sp. 26% <i>Arenaria fendleri</i> 26% <i>Hymenopappus filifolius</i> 26% <i>Opuntia polyacantha</i> 26% <i>Stephanomeria</i> sp. 25% <i>Gutierrezia microcephala</i> 25% <i>Penstemon</i> sp. 21% <i>Heterotheca villosa</i> 21% <i>Streptanthella longirostris</i>

Table 2. Associated plant species occurring at 20 percent or more of *Gilia caespitosa* sites between 5200 and 6800 feet elevation (n = 16).

Percent low-elevation <i>Gilia caespitosa</i> sites	Associated plant species
80–100%	81% <i>Juniperus osteosperma</i>
60–80%	69% <i>Cercocarpus intricatus</i> 63% <i>Stipa hymenoides</i> 63% <i>Shepherdia rotundifolia</i>
40–60%	44% <i>Artemisia</i> sp. 44% <i>Opuntia polyacantha</i> 44% <i>Pinus edulis</i>
20–40%	38% <i>Stephanomeria</i> sp. 38% <i>Streptanthella longirostris</i> 31% <i>Cryptantha</i> sp. 25% <i>Echinocereus triglochidatus</i> 25% <i>Ephedra viridis</i> 25% <i>Eriogonum corymbosum</i> 20% <i>Erigeron</i> sp. 20% <i>Heterotheca villosa</i> 20% <i>Festuca octoflora</i>

of the sites about 7,000 feet. Ponderosa pine occurs at 94 percent of the sites above 7,000 feet, but at no sites below that elevation (Clark 1999).

Other sensitive species have also been found during surveys for *Gilia caespitosa*: *Cymopterus beckii*, *Thelesperma subnudum* var. *alpinum*, *Astragalus consobrinus*, *Hymenoxys acaulis* var. *nana*, *Townsendia aprica*, and *Erigeron maguirei* (Clark 1997, 1999).

Monitoring studies, to date, are being conducted by Denver Botanical Gardens. Monitoring began in 1992 with two sites. Eight study sites have been monitored since 1995 (Denver Botanical Gardens 1998). Studies seem to indicate that fluctuations in recruitment are related to precipitation patterns and the availability of safe germination sites (Denver Botanical Gardens 1998). Even with large fluctuations in monitored population numbers due to recruitment and seedling mortality, statistical testing shows no significant differences between the total number of plants within each site for the first and last year of monitoring (Denver Botanical Gardens 1998). Monitoring has not shown any seedlings surviving more than 4 years (Table 4; Denver Botanical Gardens 1998).

Specific actions with regard to the Convention of International Trade in Endangered Species of Wild Fauna and Flora have not been initiated. Agencies contacted the Rock Garden Society at one of their annual meetings to educate them about the importance of *Gilia caespitosa* populations in the wild and the procedures required for its collection. The Center for Plant Conservation

Table 3. Associated plant species occurring at 20 percent or more of *Gilia caespitosa* sites between 7000 and 8000 feet (n = 18).

Percent high-elevation <i>Gilia caespitosa</i> sites	Associated plant species
80–100%	94% <i>Pinus ponderosa</i>
60–80%	78% <i>Stipa hymenoides</i>
40–60%	56% <i>Cercocarpus intricatus</i> 50% <i>Arctostaphylos patula</i> 50% <i>Poa</i> sp. 44% <i>Arenaria fendleri</i> 44% <i>Juniperus osteosperma</i> 44% <i>Penstemon</i> sp.
20–40%	39% <i>Gutierrezia microcephala</i> 39% <i>Hymenopappus filifolius</i> 39% <i>Erigeron</i> sp. 33% <i>Cryptantha</i> sp. 28% <i>Artemisia</i> sp. 28% <i>Artemisia ludoviciana</i> . 28% <i>Chrysothamnus nauseosus</i> 22% <i>Abronia fragrans</i> 22% <i>Heterotheca villosa</i> 22% <i>Oenothera pallida</i> 22% <i>Pinus edulis</i> 22% <i>Phlox</i> sp. 22% <i>Juniperus communis</i> 22% <i>Yucca harrimaniae</i>

endowment was funded through the efforts of the Denver Botanical Gardens. Seeds have been collected since 1991 when there has been sufficient seed crop. Seed collection remains a high priority, but to obtain genetically adequate samples will take many years, due to low levels of seed production (Denver Botanical Gardens 1998).

Public awareness is an important component of the conservation agreement and strategy and successful management and protection for *Gilia caespitosa*. Agencies have cooperated in the development of exhibits, flyers, and displays that include *Gilia caespitosa*. Additionally, an article was published in the Park Science Journal regarding rare plants, including *Gilia caespitosa*. The importance of protection and management of *Gilia caespitosa* has also been emphasized among staff members of the agencies involved.

