

**Current Knowledge and Conservation Status of *Erythranthe carsonensis*
Fraga (Phrymaceae), the Carson Valley monkeyflower.**

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Figure 1.
Carson Valley
Monkeyflower in
south Carson City,
Nevada. April 16,
2014.

SUMMARY: Carson Valley monkeyflower (*Erythranthe carsonensis*) is a small, annual herb in the Phrymaceae (lopseed) family that grows on sandy flats and gentle slopes in Carson, Eagle, and Washoe valleys of Carson City, Douglas, Lyon, and Washoe counties, Nevada, and a small portion of adjacent Alpine County, California. First collected in 1865 by C. L. Anderson and named *Mimulus rubellus* var. *latiflorus* by Watson in 1871, it had been synonymized with *Mimulus montioides* until being recognized as a distinct species named *Erythranthe carsonensis* by Naomi Fraga (Fraga 2012). An estimated 42% of the potential habitat for *Erythranthe carsonensis* has been lost to residential and commercial development (34%) and agriculture (8%).

Carson Valley monkeyflower is currently documented on about 1,016 acres (411 ha) of habitat in public (82%) and private (18%) ownership. Due to the ephemeral nature of the species and difficulty of surveying on private lands, some unsurveyed potential habitat still exists for this species. The recent recognition of this taxon as a separate species also means that there had been no focused surveys prior to 2009 to document populations, life history traits, habitats, and ecology. A solid understanding of habitat parameters is essential to identify suitable habitat and develop strategies for future recovery actions and management.

Opportunistic field surveys have been conducted for Carson Valley monkeyflower starting in 2009 as seasonal conditions have allowed, including re-surveys and moderate expansion of some sites in spring of 2014. Systematic surveys were conducted in 2016 and 2017, and due to the wet winter and spring weather, the plants were more numerous, larger, and longer lived than during the previous four years of drought, and therefore more easily detected and surveyed.

This report summarizes the best available scientific information to-date for Carson Valley monkeyflower, and provides conservation recommendations designed to minimize the risk of extinction or state or federal listing of the species.



Figure 2. Carson Valley monkeyflower population at Jumbo Grade overlooking Washoe Valley.

ACKNOWLEDGMENTS

Naomi Fraga, James Morefield, Elizabeth Bergstrom, and Kelly Howle located many of the known populations and provided most of the recent field survey data. Kathy Bobseine discovered the site behind Western Nevada College in 2014, and Charlene Duncan discovered the Old Washoe City site in 2013. Members of the Nevada Native Plant Society, John Weiser, Gary Monroe, Tom Schuster, Pat Neyman, Jim Neveln, and Renee Aldrich assisted in surveying known sites in the Carson City area, and many reports from local residents helped us locate new populations.

All photographs by the author unless otherwise stated.

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 either of the addresses above.

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I. CLASSIFICATION AND SYSTEMATICS

Scientific Name: *Erythranthe carsonensis* Fraga (2012).

Type Specimen: USA, Nevada, Carson City: Carson Valley, eastern terminus of Clear Creek Road at the base of Prison Hill, 39°7'43.54"N, 119°44'19.23"W (NAD 83), 1,460 m/4,800 ft., 17 May 2010, Fraga, Morefield, & Howle 3377 (holotype RSA!; isotypes US!, UC!).

Synonym(s): *Mimulus rubellus* var. *latiflorus* S. Watson, United States Geological Exploration of the Fortieth Parallel. vol. 5, botany: 226 (1871). TYPE: USA, Nevada, Carson City Co., Carson City, Apr 1868, Watson 798 (GH!). *Mimulus montioides* Gray (1886; misapplied).

Vernacular Name(s): Carson Valley monkeyflower.

Family: Phrymaceae (lopseed family).

Review of Alternative Taxonomic Treatments: *Erythranthe carsonensis* has previously been included in *Mimulus rubellus* (as var. *latiflorus*) and in *Mimulus montioides*. Recent research by Naomi Fraga, Guy Nesom, and others led to extensive reorganization of the genus *Mimulus* and its close allies (Barker et al. 2012). Plants previously lumped together under the name *Mimulus montioides* were found to include several distinctive species now named *Erythranthe barbata*, *E. calcicola*, *E. carsonensis*, *E. discolor*, and *E. montioides* (Fraga 2012).

Biogeography and Phylogeny: From Fraga (2012): "*Erythranthe carsonensis* is inferred to have a sister relationship with *Erythranthe suksdorfii* (Fraga unpubl.). These species are easily distinguished by corolla morphology and leaf shape. *Erythranthe carsonensis* has a longer corolla tube throat (8-11 mm) than *Erythranthe suksdorfii* (4-6 mm) and the corolla lobes are bifid. In contrast, the lobes of *Erythranthe suksdorfii* are weakly notched to entire. The leaves of *Erythranthe carsonensis* are linear to spatulate and are clasping at the base, while the leaves of *Erythranthe suksdorfii* are linear to lanceolate or ovate and are not clasping at the base."

Barker et al. (2012) place *Erythranthe carsonensis* in *Erythranthe* section *Paradantha*, which is a group of western North American dryland annual species. This lineage separated near the base of a sister evolutionary lineage leading to progressively more wetland-adapted species of western North America. The more distant ancestors of these two lineages are less clear, with possible origins in either Central America or eastern Asia.

II. TAXON HISTORY

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

1865: First collected by R.H. Stretch and C.L. Anderson near Carson City, NV.

1868: Collected by S. Watson in Carson City as part of the United States Geological Exploration of the Fortieth Parallel.

1871: Formally named *Mimulus rubellus* var. *latiflorus* by S. Watson (1871).

1886: First included in *Mimulus montioides* by Gray (1886).

1925-1991: Collected sporadically in Carson, Eagle, and Washoe valleys.

2009: First noticed to be a separate species by Fraga (pers. comm. 2009).

2009 & 2010: Surveys conducted in Eagle and Carson valleys by Fraga and others in preparation for 2012 publication.

- 2011: Nevada Rare Plant Workshop placed species on the Threatened list of the Nevada Native Plant Society, and recommended Bureau of Land Management (BLM) and U. S. Forest Service (USFS) sensitive status and state protection.
- 2012: Formally named and described as *Erythranthe carsonensis* and separated from *Erythranthe montioides* by Fraga (2012).
- 2012 & 2014: Nevada Rare Plant Workshop reaffirmed state protection recommendation.
- 2014-2017: Extensive surveys conducted in Jack's Valley, Carson Valley, Washoe Valley, Moundhouse, and Carson City by NNHP personnel.

III. PRESENT LEGAL OR OTHER FORMAL STATUS

International: Using a system established by NatureServe, 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. *Erythranthe carsonensis* was most recently ranked 2 by the Nevada Natural Heritage Program (2018) at all levels. The results of this report show that 2 is still the most appropriate rank. Due to the very small area of plants in Alpine County, the appropriate rank for California is S1.

Federal: No formal status has been designated at the federal level. *Erythranthe carsonensis* is considered a sensitive species by both the Humboldt-Toiyabe National Forest and the Carson City District of the Bureau of Land Management.

State: No formal status has been designated at the state level. *Erythranthe carsonensis* is on the Nevada Native Plant Society's Threatened List (Nevada Natural Heritage Program, 2018b) and the Nevada Native Plant Society rare plant workshop participants have recommended that *Erythranthe carsonensis* be considered for state protection. This report recommends that the Nevada Division of Forestry should consider adding *Erythranthe carsonensis* to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270 if conservation measures are not successfully implemented and habitat loss exceeds the recommended thresholds.

IV. DESCRIPTION

Technical: Annual herb. Plants 1-7 cm tall × 1-4.5 cm wide; sparsely glandular. Stems erect, simple to branched, internodes (0.2-1 cm), usually obscuring the stem. Cotyledons persistent, 0.2-1.2 mm long, round to reniform, with clasping bases. Leaves opposite, epetiolate, connate at the base; blades 3-17 mm long × 1-5 mm wide, linear to spatulate, palmately veined with three prominent veins from the base in wider leaves, margins entire. Flowers solitary in each leaf axil, fruiting pedicels 3-14 mm, exceeding calyx, ascending to erect. Calyx (3) 5-7 mm long × 2-3 (4) mm wide, campanulate to widely urn shaped, enlarging in fruit, costa prominent with sparse pubescence, and darker than the glabrous intercostal regions; calyx teeth equal, 0.5-1 mm long, acute and slightly recurved, margins glabrous. Corolla 11-18 mm long × 7-15 mm wide, yellow with red striations on the adaxial surface of the upper lobes, lobe bifid, strongly zygomorphic; tube throat (5) 8-11 mm long, cylindrical, expanding abruptly to the limb, palate bearded, and maculate with red markings and one large central spot. Stamens didynamous, 5-13 mm long; white to light yellow, glabrous, included. Gynoecium 6-15 mm long, yellow; style glabrous; stigma lobes apically fringed and subequal, equal with the throat to exerted from the orifice. Capsules 3-6 mm long, included in the calyx, campanulate, thin walled and fragile, dehiscing to the base along both sutures. Seeds 0.5-0.8 mm long × 0.1-0.2 mm wide, elliptic, brown. [based on Fraga 2012].

Field Characters:

The following key will distinguish *Erythranthe carsonensis* from other monkeyflower species (*Erythranthe* and *Diplacus*) found in northwestern Nevada, including Washoe, Carson City, Douglas, Lyon, Mineral, and Storey counties and the adjacent eastern slope of the Sierra Nevada in California.

- 1 Plants perennialmultiple species
- 1' Plants annual
 - 2 Wet or seasonally wet habitats (wetlands, meadows, perennial and intermittent stream-banks)*E. floribundus, montioides, rubellus, suksdorfii, and breweri*
 - 2' Dry habitats (sagebrush, pinyon-juniper woodlands, dry slopes with sandy or gravelly soils)
 - 3 Flowers magenta or violet.....*D. bigelovii, cusickii, mephiticus, nanus, and ovatus, and E. rubellus*
 - 3' Flowers yellow
 - 4 Leaves oblanceolate to ovate, corolla with various small red or purple dots or lines but without a large red spot on the central lower lobe.
.....*D. mephiticus* and *E. suksdorfii, rubellus, and calcicola*
 - 4' Leaves linear to spatulate, corolla with a few to many small red dots in the throat and one large red dot on the central lower lobe.
 - 5 Plants rarely more than 5 cm tall, flowers 3 mm to 10 mm wide, flowers rarely larger than largest leaf *E. suksdorfii*
 - 5' Plants 5-15 cm tall, flowers 10 – 25 mm wide, flowers often larger than the largest leaf, occasionally larger than all leaves combined *E. carsonensis*

Photographs and Line Drawings: A line drawing of *Erythranthe carsonensis* by Michelle Thompson was published in Fraga (2012, p. 57), and is reproduced in Appendix 2, Figure 4 of this report. Photographs of *Erythranthe carsonensis*, and its habitat, reproduced in Appendix 2, Figures 5-7, are filed with the Nevada Natural Heritage Program, and are available on its public website at http://heritage.nv.gov/taxon_detail/29235.

