

**Current Knowledge and Conservation Status of *Penstemon bicolor*
(Brandegee) Clokey & Keck (Plantaginaceae), the two-tone beardtongue.**

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SUMMARY: *Penstemon bicolor* is a glaucous short- lived perennial herb to 5 dm tall with few to many flowering stalks. Leaves are irregularly toothed with lower leaves petioled and the upper ones sessile and encircling the stem. The showy tubular flowers vary in color but in many sites the predominant colors are either creamy or rose. The species was first discovered and collected in 1915 by Katharine Brandegee near Goodsprings, Clark County, Nevada. Townshend Stith Brandegee named and published the new plant as *Penstemon palmeri* ssp. *bicolor* in 1916. Clokey and Keck elevated it to a species, *Penstemon bicolor*, in 1939, with subspecies *bicolor* (“*typicus*”) and *roseus* based on the yellow and rose color forms of the flowers, respectively. *Penstemon bicolor* continues to be accepted as a valid species, but the validity of the subspecies has been in question for a few years. Dr. Noel Holmgren did not recognize the subspecies in California for his 1993 and 2002 Jepson Manual treatments. In this report it is proposed that *Penstemon bicolor* be recognized as a distinct species and that the subspecies *roseus* and subspecies *bicolor* be not be recognized. It is the author’s opinion that the subspecies should be lumped because of the recent data on pollination and genetics, which indicate that there are no significant differences between the subspecies. For purposes of this report, the subspecies level will only be discussed when needed; otherwise the information presented pertains to the full species.

Penstemon bicolor is still known from many areas in the Mojave Desert of southern Nevada and adjacent southeastern California and northwestern Arizona. Due to increasing development in and around Las Vegas and concerns about subsequent threats to the species, more information was sought to determine whether the species merited listing under the Endangered Species Act. Field surveys were conducted in 2003, 2004, and 2005 to

relocate historical populations; discover additional populations; and document the biology, ecology and conservation status of the plant. This report summarizes the results of these and other recent surveys, reviews all previous knowledge of the species and recommends conservation and recovery actions designed to prevent it from becoming a threatened or endangered species.

Field surveys during this study yielded two new Nevada occurrences. Both were the yellow-flowered form and were found along the east slopes of the Spring Mountains. Including these new sites, *Penstemon bicolor* is now known from about 70 sites in Nevada, about 2/3 of which are the rose-flowered phase. Maximum known population counts for these sites total less than 7000 individuals, and numbers of individuals vary widely from year to year with climatic conditions. About 92% of the Nevada occurrences are on public lands managed by the Bureau of Land Management, with most of the remainder on privately managed lands. Many of these occurrences are also at least partly with road and highway rights of way managed by the Nevada Department of Transportation. The yellow phase of the species is found mainly on the east slopes of the Spring Mountains and Bird Springs Range in Red Rock Canyon National Recreation Area, near Blue Diamond, and near Goodsprings. The rose phase species occurs mainly south and east of this area, from the southern Las Vegas Range through the El Dorado and McCullough mountains, and into adjacent Arizona and California; and outlying population also occurs on the west slope of the Spring Mountains east of Pahrump. The two Castle Mountains sites in California support about 50 plants on BLM lands. In Arizona, about 10 sites occur in the Black Mountains, totaling about 500 plants on BLM, State of Arizona, and private lands.

Penstemon bicolor depends on insect pollinators for much of its reproductive success. The species is generally restricted to naturally or artificially disturbed, often calcareous, moisture-accumulating sites such as washes and roadsides, and also to rocky slopes, crevices, and talus in the mountains, on all aspects between 1800 and 5480 feet (550-1670 meters) elevation. All sites are surrounded by Joshua tree/shrub, mixed-shrub, or creosote bush vegetation types. *Penstemon bicolor* occurs in similar habitats in California and Arizona. These habitats are common throughout the Mojave Desert in southern Nevada. Most potential habitat searched for *Penstemon bicolor* during this survey proved to be unoccupied, but several additional populations of the species likely remain to be discovered with further survey work.

About 7 (9%) of the previously documented occurrences of *Penstemon bicolor*; 5 yellow-flowered and 2 rose-flowered, are now considered extirpated. These losses have occurred entirely in the urban fringe areas of the greater Las Vegas area. Several additional undocumented occurrences likely have been lost due to build-out of the greater Las Vegas urban area into habitat suitable for *Penstemon bicolor*, and due to road construction and maintenance activities throughout the range of the species. These additional hypothetical losses are probably counterbalanced by as-yet undocumented populations, so that the known percent loss (9%) fairly accurately represents the true losses that have occurred for this species. Hybridization, particularly of the yellow-flowered form, with *Penstemon palmeri*, a commercially available native species commonly used in reclamation seed mixes, has also been identified as a major threat to the genetic integrity of *P. bicolor*. Introduction of *P. palmeri* into the range of *P. bicolor* via road and utility corridors and by intentional planting likely has significantly accelerated the low rate of natural hybridization already occurring.

If not for the significant existing, ongoing, and threatened impacts to many of its known populations, *Penstemon bicolor* would now be too abundant and widespread, globally and in Nevada, to warrant special conservation concern. The species will remain vulnerable to human-caused declines for the foreseeable future as pressures from urban growth continue in the region surrounding Las Vegas, Nevada. In California, ongoing mining operations cover portions of a site supporting a known population of the species. Impact and threats to most of the Arizona populations are believed to be minimal due to their remote wilderness locations. Currently *Penstemon bicolor* is managed as a "sensitive species" by the Bureau of Land Management in Nevada and Arizona, and the yellow-flowered form is a High-priority Evaluation Species under the Clark County Multiple Species Habitat Conservation Plan in Nevada, but has no other legal status or protective designation.

Based on the best available scientific evidence, *Penstemon bicolor* does not now meet the definition of a candidate for listing as threatened or endangered under the Endangered Species Act. Its long-term viability remains a concern without protective management, however, and it therefore continues to meet criteria for sensitive species designation by the Bureau of Land Management. It is recommended that *Penstemon bicolor* also be added to the Nevada state list of species fully protected under N.R.S. 527. This will increase protection for the most vulnerable populations in the foothills and valleys near Las Vegas, and increase public awareness of the species' locations and needs. This report recommends several additional conservation measures which, if successfully implemented, offer the best chance to eliminate any future need to list *Penstemon bicolor* as threatened or endangered. Primary among these are elimination of introduced *Penstemon palmeri* plants and seeds from within the habitats of *P. bicolor*, careful management of road construction, maintenance, and off-road vehicle traffic, continued surveys and monitoring, and continued biological studies of the species.

ACKNOWLEDGMENTS

I would like to thank Gayle Marrs-Smith and Christina Nelson of the Bureau of Land Management for assisting in field surveys and supplying information on the species. A special thanks to Gina Glenne of the U. S. Fish and Wildlife Service for going out with me to the field and for having some long discussions about *Penstemon bicolor*. Thanks to John Anderson, Jim Andre, and Glenn Clifton for assisting in the field surveys. The herbaria cited in Appendix 1, table 3, and their curators and parent institutions, maintained and made available the specimens in their care. James Morefield of the Nevada Natural Heritage Program edited the final report, provided additional information for several sections, and we had a number of discussions about the taxonomy of *P. bicolor*. The taxonomic opinions expressed in this report are my own, however, and should not necessarily be attributed to any of the above.

All information contained in this report was believed current and complete on the date it was printed. Please submit any and all additions, corrections, updates, comments, or suggestions, whatever their magnitude, to the Nevada Natural Heritage Program or the U. S. Fish and Wildlife Service at the addresses above.

