

# Current Knowledge and Conservation Status of *Eriogonum robustum* E. Greene (Polygonaceae), the altered andesite buckwheat.

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**SUMMARY:** *Eriogonum robustum* was first discovered and collected by Virginia City native Mary Katharine Layne Curran (a.k.a. Kate Brandegee) at what would become its type locality near the base of Geiger Grade (now Nevada Highway 341) in the Virginia Range of southern Washoe County, Nevada. Edward L. Greene named the new species in 1885 using Brandegee's specimens. *Eriogonum robustum* is a robust, mounded or matted perennial herb with large, crowded, silvery-gray basal leaves, leafless flowering stems to 30 cm high, and large loose masses of pale yellow flowers. *Eriogonum robustum* remains endemic to southern Washoe County and extreme western Storey County, Nevada, in the Virginia and Carson ranges, and on Peavine Mountain and the Red Hill area. *Eriogonum robustum* is very closely related to *E. lobbii* Torrey & A. Gray, of which it has been considered a taxonomic variety by some workers. Recent investigations, and fieldwork for this report, support recognition of *E. robustum* as a separate species. At either taxonomic rank, however, it remains a distinctive genetic and geographic entity worthy of separate conservation concern.

As of the end of 1993, *Eriogonum robustum* was known from 25 sites in the Virginia Range, and on Peavine Mountain and Red Hill, covering 290.63 acres (117.61 ha) between 4410 and 7190 feet (1345-2190 meters) elevation. Most of these sites were on, or within about 3 km of, present and historic mining operations, major highways and off-road vehicle tracks, and rapidly expanding urban and residential areas, and many had been noticeably impacted by these developments. Because of these impacts and its rarity and continued vulnerability, *Eriogonum robustum* was designated a category-1 candidate for federal listing on 15 December 1980, then a category-2 candidate on 27 September 1985. Responding to this concern, the U. S. Fish and Wildlife Service and the Nevada Natural Heritage Program sponsored and conducted extensive field surveys in 1994-1996 to verify and refine the historical reports, discover any additional populations, and document the biology, ecology, and conservation status of all populations. This report summarizes the results of all recent surveys, reviews all previous knowledge of the species, and recommends conservation actions designed to prevent it from becoming a threatened or endangered species.

The recent surveys compiled for this report increase the known extent of *Eriogonum robustum* by 104 sites (416%) and 517.48 acres (209.42 ha; 178%) of habitat between 4540 and 7325 feet (1385-2230 meters) elevation. These sites included the first reports of the species from the Sierra Nevada, on the east slopes of the Carson Range in the Hunter Creek drainage. As now documented, *Eriogonum robustum* is known worldwide from 129 sites in about 14 scattered groups, totaling roughly 1,615,000 plants and covering about 808 acres (327 ha) of private (roughly 50.1%), Bureau of Land Management (23.0%), Humboldt-Toiyabe National Forest (17.4%), Nevada Department of Transportation (6.4%), and County (3.1%) lands. At least 1-2 historical sites now appear to be extirpated. The most distant two extant occurrences are separated by about 25 miles (40 km), and the number of extant occurrences is reduced to 25 if a 1 km minimum separation distance is imposed.

*Eriogonum robustum* was entirely restricted to shallow, rocky, highly acidic (pH 3.3-5.5) Smallcone soils derived from weathering of hydrothermal iron sulfide deposits formed mainly in andesite, and occasionally in rhyolitic

or granitoid rocks, on dry, nearly barren ridges, knolls, and gentle to steep slopes on all aspects. All but the driest and warmest sites support a sparse and stunted relict woodland mainly of Jeffrey and/or ponderosa pine, with singleleaf pinyon pine and an equally sparse understory codominated by *Eriogonum robustum* in association with fragile sandwort, rabbitbrush, squirreltail grass, and western bluegrass. Recent surveys focusing on over 1500 acres (607 ha) of additional potential habitat in western Nevada and Eastern California have revealed no further populations of *Eriogonum robustum*, but about 667.44 acres (270.10 ha) of potential habitat remain unsurveyed. Based on the probable occupancy rate of this habitat, the true total population of *Eriogonum robustum* is estimated to be no more than 25% greater than now documented.

The barren habitat of *Eriogonum robustum*, frequently located on ridges and hill tops, and its high mineral potential and close proximity to existing mineral, transportation, utility, urban, and residential developments, makes the sites convenient and attractive for access roads, off-road vehicle use, transmission facilities, utility corridors, fire suppression activities, and additional mineral, urban, and residential development. Most of the species' habitat is acknowledged to have high mineral extraction potential, and mineral claim markers or evidence of past, present, or planned mining activities were observed in or near most populations. As of this report, significant impacts from one or more of these sources had been observed at 71 (54.2%) of the known and historic populations, although only one of these sites had been extirpated and the viability of most did not yet appear compromised. Without these impacts and threats, *Eriogonum robustum* would probably now be too abundant to merit conservation concern. *Eriogonum robustum* is capable of recolonizing moderate to severe past disturbance, such as road cuts and mine dumps, within its specific habitat and soil type, but appears incapable of surviving sustained disturbance, or of spreading to other habitats on disturbed or undisturbed substrates. The species likely depends on insect pollinators for most or all of its reproductive success, but nothing is known about the identity, specificity, rarity, status, current effectiveness, and viability trends of these pollinators. Currently *Eriogonum robustum* is managed as a "sensitive species" by the Bureau of Land Management, but has no other legal status or protective designation.