VI. GEOGRAPHIC DISTRIBUTION

Geographic Range: (Appendix 1, Tables 1; Appendix 3, Map 1). Globally, *Erythranthe carsonensis* has been documented from 16 sites in the foothills surrounding the Washoe, Eagle, and Carson Valley areas of Carson City and Douglas, Lyon, and Washoe counties, Nevada, and Alpine County, California. The populations occur on the Humboldt-Toiyabe National Forest, Carson City Ranger District (HTNF; 29%), Bureau of Land Management, Carson City District (BLM; 27%), private (18%), Carson City (13%), Indian Hills General Improvement District

(IHGID, 5%), state of Nevada (4%), Douglas County (3%), Bureau of Indian Affairs and other tribal (BIA, 1%), and Incline Village General Improvement District (IVGID, <1%) lands. Three additional historical sites are now believed to be extirpated. The range of known occupied sites is currently 36 miles long, north to south, and 9 miles wide, east to west.

Precise Occurrences: Site numbers and descriptions are given in Appendix 1, Table 1. The table shows estimated areas for each site, apparent land management status, as well as its most recent year observed. Sites have been grouped according to the NatureServe spatial methodology for delineating plant populations (NatureServe 2004).

Historical site(s) rediscovered or recently known extant: (Appendix 1, Table 1) Prior to 2009, six occurrences of *Erythranthe carsonensis* had been documented or reported (numbers 1, 2, 4, 5, 8, & 9), which are herein considered to be the historical sites for this species. Three of these (numbers 4, 5, & 8) were subsequently rediscovered and further documented. All other sites are considered new and are discussed below.

New site(s) discovered: (Appendix 1, Table 1) From 2009 to 2015, five new populations (numbers 3, 6a, 6c, 10, & 11) were discovered and documented covering about 118 acres in Carson City, Douglas, and Washoe counties, Nevada, and Alpine County, California. During surveys for this report in 2016 and 2017, 13 new populations and subpopulations were discovered, expanding the range to Lyon County, Nevada (4b, 6b, 7, 12, 13 a & b, 14 a-c, 15 a-c, & 16). Populations 6a and 6b were considered separate in our initial status report (NNHP 2015) but patches of plants were discovered between them so they were merged into one large population. The current occupied area is approximately 946 acres.

Historical site(s) known or suspected to be erroneous reports: The northernmost historical site (number 1) was determined to be misidentified *Diplacus mephiticus*. The specimens were re-examined by Naomi Fraga at Rancho Santa Ana Botanic Garden (RSABG). The small specimens and poor mounting technique obscured the diagnostic characteristics and led to the misidentification (Fraga, pers. comm. 2018).

Historical site(s) known or assumed extirpated: The site at Franktown (Appendix 1, Table 1, number 2) is likely extirpated as all areas of potentially suitable habitat have been converted to irrigated agriculture. The southern portion of the Carson Hot Springs population (number 4) lies underneath the Northridge neighborhood and the commercial development at Market Street (Walmart and Home Depot). A portion of the north Indian Hills population has been removed by recent construction activities in the area of the new freeway near Arthur Drive. *Erythranthe carsonensis* plants grow up to the edge of the new freeway construction in several places between Fairview Drive and South Carson Street, indicating that much of the area excavated for the freeway was once habitat for this species.

Due to a lack of historical surveys for this species and the amount of land around Carson and Eagle valleys, there is no direct historical comparison for sites lost. As a proxy, we developed a habitat model to estimate potential habitat, including the more recently developed areas for which soil data exist. Refinements to our habitat model using the Maxent modeling program indicate that the most important variables in our dataset are: vegetation type, annual precipitation, slope, soil salinity, soil texture, percent clay content, and mean annual temperature. Bulk density, organic matter content, and pH were of low importance. To avoid artifacts from including areas well outside the range of *Erythranthe carsonensis*, a boundary polygon was used to restrict the model to the valleys and foothills near the known populations. Due to a lack of data, the sites in Alpine

County were also excluded from the model. See white paper on the Maxent model parameters and results for Carson Valley monkeyflower habitat for details; available on the NNHP website at http://heritage.nv.gov/taxon_detail/29235.

The Maxent model results indicate how similar any particular area is to the known populations and the scores were divided into the following categories (score, % of modeled area): Very Low (0.0-0.1, 68%), Low (0.1-0.2, 10%), Medium (0.2-0.4, 11%), High (0.4-0.6, 7%), and Very High (0.6-0.99, 4%).

Using these results, we determined that of the combined medium, high, and very high score areas, 8% has been lost to agricultural development and 34% to residential, commercial, and industrial development. This is a departure from our original model, which did not consider soil salinity or clay content. Much of the agricultural development in Carson Valley is on floodplain soils where the clay content and salinity are too high to support *Erythranthe carsonensis*.

Historical site(s) where present status unknown: The status of two historical sites (numbers 9 and unmappable “Carson City” sites; see Appendix 1, Table 1) could not be determined due to development and vague location information, respectively.

Potential site(s) meriting future field surveys: The Maxent model (discussed under extirpated sites) shows areas of undeveloped, unsurveyed potential habitat (medium, high, and very high scored areas) in southwest, south, and east Carson Valley, east of Hot Spring Mountain, Indian Hills, the eastern and northern margins of Carson City, and north Washoe Valley. These potential habitat areas are managed by: BLM (46%), private (24%), Washoe Tribe (11%), USFS (10%), and the remainder by cities, counties, and the state of Nevada.

VII. HABITAT CHARACTERISTICS

Environment and Habitat Summary: (Appendix 2, Figure 4) *Erythranthe carsonensis* appears to be restricted to deep, sandy loam soils derived from alluvial, colluvial, or aeolian deposits of weathered granite. These soils are found on gentle slopes and rolling hills on all aspects in a band between 4,600 and 5,820 feet (1,400 and 1,775 meters) elevation. Most of the sites support a tall brush community dominated by a mix of antelope bitterbrush (*Purshia tridentata*), basin big sagebrush (*Artemisia tridentata* var. *tridentata*), and desert peach (*Prunus andersonii*) except in areas where the shrubby species have been removed by various disturbances. The species seems to be tolerant of light surface disturbance such as fire, brush removal, and trails as long as the disturbance is not accompanied by significant soil disturbance (more than 3-4 inches deep or removal or addition of soil) or weed infestation.

Physical Characteristics:

Physiography: The range of *Erythranthe carsonensis* lies along the eastern edge of the northern Sierra Nevada and the adjacent northwestern edge of Holmgren's (1972) Reno Section of the Great Basin Division of the Intermountain Flora region. The Reno Section is a strip of generally high mountain ranges adjacent immediately east of and parallel to the Sierra Nevada, and is characterized by the "climatic influences of high mountains within and adjacent to the section, and the high, sagebrush covered valleys" (Holmgren 1972). The Great Basin Division consists of a series of mostly north-south-oriented

ranges and basins block-faulted from rocks that age progressively toward the northwest and that have been arched upward in the middle.

Climate: Hidy and Klieforth (1990) aptly describe the climate of the Great Basin as "...one of the most extreme and variable climates on earth." This high variation occurs along horizontal and elevational gradients and at all time scales: hourly, daily, seasonally, annually, and over the tens of thousands of years of glacial cycles. 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 (Hidy and Klieforth 1990). Most annual precipitation falls from about November through April in Pacific storm systems from the west. The Great Basin 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 about a quarter to half of the annual total, and is 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 25% and 250% of the long-term averages. Variability decreases somewhat toward the northeast and at higher elevations.

Temperature variations range up to 40-50°F (22-28°C) in daily changes, in average differences between warmest and coldest months, and in departures of extreme highs and lows from seasonal averages (Hidy and Klieforth 1990, Holmgren 1972, Morefield personal observations). This can result in differences up to 120-140°F (67-78°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 and toward the central (more continental) part of the region. 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). Climatic conditions in the adjacent eastern Sierra Nevada tend to be somewhat less extreme and variable, with higher and more consistent annual precipitation.

The sites where *Erythranthe carsonensis* populations presently occur experience warm to hot dry summers and cold moist to dry winters. Annual precipitation averages 8-14 inches (205-610 mm) of water equivalent at most sites. Depending on the elevation, 15-20% of the precipitation falls as snow. Some of the higher apparent precipitation amounts may be effectively reduced for *Erythranthe carsonensis* by the high permeability and low water-holding capacity of its preferred soil types, with most of the excess precipitation leaving the site as run-off. Daily mean temperatures at *Erythranthe carsonensis* sites average about 65-71°F (17-19°C) in July and 29-33°F (-2 to +1°C) in January. The years during which recent surveys were conducted (2016-2017) were much wetter than average, with much of the precipitation falling in late winter and spring. (WRCC 2018).

Geomorphology, aspect, and slope: Populations of *Erythranthe carsonensis* occur on all aspects, primarily on flats, toeslopes, rolling hills, and terraces. The plants are usually found on flat to gentle slopes though may occupy steeper banks and micro-drainages within generally flat terrain.

Geology: Most *Erythranthe carsonensis* sites appear to be underlain by alluvial, colluvial, or aeolian deposits of sandy loams derived from weathered granite. Granite outcrops can typically be found uphill or upwind of the populations.

Soils: A GIS analysis of detailed (1:24,000) digital soil survey geographic (SSURGO) data (USDA NRCS 2015a, b, c, d), show that *Erythranthe carsonensis* populations are associated with the following soil map units: Aquinas, Dalzell, Glenbrook, Greenbrae, Haybourne, Incy, Indiano, Mottsville, Oest, Old Camp-Holbrook, Prey, Reno, Saralegui, Springmeyer, Surprise, Toll, and Washoe. All of these soil types are comprised of deep, sandy loam soils derived from nearby granitic outcrops or windblown deposits.

Erythranthe carsonensis occurs primarily on flat or gently sloping areas within these soil types, though it may also occur on steeper slopes within the right soil type. Although the soils where the species has been found typically exhibit a small to moderate organic component, *Erythranthe carsonensis* does not appear to tolerate areas of either pure sand or thick deposits of organic litter (mulch) within these soil types.