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- Table 3. Specimens documenting known and reported *Penstemon bicolor* sites.

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APPENDIX 3. MAP.

- Map 1. Distribution of *Penstemon bicolor* in Nevada (1:700,000, western Clark County). Pink denotes rose-flowered form, orange denotes yellow-flowered form, green denotes hybrids or unknown color form. X denotes an extirpated site, and ? denotes a historical site that is doubtfully extant. Red lines are federal highways; state highways and major roads are in black and gray.

APPENDIX 4. CORRESPONDENCE.

I. CLASSIFICATION AND SYSTEMATICS

Scientific Name: *Penstemon bicolor* (T. S. Brandege) Clokey & Keck (1939, p. 12).

Type Specimens: *Penstemon palmeri* var. *bicolor*: NEVADA, Clark County, “at Good Springs,” May 1915, K. Brandege s.n. (lectotype, by Clokey & Keck 1939, p. 12: UC 178265; isotype: US; excluded syntype: UC 178259). *Penstemon bicolor* ssp. *roseus*: NEVADA, Clark County, El Dorado Canyon, Nelson, 14 May 1938, Clokey 5850 (holotype: UC; isotypes: CAS, DS, NY, POM, RENO, US, UT, UTC). Information from original publications and from Tiehm (1996).

Synonym(s): *Penstemon palmeri* var. *bicolor* Brandege (1916, p. 360). *Penstemon pseudospectabilis* ssp. *bicolor* (Brandegee) Keck (1937, p. 806). *Penstemon bicolor* ssp. *roseus* Clokey & Keck (1939, p. 12).

Vernacular Name(s): two-tone beardtongue [yellow or rosy], pinto penstemon.

Family: Plantaginaceae (plantain family).

Major Groups:	Maddison & Schulz (1996-2006); Stevens (2001-2006)	Thorne (1992)	Cronquist (1988)
Class	Spermatopsida	Magnoliopsida (Angiospermae)	Magnoliopsida (Dicotyledoneae)
Subclass	[Angiospermae of Thorne]	Magnoliidae (Dicotyledoneae)	Asteridae
Superorder	[Dicotyledoneae of Thorne]	Gentiananae	_____
Order	Lamiales	Scrophulariales	Scrophulariales
Family	Plantaginaceae	Scrophulariaceae	Scrophulariaceae

Review of Alternative Taxonomic Treatments: Some concerns have been raised over the years about the taxonomy of *Penstemon bicolor* (Clokey and Keck 1939). I have seen no morphological differences between the two subspecies except for flower color. The syntype specimens collected by Katherine Brandege included both the yellow and purple (rose) color forms. Both color forms are found in similar habitats such as washes, roadsides and rocky sites in the mountains. The only ecological difference I have observed between the subspecies is that ssp. *bicolor* has been collected at a slightly higher elevation.

Shelly *et al.* (1998) discovered that *Claytonia lanceolata* var. *flava* has both yellow and white flowers. The yellow and white flowered plants were biotically sympatric, and were otherwise indistinguishable. In the case of both *C. lanceolata* var. *flava* and *Penstemon bicolor*, the difference in flower color may be the result of a difference in only one gene. In the author’s opinion, a difference in flower color only within a species is not an adequate basis on which to separate a variety or subspecies.

Noel Holmgren (1993, 2002) of the New York Botanical Garden lumped the subspecies in the *Jepson Manual* (Baldwin *et al.* 2002, Hickman 1993). In correspondence on the matter (see Appendix 4), he stated “In my treatment of *Penstemon* in the *Jepson Manual* I purposely lumped *P. bicolor* subsp. *roseus* into *P. bicolor*. A similar situation occurs in *P. whippleanus* where

corolla color in some populations are all of one color form (pinkish-white) or all of the other (dark purple), but there are some populations containing both, and there is no geographical, ecological, or morphological pattern suggesting two distinct entities that diverged from a common ancestor. As with *P. whippleanus*, my guess is that it is likely a one or a few linked-gene phenomenon that it is not worthy of taxonomic recognition.”

Cymopterus ripleyi var. *saniculoides* is another rare taxon, recognized on the basis of flower color, that has been lumped. Well regarded taxonomists such as Lincoln Constance and James Reveal consider var. *saniculoides* as a synonym of *Cymopterus ripleyi* (Blomquist *et al.* 1995). In the *Jepson Manual* (Baldwin *et al.* 2002, Hickman 1993), var. *saniculoides* is treated as a synonym of *C. ripleyi*.

Gina Glenne (2003) conducted a pollination study for her Master’s thesis and found no significant differences in the way the subspecies were pollinated. Also, Andrea Wolfe *et al.* (2000) concluded in a genetic study that there was insufficient evidence to treat the subspecies as distinct taxa, though further study was needed since one area showed some unique alleles.

For this report it is the author’s opinion that the subspecies *roseus* and subspecies *bicolor* should be lumped together. (See Appendix 4, correspondence).

Based on the existing geographic, ecologic, and genetic information, the Nevada Natural Heritage Program continues to recognize the subspecies of *Penstemon bicolor* as valid taxa. A position paper to accompany this report will detail the reasons for this alternative treatment.

Biogeography and Phylogeny: *Penstemon* is the largest genus of flowering plants that is endemic to North America (Holmgren 1993, 2002), with most of its approximately 275 species concentrated in the western United States. A study of *Penstemon* is currently underway, focusing on reconstructing its phylogeny. Species closely related to *Penstemon bicolor* include *P. clutei*, *P. floridus*, *P. palmeri*, and *P. rubicundus* (Wolfe 2005), all restricted to the Basin and Range province of western North America. *Penstemon pseudospectabilis* has also been considered closely related (Keck 1937), but is tentatively placed in the *Habroanthus* group. *Penstemon bicolor* is in the subgenus *Penstemon* which is characterized by anthers that dehisce across the connective and are divaricate or explanate at maturity.

II. TAXON HISTORY

Unless otherwise cited, reports and correspondence documenting the following chronology are on file with the Nevada Natural Heritage Program.

- 1915: First discovered by Katharine Brandegee (a.k.a. Mary Katharine Layne Curran), who collected the type specimens (both color forms) at or near Good Springs, Clark County, Nevada, in May (Tiehm 1996).
- 1916: Formally named and described as a new variety, *Penstemon palmeri* var. *bicolor*, by T. S. Brandegee (1916).
- 1937: First collected in Arizona by Peebles and Kearney (1937) on 16 April.
- 1937: Transferred as *Penstemon pseudospectabilis* ssp. *bicolor* by Keck (1937).
- 1939: Recognized as a distinct species, *Penstemon bicolor*, by Clokey and Keck (1939) containing two subspecies, var. *roseus* for the rose-flowered form, and var. *bicolor* (as “var. *typicus*”) for the yellow-flowered form. Brandegee’s 1915 yellow-flowered specimen was chosen from the original type material to be the lectotype of *Penstemon palmeri* var. *bicolor*.