Based on the best available scientific evidence, *Eriogonum robustum* 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 could become a threatened or endangered species in the future if current trends continued and more than 10-20% of the known populations were lost. It therefore continues to meet criteria for sensitive species designations by the U. S. Forest Service and Bureau of Land Management. This report recommends several conservation measures which, if successfully implemented, offer the best chance to eliminate any future need to list *Eriogonum robustum* as threatened or endangered. Primary among these are active near-term cooperative management and public planning to minimize further impacts and habitat destruction, public acquisition of privately held sites through voluntary exchange or sale, closure of unauthorized roads on public lands and careful management of authorized ones, long-term monitoring, careful design and mitigation of fire suppression sites and activities, and study of insect pollinators.

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*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:** *Eriogonum robustum* E. Greene (1885, p. 126).

**Type Specimen:** NEVADA, Washoe County: Geiger Grade ("on the Geiger Grade between Reno and Virginia City"; Greene 1885), July 1884, *Curran s.n.* (holotype: CAS; isotype: GH) (Tiehm 1996).

**Synonym(s):** *Eriogonum lobbii* Torrey & A. Gray var. *robustum* (E. Greene) M. E. Jones (1903). *Eriogonum lobbii* var. *robustius* (orthographic variant, Reveal and Munz 1968). *Eriogonum robustium* (orthographic variant, Reveal 1985a, fide Kuyper *et al.* 1997).

**Vernacular Name(s):** altered andesite buckwheat, Lobb buckwheat, Lobb's buckwheat, robust buckwheat, Geiger Grade buckwheat.

**Family:** Polygonaceae (buckwheat family).

<b>Major Groups:</b>	<b>Cronquist (1988)</b>	<b>Thorne (1992)</b>
<b>Class</b>	Magnoliopsida (Dicotyledoneae)	Magnoliopsida (Angiospermae)
<b>Subclass</b>	Caryophyllidae	Magnoliidae (Dicotyledoneae)
<b>Superorder</b>	[Caryophyllanae of Thorne]	Theanae
<b>Order</b>	Polygonales	Polygonales

**Review of Alternative Taxonomic Treatments:** Kuyper *et al.* (1997) summarized well the history and sources of divergent taxonomic opinions regarding *Eriogonum robustum*. Their review showed, with some exceptions, that those workers whose studies were predominantly field-based treated the taxon as a distinct species, *Eriogonum robustum*, while those whose studies were based predominantly on the study of herbarium specimens treated the taxon as *Eriogonum lobbii* var. *robustum*. This probably reflects the highly distinctive appearance of *E. robustum* in life, which is not fully preserved in specimens, and the larger range-wide variation in *E. lobbii* (Kuyper *et al.* 1997), which becomes more apparent when studying a large set of specimens, and which can superficially appear to include the variation in *E. robustum*.

In studying a large set of herbarium specimens themselves, Kuyper *et al.* (1997) showed that, while there was at least some overlap in all character measurements used to distinguish *E. robustum* from *E. lobbii*, the differences between taxa were highly significant statistically for all characters. *Eriogonum robustum* was most similar to the small subset of *E. lobbii* with which it shares compoundly branched inflorescences, but was still distinguishable in the great majority of cases by a combination of flowering stem length and width and bract length and width.

Field observations of both taxa for this report confirmed the highly distinctive appearance of the two taxa in the field (see Appendix 2 figures). *Eriogonum lobbii* generally had a small, few-branched root crown, flowering stems and inflorescences prostrate, and flowers white to pink, aging dark red. *Eriogonum robustum*, on the other hand, had massive, many-branched, mounded root crowns when mature, flowering stems ascending to erect, inflorescences never prostrate, and flowers pale yellow, aging tan. Combined with its geographic and ecologic separation from *E. lobbii*, and its highly specialized habitat, these observations convinced me that *Eriogonum robustum* constitutes a species separate from *E. lobbii*, and it is so treated in this report.

**Biogeography and Phylogeny:** The genus *Eriogonum* Michaux consists of about 240 species distributed nearly throughout North America but most abundant and diverse in the western United States (Hickman 1993b, Reveal 1989b). It belongs to the tribe Eriogoneae of the buckwheat family (Polygonaceae), where its closest relatives appear to be *Dedeckera* Reveal & Howell, *Stenogonum* Nuttall, and, perhaps more distantly, *Oxytheca* Nuttall, all of which are centered in the southwestern United States and are much less diverse. These genera may share common ancestors, or some may have evolved from ancient members of the others.

No detailed studies of the origin and evolution of the genus *Eriogonum*, much less of *Eriogonum robustum*, are known to exist. Within the genus, *Eriogonum robustum* is placed in the subgenus *Oligogonum* Nuttall (Reveal 1989a,b), a group of about 33 relatively distinct perennial species distributed throughout the western United States, with its greatest diversity centered along the Sierra Nevada and Cascade mountain chains. Greene (1885) compared *Eriogonum robustum* most closely with *E. lobbii* Torrey & A. Gray and *E. compositum* Douglas ex Benthams, both of which are centered in northern and eastern California and Oregon. Reveal (1989a,b) placed *Eriogonum robustum* (as *E. lobbii* var. *robustum*) in sequence between *E. pyroliifolium* Hooker and *E. alpinum* Engelmans, both of which are also centered to the north and west of *E. robustum*. Many of its closest relatives in subgenus *Oligogonum* are characterized by similar adaptations to harsh, nutrient-poor soils such as those derived from serpentine.

It appears undisputed that the closest relative of *Eriogonum robustum* is *E. lobbii* (Kuyper *et al.* 1997). The latter is common and widespread at higher elevations in the Sierra Nevada, starting immediately west of the range of *E. robustum*. *Eriogonum lobbii* probably originated from one or more populations of *E. lobbii* that became isolated on islands of highly acidic soil derived from hydrothermally altered andesite, as populations of *E. lobbii* contracted and fragmented during interglacial cycles, much as Billings (1992) described for the remnant yellow pine forests associated with these same habitats.