Hydrology: *Erythranthe carsonensis* is not associated with free water, and is entirely dependent on incident precipitation and its retention in the soil. The soils supporting most *Erythranthe carsonensis* populations are deep, sandy loam with sagebrush, bitterbrush, and desert peach. Slight increases in plant size and population density were sometimes noted where moisture-accumulating or moisture-retaining microsites, such as micro-drainages, occurred within the habitat.

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

Biological Characteristics:

Community physiognomy: *Erythranthe carsonensis* grows in the spaces between large shrubs and may grow directly under the shrubs if the ground is not covered by litter.

Erythranthe carsonensis does not tolerate the thick mulch generated by shrub mastication and is absent from masticated areas adjacent to known populations (field obs, J. Morefield, 2014.)

Vegetation type: The habitat is dominated by various mixtures of antelope bitterbrush (*Purshia tridentata*), basin big sagebrush (*Artemisia tridentata* var. *tridentata*), and desert peach (*Prunus andersonii*), though *Erythranthe carsonensis* is not found in stands of pure desert peach.

Associated plant species: associated species (*indicates non-native) include but are not limited to:

Allium parvum Kellogg

Allophyllum gilioides (Benth.) A.D. Grant & V. Grant ssp. *violaceum* (A.A. Heller) Day

Anisocoma acaulis Torrey & A. Gray

Artemisia tridentata Nuttall var. *tridentata*

**Bromus tectorum* L.

Calyptridium roseum S. Watson

Centrostegia thurberi Benth.

Camissonia contorta (Douglas) Kearney

Cryptantha circumscissa I.M. Johnst.

Chrysothamnus viscidiflorus Nutt.

Descurainia pinnata (Walter) Britton
Diplacus nanus (Hook. & Arn.) G.L. Nesom
Diplacus ovatus (A. Gray) G.L. Nesom
Draba verna L.
Eatonella nivea (D. Eaton) A. Gray
Ephedra viridis Coville
Eriogonum baileyi S. Watson
 **Erodium cicutarium* (L.) L'He´r.
Erythranthe suksdorfii (A. Gray) N.S. Fraga
Gayophytum diffusum Torr. & A. Gray
Gilia inconspicua (Sm.) Sweet
Grayia spinosa (Hook.) Moq.
Gymnosteris nudicaulis (Hook. & Arn.) Greene
Layia glandulosa Hook. & Arn.
Leucocrinum montanum Nutt. ex A. Gray
Mentzelia albicaulis (Douglas) Douglas ex Torr. & A. Gray
Myosurus apetalus C. Gay
Pectocarya penicillata (Hook. & Arn.) A. DC.
Plagiobothrys tenellus (Nutt. ex Hook.) A. Gray
Plectritis macrocera Torrey & A. Gray
Phacelia curvipes Torr. ex S. Watson
Phacelia linearis (Pursh) Holz.
Plagiobothrys Fisch. & C.A. Mey. sp.
Prunus andersonii A. Gray
Purshia tridentata (Pursh) DC.
 **Sisymbrium altissimum* L.
Uropappus lindleyi (DC.) Nutt.
Vulpia octoflora (Walter) Rydb.
V. microstachys (Nutt.) Munro
Zigadenus paniculatus (Nutt.) S. Watson.

From Fraga (2012) and field observations by J. Johnson and J. Morefield (2016 & 2017).

Other endangered, threatened, and sensitive species:

Another rare annual monkeyflower species, Steamboat monkeyflower, *Diplacus ovatus*, inhabits some of the locations where *Erythranthe carsonensis* are found, as do two other annuals of potential conservation concern, *Gymnosteris nudicaulis* (starcup) and *Loeflingia squarrosa* var. *artemisiarum* (sagebrush pygmyleaf). In addition, much of the habitat of *Erythranthe carsonensis* is within mule deer winter range, and the bitterbrush overstory is favored winter forage.

Land Management: See Appendix 1, Table 1 for specific ownership of each site. 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. Because surveys are incomplete for some historical sites, area, management, and percent extant vs. extirpated have not yet been estimated for these sites.

VIII. BIOLOGY AND ECOLOGY

Population Summary: Based on the information gathered for this report, the total known global occupied habitat covers 1,016 acres (411 ha) divided among 16 sites in the foothills surrounding the Carson, Eagle, and Washoe Valley areas of Carson City and Douglas, Lyon, and Washoe counties, Nevada, and Alpine County, California. One additional historical site in Washoe County north of Reno was determined to be a different species. At least 1-2 additional historical sites are now believed to be extirpated. The most distant two extant occurrences are separated by about 36 miles (50 km). Unsurveyed potential habitat still exists in all three valleys.

Because *Erythranthe carsonensis* is a seed-banking annual species, no attempt has been made to quantify the number of individuals at each site due to the extreme variability in density from year to year. See Demography section below.

Demography: Long-term monitoring has not been conducted for *Erythranthe carsonensis* populations to determine demographic trends. No research has been conducted on the seed bank or long-term seed viability.

As a desert annual species, *Erythranthe carsonensis* is highly dependent on the timing and amount of precipitation in any year to support its growth and reproduction. Precipitation on the eastern slope of the Sierras can be very spatially and temporally variable, resulting in population density changes of several orders of magnitude from site to site and year to year. The Prison Hill population was estimated to contain many thousands of individuals in 2010 and 2016 but field surveys found just two plants in 2014, while the Jack's Valley area appeared to have approximately the same density in 2010, 2014, and 2016. This extreme variability should be considered when surveying an area to determine whether or not *Erythranthe carsonensis* is present. Most of the population likely exists as undetectable seeds within the soil that may or may not germinate in any given year based on the soil moisture and temperature.

Phenology: *Erythranthe carsonensis* plants are likely to emerge in March and April, though the exact timing is difficult to determine due to its small size and the difficulty of identifying it compared to the many other small annual plants that occur in the same habitat. The flowering period coincides closely with the flowering period of desert peach (*Prunus andersonii*) and varies from late-March in warm years to mid-May in cold years. No research has been conducted on the length of time required to ripen seeds but it is likely similar to other small annual plants that occupy the same habitat. Active *Erythranthe carsonensis* plants may take advantage of late spring precipitation to continue blooming and producing seeds as late as June.

Genetics: No studies of the genetic structure in *Erythranthe carsonensis* are known. Most *Erythranthe* species appear to reproduce from seed produced by insect-mediated pollen exchange between flowers of the same or different plants. This species also exhibits “approach herkogamy” (i.e., spatial separation of the flower's reproductive parts) and has prominent nectar guide patterns on the palate. Based on evidence from corolla morphology, this species is presumed to be primarily outcrossing. Several insects were observed visiting this species, including skipper butterflies (Hesperiidae), halictid bees (Halictidae) (Fraga 2012) and honey bees (*Apis mellifera*) (pers. obs., J. Johnson.)

Reproduction and Dispersal: No studies of reproduction, dispersal, or seed bank demographics are known for *Erythranthe carsonensis*. As discussed above under Genetics, insect-mediated outcrossing is most likely the dominant reproductive mode in *Erythranthe carsonensis*. Wind, water, and gravity may all play roles in dispersing the tiny seeds.

Hybridization: No evidence of hybridization or intergradation between *Erythranthe carsonensis* and any other taxon has been observed or reported.

Pathology: No evidence of disease or other pathology has been reported for *Erythranthe carsonensis*.

Predation: No evidence of predation has been reported for *Erythranthe carsonensis*, though the small size of the plants would leave little evidence if the entire shoot was removed by herbivory. No studies of seed predation or parasitism are known.

Competition: *Erythranthe carsonensis* may compete with other small annuals in its habitat for water and soil nutrients. *Bromus tectorum*, *Camissonia contorta*, *Cryptantha circumscissa*, *Descurainia pinnata*, *Diplacus nanus*, *Draba verna*, *Eriogonum baileyi*, *Erodium cicutarium*, *Erythranthe suksdorfii*, *Gayophytum diffusum*, *Gilia inconspicua*, *Gymnosteris nudicaulis*, *Layia glandulosa*, *Mentzelia albicaulis*, *Pectocarya penicillata*, *Plectritis macrocera*, *Phacelia curvipes*, *Phacelia linearis*, *Plagiobothrys* sp., *Sisymbrium altissimum*, *Vulpia octoflora*, and *V. microstachys* occupy the same patches as *Erythranthe carsonensis* within the habitat. Dense patches of annual weeds, particularly *Erodium*, appear to exclude *Erythranthe carsonensis*.

Response to Disturbance: At several sites, *Erythranthe carsonensis* has been observed to colonize and reproduce on recent, recovering minor surface disturbances such as erosion rills and trails, as long as major soil disturbance and weeds are absent. Winter floods in 2017 washed soil down from the Nine Hill population toward Washoe Lake and *Erythranthe carsonensis* plants were observed growing in the soil deposited downstream.

In a high precipitation year (2011), larger plants were observed in an area of the North Indian Hills population where the shrubs were removed, whereas no plants were observed in an adjacent undisturbed area. The following year was a low precipitation year, and no *Erythranthe carsonensis* plants were observed within the cleared area while plants were present in the adjacent undisturbed area. (J. Johnson field observations.)

Disturbances that cover the soil surface with unsuitable soils or materials, such as grading, illegal dumping, and mastication of shrubs, prevent *Erythranthe carsonensis* from growing.

Other Interactions: No other interactions noted.

IX. EVIDENCE OF THREATS TO SURVIVAL

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

Because of the relatively recent taxonomic status as a separate species, no mapping of precise locations was completed prior to 2009. This fact combined with the small stature of the plant and indistinct nature of the habitat makes it difficult to estimate losses of habitat. In order to direct our survey efforts, NNHP created a habitat model based on vegetation, soil type, slope, and climate for Carson City, Douglas, northwestern Lyon, and southern Washoe counties. The modeled habitat areas were overlaid with disturbed and developed areas from recent aerial imagery. Approximately 43% of the potential habitat determined by the model has been permanently lost to development of agriculture, housing, roads, commercial areas, and mining.

Road development and maintenance and off-road vehicle use: The North Indian Hills population has been significantly impacted by road building. Herbarium collections from the 1960s and 70s indicate the species presence along Highway 395 near the junctions with Jack's Valley Road and Topsy Lane. Highway 395 has been expanded multiple times in the past 50 years and the plants are no longer found near those intersections. A

patch within this population was mapped on Arthur Drive near Clear Creek Road in 2009 and has been partially removed by construction of the new freeway.