- 1951: *Penstemon bicolor* and ssp. *roseus* included and recognized in Clokey's (1951) *Flora of the Charleston Mountains*.
- 1951: *Penstemon bicolor* ssp. *roseus* included and recognized in Kearney and Peebles' (1951) *Arizona Flora*.
- 1980: *Penstemon bicolor* var. *bicolor* and var. *roseus* were designated as category-1 candidates for listing under the Endangered Species Act on 15 December (U. S. D. I. Fish and Wildlife Service 1980).
- 1981-1983: *Penstemon bicolor* ssp. *roseus* was documented on the Desert National Wildlife Range by Ackerman (1981, with supplementary notes in 1983; 2003).
- 1983: *Penstemon bicolor* var. *bicolor* and var. *roseus* were re-classified as category-2 candidates for listing under the Endangered Species Act on 28 November (U. S. D. I. Fish and Wildlife Service 1983), where they remained until 1996.
- 1987: *Penstemon bicolor* var. *bicolor* and var. *roseus* were included and recognized in Kartesz's (1987) *Flora of Nevada*, wherein some doubt as to the taxonomic significance of the two color forms was expressed.
- 1990: First collected (rose-flowered form) in California by Alan P. Romsper on 24 April.
- 1992: Surveyed by Knight (1992) in Lake Mead National Recreation Area.
- 1993: Recognized as a species without subspecies by Holmgren (1993) in the *Jepson Manual*.
- 1994: Surveyed by Sheldon (1994) in the Hidden Valley Area.
- 1996: Category-2 candidate designations eliminated for all species on 28 February by the U. S. D. I. Fish and Wildlife Service (1996); all in Nevada converted to sensitive species designations by the U. S. D. I. Bureau of Land Management (1996).
- 1999-2000: Genetic survey of both color forms conducted by Wolfe *et al.* (2000).
- 1999-2003: Reproductive biology studied by Glenne (2003) using field sites in the McCullough Mountains and near Jean.
- 2002: Again recognized as a species without subspecies by Holmgren (2002) in the *Jepson Desert Manual*.
- 2003-2005: Surveys conducted for this report.

III. PRESENT LEGAL OR OTHER FORMAL STATUS

International: Using a system established by NatureServe (formerly part of The Nature Conservancy), the various state Natural Heritage Programs rank sensitive taxa at state, national, and global levels on a scale of 1 to 5, with 1 being the most vulnerable and 5 the most secure. *Penstemon bicolor* was most recently ranked 3 (vulnerable) by the Nevada Natural Heritage Program (2005) at the species level (2 [imperiled] for the yellow flowered form and 3 for the rose flowered form). The results of this report suggest that these are still the most appropriate ranks for the species.

Federal: Both subspecies of *Penstemon bicolor* were designated as category-2 candidates for listing as endangered or threatened under 16 U.S.C. 1531 *et seq.*, the Endangered Species Act as amended in 1988, until the U. S. D. I. Fish and Wildlife Service (1996) eliminated that category. Category-2 included taxa for which “proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules” (U. S. D. I. Fish and Wildlife Service 1985). *Penstemon bicolor* remains a “species of concern” to the Fish

and Wildlife Service, but this term has no formal or legal status. In Nevada, both subspecies of *Penstemon bicolor* are on the sensitive species lists of the U. S. D. I. Bureau of Land Management (1996) and of the Humboldt-Toiyabe National Forest (Nevada Natural Heritage Program 2005). In 2005 the Bureau of Land Management listed *Penstemon bicolor* as a sensitive species in Arizona (Anderson 2005).

State and Local: No formal status has been designated at the state or local level. Both subspecies of *Penstemon bicolor* are on the Nevada Natural Heritage Program's at-risk species list and on the Nevada Native Plant Society's Watch List (Nevada Natural Heritage Program, 2005). The yellow-flowered form of *Penstemon bicolor* is a high-priority evaluation species under the Clark County Multiple Species Habitat Conservation Plan, and the rose-flowered form is a watch list species under that plan. *Penstemon bicolor* ssp. *roseus* is on list 2.3 of the California Native Plant Society (2006). This report recommends that the Nevada Division of Forestry consider adding *Penstemon bicolor* to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270, due to increasing habitat loss from urban expansion in the Las Vegas area and accompanying recreational pressures, and increase threats from hybridization with other *Penstemon* species. No changes to the other designations are recommended.

IV. DESCRIPTION

NOTE: in the following descriptions, the staminode (sterile stamen) of *Penstemon bicolor* is described as exerted (sticking out past the throat of the flower). This is in accord with Clokey and Keck (1939) and other early descriptions, and with the specimens and photographs examined for this report. Holmgren (1993, 2002) described the staminode as included, apparently in error.

Non-technical: Perennial 5 to 15 dm tall, hairless. **Leaves** thick, upper 4-11 cm long, oval, bases fused around stem, coarsely toothed. **Inflorescence** sticky, often half the height of the plant. **Flower cup** 4-6 mm, lobes more or less oval. **Flower** 18-27 mm, throat 6-11 wide when pressed, rose pink to yellowish, strongly lined, abruptly inflated from a tube twice as long as flower cup, inflated portion sparsely hairy within near base of lower lobes. **Anther sacs** 1.3-2 mm, splitting completely across the connecting portion, spreading flat. **Sterile stamen** sticking out past throat of flower, yellow-hairy. (based on Ackerman 1981, Clokey and Keck 1939, Holmgren 1984, 1993, Mozingo and Williams 1980)

Technical: Perennial 5-15 dm tall, glabrous. **Leaves** thick, glaucescent, sharply serrate, opposite, distal leaves connate-perfoliate, 4-11 cm, ovate. **Inflorescence** glandular. **Calyx** 4-6 mm, lobes +/- ovate. **Corolla** 18-27 mm, 6-11 mm wide when pressed, cream to magenta, strongly lined, glandular outside, floor long-whitish-hairy. **Anther sacs** 1.3-2 mm, dehiscing across the connective, explanate. **Staminode** exerted, densely yellow-bearded. (based on Clokey and Keck 1939, Holmgren 1984, 1993)

Field Characters: (see Appendix 2 figures) *Penstemon bicolor* is easy to identify in the field when in flower. Otherwise it is impossible to distinguish from *P. palmeri* in the non-flowering and vegetative state. The following is a key to closely related *Penstemon* species that are found in the desert in and near the range of *Penstemon bicolor*:

1. Leaf margins entire, and/or leaves linear, or flowers blue **other *Penstemon* species**
- 1' Leaf margins toothed; leaves broad; flowers not blue (go to 2).

2. Corolla abruptly inflated from a short tube +/- equaling calyx; flowers whitish with lavender or pink markings (upper leaves connate perfoliate; staminode bearded with tip hooked) *P. palmeri*
- 2' Corolla nearly tubular to inflated from tube 1.5-2 times as long as calyx (go to 3).
 3. Upper leaves sessile or auriculate-clasping but distinct; corolla not villous within; staminode not bearded or exserted..... *P. floridus ssp. austinii*
 - 3' Upper leaves connate perfoliate (leaf entirely surrounding stem) (go to 4).
 4. Corolla throat 4-5 mm wide when pressed..... *P. stephensii*
 - 4' Corolla throat 6-9 mm wide when pressed (go to 5).
 5. Staminode glabrous, included inside flower; anther-lobes wider than long; corolla gradually and moderately inflated; throat not hairy at lower lip; corolla reddish pink *P. pseudospectabilis*
 - 5' Staminode bearded, exserted from flower; anther-lobes longer than wide; corolla abruptly inflated; throat hairy within near lower lip; corolla pale yellow (sometimes with pink tinge on lobes) or rose-pink *P. bicolor*

Photographs and Line Drawings: A line drawing of *Penstemon bicolor* by Jeanne R. Janish was published in Mozingo and Williams (1980, p. 214), was reproduced in Weixelman and Atwood (1990), and is reproduced in Appendix 2, figure 1 of this report. Photographs of *Penstemon bicolor* and its habitat were published in Weixelman and Atwood (1990). Photographs of *Penstemon bicolor* and its habitat were also made for this report, are reproduced in Appendix 2, are filed with the Nevada Natural Heritage Program, and are available on its public web site at <http://heritage.nv.gov>.