## II. TAXON HISTORY

Unless otherwise cited, reports and correspondence documenting the following chronology are on file with the Nevada Natural Heritage Program. Kuyper *et al.* (1997) provided a more complete and detailed history of the differing taxonomic treatments of *Eriogonum robustum*.

- 1884: First discovered by Mary Katharine Layne Curran, a.k.a. Kate Brandegee, who collected the type specimens from the Geiger Grade area in July (Tiehm 1996).
- 1885: Formally described as a new species by E. Greene (1885).
- 1894: First collected on Peavine Mountain by F. H. Hillman on 15 June.
- 1903: First combined as *Eriogonum lobbii* Torrey & A. Gray var. *robustum* (E. Greene) M. E. Jones (1903).
- 1971: First collected in the Lockwood and Red Hill areas by James Reveal on 24-25 June.
- 1978: Surveyed extensively in the Virginia Range by Larson (1978).
- 1980: Designated a category-1 candidate for listing under the Endangered Species Act on 15 December (U. S. D. I. Fish and Wildlife Service 1980, as *E. lobbii* var. *robustum*).
- 1981: First collected at Steamboat Springs by Margaret Williams on 27 December.
- 1985: Designated a category-2 candidate for listing under the Endangered Species Act on 27 September (U. S. D. I. Fish and Wildlife Service 1985, as *E. lobbii* var. *robustum*).

- 1987: Included and recognized in Kartesz's (1987) flora of Nevada as *E. lobbii* var. *robustum*, based on Reveal (1985b).
- 1987-88: Numerous sites surveyed floristically by W. Dwight Billings and Janet L. Nachlinger (unpublished field notes on file with the Nevada Natural Heritage Program).
- 1989: Treated as *E. lobbii* var. *robustum* in Reveal's (1989a) checklist of Eriogonoideae.
- 1994-1996: Surveys conducted by the Nevada Natural Heritage Program for this report, during which the species was first documented in the Jumbo Falls and Hidden Valley areas of the Virginia Range, and in the Carson Range of the Sierra Nevada.
- 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).
- 1997: Morphologic study by Kuyper *et al.* (1997) concludes that *Eriogonum robustum* should be recognized as a species separate from *E. lobbii*.

### III. PRESENT LEGAL OR OTHER FORMAL STATUS

**International:** Using a system established by 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. *Eriogonum robustum* was most recently ranked 2-3 by the Nevada Natural Heritage Program (2000) at all levels. The results of this report show that 2-3 is still the most appropriate rank.

**Federal:** Until recently *Eriogonum robustum* was designated (as *E. lobbii* var. *robustum*) a category-2 candidate for listing as endangered or threatened under 16 U.S.C. 1531 *et seq.*, the Endangered Species Act as amended in 1988. 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). The U. S. D. I. Fish and Wildlife Service (1996) subsequently discontinued use of that category. *Eriogonum robustum* remains a "species of concern" to the Fish and Wildlife Service, but this term has no formal or legal status. *Eriogonum robustum* is on the sensitive species list of the U. S. D. I. Bureau of Land Management (1996). This report recommends that *Eriogonum robustum* be added to the Humboldt-Toiyabe National Forest sensitive species list, and that all other designations remain unchanged.

**State:** No formal status has been designated at the state level. *Eriogonum robustum* is on the Northern Nevada Native Plant Society's Watch List (Nevada Natural Heritage Program, 2000). This report recommends no changes to this designation. If populations continue to be degraded or lost, the Nevada Division of Forestry should consider adding *Eriogonum robustum* to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270.

### IV. DESCRIPTION

**Non-technical:** **Herbaceous, perennial**, compact to slightly spreading mats or mounds to 7 dm across and 3 dm high, silvery-gray woolly or cobwebby from leaves to flower cups; **root crown** much-branched, woody, arising from a stout, gnarled taproot; **overall color** silvery-gray with pale-yellow masses of flowers, the whole plant becoming tan-colored late in the season. **Stems** annual, generally 10 to 100 or more, upright to angled upward, rounded, branched among the flower groups, leafless above the base except for smaller leaf-like bracts at branch nodes, to

9(15) cm long below first branches, stout, (1)1.7-3(9) mm wide 4 cm below the first branches (pressed). **Leaves** annual, many in crowded circles at base, upright to lying flat, unlobed; **stipules** none; **leaf stalks** 1-4(6) cm long; largest **leaf blades** more or less egg-shaped, blunt to rounded at tip, 2.5-5 × 1.5-3.5 cm, thickened, edges smooth and flat or somewhat wavy-margined, upper surface occasionally losing its hair to become shiny dark green. **Flower groups** arranged as a 2-3-times branched umbrella-like structure, ca. 4-9 cm long and 7-15 cm wide, main branches up to 5-15, 2-4 cm long, with as many leaf-like bracts 14-32 × 3-10 mm at their base; **flower cups** one on each branch tip, stalkless, broadly conic to bell-shaped, largest 7-15 mm long and wide, thickened, stiff, teeth at tip 6-10, pointing outward to downward, 2-6 mm long, flower stalks extending outside the cup. **Flowers** (April-July) each with male and female parts, about 10-15 per flower cup, upright to pointing outward, jointed to stalk and falling together with the mature fruit, pale yellow, aging tannish outward from the initially greenish middle veins, radially symmetric, the parts spread nearly flat after opening, base (above the joint with the flower stalk) stalked an additional 0.1-0.4 mm; **flower parts** remaining attached after opening, 6, in 2 circles of 3, separate from one another to their bases, oval to narrowly egg-shaped, all about the same size and shape, 5-9 mm long, papery, smooth, hairless; **stamens** 9, extending far beyond the other flower parts, falling away in fruit, stalks about 5-10 mm long, hairy at base, anthers pale yellow, oval, 0.7-0.9 mm long; **ovary** attached above the surrounding flower parts, 1-chambered, **styles** 3. **Fruit** (June-September) dry, hard, enclosed by and falling with the flower parts, light brown, 4.5-8 mm long, narrowly egg-shaped, tip long, tapered, 3-angled, hairless. **Chromosome number** unknown, probably derived from a multiple of 10 or 20 [based on Greene (1885), Hickman (1993b), Kuyper *et al.* (1997), Reveal and Munz (1968), Reveal (1985b, 1989b), and personal observations].