Much of the potential habitat in Carson City contains a very high density of roads. Potential habitat in Douglas County is also impacted by roads but not as severely overall as Carson City. However, the Douglas County Transportation Plan (2016) proposes major new roads through two of the largest populations: Hot Spring Mountain and Gardnerville Ranchos. These new roads would pave over occupied habitat, alter drainage patterns, fragment the known populations, and encourage future commercial and residential development adjacent to the roads. A proposed Bypass on the east side of Carson Valley would pass directly through one of the largest areas of unsurveyed potential habitat. While these plans are still only conceptual, construction could begin in the next decade given the current pace of development in western Nevada.

OHV use has been observed in the North Indian Hills, Prison Hill, North Carson City, Jumbo Grade, Flint Drive, Moundhouse, Hot Spring Mountain, and Mud Lake areas with more intense disturbance at Nine Hill and Gardnerville Ranchos. See Appendix 1 for ratings of OHV and road disturbance at each site. OHV use is quite common on public land in Carson City and Douglas County, and OHV trails are visible in many areas of potential habitat.

The proposed closure of several OHV trails on the south slope of Hot Spring Mountain would benefit a small area of occupied habitat but the OHV users would likely just be displaced into adjacent occupied habitat on the north and west sides of the mountain.

Mineral exploration and development: No impacts from mining operations have been directly observed, but a gravel pit on USFS land at the Gardnerville Ranchos has likely removed a portion of that population.

Urban and residential development: Urban and residential development is the single largest threat to *Erythranthe carsonensis*. Approximately 34% of the potential habitat in Nevada has been permanently lost to urban and suburban development. Portions of the Carson Hot Springs population were lost to residential and commercial development between 1991 and 2009. Much of the North Indian Hills population lies within BLM managed parcels that are proposed for disposal to private ownership and would likely be developed for commercial use in the near future given the pace of recent developments in that area. In several populations including the North and South Indian Hills, Prison Hill, Fredericksburg, north Carson City, Western Nevada College, and Gardnerville Ranchos, *Erythranthe carsonensis* plants grow up to the edge of developed areas and were likely found in those areas prior to development.

A large portion of the population at Gardnerville Ranchos is on private land that may be developed into additional housing. A 350 home project named Rancho Sierra will impact a portion of the western end of the population, and construction of the secondary access road to the development will likely extirpate a portion of the Mud Lake population.

The lands transferred from the BLM to Carson City in 2015 had no restrictions placed on use regarding rare plants. These lands could be developed by the city Parks Department into new recreational facilities like the Pete Livermore Sports Complex and the RC Airport, which both occupy former *Erythranthe carsonensis* habitat. The master plan for the Pete Livermore Sports Complex includes expanding the grass playing fields into areas of occupied habitat on the east and south sides of the parcel.

Trash dumping: There is a long history of dumping refuse, including household trash, appliances, vehicles, construction debris, and yard waste, in Nevada's deserts. Many of the populations are affected by historical dumping to some degree with some areas such as North Carson City, North Indian Hills and Hot Spring Mountain still receiving moderate amounts of trash and yard debris. Areas of West Prison Hill were used as informal dumps for decades prior to the construction of houses in the area and the area still receives a steady stream of windblown household trash from the surrounding neighborhood. Even in areas where household trash is less of a problem, yard debris is still frequently dumped. This yard debris may contain chemical fertilizers and pesticides, animal waste, weed seeds, and pathogens which can negatively impact the habitat for all native species.

The dumping of any material that covers the soil surface (including, garbage, gravel, and yard waste) will prevent *Erythranthe carsonensis* seeds from germinating and growing.

Utility corridor development and maintenance: A pipeline, well head, and other water utilities cross the South Indian Hills population in the Jack's Valley area, and the Virginia City water pipeline bisects the Nine Hill population. *Erythranthe carsonensis* plants have been observed growing in the recovering disturbance around the wellhead and pipeline areas but do not grow in the compacted soils around the maintenance roads. Construction of these maintenance roads has also changed the soil surface and runoff patterns adjacent to the roads within the population making these areas unsuitable for *Erythranthe carsonensis*.

Construction of the water tanks and natural gas pipeline and compressor station in Goni Canyon probably removed some *Erythranthe carsonensis* habitat in the North Carson City population.

It is difficult to separate the utility corridor impacts from other development within the urban areas around most of the populations.

Animal grazing or trampling: Domestic animal grazing does not currently occur in any of the known populations. Feral horses, however, frequent the flat area around the population in Moundhouse, and the animals are clearly attracted to the area by food handouts from the local residents. The horses do not appear to graze the *Erythranthe carsonensis* plants but they may be crushed by trampling and in bedding areas.

Water development or diversion: See the section above on Utility corridor development. *Erythranthe carsonensis* habitat is not associated with significant surface water resources.

Fire and fire suppression activities: The population behind Western Nevada College was burned during the Waterfall Fire of 2004. Recent targeted surveys have located patches of *Erythranthe carsonensis* in both burned and unburned areas. The density of non-native filaree (*Erodium cicutarium*) is much higher in the burned areas. Preventative mastication projects appear to decrease the density of *Erythranthe carsonensis*, but the effects have not been systematically studied (Morefield field surveys 2010-2016).

While we have not had the opportunity to study the effect of fire retardant on *Erythranthe carsonensis* populations, firefighting activities such as control line and staging area construction are very disruptive and often lead to new weed infestations.

Fire danger is ubiquitous across the habitat for *Erythranthe carsonensis* so the risk for individual sites has not been evaluated.

Electronic communication site development and maintenance: The low, flat terrain favored by *Erythranthe carsonensis* makes these sites undesirable for electronic sites and no electronic sites are known to impact any populations.

Recreational use: So far, no significant impacts have been observed from non-vehicular recreational use of *Erythranthe carsonensis* habitat. The Faye Luther, Prison Hill, Western Nevada College, and South Indian Hills populations are within heavily used non-motorized recreation areas, and there does not appear to be any adverse impacts outside of the existing trails.

Flooding: The Sunridge Drive portion of the North Indian Hills population lays downslope from the stormwater catchment area behind Sierra Lutheran High School. This stormwater catchment was inadequately designed for the easily eroded slope, causing significant erosion of the slope and deposition of the eroded material onto the *Erythranthe carsonensis* population. This problem has been reduced since our initial report by adding a culvert and filling in the most eroded part of the slope. In 2016, *Erythranthe carsonensis* plants were observed growing on the disturbed soils around the new culvert.

During the winter of 2017, heavy winter rains caused serious erosion in many small drainages and dirt roads. The Nine Hill population was particularly affected by the flooding due to the soil washing down from dirt roads and burying about 15% of the area in the center of the population. Vehicles trying to avoid the washed out roads drove through the population, causing additional damage to the soils. Future surveys in this area are needed to monitor the long-term effects of this soil deposition on the population.

While *Erythranthe carsonensis* habitat is not associated with significant surface water resources, the lack of planning within the Johnson Lane area of Douglas County has created a susceptibility to flooding during heavy rains. The soft, highly erodible, sandy soils are naturally prone to erosion during flash flood events and removal of native vegetation, alteration of the wash channels, and proliferation of unplanned OHV trails have increased the erosion (CWSD 2018). Placement of homes within the depositional fan of the washes means that much of the eroded soil is deposited in and around the homes in the area.

The proposed ideas to reduce the flooding and erosion include stormwater catchment basins, a dam on Johnson Lane Wash, and contour trenching on the hillsides around the neighborhood. Of these proposals, the contour trenching is by far the most disruptive to *Erythranthe carsonensis* habitat. The areas proposed for trenching have existing shrubby vegetation and removal of that vegetation along with disturbance of the soil would likely lead to much greater erosion on the slopes and new weed infestations. Given the highly erodible nature of the soils (aeolian sand deposits) the trenches would need frequent maintenance, increasing the disturbance to the habitat (CWSD 2018). The cost and difficulty of constructing and maintaining the trenching makes this option unlikely to be implemented but a fire on the slope may prompt residents to demand that the county revisit the proposal.

The stormwater detention basins and connecting channels would all be located on BLM land surrounding the neighborhood, in both occupied and high potential habitat. The Johnson Lane Wash dam would have the least impact on *Erythranthe carsonensis* habitat.

Invasion of exotic plant species: Patches of invasive annual forbs within the populations seem to exclude or reduce the density of *Erythranthe carsonensis*. The most prevalent

invasive species in this habitat are filaree (*Erodium cicutarium*) and tumble mustard (*Sisymbrium altissimum*). Weed density is highest in disturbed areas, including fire scars and fuel removal projects, and areas closer to developments and agricultural fields.

Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes:

The few scientific collections that have been taken to document populations (Appendix 1, Table 2) are neither known nor likely to have had significant impacts on any population of the species. No other uses of the species for such purposes are known.

Disease or Predation: No evidence of predation, disease, or other pathology has been reported for *Erythranthe carsonensis*, though the small size of the plants would leave little evidence if the entire shoot was removed by herbivory. No studies of seed predation or parasitism are known.

Climate change: Predictions for future climate change in the range of *Erythranthe carsonensis* indicate higher average temperatures, lower average soil moisture, and 10-20% less precipitation in the spring, when the plants rely on precipitation to replenish shallow soil moisture. While the models predict slightly less precipitation overall, they do predict an increase in violent thunderstorms that may cause flash flooding, eroding the soft soils in occupied habitats, or lightning strikes that could start wildfires, leading to impacts from firefighting activities and weed invasion. (U.S. Global Change Research Program 2014).

Inadequacy of Existing Regulatory Mechanisms: No enforceable protective designations, conservation agreements, or approved management plans are known to exist for *Erythranthe carsonensis* 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 (USFS, BLM) 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 removing, 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. It should also be noted that the ESA and the various agency regulations implementing it are 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.

USDA Forest Service (28% of known occupied habitat): U.S. Department of Agriculture (USDA) regulation 9500-4 directs the USFS to manage "*habitats for all existing native and desired nonnative plants, fish, and wildlife species in order to maintain at least viable populations of such species,*" and to avoid actions "*which may cause a species to become threatened or endangered.*" USFS objectives further state that viable populations of all species must be maintained "*in habitats distributed throughout their geographic range on National Forest System lands*" (Forest Service Manual [FSM] 2670.22). Addition of *Erythranthe carsonensis* to the sensitive species list of the Humboldt-Toiyabe National Forest would identify it as a species "*for which population viability is a concern as evidenced by . . . significant current or predicted downward trends in population numbers or density or . . . in habitat capability that would reduce a species' existing distribution*" (FSM 2670.5). Current USFS policy on species designated sensitive is to "*review programs and activities, through a biological evaluation, to determine their potential effect on sensitive species*" as part of the NEPA process, to "*avoid or*

minimize impacts" from such activities or, if impacts cannot be avoided, to "*analyze the significance*" of those impacts for the species as a whole. Any decision to allow impacts "*must not result in loss of species viability or create significant trends toward Federal listing*" (FSM 2670.32). USDA regulation 9500-4 has the force of law at least until changed; specific provisions of written USFS policy implementing that regulation are of uncertain legal standing in specific cases.