V. SIGNIFICANCE OF TAXON

Natural: *Penstemon bicolor* is one of a small suite of relatively rare plant species that specialize in disturbed areas, and as such may be important in studies of plant evolution and adaptations to disturbance. In some areas the plants may be important in stabilizing and re-establishing soils on recent natural and artificial disturbances within its general habitat. The flowers likely serve as an important source of pollen and/or nectar for insects in and near its habitat during the months of March through May (Glennie 2003). The pattern of flower color variation within the species, and its ability to hybridize with *Penstemon palmeri* and possibly other taxa, make *P. bicolor* an interesting system for the study of flower color differentiation, and of the role of hybridization in evolution and rare species conservation.

Human: No studies of medicinal or other qualities of potential human benefit are yet known to have been performed on *Penstemon bicolor*. It is an attractive plant with good potential for use in the horticultural trade if it can be grown from seed. In the town of Nelson, *P. bicolor* has been observed growing in yards around homes (Appendix 2 figures). At the Bureau of Land Management Red Rocks visitor center, the yellow phase of *P. bicolor* grows with *P. palmeri*. Along with the many other rare plant species in the area, *P. bicolor* has potential as an eco-tourism attraction.

VI. GEOGRAPHIC DISTRIBUTION

Geographic Range: (Appendix 3 map; Glennie 2003). Globally, *Penstemon bicolor* is restricted to the Mojave Desert of southern Nevada and adjacent southeastern California and northwestern Arizona. In Nevada (Appendix 3 map), *Penstemon bicolor* has been documented from about 80

occurrences in western and southern Clark County, primarily on Bureau of Land Management, Las Vegas District (BLM), private, and Nevada Department of Transportation managed lands and rights of way. About 7 of these occurrences (9%; 5 yellow-flowered and 2 rose-flowered) are now considered extirpated, and another 3 occurrences (4%) are considered historical and doubtfully still extant. This leaves about 70 occurrences of *Penstemon bicolor* extant in Nevada, about 2/3 of which are the rose-flowered form. The rarer yellow-flowered form is apparently endemic to Nevada, primarily along the eastern foothills of the Spring Mountains and Bird Spring Range, with outliers scattered southeastward in the higher elevations of the McCullough and El Dorado mountains.

In California, only the rose-flowered form of *Penstemon bicolor* is known, from 3-4 occurrences in northeastern San Bernardino County, adjacent to the species' range in Nevada, in the Clark, New York, and Castle Mountains (California Native Plant Society 2006, Glenne 2003), mainly on public lands. Plants were documented within a mining site in the Castle Mountains but have not been revisited since 1990. This population at the Viceroy Mine could be extirpated.

In Arizona, only the rose-flowered form of *Penstemon bicolor* is known, from about ten sites in the Black Mountains of northwestern Mohave County, also adjacent to the species' range in Nevada (Glenne 2003). Approximately 500 plants are known (Anderson 2005). More information can be obtained by searching the specimen collections databases of the Southwest Environmental Information Network (2006).

The predominantly calcareous washes and rocky mountain slopes harboring *Penstemon bicolor* occur frequently throughout the Mojave Desert in southern Nevada. Several additional areas of potential habitat were surveyed in Nevada without finding the species.

Precise Occurrences: Precise spatial and ecological data on the Nevada occurrences of *Penstemon bicolor* were compiled from a wide variety of sources whose survey methods were not always exactly comparable. The detailed data have been compiled by and are available from the Nevada Natural Heritage Program databases, including the data gathered during surveys conducted for this report.

To the best of my knowledge, no privately managed sites were entered upon to obtain any of the new information documented by these surveys against the restrictions of the owners or managers. In many cases, private sites were small and easily viewed and documented from adjacent public lands or public access areas. In a few cases, sites were not surveyed due to lack of access, and the information in this report is then based solely on any previously existing information.

Historical site(s) rediscovered or recently known extant: About 21 previously known sites were visited during surveys for this report and deemed to remain extant. Because of severe drought conditions during most of these surveys, plants were sometimes not in evidence, or only dead plants were seen. In these cases, if appropriate habitat still existed at a site, the occurrence was considered to remain extant as part of the soil seed bank.

New site(s) discovered: Two new occurrences of *Penstemon bicolor* were discovered and documented during surveys for this report. Both were the yellow-flowered form and were found along the east slopes of the Spring Mountains. Other recent surveys and collections (BLM GIS data, Glenne 2003, Wolfe *et al.* 2000) added several more sites to those previously documented by the Nevada Natural Heritage Program.

Historical site(s) searched for but not rediscovered: About 12 additional historical occurrences were searched for but not relocated during surveys for this report. Most of

these were found to be definitely or probably extirpated. Most of the remainder were determined to represent mapping errors of the original historical data. Glenn Clifton surveyed for but could not relocate the populations in the Searchlight area

Other site(s) searched where not discovered: A few areas of potential habitat were visited during surveys for this report, without finding *Penstemon bicolor*. Most surveys were focused on relocating and better delineating previously known sites.

Historical site(s) known or suspected to be erroneous reports: About 5 historical sites included in the Nevada Natural Heritage Program databases were found to have been mislocated by several miles based on the original location data provided, and have been more accurately located for this report. The results of field surveys required small adjustments to several other location records, including the previous report of *Penstemon bicolor* in Nye County on the west slope of the Spring Mountains; field surveys demonstrated this occurrence to fall on the Clark County side of the boundary line.

Historical site(s) known or assumed extirpated: (Appendix 3 map) About 7 (9%) of the previously documented occurrences of *Penstemon bicolor*; 5 yellow-flowered and 2 rose-flowered, are now considered extirpated. These losses have occurred entirely in the urban fringe areas of the greater Las Vegas area. Several additional undocumented occurrences likely have been lost due to build-out of the greater Las Vegas urban area into habitat suitable for *Penstemon bicolor*, and due to road construction and maintenance activities throughout the range of the species. These additional hypothetical losses are probably counterbalanced by as-yet undocumented populations, so that the known percent loss (9%) fairly accurately represents the true losses that have occurred for this species.

Historical site(s) where present status unknown: Several historical populations in the Kyle Canyon area of the Spring Mountains, the southern Las Vegas Range, the Muddy Mountains, the southern McCullough Mountains, and the Castle Mountains could not be revisited during surveys for this report. All of these are located in generally remote and/or lightly impacted areas, and are assumed extant for the time being.

Potential site(s) meriting future field surveys: The predominantly calcareous washes and rocky mountain slopes harboring *Penstemon bicolor* are common habitats throughout the Mojave Desert in southern Nevada. While most potential habitat searched for *Penstemon bicolor* has proven to be unoccupied, several additional populations of the species likely remain to be discovered with further survey work.

VII. HABITAT CHARACTERISTICS

Environment and Habitat Summary: (Appendix 2 figures) In Nevada *Penstemon bicolor* is generally restricted to naturally or artificially disturbed, often calcareous, moisture-accumulating sites such as washes and roadsides, and also to rocky slopes, crevices, and talus in the mountains, on all aspects between 1800 and 5480 feet (550-1670 meters) elevation. All sites are surrounded by zonal creosote bush - bursage (*Larrea tridentata* - *Ambrosia dumosa*) or joshua tree (*Yucca brevifolia*) - mixed shrub vegetation (Appendix 1, table 1). In California, the species is found on limestone mountain slopes. In Arizona, the species is found in washes and on volcanic substrates in the mountains (Anderson 2005).