**Technical:** **Herbaceous, perennial**, compact to slightly spreading mats or mounds to 7 dm across and 3 dm high, silvery-gray tomentose or arachnoid from leaves to involucre; **caudex** much-branched, woody, arising from a stout, gnarled taproot; **overall color** silvery-gray with pale-yellow masses of flowers, the whole plant becoming tan-colored late in the season. **Stems** annual, generally 10 to 100 or more, erect to ascending, terete, branched in the inflorescence, scapose, bracteate at branch nodes, to 9(15) cm long below first branches, stout, (1)1.7-3(9) mm wide 4 cm below the first branches (pressed). **Leaves** annual, many in crowded basal rosettes, erect to spreading, simple; **stipules** none; **petioles** 1-4(6) cm long; largest **blades** ovate to obovate, obtuse to rounded, 2.5-5 × 1.5-3.5 cm, thickened, entire, planar or somewhat wavy-margined, upper surface occasionally glabrate and dark green. **Inflorescence** a 2-3-compound umbel, ca. 4-9 cm long and 7-15 cm wide, primary rays up to 5-15, 2-4 cm long, subtended by foliose bracts 14-32 × 3-10 mm; **involucre** single on each ultimate ray, sessile, campanulate, largest 7-15 mm long and wide, thickened, rigid, lobes 6-10, spreading to reflexed, 2-6 mm long, pedicels exerted. **Flowers** (April-July) bisexual, ca. 10-15 per involucre, erect to spreading, jointed to pedicel and falling together with the mature fruit, pale yellow, aging tannish outward from the initially greenish midribs, radial, nearly rotate at anthesis, base above pedicel joint stipitate 0.1-0.4 mm; **tepals** persistent, 6, in 2 whorls of 3, free to base, oblong-obovate, about equal, 5-9 mm long, papery, smooth, glabrous; **stamens** 9, long-exserted, deciduous in fruit, filaments ca. 5-10 mm long, pilose basally, anthers pale yellow, oblong, 0.7-0.9 mm long; **ovary** superior, of 3 united carpels, unilocular, **styles** 3. **Fruit** (June-September) an achene enclosed by and falling with the perianth, light brown, 4.5-8 mm long, lance-ovoid, apex 3-angled, glabrous. **n** unknown, probably based on  $x = 10$  or  $20$  [based on Greene (1885), Hickman (1993b), Kuyper *et al.* (1997), Reveal and Munz (1968), Reveal (1985b, 1989b), and personal observations].

**Field Characters:** (see Appendix 2 figures) *Eriogonum robustum* is distinguished by its combination of perennial, mounded or matted growth form; longest flower cups 7-15 mm; smooth hairless pale yellow flowers (aging tan) 5-9 mm long in 2-3-times branched umbels and falling with a short stalk attached; abundant silvery-gray woolly hairs on leaves and stems; leaf blades ovate to obovate, 2.5-5 cm long on stalks about as long, flowering stems upright to angled upward, leafless, bracteate, 2-3-times branched in the inflorescence, mostly 1.7-3 mm thick 4 cm below the first branches. It is also strictly limited to highly acidic soils derived from hydrothermally altered andesite and rhyolite, which form distinctive habitat patches throughout its range. The following artificial, idealized key is synthesized mainly from Hickman (1993b), Kuyper *et al.* (1997), Reveal (1985b), and personal observations, and will separate typical *Eriogonum robustum* from typical members of similar or co-occurring taxa. Specimens for which the key is ambiguous should be compared with the discussion in Kuyper *et al.* (1997):

1. Plants annual *or* shrubby *or* flowering stems leafy *or* unbranched *or* flowers in a single tight ball on each stem *or* bright yellow when fresh *or* longest leaf stalks < 10 mm *or* largest leaf blade < 20 mm long *or* < 12 mm wide *or* stalk of each flower jointed at base of flower parts, old flowers falling free from stalk ..... other *Eriogonum*
- 1' Plants perennial, often forming mounds or mats, not shrubby; flowering stems leafless, branched and leafy-bracted among the flowers; fresh flowers whitish to pale yellow or pink, forming 2 or more groups on each stem; largest leaf blades > 20 mm long, > 12 mm wide, stalked > 10 mm; stalk of each flower jointed 0.1-0.4 mm below base of flower parts, old flowers falling with a stalk portion attached.
  2. Largest flower cups < 7 mm long *or* flowers hairy *or* stems hairless *or* leaf hairs short, straight ..... other *Eriogonum*
  - 2' Largest flower cups 7-15 mm long; flowers hairless; stems and leaves cobwebby to woolly.
    3. Flowering stems prostrate, 0.3-1.6(2) mm thick 4 cm below first branch (pressed), usually branched once below flowers, if branched twice then the longest stem mostly 9.5-18 cm below the first branches; flowers mostly white to pink, aging raspberry red ..... *Eriogonum lobbii*
    - 3' Flowering stems upright or angled upward, the thickest (1)1.7-3(9) mm thick 4 cm below first branches (pressed), all branched at least twice below flowers, generally (4.5)6-9(15) cm below first branches; flowers aging cream to tan ..... *Eriogonum robustum*