Bureau of Land Management (23% of known occupied habitat): *Erythranthe carsonensis* was added to the BLM list of Species of Concern in 2017. This listing occurred after the transfer of lands to Carson City so no stipulations were included for rare plants in the transfer agreement.

The BLM Planning Manual 6840.06.2 states the following:

"In compliance with existing laws, including the BLM multiple use mission as specified in the FLPMA, the BLM shall designate Bureau sensitive species and implement measures to conserve these species and their habitats, including ESA proposed critical habitat, to promote their conservation and reduce the likelihood and need for such species to be listed pursuant to the ESA. (6840.06.2.A)

When BLM engages in the planning process, it shall address Bureau sensitive species and their habitats in land use plans and associated NEPA documents (as per BLM 1610 Planning Manual and Handbook, Appendix C). (6840.06.2.B)

On BLM-administered lands, the BLM shall manage Bureau sensitive species and their habitats to minimize or eliminate threats affecting the status of the species or to improve the condition of the species habitat... " (6840.06.2.C)

State of Nevada (8% of known occupied habitat in direct ownership, critically endangered status applies to any plants within the state of Nevada): *Erythranthe carsonensis* 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 firewarden" 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, neither of which is provided for under current law. It also depends on the state forester firewarden's discretion in issuing or withholding permits, and in placing protective conditions on permits that are issued. Nevada Administrative Code (NAC) Chapter 527 clarified the requirements and procedures for obtaining such a permit, helping to ensure the long-term survival of state-listed plants in Nevada.

City/County/General Improvement District (22% of known occupied habitat): There are no provisions in the laws or operating procedures of the local government jurisdictions that administer occupied habitat (Carson City (15%), IHGID (4%), Douglas County (3%), and IVGID (<1%)).

Other Natural or Man-made Factors: To the extent that *Erythranthe carsonensis* may depend upon insect pollinators for successful reproduction, any natural or man-made factors affecting the viability of such insects would also affect the viability of *Erythranthe carsonensis*.

X. GENERAL ASSESSMENT AND RECOMMENDATIONS

General Assessment: As now known, the global population of *Erythranthe carsonensis* consists of about 1,016 acres (411 ha) of private and public lands divided among 17 groups in the

foothills surrounding the Carson City, Genoa, Minden, Gardnerville, Moundhouse, and New and Old Washoe City areas of Carson City, Douglas, Lyon, and Washoe counties, Nevada, and Alpine County, California, between 4,600 and 5,820 feet (1,400 and 1,775 meters) elevation. The most distant two extant occurrences are separated by about 36 miles (58 km). *Erythranthe carsonensis* is related to a group of small yellow-flowered monkeyflowers (all formerly *Mimulus montioides*) that are found through the Sierra Nevada Mountains and western edge of the Great Basin. Recent investigations (Fraga 2012), and observations during fieldwork for this report, support recognition of *Erythranthe carsonensis* as a separate species. The species is restricted to deep, sandy loam soils derived from granitoid rocks, on dry flats, terraces, and toeslopes on all aspects. Undisturbed sites support shrublands containing antelope bitterbrush (*Purshia tridentata*), basin big sagebrush (*Artemisia tridentata* var. *tridentata*), and/or desert peach (*Prunus andersonii*).

Erythranthe carsonensis is vulnerable to human-caused extinction in the long-term as pressures from urban growth continue in the region surrounding Carson City, Moundhouse, New Washoe City, Genoa, Minden, and Gardnerville, Nevada. Due to a lack of historical surveys for this species, the number or area of previously extirpated or partially extirpated populations cannot be fully determined. Habitat modeling suggests that approximately 42% of potential habitat has been lost to development across the species' range. The primary threat to this species is from development of the habitat around urban areas and the attendant development of roads and utilities to support the urban areas. Threats from these sources will exist indefinitely under present circumstances, and no permanent formal protective measures are in place to prevent or reduce future impacts.

Status Recommendations: Due to extensive habitat loss to development and continued threat from development and disturbance, *Erythranthe carsonensis* meets the definition of a threatened species under the ESA. With active, long-term, cooperative management to reduce or eliminate further habitat destruction, and appropriate long-term monitoring, this trend can be stopped, and human-caused extirpation or extinction can be avoided. Absent such management, the long-term possibility of extinction or major declines will remain.

The species is ranked 2 (imperiled) at the global (G2) and state (S2) levels by the Nevada Natural Heritage Program, and is on the Threatened list of the Nevada Native Plant Society (NNPS). Because of its documented occurrences on USFS lands, the USFS should maintain *Erythranthe carsonensis* on its sensitive species list. If habitat for this species continues to be lost and degraded by both direct human activities and human influenced natural events, the Nevada Division of Forestry should consider adding *Erythranthe carsonensis* to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270. Due to the small number of populations in Alpine County, a rank of S1 is recommended for California.

Critical Habitat Recommendations: If critical habitat is designated through the provisions of the ESA or any other law or regulation, it should include all populations then known, along with any additional sandy loam soil habitat contiguous with those populations within 500 feet above and below the known elevation limits of the species. It should include a 250-foot (75-meter) horizontal buffer zone on each side of the populations and of the contiguous habitat, excluding previously developed areas. Critical habitat should not be formally designated in cases where it might subject *Erythranthe carsonensis* 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 *Erythranthe carsonensis*, 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. If monitoring (outlined in recommendation 6) indicates that preventable declines in viability of the species are occurring, then more aggressive conservation and recovery measures should be identified and pursued.

1. The USFS should maintain *Erythranthe carsonensis* on their list of sensitive species, and manage it accordingly for all future project planning and implementation.
2. Populations and habitat of *Erythranthe carsonensis* currently managed by BLM and USFS should be retained in public ownership, and should be managed in a manner compatible with long-term conservation of the species and its habitat. Any public lands conveyed into county, local, or private ownership should be restricted for purposes and uses compatible with such conservation.
3. The Carson City Open Space Commission should develop a plan to manage the populations of *Erythranthe carsonensis* on all of its lands, including locations of future park facilities, fire prevention, and management of OHV use and illegal dumping.
4. USFS, BLM, and the parks departments of Carson City, Douglas, and Washoe counties should plan existing and new recreational facilities, patterns, and uses carefully to avoid (or minimize if avoidance is not feasible) impacts to *Erythranthe carsonensis* and its habitat, and to take advantage of interpretive opportunities for same.
5. NDF, BLM, USFS, Carson City, NNHP, NNPS, and other interested parties should cooperatively seek funding for and pursue a public education program to raise awareness of *Erythranthe carsonensis* and its conservation needs, including but not limited to trailhead brochures, interpretive signs, and seasonal media releases to coincide with its flowering period.
6. BLM, USFS, NDF, NNHP, NNPS, and any other parties interested in participating, should cooperatively field-check as many *Erythranthe carsonensis* 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 intensified 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. Due to its annual nature and variable weather conditions, the plant may not grow in all years. During dry years, sites should be evaluated for suitable habitat rather than actual presence of the species. Core sites on public land that are susceptible to increased OHV use should be monitored more frequently for new or expanded unofficial OHV trails and parking areas.
7. BLM, USFS, and NDF should plan future fire-suppression actions and strategies, including identifying potential sites for fire breaks, access roads, landing pads, fuel reduction projects etc., to avoid (or minimize if avoidance is not feasible) impacts to known *Erythranthe carsonensis* populations and other sensitive resources.
8. BLM, USFS, Nevada Division of Transportation (NDOT), and Carson City, Douglas, and Washoe counties should aggressively manage and control invasions of exotic weeds

within the range of *Erythranthe carsonensis*, in cooperation with adjacent landholders and managers, to help reduce fire hazards to more natural levels, thereby helping minimize the need for fire suppression activities within *Erythranthe carsonensis* habitat, and increasing public safety.

9. BLM, USFS, Carson City, Douglas, and Washoe counties should pursue closure and barrier blockage of any and all unauthorized roads on their lands that impact or provide access to *Erythranthe carsonensis* sites, and should provide sufficient enforcement resources to ensure compliance.
10. NDOT, BLM, USFS, Carson City, Douglas, and Washoe counties should plan any future road development and maintenance to avoid (or minimize if avoidance is not feasible) impacts to known populations. Roads should avoid known habitat, and impacts from grading or other maintenance activities should be contained within the existing roadbed within known populations.
11. To minimize additional impacts from non-native species, any future artificial revegetation actions in and near the range of *Erythranthe carsonensis* should only use plant species native to the local area. USFS, BLM, NDF, NDOT, 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. In appropriate cases, other species documented not to persist under local conditions could be added at non-competitive levels for temporary stabilization until the native species can establish.
12. Studies of pollinator populations, and their effectiveness in the reproductive success of *Erythranthe carsonensis*, should be encouraged and supported. If found to play a significant role, pollinators should be monitored on the same schedule as *Erythranthe carsonensis* to detect any downward trends that could contribute to reproductive failure in *Erythranthe carsonensis*, and the cause(s) and possible remedies of any such declines should be assessed.
13. We have categorized the occupied sites as high, medium, or low priority for conservation, based on our assessment of their importance to the long-term viability and survival of the species (Site Priority column, Appendix 1, Table 1). This assessment included factors such as areal extent, extent and intensity of existing impacts (or lack thereof), current management, and potential for future conservation management. Below we have further defined and recommended thresholds for acceptable areal percentages of additional temporary and permanent losses for various numbers and priorities of sites. If monitoring (see recommendation 6) indicates that any one of these loss thresholds have been, or are about to be, exceeded, NDF should consider adding *Erythranthe carsonensis* to the Nevada list of critically endangered flora under NRS 527.270, and should use the management tools provided by NRS 527 and NAC 527 to minimize further losses and impacts to the species.

	Combined Area Temporarily + Permanently Lost	Area Permanently Lost
Any one medium priority site	100% x 2	100%
All medium priority sites (24% of total area)	90%	70%
Any one high priority site	100%	70%
All high priority sites (75% of total area)	70%	50%
All sites	70%	50%

Temporary Losses include, but are not limited to:

- Removal of natural vegetation due to fire.
- Weed infestation (more than 70% cover of non-natives).
- Mastication that covers more than 50% of the soil surface with debris.
- OHV or hiking trails.
- Soil grading less than 4" deep.
- Construction that stockpiles topsoil and restores site to natural condition after completion.
- Dumping of solid materials (garbage, yard waste, gravel, manure).