Physical Characteristics:

Physiography: The range of *Penstemon bicolor* lies in the Mojave Desert of the southern Basin and Range Province (Hunt 1967). This region is characterized by broad desert valleys averaging 2000-3000 feet (610-915 meters) elevation, interrupted by isolated mountain ranges of moderate elevation rarely exceeding 9000 feet (2740 meters).

Climate: The Mojave Desert has a highly variable climate, exhibited along both horizontal and elevational gradients and at all time scales: hourly, daily, seasonally, and annually. The region's latitude, interior continental position, and high mountainous borders combine to create a generally arid climate. As in most arid regions, evapotranspiration greatly exceeds precipitation at all elevations, producing an average net loss of surface moisture. Most annual precipitation falls from about November through April in Pacific storm systems from the west. The Mojave Desert also lies within the influence of sub-tropical summer moisture, which originates in the Gulfs of Mexico and California and spreads over most of Arizona during July and August. This "monsoonal" influence produces a secondary peak of precipitation particularly toward the eastern and southern parts of the region, averaging up to half or more of the annual total, and capable of delivering a substantial majority of annual precipitation to limited areas in any given year. Both summer and winter precipitation are highly variable from year to year, ranging between about 15% and 250% of the long-term averages. Variability decreases somewhat at higher elevations.

Temperature variations range up to 35-45°F (19-25°C) in daily changes, in average differences between warmest and coldest months, and in departures of extreme highs and lows from seasonal averages. This can result in differences up to 110-130°F (61-72°C) in the extremes experienced at any one site during a year. In general, temperature ranges at all the above scales tend to increase toward lower elevations. Daily variations further tend to be greatest at the lowest humidities during the spring and fall seasons. The average daily temperature range throughout the year is about 25-30°F (14-17°C)

The McCarran International Airport weather station in Las Vegas is located at an elevation of 2162 feet (660 meters), with climatic records from 1949 to 2005. At that station, the average maximum temperature is 79.7°F (26.5°C) and the average minimum temperature is 42.0°F (5.6°C). The average annual maximum temperature is 112.9°F (44.9°C) and the average annual minimum temperature is 19.9°F (-6.7°C). The record maximum temperature is 116°F (46.7°C) and the record minimum temperature is 8°F (-13.3°C). The average annual precipitation is 4.12 inches (105 mm). The greatest annual precipitation was 9.88 inches (251 mm) and the least annual was 0.56 inches (14 mm). See Appendix 1, table 2, for total precipitation, and average daily minimum and maximum temperatures, for each month from 2002 to 2005.

This climatic station is located at a lower elevation than most of the known sites of *Penstemon bicolor*, and is surrounded by the urban "heat island" of Las Vegas. The temperatures noted are probably somewhat warmer, and the precipitation somewhat lower, than at the sites supporting *Penstemon bicolor*.

Geomorphology, aspect, and slope: Populations of *Penstemon bicolor* occur on flats, washes or gentle to steep slopes of all aspects on valley floors and mountain slopes.

Geology: In Nevada, the plants occupy geologic formations that are calcareous, carbonate, granitic or volcanic. In California, the plants are found on soils derived from carbonate substrates. In Arizona, the plants occupy volcanic formations.

Soils: In Nevada, *Penstemon bicolor* occurs on gravelly to rocky soils. The following information on soil particle size and pH was determined by Lathrop (1987):

Particle Size or pH	Nelson (R64E T25S S33; 2650')	Mission Hills (R63E T22S S33; 2700')	Black Mountains (R63E T23S S10; 3000')
Gravel	54%	47%	63%
Fine Gravel	30%	23%	32%
Coarse Sand	7%	10%	4%
Fine Sand	5%	14%	1%
Silt & Clay	4%	6%	0.2%
pH	8.0	8.8	6.4

Hydrology: *Penstemon bicolor* does occur in washes, on roadsides, along drainages, and in rock crevices, which in times of heavy rains often have running water, and which generally concentrate incident precipitation. Otherwise, *Penstemon bicolor* is not associated with free water, and is entirely dependent on incident precipitation and its retention in the soil. The soils supporting most *Penstemon bicolor* populations are shallow, well drained, and highly permeable, with low water holding capacity.

Air and water quality requirements: No specific requirements or unusual tolerances are known. Plants were observed to grow well immediately adjacent to heavily traveled highways when otherwise left undisturbed.

Biologic Characteristics:

Community physiognomy: *Penstemon bicolor* occurs in washes, roadsides, rock outcrops that mostly support a shrub and forb cover with a low percent of grasses. Most of the forb species present are annual. Plant cover ranges from 1 to 10 percent.

Vegetation type: *Penstemon bicolor* is found in mixed shrub communities in the mountains. Joshua tree or creosote bush - bursage communities are associated with the two-toned penstemon on foot-slopes and valley floors. Within these plant communities the species is also found along drainages and/or washes. In the washes, there is no distinct vegetation type associated with the species and no one associated species is dominant.

Associated plant species: All associates observed or reported at 15 Nevada *Penstemon bicolor* sites are listed in Appendix 1, table 1. The most frequent species associated with *Penstemon bicolor* were (in descending order): *Hymenoclea salsola*, *Erioneuron pulchellum*, *Gutierrezia microcephala*, *Ambrosia eriocentra*, *Encelia virginensis*, *Ambrosia dumosa*, *Baileya multiradiata*, *Bromus rubens* var. *rubens*, *Gutierrezia sarothrae*, *Eriocameria paniculata*, *Salvia dorrii*, *Achnatherum hymenoides*, *Aristida purpurea*, and *Sphaeralcea ambigua*. Many of these species are characteristic of desert washes and drainages.

Other endangered, threatened, and sensitive species: *Penstemon bicolor* has been found growing in the immediate vicinity of *Astragalus remotus*, *Cylindropuntia multi-*

geniculata, and *Penstemon albomarginatus*. Contact the Nevada Natural Heritage Program for current information on these and the numerous other rare and sensitive species found in the vicinity of *Penstemon bicolor* sites.

Land Management: For all sites, management status was determined based on the best maps, GIS data, and other information available, but generally was not further verified. Ownership status of associated minerals and water rights was not determined for any site, nor was the presence or absence of any easements or other encumbrances.

Bureau of Land Management (BLM), Carson City District, U. S. Dept. of Interior:

Nearly all (about 92%) of the Nevada *Penstemon bicolor* population occurs on public lands managed by BLM. Most of these lands are currently open to multiple uses, and/or are identified as available for disposal or exchange. Those within Red Rock Canyon National Recreation Area are managed for both recreation and greater resource protection, and two occurrences appear to fall within recently designated BLM Wilderness Areas.

Public lands in urban interface areas, where a number of *Penstemon bicolor* occurrences are located, are also subject to heavy recreational pressures, increased threat of fire, and to aggressive suppression activities when fires occur.

Private lands: Roughly 8% of the Nevada *Penstemon bicolor* population occurs on lands identified as privately managed, which may include some county or municipal lands. Land use and/or management plans and actions on these lands are not known to or likely to consider the presence of *Penstemon bicolor* or its habitat.

Nevada Department of Transportation (NDOT) rights-of-way: Many of the known occurrences of *Penstemon bicolor* are wholly or partially within federal or state road and highway corridors. NDOT consults the Nevada Natural Heritage Program databases regularly during project planning, and this should help maintain awareness and minimize impacts from highway-related projects in the future.