**Photographs and Line Drawings:** A line drawing of *Eriogonum robustum* by Peggy Duke was published in Mozingo and Williams (1980, p. 190, as *Eriogonum lobbii* var. *robustum*), and is reproduced in Appendix 2, Figure 1 of this report. Another line drawing of *E. robustum* by Lynette Wise was published in Tiehm and Williams (1978, p. 6). A line drawing of *E. lobbii* was published in Fauver and Steinbach (1992, p. 160), and is reproduced in Appendix 2, Figure 2 of this report for comparative purposes. Another uncredited line drawing of *E. lobbii* was published in Hickman (1993b, p. 877). An uncredited photograph of *Eriogonum robustum* was published in Osmond *et al.* (1990, plate 11.2, between pages 142-143). A photograph of *E. lobbii* by Michael Graf was published in Graf (1999, p. 217). Photographs of *Eriogonum robustum*, *E. lobbii*, and their habitats were also made for this report, are reproduced in Appendix 2, Figures 3-12, are filed with the Nevada Natural Heritage Program, and are available on its public web site at <http://www.state.nv.us/nvnhp>.

## V. SIGNIFICANCE OF TAXON

**Natural:** The many rare, geographically restricted, very similar and closely related forms specializing on unusual soil types in the genus *Eriogonum* suggest that evolution of these forms is relatively recent, rapid, and ongoing. As one of these forms, *Eriogonum robustum* may be a significant link in studies of evolution, biogeography, and autecology. It is extremely unusual in its complete restriction to highly acidic and nutrient-depleted soils. In these many of these habitats, *Eriogonum robustum* is virtually the primary contributor to soil formation and retention, nutrient cycling, and annual biomass production. The relatively large and showy masses of flowers seem to serve as an important source of pollen or nectar for insects in the region during the months of May and June. The species is also characteristic of a very specialized habitat from which much new information on plant physiologic and ecologic responses has been learned.

**Human:** No studies of medicinal or other qualities of potential human benefit are yet known to have been performed on *Eriogonum robustum*. As a member of the buckwheat family, *Eriogonum robustum* is closely related to crops such as buckwheat (*Fagopyrum*) and rhubarb (*Rheum*), as well as certain timber and ornamental species (Reveal 1989b). Some species of *Eriogonum* are reported to make excellent bee fodder (Hickman 1993b). Its demonstrated tolerance of harsh acidic soils and severe growing conditions at relatively high elevations make it a potentially valuable source of genetic material for use in enhancing existing crop varieties or in developing new varieties. The plant is aesthetically pleasing and of potential horticultural interest for rock gardens where appropriate soil conditions can be provided. Many other species of *Eriogonum* are already in the horticultural trade, and are easily grown from seed in well-drained soils (Hickman 1993b, Reveal 1989b).

## VI. GEOGRAPHIC DISTRIBUTION

**Geographic Range:** (Appendix 1, Tables 1-3; Appendix 3 maps). Globally, *Eriogonum robustum* has been documented from at least 131 sites in about 14 scattered groups, containing 265 total patches or stands, in the mountains and foothills surrounding the Reno-Sparks and Virginia City areas of western Storey County and southern Washoe County, Nevada, on Private (roughly 50.1%), Bureau of Land Management, Carson City District (BLM; 23.0%), Humboldt-Toiyabe National Forest, Carson City Ranger District (HTNF; 17.4%), Nevada Department of Transportation (NDOT; 6.4%), and County (3.1%) lands. Within HTNF lands, sites in the Mount Rose Wilderness Area comprise about 0.7% of the global population. At least 1-2 additional historical sites are now believed to be extirpated. The most distant two extant occurrences are separated by about 25 miles (40 km), and the number of extant occurrences is reduced to 25 if a 1 km minimum separation distance is imposed.

The hydrothermally altered habitat patches to which *Eriogonum robustum* is restricted occur in a band along and east of the eastern Sierra Nevada in eastern California and western Nevada, from the White Mountains in the south to Pyramid Lake in the north (Billings 1992, DeLucia and Schlesinger 1990). A number of these potential sites to the north and south of the presently known range of *Eriogonum robustum* have been surveyed floristically without finding the species (Billings and Nachlinger, unpublished field notes on file at the Nevada Natural Heritage Program). A few additional potential sites from north of Reno to the Peterson Mountain and Pyramid Lake areas were recently identified using soil survey data (U. S. D. A. Soil Conservation Service 1983, U. S. D. A. Natural Resources Conservation Service 1999), and the currently known range of the species could extend several miles farther north in Washoe County if any of these sites are found to be occupied by *Eriogonum robustum*.

**Precise Occurrences:** Site numbers and descriptions are given in Appendix 1, Tables 1-3. The tables cross-reference each site to its related maps and figures, as well as its most recent year observed and source(s) of documentation. The tables also show estimated areas and numbers of individuals for each site, along with elevations, apparent land management status, and types of impacts or threats. The site numbers given in Table 1 correspond to the element occurrence numbers for *Eriogonum robustum* in the databases of the Nevada Natural Heritage Program.

Information for a small number of the sites in Appendix 1 was compiled from other sources whose survey methods were not always exactly comparable to those used for this report. For all sites, numbers of individuals in smaller populations (less than about 200 individuals) were estimated by direct counting, and the areas, elevation ranges, and land management information given in Tables 1-3 were derived from the final mapped site boundaries. Threats and impacts were assessed from all available information, including but not limited to visual inspection on the ground, and association with mapped disturbances.