Permanent Losses include, but are not limited to:

- Removal of native vegetation and removal or covering of natural soil profile.
- Construction of buildings, roads, agricultural fields, housing developments, flood control, and other construction or grading that does not restore topsoil following completion.
- Erosion of the topsoil or burying by eroded sediment.
- Water impoundment that floods the area.
- Dumping of solid or liquid waste that contaminates the soil and prevents plant growth.



Figure 3. A large Carson Valley monkeyflower plant in Carson City, Nevada. May 10, 2016.

XI. INFORMATION SOURCES

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Field Research: Field surveys contributing to this report were conducted on 15 May 2009, from 16 to 21 May, 2010; 28 April and 15 May, 2011; 14 April to 26 April, 2014; 12 April to 15 April, 2015; 30 March to 18 May, 2016; and 5 April to 27 May, 2017. Please refer to Acknowledgments section for a list of contributors.

Specimens: All specimens known to document *Erythranthe carsonensis* sites are listed by site in Appendix 1, Table 2. 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.

Soil Samples: Soil samples were collected in *Erythranthe carsonensis* populations and in adjacent unoccupied habitats. All soil samples are stored at the NNHP office until funds are available for analysis.

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Appendix 1. Table 1. Known Populations.

Pop #	Population name	Total Area (m2)	Total Area (acres)	% of Total Area	Site Priority	Land Management (% by area)						Likelihood of loss (% by area)				Threats				First Survey	Last Survey	Notes
						BLM	USFS	State	City/County /GID	Private	Other	Low	Medium	High	Known Extirpated **	OHV / Roads	Dumping	Development	Utilities			
1	Red Rocks	NA			NA														1960	2015	Specimens from this location were misidentified, the plants are <i>Diplacus mephiticus</i> .	
2	Franktown	Unknown			NA							0	0	0	100					1925	1925	Likely extirpated. All suitable habitat has been converted to irrigated agriculture.
3	Western Nevada College	390009	96.4	9.5	High	0	0	77	23	0	0	100	0	0	0	Low	Low	Low	Low	2014	2017	This population is fairly well protected as open space with non-motorized trails.
4a	North Carson City	278670	68.9	6.8	Medium	22	0	0	50	28	0	27	48	15	10	High	High	Med	Med	1991	2017	Northridge, Madison Dr., and parcels off Arrowhead are extirpated. Other private parcels in this area are likely to be developed in the near future.
4b	Nine Hill	170766	42.2	4.2	Medium	84	0	1	0	15	0	70	15	0	15	Very High	High	Med	High	2016	2017	Severe erosion in early 2017 washed soil out of the roads and onto the center of the population. Vehicle traffic around damaged roads further disturbed habitat.
5	Empire	677	0.2	<0.1	Low	0	0	0	1	99	0	0	100	0	0	Low	High	High	Low	1882	2016	Undeveloped parcels still exist in this area and should be surveyed.
6a	Prison Hill - West	418706	103.5	10.2	High	9	0	3	86	2	0	90	10	0	0	Med	Med	Low	Low	2010	2017	Prison Hill and Indian Hills are now connected by patches found around the Edmonds Sports Complex in 2016. City parks master plan includes new sports fields at Edmonds.
6b	Prison Hill - North	17550	4.3	0.4	Low	0	0	65	31	4	0	65	35	0	0	Med	Med	Low	Med	2016	2017	
6c	North Indian Hills	256274	63.3	6.3	Medium	34	35	1	0	29	1	35	60	15	0	Med	High	High	Med	1937	2017	All BLM parcels proposed for disposal under 2015 RMP revision. Portions of the population have likely been extirpated by development but older records are too vague to know how many.
7	East Prison Hill	13796	3.4	0.4	Medium	0	0	0	100	0	0	100	0	0	0	Low	Low	Low	Low	2016	2016	This small population is within the Silver Saddle recreation area.
8	South Indian Hills/Jack's Valley	1030257	254.6	25.1	High	0	71	0	25	1	3	70	30	0	0	Low	Low	Low	Med	2010	2017	Jack's Valley area is protected within non-motorized wildlife and trailhead areas. The GID land is designated "open-space" on county assessor's records but legal status is unclear.
9	Hanson Lane	Unknown			NA	0	0	0	0	0	0	0	0	0	0					1950	1950	This area has been heavily developed but undeveloped potential habitat still exists north and south along the toeslope.
10a	Faye-Luther Trailhead	1201	0.3	<0.1	Low	0	0	0	0	100	0	0	100	0	0	Low	Low	Med	Low	2009	2014	Transferred from USFS to private ownership in 2004
10b	Fredricksburg	26312	6.5	0.6	Medium	50	40	0	0	10	0	90	10	0	0	Low	Low	Low	Low	2009	2014	The BLM land in this area is proposed for Extensive Recreation Management Area designation.
11	Old Washoe City	10219	2.5	0.3	Medium	73	0	0	0	27	0	73	27	0	0	Low	Med	Med	Low	2013	2016	Two tiny patches east and west of Little Washoe Lake. Northernmost known population.

Pop #	Population name	Total Area (m2)	Total Area (acres)	% of Total Area	Site Priority	Land Management (% by area)						Likelihood of loss (% by area)				Threats				First Survey	Last Survey	Notes
						BLM	USFS	State	City/County /GID	Private	Other	Low	Medium	High	Known Extirpated **	OHV / Roads	Dumping	Devel- opment	Utilities			
12	Jumbo Grade	177113	43.8	4.3	High	100	0	0	0	0	0	100	0	0	0	Med	Low	Low	Low	2016	2016	The road to this population is in very poor condition and receives little use.
13a	Flint Drive	26620	6.6	0.7	Medium	26	0	0	74	0	0	0	100	0	0	High	High	Med	Med	2017	2017	Plans for this area include expansions of recreational facilities and biomass waste storage.
13b	Moundhouse	13234	3.3	0.3	Medium	100	0	0	0	0	0	100	0	0	0	High	Med	Low	Low	2017	2017	This site is moderately impacted by a feral horse herd that frequents the area. Easternmost known population.
14a	Hot Spring Mountain	402842	99.5	9.8	High	95	0	2	2	1	0	97	3	0	0	Med	Med	Low	Low	2016	2017	The areas around Hot Spring Mountain receive a lot of vehicle traffic from the surrounding neighborhood and illegal dump sites are fairly active with those closer to the houses used more frequently. Flood mitigation for Johnson Lane area may impact southern subpopulation.
14b	Hot Spring Mountain NE	504	0.1	<0.1	Low	100	0	0	0	0	0	100	0	0	0	Med	Low	Low	Low	2016	2016	
14c	Hot Spring Mountain - South	3275	0.8	<0.1	Low	100	0	0	0	0	0	100	0	0	0	Med	Med	Low	Low	2016	2016	
15a	Gardnerville Ranchos	762748	188.5	18.6	High	0	55	0	1	43	1	40	58	2	0	Very High	Very High	High	Low	2016	2017	This area is heavily disturbed by OHV traffic and a gravel pit. Douglas County plans new major roads through the area connecting Highways 88 and 395. The Rancho Sierra development will extirpate a portion of this population. Secondary access road for Rancho Sierra development will likely extirpate the NE location. This area is mostly used for agriculture. Erythranthe plants persist in the corners and margins of pivot irrigated fields but vegetation removal or herbicide spraying could extirpate this population.
15b	Mud Lake	19498	4.8	0.5	Low	0	0	0	0	100	0	0	60	40	0	High	Low	Med	Low	2017	2017	
15c	Mud Lake Road	62322	15.4	1.5	Medium	0	0	0	6	94	0	0	100	0	0	Low	Low	Med	Low	2017	2017	
16	Mesa Vista (Alpine Co.)	30065	7.4	0.7	Medium	0	0	0	0	100	0	0	100	0	0	Low	Low	Med	Low	2017	2017	High potential for residential development.
N/A	Carson City	Unknown			NA											1865	1868	Early surveys recorded site locations as in or near Carson City or Eagle Valley and are too vague to map.				
	Totals	4112659	1016			23	28	8	22	18	1	68	29	3	1	High	Med	Med	Low	1865	2017	Only includes populations with known areas.

**Due to lack of historical data, the actual amount of extirpated habitat is likely higher. Habitat modeling (see report text) suggests that the amount lost may be closer to 42% of the historical population.

Appendix 1 - Table 2. Specimens of *Erythranthe carsonensis*. Threats: D=Development, A=Agriculture, R=Recreation, EX= abundant exotic plant species, RM=Road construction and maintenance.

Specimen number	Population Number	Sources	Collector	Date	Locality	Threats
01	N/A	GH-00078851	Anderson, C.L.	1865	Carson City	D
02	N/A	NY-01245504	Stretch, R.H.	01 Apr 1865	Eagle Valley	D
03	N/A	GH-00078849	Watson, S.	1868	Carson City	D
04	5	POM-43906	Jones, M.E.	15 Jun 1882	Empire City	D
05	5	NY-01245500	Jones, M.E.	20 Jun 1889	Empire City	D
06	N/A	RSA-741078	Baker, C.F. 1023, 1029	07 Jun 1902	Eagle Valley	D
07	N/A	NY-01245499	Anderson, C.L.	07 Feb 1905	Near Carson City	D
08	2	RENO-15651	P.A.L.	04 May 1925	Franktown	D, A
09	6c	RENO-15653	Archer, W.A. 5047	24 Apr 1937	On Gardnerville Hwy, SW of Carson Indian Agency.	D
10	6c	RENO-5313	Solari, D. 19	11 Apr 1941	3 miles south of Carson City	D
11	9	RENO-11813	Woodbury, V. 23	27 Apr 1950	5 miles south of Genoa	D
12	1	RENO-52297	Urrutia, A.	30 Apr 1960	Red Rock Canyon T21N R18E Originally Misidentified	N/A
13	6c	NY- 1245505	Williams, M.J.	03 Apr 1976	At the intersection of Highway 395 and the Jack's Valley Road	D, RM
14	6c	RENO-35801	Wise, L. 4850	13 Apr 1976	Indian Hill, 3 miles south of Carson City near the Jacks Valley Road.	D
15	6c	NY-1245501	Genz, K.R. 9097	15 May 1979	Topsy Lane S of Clear Creek	D
16	4a	RSA-537608	Morefield, J.D. 5452	12 May 1991	Eagle Valley: 0.5 mile south of Carson Hot Springs, 0.5 mile ENE of Lone Mountain summit	D
17	6c	RSA	Fraga, N. 2743	15 May 2009	Topsy Lane south of Clear Creek.	D
18	10a	RSA	Fraga, N. 2744	15 May 2009	Near trailhead parking for Faye Luther Trail	D, R
19	8	RSA	Fraga, N. 3366, 3367	16 May 2010	Jacks Valley Management Area near Plymouth Road.	R, EX
20	8	RSA	Fraga, N. 3369	16 May 2010	James Lee Memorial Park, near baseball Field	R, EX
21	6c	RSA	Fraga, N. 3370	16 May 2010	Corner of Lynnette Ave and Arthur Dr., NE corner across from Nevada DOT building	D, EX, RM

Appendix 1 - Table 2, continued. Specimens of *Erythranthe carsonensis*. Threats: D=Development, A=Agriculture, R=Recreation, EX= abundant exotic plant species, RM=Road construction and maintenance.