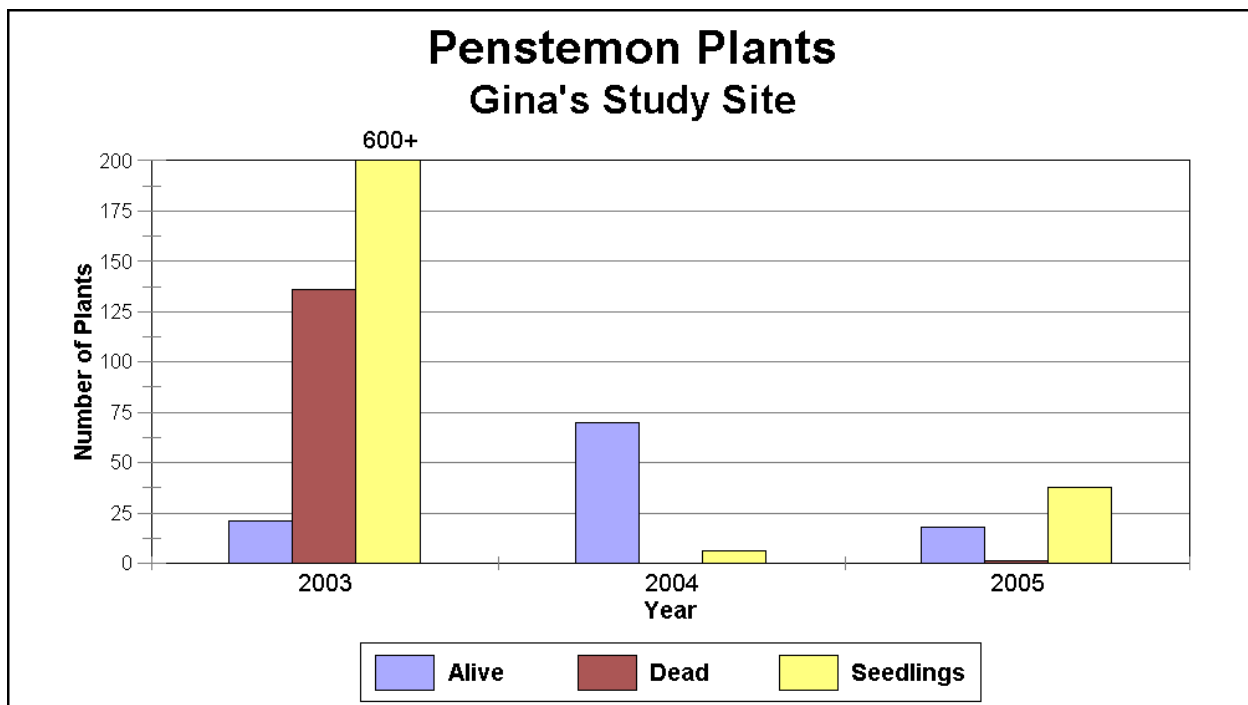
Humboldt-Toiyabe National Forest (HTNF), Carson City Ranger District, U. S.

Dept. of Agriculture: A few scattered individuals of uncertain genetic composition have been reported from public lands managed by HTNF in Spring Mountains National Recreation Area (Glennie 2003). The locations, extents, and identities of these plants need to be better determined.

VIII. BIOLOGY AND ECOLOGY

Population Summary: Numbers of plants of *Penstemon bicolor* have been observed to fluctuate widely as climatic conditions vary from year to year. Maximum numbers of plants observed at Nevada sites appear to total less than 7000. In California, the two Castle Mountains sites were estimated to contain about 50 individuals in 2005 (Andre 2005). In Arizona, the population is estimated to be about 500 plants in the Black Mountains in Mohave County (Anderson 2005).

Demography: The author conducted a demographic study from 2003 to 2005 at one of the study areas used by Glennie (2003). The data illustrated in the following chart seem to indicate that precipitation is not the primary factor determining timing of germination.



Phenology: All observations and data examined for this report indicate that plants flower primarily from March through May. Fruits probably mature from May into July.

Genetics: Wolf *et al.* (2000) studied the genetics of the yellow and rose color forms. There were no significant differences in the genetic profiles of the subspecies in the quantitative analyses, and the majority of genetic diversity occurred within populations rather than among populations or subspecies. However, some populations of *ssp. bicolor* exhibited unique alleles. Based on genetic similarity, populations of *ssp. bicolor* from the western portion of the species' range, at higher elevations of the Spring Mountains, grouped together, and the populations of *ssp. roseus* from the eastern portion of the species' range grouped together. The remaining populations of *ssp. bicolor*, from the Goodsprings area and lower Spring Mountains foothills in the central portion of the species' range, grouped with a *ssp. roseus* population from the same area (where the two are known to hybridize occasionally). Wolfe *et al.* (2000) saw this as "consistent with a pattern of recent infraspecific differentiation." Because the area of hybridization, where populations of *ssp. bicolor* and *ssp. roseus* grouped together, is geographically intermediate between the other groups of the two subspecies, this pattern could also be consistent with a zone of secondary contact and hybridization between two formerly distinct taxa.

Reproduction and Dispersal: Glenne (2003) studied the reproductive biology of *Penstemon bicolor* in detail, especially as it related to hybridization and its conservation implications. She found that, while outcrossing was prevalent in most *Penstemon* species studied, *P. bicolor* exhibited a mixed-mating breeding system, with outcrossing most successful, but also with considerable autogamy and self-compatibility. Autogamy was significantly higher in *ssp. roseus* than in *ssp. bicolor*. Glenne concluded that such a mixed breeding system was advantageous in desert habitats where pollinator populations fluctuate widely from year to year. (It is worth noting, in that regard, that *ssp. roseus* inhabited lower elevations, on average, than did *ssp. bicolor*.)

Visitors of *Penstemon bicolor* flowers included a wide array of bees, beetles, flies, butterflies, moths, and hummingbirds. Two species of bee in the genus *Osmia* (Megachilidae) were determined to be the most effective pollinators.

Hybridization: Natural hybridization between *Penstemon bicolor* and *P. palmeri*, and possibly also between the color forms of *P. bicolor* where sympatric with each other and with *P. palmeri*, have long been noted (Brandege 1916, Clokey and Keck 1939). Glenne (2003) confirmed the existence of such hybrids in certain areas, and that those involving *P. palmeri* exhibited little or no reduction in vigor or fertility. She concluded that hybrid swamping due to artificial introduction of *P. palmeri* into *P. bicolor* habitat constitutes a significant threat to the latter species.

Pathology: No evidence of pathogen activity on *Penstemon bicolor* has been reported or observed.

Predation: In Nevada, cattle and burro grazing as well as trampling could affect *Penstemon bicolor*. During this survey, however, I didn't encounter any signs of animal grazing and/or trampling.

Competition: *Penstemon bicolor* occurs as a dominant or subdominant plant in washes and roadsides. The *Penstemon bicolor* that occurs in the mountains generally has a cover of less than 10 percent. In the mountains a mixed shrub community is generally dominant. A few exotic grass species such as *Bromus rubens* have begun invading some of the Nevada sites, but it is not known how competitive they are in *Penstemon bicolor* habitats, or whether *Penstemon bicolor* has yet been impacted by their presence.

Response to Disturbance: *Penstemon bicolor* appears to be dependent on moderate periodic disturbance to grow. The seeds probably need to be scarified, which allows water to move into the seed and initiate germination. Populations of *P. bicolor* fluctuate year to year because of flash floods and road disturbance. The species does appear to be able to recolonize when such disturbance occurs, as long as the habitat is not permanently altered.

Other Interactions: No other interactions have been noted.