At all of the sites surveyed for this report, population boundaries were mapped at 1:24,000 scale to the greatest precision possible in the field, and later digitized into a Geographic Information System (GIS) database for analysis and map production. Counts for large populations were estimated by taking the average density of plants observed in several square-meter areas representative of the middle of the population, assuming that the density decreased uniformly (linearly) out to the edges of the population, and applying that adjusted density (about 0.25 of the average central density) to the entire mapped area of the population. Because they were extrapolated from very small, subjectively chosen density samples, these population estimates were probably accurate only to within half an order of magnitude at best, and were intended mainly to reflect relative population sizes among those surveyed in this way.

Three of the other surveys compiled herein (sites 48, 52, and 120) appeared to show less precisely mapped boundaries, with population sizes determined by direct visual estimation of total numbers of individuals. Such surveys probably overestimated surface area and underestimated individuals by significant amounts. Because of the uncertainties involved with all the survey methods, the rough percentages given above for each surface management category are averages of the percentages based on numbers of populations, total surface areas, and total population estimates for each category.

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:** (Appendix 1, Table 1)

Through the end of 1993, 29 occurrences of *Eriogonum robustum* had been documented or reported (sites 1-16, 18, 23, 28, 39, 71, 79, 86, 90, 111, 113, 117, 118, and 132), which are here considered to be the historical sites for this species. Historical documentation for 14 of these became known only after surveys for this report were complete. All but four of these (see further below) were subsequently rediscovered and further documented. The 25 known historical populations are now estimated to comprise 639,194 individuals in 65 separate patches or stands, covering about 290.63 acres (117.61 ha) of BLM, HTNF, NDOT, Private, and possibly County lands between 4410 and 7190 feet (1345-2190 meters) elevation. All other sites are considered new and are discussed below.

**New site(s) discovered:** (Appendix 1, Table 1) From 1994 on, 104 new populations were discovered and documented, comprising about 974,264 individuals in 200 separate patches or stands, and covering about 517.48 acres (209.42 ha) of BLM, County, HTNF, NDOT, and Private lands between 4540 and 7325 feet (1385-2230 meters) elevation. These sites included the first reports of the species from the Sierra Nevada, on the east slopes of the Carson Range in the Hunter Creek drainage.

**Historical site(s) searched for but not rediscovered:** The Gould and Curry Mill occurrence (site 9) was searched and found to be extirpated due to renewed disturbance of the site (see below). The current status of site 5 could not be determined due to lack of access. The locations of sites 6 and 15 could not be determined precisely from the historical records, and may correspond to other sites found and surveyed for this report. In reporting site 6, Larson (1978) described its location as "mine dump across road from Old Hospital (now the Art Center)." On her accompanying map, the only site shown that might have corresponded to this location is at the current coordinates for site 118, and these two locations may refer to the same site.

**Other site(s) searched where not discovered:** (Appendix 1, Table 3) Sites U01-U84, comprising over 1500 acres (607 ha) between 4360 and 7440 feet (1330-2265 meters) elevation in Lyon, Storey, and Washoe counties, Nevada, were surveyed for this report without encountering *Eriogonum robustum*. Another seven sites (U85-U91) containing potential habitat in western Nevada and eastern California were surveyed by W. Dwight Billings and Janet L. Nachlinger in the late 1980s (unpublished field notes on file at the Nevada Natural Heritage Program) without noting the presence of *Eriogonum robustum*. Because these workers were familiar with the species and noted its presence at numerous additional sites, it is presumed that these sites were not occupied by *Eriogonum robustum*. This is true also for two sites (P22, P34) that were identified as potential sites during preparation of this report (Appendix 1, Table 2). These were later found to have been surveyed by Billings and Nachlinger as well, without noting any *Eriogonum robustum*. An estimated 667.44 acres (270.10 ha) of potential habitat remains unsurveyed in western Nevada, and complete surveys could increase the population now known by up to about 25% (see Potential Sites below).

**Historical site(s) known or suspected to be erroneous reports:** No specific erroneous reports were detected in the historical record. Anecdotal reports of the species in Lyon County and Carson City appear to have been based on potential habitat, not actual sightings.

**Historical site(s) known or assumed extirpated:** The Gould and Curry Mill occurrence (site 9) in Virginia City was last reported extant by Larson (1978). This extensive area of old mine tailings was actively being re-worked in 1995 during surveys for this report. The entire area was observed to be severely impacted, and no evidence of remaining plants of *Eriogonum robustum* could be found. This site is therefore presumed extirpated. Large additional areas of suitable soils occur in and around Virginia City, major portions of which have been completely altered by past mining activities and/or current residential development. These impacts may have extirpated one or a few additional populations prior to their documentation.

Similarly, a few undocumented populations may already have been lost along the northern edge of the Reno-Sparks metropolitan area due to urban encroachment. Tiehm and

Williams (1978) reported that "a small population on the east side of Peavine Mtn (Ecology Canyon) was recently wiped out by a bull-dozer." The location of this site could not be determined with certainty, but it may be in a residential development adjacent to the northeast of extant site 53 (Appendix 3, Map 14).

Permanent habitat losses totaling 51.40 acres (20.80 ha) were also documented at 26 (20.2%) of currently extant sites during surveys for this report. This represents 6% of the total currently and previously known population area of *Eriogonum robustum*.

**Historical site(s) where present status unknown:** The status of three historical sites (5, 6, and 15; see Appendix 1, Table 1) could not be determined. See further discussion above under Historical site(s) searched for but not rediscovered.

**Potential site(s) meriting future field surveys:** (Appendix 1, Table 2). Some 28 sites (P1-P26 and P28-P29), comprising 186.58 acres (75.51 ha) between about 4560 and 6940 feet (1390-2115 meters) elevation, were identified through visual inspection as further potential habitat for *Eriogonum robustum*, but could not be visited during surveys for this report. Another 32 sites (P27, P30-P60), comprising 1923.44 acres (778.39 ha) between about 4205 and 6590 feet (1280-2010 meters) elevation, were identified after completion of field surveys by the use of recently-released digital soil survey data for Storey and southern Washoe counties, Nevada (U. S. D. A. Natural Resources Conservation Service 1999a, 1999b). All of these sites are in Storey and southern Washoe counties, Nevada.