Specimen number	Population Number	Sources	Collector	Date	Locality	Threats
22	4a	RSA	Fraga, N. 3371	16 May 2010	Corner of Old Hot Springs Road and Goni Road, Eagle Valley	D, EX
23	8	RSA	Fraga, N. 3372	17 May 2010	Jacks Valley, west of Elementary School	R
24	8	RSA	Fraga, N. 3374	17 May 2010	North side of Jacks Valley Road, across from the Elementary School	R, RM
25	6a	RSA, US, UC	Fraga, N. et al. 3377	17 May 2010	Prison Hill at east end of Clear Creek Road	R
26	10b	RSA	Fraga, N. 3803	23 May 2011	Near Fredericksburg, Alpine County, California	R, D

Appendix 2 – Additional Figures

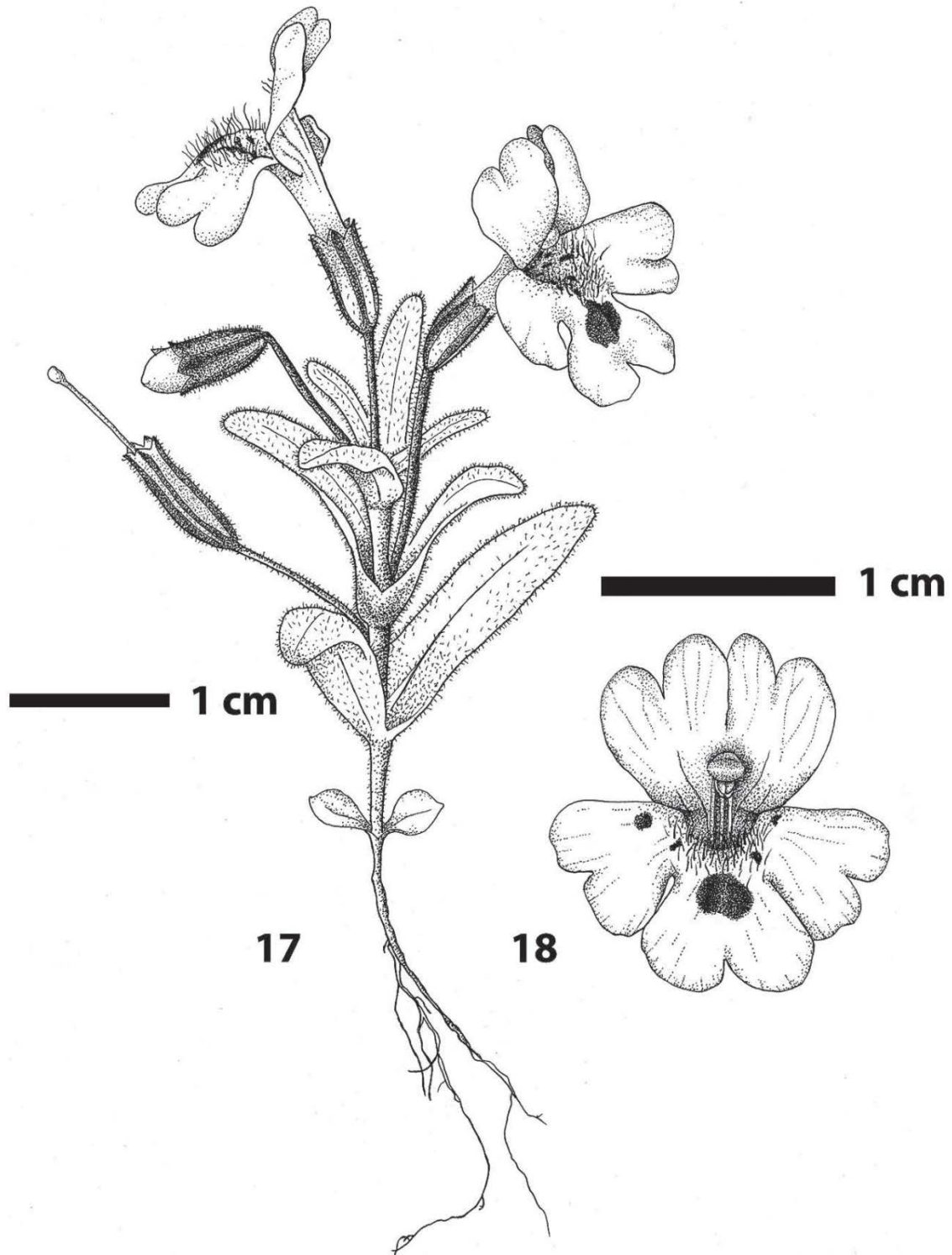


Figure 4. Illustration by Michelle Thompson, from Fraga (2012).



Figure 5. Large *Erythranthe carsonensis* plant by Jim Morefield, May 15, 2009.



Figure 6. Small *Erythranthe carsonensis* plant by Reese Tietje, April 12, 2015.



Figure 7. *Erythranthe carsonensis* habitat, Jack's Valley, NV by Janel Johnson, April 16, 2014.

Appendix 3 – Maps

The maps in this appendix show the currently known occupied and unoccupied habitat areas along with the Maxent model in developed (residential, commercial, or agricultural) and undeveloped areas. The mapped developed areas may contain small undeveloped areas such as vacant lots and road margins and the undeveloped areas contain scattered developments such as isolated houses and farm buildings.






Map Legend for Maps in this Appendix:

Carson Valley Monkeyflower (*Erythranthe carsonensis*)