Discussion

Agencies participating in the *Gilia caespitosa* conservation agreement and strategy have actively taken part in providing the budget, labor, and expertise to promote conservation of *Gilia caespitosa* and to initiate the action items listed in the strategy over the last 4 years. To date, all but one of the items have been either fully or partially completed as a result of agency efforts. Although many of the action items have been completed, agencies are continuing to support additional efforts that will enhance the knowledge of and ability to protect *Gilia caespitosa*. The term of the conservation agreement and strategy is 10 years; however, to do to initial support, the strategy will be updated with new information and new action items much earlier than anticipated.

Base knowledge has been greatly enhanced since the completion of the *Gilia caespitosa* strategy. These results have led to better species manage-

Table 4. *Gilia caespitosa* seedling survivorship.

	1992	1993	1994	1995	1996	1997
1992, 2 sites	31 alive seedlings*	12 alive 19 died	7 alive 5 died	2 alive 5 died	0 alive –	– –
1993, 3 sites	– –	1 alive seedling*	1 alive 0 died	0 alive –	– –	– –
1994, 4 sites	– –	– –	0 new live seedlings*	– –	– –	– –
1995, 8 sites	– –	– –	– –	68 alive seedlings*	2 alive 66 died	0 alive –
1996, 8 sites	– –	– –	– –	– –	17 alive seedlings*	5 alive 12 died
1997, 8 sites	– –	– –	– –	– –	– –	44 alive seedlings*

Asterisk indicates new seedlings found at additional monitoring sites. (In 1992, 31 seedlings were found at 2 sites. In 1993, only 12 of 31 individuals survived and 19 died. In 1994, of the 12 surviving individuals, only 7 individuals survived and 5 died. In 1995, of the 7 surviving individuals, only 2 individuals survived. By 1996, all the initial 31 seedlings tagged in 1992 had died.)

ment, further enhancing the ability to protect Rabbit Valley gilia and the habitat on which it depends. Cooperation between agencies has proven to be a vital factor in the ability to accomplish the measures outlined in the strategy.

Although the federal agencies have been the key players in the conservation agreement and strategy, many other groups have contributed funding, personnel, and support, including the Denver Botanical Gardens, Canon USA, the National Park Foundation, the Capitol Reef Natural History Association, Utah Valley State College, Southern Utah University, Utah State University, Northern Michigan University, and Worthington

Ohio High School.

As a result of efforts associated with the *Gilia caespitosa* conservation agreement and strategy, it is obvious that Rabbit Valley gilia is more abundant than originally thought and is doing well (Figure 1). Advances in knowledge have been obtained and better management decisions are able to be made. The ability to attain the overall purpose of long-term conservation of *Gilia caespitosa* throughout its range has been greatly enhanced. The knowledge gained will continue to contribute to proactive management decisions not only for *Gilia caespitosa*, but also for other rare species that inhabit the same ecosystem.

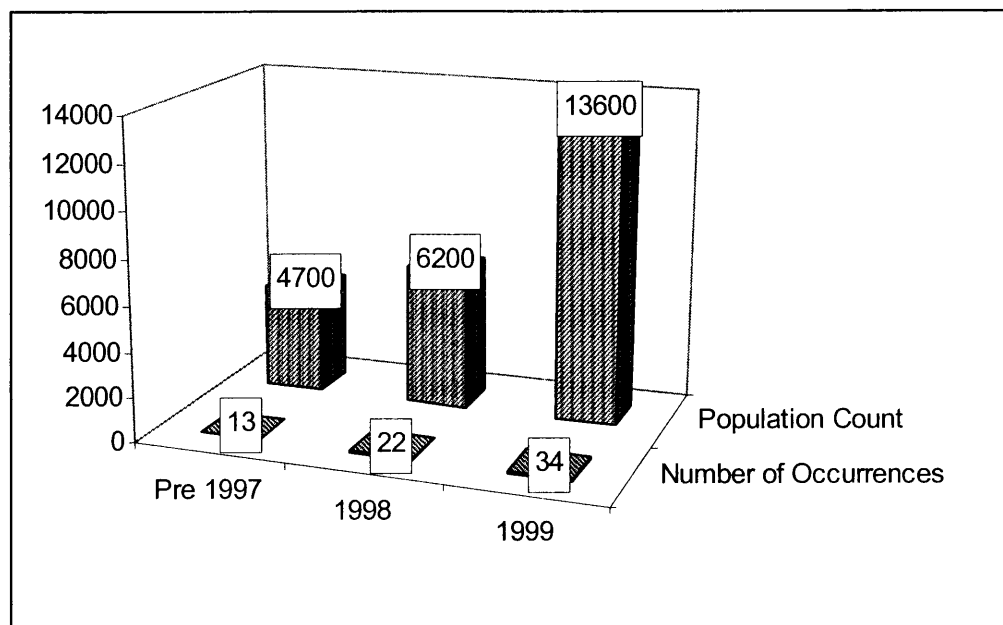


Figure 1. *Gilia caespitosa* survey results.

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