IX. EVIDENCE OF THREATS TO SURVIVAL

Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range:

Permanent habitat losses totaling about 9% of the Nevada occurrences were documented during surveys for this report. Most of these losses had resulted from urban and residential development. All impacts observed are discussed in more detail below, in approximate order of greatest to least current significance.

Urban and residential development: Seven *Penstemon bicolor* sites have been extirpated in Las Vegas Valley by housing and road development projects. Other populations of *Penstemon bicolor* will always be vulnerable in the Las Vegas area primarily due to the Federal Land Exchange Program of the Bureau of Land Management. Other rare plants in the area are vulnerable as well. Most other development impacts in Nevada are likely to be indirect ones as the Las Vegas metro area grows. In Arizona, the species is protected by its location in a wilderness area. Urban growth, and its associated collateral impacts (which include most of the other items listed in this section), will remain the most significant long-term threat to *Penstemon bicolor*.

Mineral exploration and development: In California, *Penstemon bicolor* could be impacted by the Viceroy Mine. Populations in Nevada have been impacted by development

of material pits associated with urban construction, and possibly by mining activities in the Blue Diamond Hills, the Nelson area, etc.

Road development and maintenance and off-road vehicle use: When not disturbed or impacted too frequently, roadsides provide habitat similar to the natural desert wash habitat of *Penstemon bicolor*, and can serve as additional refugia for the species when they pass through previous habitat for the species. A few roadside populations even appear to have spread there due to the presence of the corridor, though most roadside populations occur adjacent to known natural habitat. Heavy blading and other maintenance activities may have permanently impacted a few roadside populations (as, of course, have the roadbeds themselves). But moderate right-of-way maintenance, when allowed to recover for several years, may actually benefit some populations of the species.

Heavy recreational off-road vehicle use in desert washes adjacent to urban areas has potential to permanently impact or extirpate some populations of *Penstemon bicolor* unless such disturbances are regularly allowed several years to recover.

Utility corridor development and maintenance: Utility corridors, above and below ground, pass through sites supporting *Penstemon bicolor* and have had an unknown but probably small impact to those populations. The greatest threat from such corridors is the intentional or accidental introduction or spread of *Penstemon palmeri* into *P. bicolor* populations, with the resulting potential for hybridization and genetic swamping. All of the Clark County sites are vulnerable to further development of utility corridors.

Water development or diversion: At least one known population has been found in the vicinity of a retention pond, and many populations near urban areas are vulnerable, because of their desert wash habitats, to development of flood control and other drainage diversion projects.

Invasion of exotic plant species: Only minor populations of exotic plant species such as red brome (*Bromus rubens*) have been able to invade and establish within *Penstemon bicolor* habitat in Nevada, and such invasions do not yet appear to have affected the viability of any population of the species.

Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes: The scientific collections that have been taken to document populations (Appendix 1, Table 3) are neither known nor likely to have had significant impacts on any population of the species. Seeds appear to have been collected from one or more populations for commercial purposes, as web sites advertising their availability have been found. *Penstemon* species are of strong horticultural interest, and impacts from collecting for such purposes could increase in the future. No other uses of the species for such purposes are known.

Disease or Predation: No impacts from disease or predation have been observed or reported.

Inadequacy of Existing Regulatory Mechanisms: No enforceable protective designations, conservation agreements, or approved management plans are known to exist for *Penstemon bicolor* or its habitat. Unless it is listed as endangered or threatened (50 CFR 17.61, 17.71) and occurs within federal jurisdiction, a plant has no formal protection under the federal Endangered Species Act (ESA), except for regulatory determinations by some federal land management agencies (U. S. Forest Service, Bureau of Land Management) that candidate and other sensitive species will be managed in order to avoid the need for listing. No federal protection currently extends to plants under non-federal jurisdiction unless they are listed as endangered and remov-

ing, cutting, digging up, damaging, or destroying them would be “*in knowing violation of any law or regulation of any state or . . . of a state criminal trespass law*” [ESA Sect. 9(a)2(B)], and that law extended to non-federal jurisdictions. The Endangered Species Act and the various agency regulations implementing it are also in direct conflict with provisions of the mining law of 1872 (30 U.S.C. 21 *et seq.*), and are therefore of uncertain protective value when mineral-related projects are involved.

U. S. D. I. Bureau of Land Management (BLM) policy provides that the agency “*shall carry out management, consistent with the principles of multiple use, for the conservation of candidate species and their habitats and shall ensure that actions authorized, funded, or carried out do not contribute to the need to list any of these species as Threatened or Endangered.*” If a candidate species occurs entirely on federal lands, BLM policy further requires that it be included as a priority species in land use plans, and that range-wide or site-specific management plans be prepared “*that identify specific habitat and population management objectives designed for recovery, as well as the management strategies necessary to meet those objectives*” (BLM Manual Section 6840). Although *Penstemon bicolor* is no longer a candidate for Federal listing, the Nevada State Office of BLM continues to track former candidates as Sensitive Species for planning purposes (U. S. D. I. Bureau of Land Management 1996). No management plans specific to *Penstemon bicolor* are known to exist, however, and the effectiveness of such plans would still depend upon adequate implementation and enforcement resources.

The Clark County Multiple Species Habitat Conservation Plan, to which the Bureau of Land Management is a signatory, provides for conservation of 79 species in Clark County, pursuant to Section 10 of the Endangered Species Act. Neither of the color forms of *Penstemon bicolor* are covered species under Clark County’s section 10(a) take permit. The consequences of this vis-à-vis management of the species as sensitive by BLM are uncertain.

Penstemon bicolor is not listed as “critically endangered” under Nevada Revised Statutes (NRS) 527.270. Such listing would provide that “. . . *no member of its kind may be removed or destroyed at any time by any means except under special permit issued by the state forester fire-warden*” on any lands in Nevada. The adequacy of this law, however, depends on informed and cooperative land managers, or on some form of deterrent enforcement, for either of which the current law does not provide. It also depends on the Nevada State Forester’s discretion in placing species on the list of fully protected plants, in issuing or withholding permits, and in placing protective conditions on permits that are issued. Recently enacted regulations in Nevada Administrative Code (NAC) Chapter 527 greatly expanded and clarified the requirements and procedures for obtaining such permits.

Other Natural or Man-made Factors: Apparent natural hybridization between *Penstemon bicolor* and *P. palmeri*, and possibly also between the color forms of *P. bicolor*, has likely been further facilitated by the spread of these taxa along roads and other disturbance corridors connecting natural populations, and by the intentional introduction of *P. palmeri* for revegetation and reclamation purposes. Loss of genetically “pure” populations of *P. bicolor*, due to contamination and swamping via hybridization with *P. palmeri*, represents a very real threat to the species (Glenné 2003) and may be the single greatest threat, after habitat loss, to the yellow-flowered form of the species.

To the extent that *Penstemon bicolor* depends upon insect pollinators for successful reproduction, any natural or man-made factors affecting the viability of such insects would also affect the viability of *Penstemon bicolor*.

X. GENERAL ASSESSMENT AND RECOMMENDATIONS

General Assessment: About 9% of the estimated 80 historical occurrences of *Penstemon bicolor* in Nevada are known to have been extirpated to date. Most of these losses have been of the yellow-flowered form, suggesting that this segment of the genetic variation in *Penstemon bicolor* may be particularly vulnerable to further losses. While additional potential habitat has yet to be explored, and some likely contains as-yet undocumented populations of the species, this is probably counterbalanced by earlier undocumented losses of *Penstemon bicolor* occurrences in areas of Las Vegas valley already built over prior to conservation concern for the species.