-  Occupied
-  Unoccupied






Maxent model

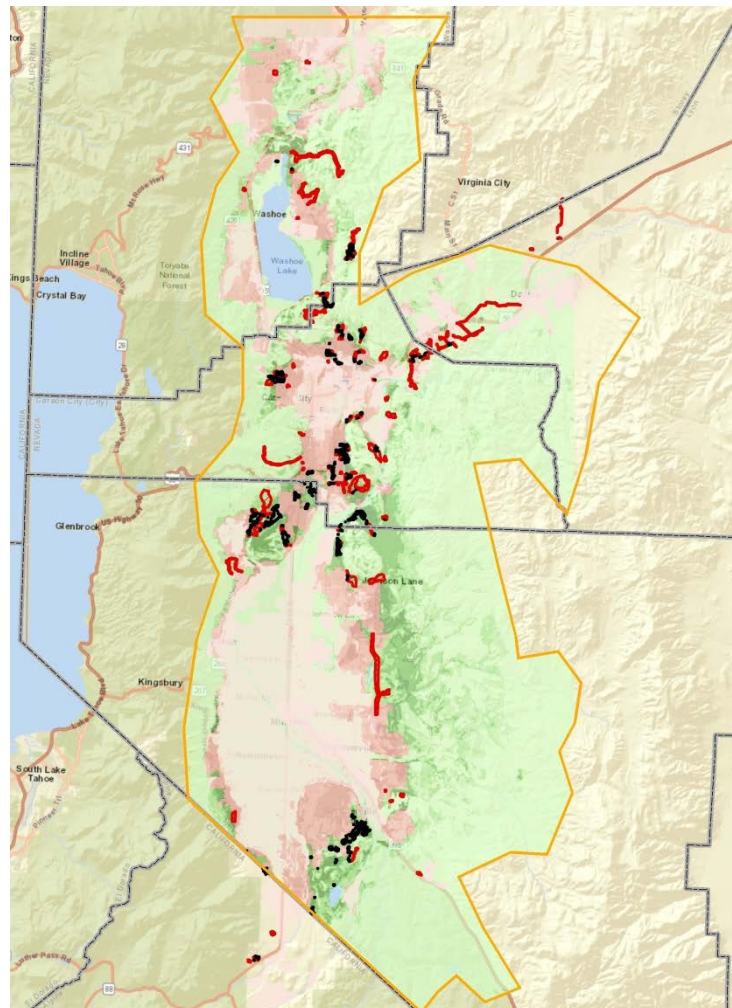
Developed Areas

-  Very Low
-  Low
-  Medium
-  High
-  Very High

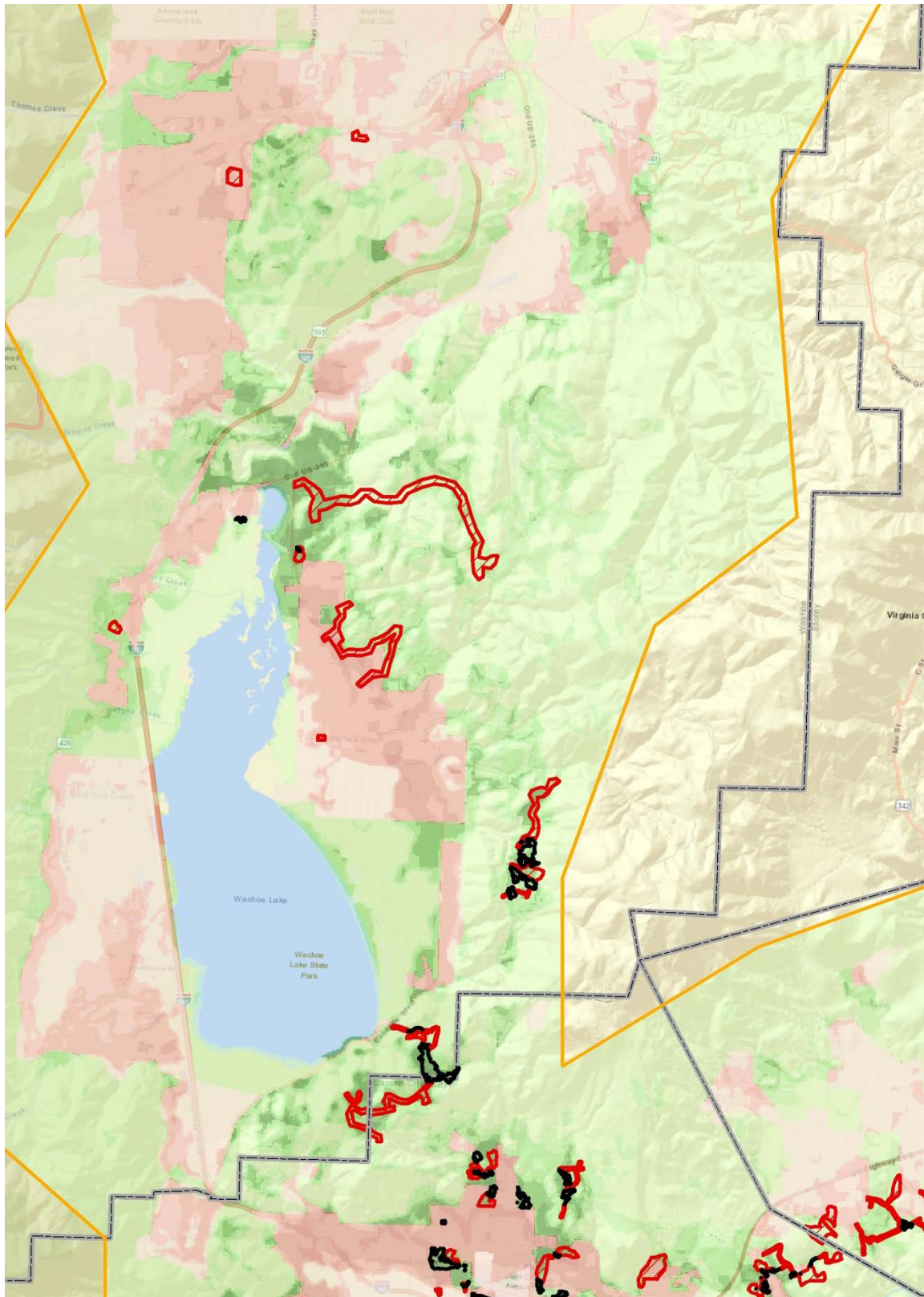
Maxent model

Undeveloped Areas

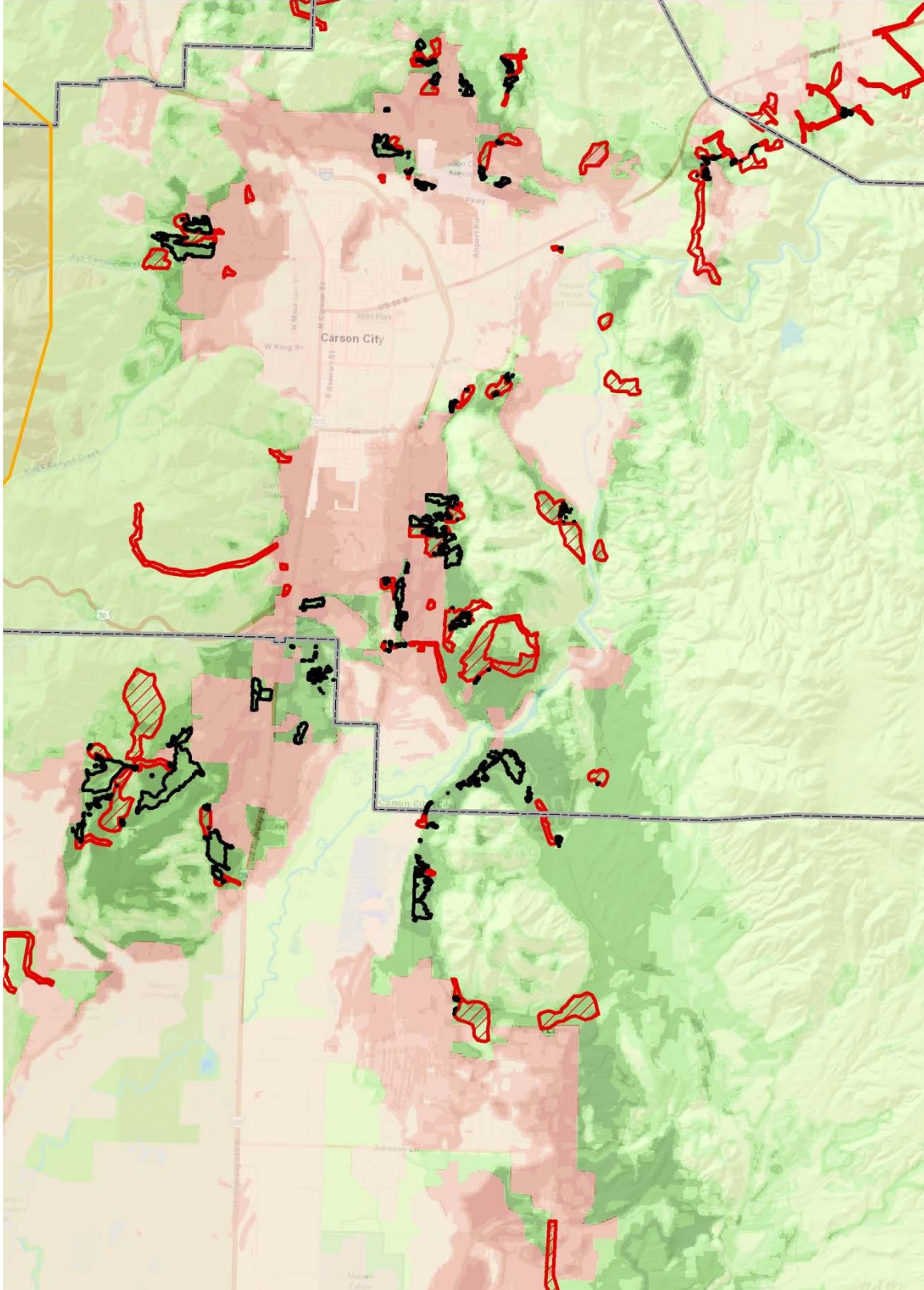
-  Very Low
-  Low
-  Medium
-  High
-  Very High



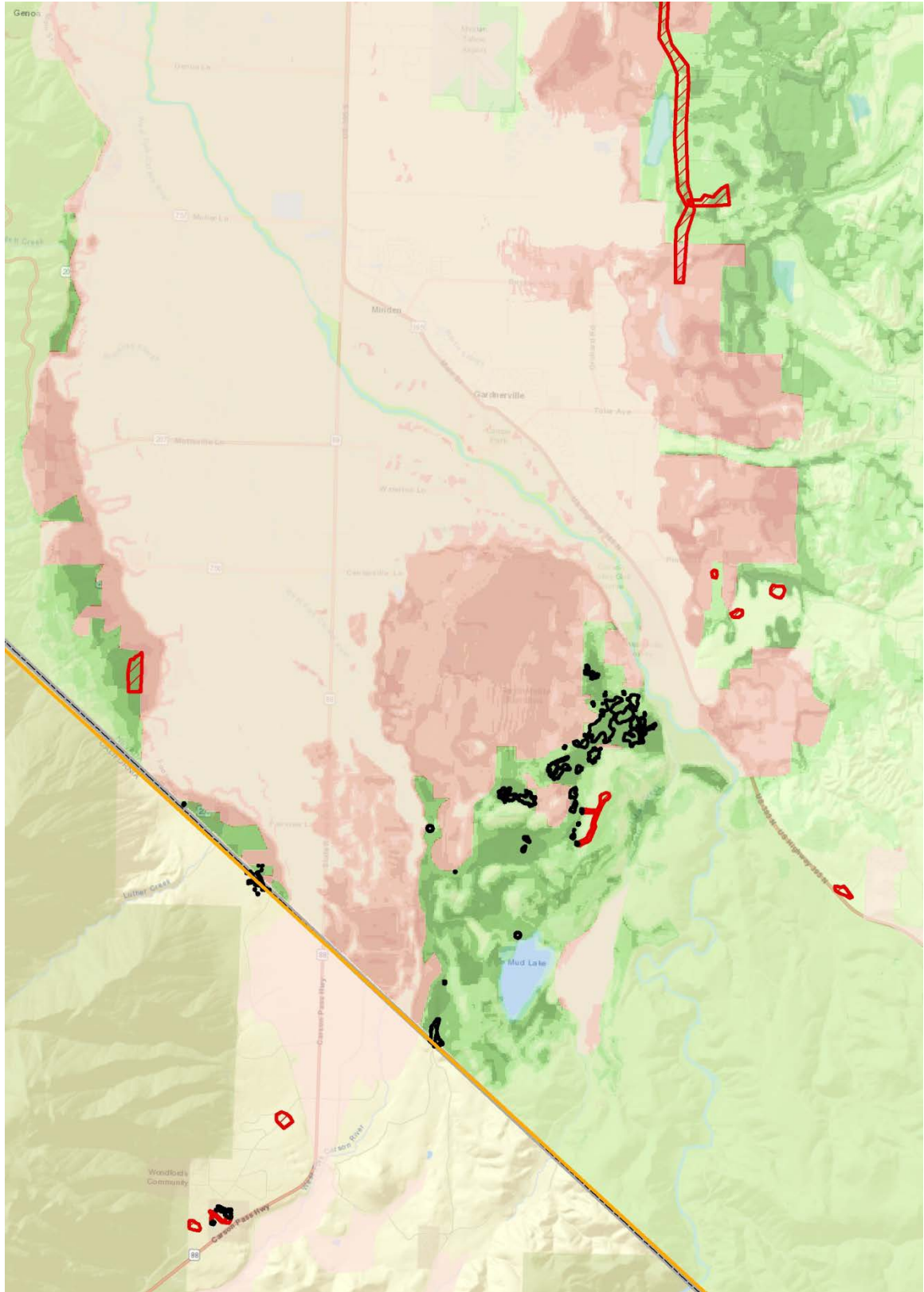
Map 1. Overview Map of *Erythranthe carsonensis* populations and habitat model.



Map 2. Known distribution of *Erythranthe carsonensis* and habitat model in Washoe Valley. See Appendix 3 page 1 for map legend.



Map 3. Known distribution of *Erythranthe carsonensis* and habitat model in Carson City and northern Carson Valley. See Appendix 3 page 1 for map legend.



Map 4. Known distribution of *Erythranthe carsonensis* and habitat model in southern Carson Valley. See Appendix 3 page 1 for map legend.