If not for the significant existing, ongoing, and threatened impacts to many of its known populations, *Penstemon bicolor* would now be too abundant and widespread, globally and in Nevada, to warrant special conservation concern. For now the species remains vulnerable to human-caused declines in the long-term as pressures from urban growth continue in the region surrounding Las Vegas, Nevada. All of the Clark County sites have been variously impacted by off-road vehicle recreation, road construction and maintenance, livestock grazing and trampling, development of public facilities, and development of utility corridors. Threats from all these sources will exist indefinitely under present circumstances, and no permanent formal protective measures are in place to prevent future impacts.

Status Recommendations: Both color forms of *Penstemon bicolor* were classified as category-2 candidates for listing by the U. S. D. I. Fish and Wildlife Service (1983, 1985, 1990, 1993). That category was eliminated on 28 February 1996 (U. S. D. I. Fish and Wildlife Service 1996). Based on the best available scientific evidence, the species does not now meet the definition of a candidate for listing as threatened or endangered under the Endangered Species Act. It should remain a “species of concern” to the U. S. Fish and Wildlife Service, however. With active long-term management to reduce or eliminate further habitat destruction, and appropriate long-term monitoring, any trend toward federal listing can be halted.

Because of increasing habitat loss from urban expansion in the Las Vegas area and accompanying recreational pressures, and increasing threats to the genetic integrity of *P. bicolor* due to human-aided hybridization with other *Penstemon* species, this report recommends that the Nevada Division of Forestry consider adding *Penstemon bicolor* (or at least its yellow-flowered form) to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270. No other changes in status or rank are recommended at this time. (See Present Legal or other Formal Status section on page 9.)

Critical Habitat Recommendations: If critical habitat were ever designated through the provisions of the Endangered Species Act or any other law or regulation, it should include all populations then known. Critical habitat should not be formally designated in cases where it might subject *Penstemon bicolor* to increased threats to its survival, would interfere with habitat management, or would subject managers of the habitat to problems of trespass by curiosity seekers.

Conservation and Recovery Recommendations: The following recommendations, roughly in descending order of priority, are offered as the best opportunities to maintain the long-term viability of *Penstemon bicolor* in Nevada, to avoid any future need to list it as threatened or endangered, and to reduce the overall long-term management costs for the species. They generally do not take into account limited agency resources or other conservation priorities, which may preclude implementation of some recommendations. Some of the recommendations may already have been implemented. If monitoring (outlined in recommendation 9) indicates that preventable

declines in viability of the species are occurring, then more aggressive conservation and recovery measures should be identified and pursued.

1. *Penstemon bicolor* should be considered for addition to the list of covered species under the Clark County Multiple Species Habitat Conservation Plan (CCMSHCP). The Nevada Division of Forestry (NDF) should consider adding *Penstemon bicolor* to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270.
2. All federal, state, and local agencies, organizations, and individuals should immediately cease the use of *Penstemon palmeri* (Palmer penstemon) for any purpose within the geographic range of *Penstemon bicolor*, and appropriate agencies should begin, and continue until successful, efforts to eradicate introduced populations of *Penstemon palmeri* from that range, focusing initially on the east slopes of the Spring Mountains and Bird Spring Range in southwestern Clark County, Nevada.
3. BLM should immediately pursue closure and barrier blockage of all unauthorized roads on their lands that impact or provide access to *Penstemon bicolor* sites, and should provide sufficient enforcement resources to ensure compliance. If necessary, BLM should additionally identify and designate alternate off-road vehicle recreational areas where there would be no or fewer impacts to sensitive resources.
4. BLM should implement its upland assessment methodology for assessing the condition of *Penstemon bicolor* habitat.
5. Any publicly held sites, or portions thereof, conveyed into private ownership should include deed restrictions sufficient to prevent destruction of *Penstemon bicolor* and its habitat on those lands. Existing public sites should be considered for protective withdrawal as ACECs or other categories providing a conservation management and research emphasis.
6. The Nevada Department of Transportation (NDOT), BLM, Nevada Power Company (NPC), and other appropriate agencies should manage and maintain roads and other rights-of-way carefully to avoid or minimize any further impacts to *Penstemon bicolor* and its habitat. Any new road corridors should be planned to avoid this and other sensitive habitats.
7. Any artificial revegetation efforts in and near the range of *Penstemon bicolor* should only use plant species native to the local area. In particular, *Penstemon* species, including *P. bicolor*, should *never* be used unless native to and collected in the immediate vicinity of the project area. BLM and other agencies anticipating the need for artificial revegetation should plan for reasonably foreseeable needs to ensure sufficient sources and/or supplies of 100% native-species seeds.
8. BLM, NDOT, and other appropriate agencies should conduct or require additional surveys, following recognized professional standards (Nelson 1994), for undocumented *Penstemon bicolor* populations prior to implementation of projects within potential habitat of the species, and any new populations found should be thoroughly documented. Impacts to new populations should be avoided or minimized during project implementation. When habitat loss is unavoidable, topsoil containing the seedbank of *Penstemon bicolor* should be salvaged and transferred to adjacent areas of suitable, unoccupied habitat. Whenever funding and personnel permit, similar surveys should be continued outside of the project evaluation process as well.
9. BLM, USFWS, NDOT, NPC, and any other parties interested in participating, should cooperatively field-check as many *Penstemon bicolor* sites as possible at least every 3 years, and more often where significant impacts have previously occurred or are reasonably foreseeable, to

detect any new or habitat or hybridization impacts, and should take immediate steps to eliminate and correct any such impacts on lands under their management. Field checks should include field tours for appropriate personnel to familiarize them with the plant and its habitat. If extirpations or new significant impacts become likely for more than 10% of the known populations, yearly monitoring efforts should be initiated.

10. Further studies of pollinator populations, and of their effectiveness in the reproductive success of *Penstemon bicolor*, should be encouraged and supported. Pollinators should be monitored on the same schedule as *Penstemon bicolor* to detect any downward trends that could contribute to reproductive failure in *Penstemon bicolor*, and the cause(s) and possible remedies of any such declines should be assessed.

11. Further studies to assess the nature and amounts of genetic diversity within and among the Arizona, Nevada, and California populations should be encouraged and funded whenever possible. Any management adjustments indicated by the results of such studies should be implemented.

12. A monitoring study should be established to study the biology and ecology of the species throughout its entire range. Some suggested areas of study include soil requirements, seed production, age structure, spatial distribution, seed dispersal, seed bank composition, plant community structure, seed viability, and the effects of off-road vehicle use and livestock grazing. Permanent plots should be established at the study sites.

13. Propagation studies should be conducted to determine whether seedlings, cuttings, or transplantation could be used for mitigation efforts. Any such mitigation should occur in the immediate vicinity of the source population(s), so as not to inadvertently introduce genetic material of *Penstemon bicolor* from another portion of its range.

14. BLM and other appropriate entities should aggressively manage feral animal populations and domestic livestock to avoid or minimize trampling impacts in *Penstemon bicolor* habitat.

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Nevada (State of) (1990)

Field Research: Field surveys for this report were conducted on 31 March 2003, from 21-30 April 2003, on 10 April 2004, from 25-29 April 2004, and from 1-5 May 2005.

Specimens: All specimens known to document *Penstemon bicolor* sites are listed by site in Appendix 1, table 3. The list was compiled from all available published and unpublished sources, but is not necessarily complete. Although new collections from previously documented sites are discouraged, the Nevada Natural Heritage Program welcomes further additions or corrections to this table as they become known.

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