Of the total occupied and unoccupied habitat area documented in this report, about 32% was occupied by *Eriogonum robustum*. Of the potential habitat identified using digital soil survey data, about 25% (480.86 acres, 194.60 ha) of the area is actually covered by the Smallcone soil type (U. S. D. A. Soil Conservation Service 1983, 1990), which is the type most correlated with *Eriogonum robustum* occurrences. Applying a 32% occupancy rate to the resulting 667.44 acres (270.10 ha) total acres of high-probability unsurveyed potential habitat remaining, an additional 213.58 acres (86.43 ha) of occupied habitat might be expected with exhaustive surveys. This would increase the currently known population by about 26%, and would suggest that surveys to date are about 79% complete.

## VII. HABITAT CHARACTERISTICS

**Environment and Habitat Summary:** (Appendix 2, Figures 6-9) *Eriogonum robustum* appears entirely restricted to shallow, rocky, highly acidic (pH 3.3-5.5) Smallcone soils derived from weathering of hydrothermal iron sulfide deposits formed mainly in andesite, and occasionally in rhyolitic or granitoid rocks. These soils are found mainly on dry, nearly barren ridges, knolls, and steep slopes on all aspects between 4410 and 7325 feet (1345-2235 meters) elevation. All but the driest and warmest sites support a sparse and stunted relict woodland mainly of Jeffrey and/or ponderosa pine (*Pinus jeffreyi* and/or *P. ponderosa*) and singleleaf pinyon pine (*Pinus monophylla*), with an equally sparse understory dominated or codominated at almost all sites by altered andesite buckwheat (*Eriogonum robustum*), fragile sandwort (*Arenaria nuttallii* ssp. *fragilis*), rabbitbrush (*Ericameria parryi* or *E. nauseosa*), squirreltail grass (*Elymus elymoides*), and western bluegrass (*Poa secunda* ssp. *secunda*). Other normally mesic montane conifer taxa are present occasionally in the woodland, and numerous additional shrubby and herbaceous taxa occur less frequently in the understory (Appendix 1, Tables 4a-b). Total areal cover of all taxa averages about 17%, but can exceed 30% at some sites.

## **Physical Characteristics:**

**Physiography:** The range of *Eriogonum robustum* 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 subtropical 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 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 northeast (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 *Eriogonum robustum* populations occur presently experience hot to warm dry summers and cold moist winters. Annual precipitation averages between about 8-24 inches (205-610 mm) water equivalent at most sites, but possibly up to 32 inches (815 mm) at Hunter Creek sites 127-128 in the Carson Range. Between about 15-50% or more of these amounts fall as snow, depending on the elevation. Some of the higher apparent precipitation amounts may be effectively reduced for *Eriogonum robustum* by the shallowness, 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 *Eriogonum robustum* sites average about 65-71°F (18-22°C) in July and 29-33°F (-2 to +1°C) in January. The years during which surveys were conducted for this report (1994-1996) had unusually cool and wet spring seasons.

**Geomorphology, aspect, and slope:** Populations of *Eriogonum robustum* occur on all aspects on a variety of landforms, including ridgelines, hilltops and low knolls, and very steep to nearly level slopes. The only common factor seems to be the presence of the appropriate soils. There is a slight tendency for populations to be denser or more extensive on their southwest to southeast aspects, possibly because of the sparser cover of other competing vegetation. The densest areas, though, were found on northwest to northeast exposures where no woodland overstory was present, perhaps due to optimal soil moisture conditions.

**Geology:** Most *Eriogonum robustum* sites appear to be underlain by Tertiary andesite of the Alta and Kate Peak formations (Billings 1992), although some sites were observed over rhyolitic or even granitoid rocks. The common denominator appears to be the presence of pockets of hydrothermal iron sulfide mineralization, probably of late Miocene origin (Billings 1992, DeLucia and Schlesinger 1990). Weathering of these sulfides to sulfuric acid at the surface forms the distinctive harsh soil type to which *Eriogonum robustum* is adapted and completely restricted (see below).

**Soils:** A GIS analysis of detailed (1:24,000) digital soil survey geographic (SSURGO) data (U. S. D. A. Natural Resources Conservation Service 1999a,b), versus the known extent of occupied *Eriogonum robustum* habitat, revealed that nearly all known populations occur on one of the three soil associations that contain the Smallcone soil and related types. In comparing descriptions of the Smallcone soil to field observations of *Eriogonum robustum* sites, it became clear that *Eriogonum robustum* is nearly restricted to this soil type or its immediate vicinity.

The Smallcone soil is described (U. S. D. A. Soil Conservation Service 1983, p. 114, 186) as:

*"very shallow and well drained. It formed in residuum derived dominantly from altered andesite. Typically, the Smallcone soil is very pale brown very gravelly sandy loam about 6 inches deep over hard altered volcanic bedrock. Depth to weathered andesite ranges from 4 to 10 inches. Permeability of the Smallcone soil is rapid. Available water capacity is very low. Effective rooting depth is 4 to 10 inches. Runoff is medium, and the hazard of water erosion is moderate. ... The present vegetation in most areas of the Smallcone soil is a sparse stand of Jeffrey pine with an extremely thin understory of big sagebrush, antelope bitterbrush, and bottlebrush squirreltail. ... Typically, 50 percent of the surface is covered with gravel."*

The typical pedon of Smallcone very gravelly coarse sandy loam is located within *Eriogonum robustum* site 85 (Appendix 3, Map 3), and is described (U. S. D. A. Soil Conservation Service 1983, p. 268) as:

*"[A1 horizon] 0 to 3 inches; very pale brown very gravelly coarse sandy loam, yellowish brown moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine interstitial pores; 45 percent pebbles; medium acid; clear smooth boundary. [C horizon] 3 to 6 inches; very pale brown extremely gravelly coarse sandy loam, yellowish brown moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine and medium roots; common very fine and medium interstitial pores; 50 percent pebbles, 10 percent cobbles, 5 per-*

cent stones; strongly acid; abrupt wavy boundary. [R horizon] 6 inches; weathered andesite with pockets of clay loam and roots in cracks; strongly acid. ... Bedrock is at a depth of 4 to 10 inches. Reaction is medium acid or strong acid throughout the profile. Texture from the surface to bedrock is sandy loam or coarse sandy loam. The profile is 5 to 15 percent clay and is 35 to 75 percent rock fragments."

The above was indeed descriptive of the soils at the vast majority of *Eriogonum robustum* sites surveyed. Even in the few exceptional areas, the common denominator remained the highly acidic soils that support a sparse and stunted woodland of *Pinus ponderosa* and *P. jeffreyi* to the exclusion of most of the surrounding sagebrush-zone species. The soil pH at these sites ranges between about 3.3 and 5.5 (DeLucia and Schlesinger 1990, Gallardo and Schlesinger 1996). Billings (1950, 1992) found that this was the result of iron sulfides, formed hydrothermally in the bedrock, weathering at the surface to sulfuric acid. The acid, in turn, leached most of the soil nutrients away or rendered them unavailable to plant uptake. The result was nearly barren, extremely harsh soil patches depleted in calcium and phosphorus and enriched in sulfate (DeLucia and Schlesinger 1990). The few species that could adapt to such conditions, including *Eriogonum robustum*, were thereby protected from competition with most other plant species of the surrounding vegetation.

**Hydrology:** *Eriogonum robustum* is not associated with free water, and is entirely dependent on incident precipitation and its retention in the soil. The soils supporting most *Eriogonum robustum* populations are shallow, well drained, and highly permeable, with low water holding capacity. Cracks and clay pockets in the near-surface bedrock, however, probably hold more available water for the roots of *Eriogonum robustum* to exploit. Slight increases in plant size and population density were sometimes noted where moisture-accumulating or moisture-retaining microsites, such as tree drip-lines, areas receiving road bed runoff, or unshaded northern exposures, 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 highways when otherwise left undisturbed.

### **Biologic Characteristics:**

**Community physiognomy:** *Eriogonum robustum* generally codominates a sparse herbaceous understory with a few other, mostly dwarfed perennial herbs and grasses, with most sites supporting a very sparse woodland overstory of montane conifer species, these forming patches between about 0.05-61 acres (0.02-25 ha) in size within the sagebrush and pinyon-juniper zones, and rarely within the shadscale or montane conifer forest zones, that characterize the low- to mid-elevation slopes of the transition area between the western Great Basin and the east slope of the Sierra Nevada.

**Vegetation type:** *Eriogonum robustum* is part of a unique, well-known, and long-studied vegetation type (Billings 1992) which nevertheless appears not to have been formally named and described as such. Floristically this type is characterized by an overlapping assemblage of endemic species and relict Sierra Nevada forest taxa supported by islands of highly acidic soil within zonal Great Basin sagebrush and pinyon-juniper vegetation, and less commonly within shadscale or montane coniferous forest vegetation. Most stands would comprise a new association within the Jeffrey pine - ponderosa pine series of Sawyer and Keeler-Wolf (1995), and could be termed "*Pinus ponderosa* - *Pinus jeffreyi* acid sparse woodland." Since no species appears to occur consistently on all such patches, though (the most consistent being *Arenaria nuttallii* ssp. *fragilis* and perhaps

*Eriogonum robustum*), a better name, consistent with the National Vegetation Classification System (NVCS; Anderson *et al.* 1998), might be "acid soil sparsely vegetated alliance." This would fit into the NVCS under VII.C.3.N.b.: Sparsely Vegetated Dry Soil Slopes.

**Associated plant species:** All associates observed at 24 *Eriogonum robustum* sites, along with their absolute and relative frequencies, are listed in Appendix 1, Tables 4a-b. The most frequent species associated with *Eriogonum robustum* were (in descending order): *Arenaria nuttallii* ssp. *fragilis*, *Ericameria* (including *Chrysothamnus*) *parryi* or *nauseosa*, *Pinus ponderosa*, *P. monophylla*, *Elymus elymoides*, *Poa secunda* ssp. *secunda*, *Pinus jeffreyi*, *Bromus tectorum* (an exotic only rarely exceeding 1% cover), *Eriogonum ochrocephalum* var. *ochrocephalum*, *Prunus andersonii*, *Amelanchier utahensis*, *Juniperus osteosperma*, *Eriogonum wrightii* var. *subscaposum*, *Eriophyllum lanatum* var. *integrifolium*, *Plagiobothrys glomeratus*, *Eriogonum strictum* var. *anserinum*, and *Penstemon speciosus*.

**Other endangered, threatened, and sensitive species:** At least 15 other sensitive plant and animal species are known in and near the range of *Eriogonum robustum*, and are listed in Appendix 1, Table 5. Six of these are documented to occur within or adjacent to *Eriogonum robustum* sites. Populations of *Eriogonum ovalifolium* var. *williamsiae* (a federal and state endangered species), *Ivesia webberi*, and *Plagiobothrys glomeratus* were encountered and documented during surveys for this report (Appendix 1, Tables 4a-4b, Appendix 3 maps). *Plagiobothrys glomeratus* is endemic to the same habitats as *Eriogonum robustum* (Arnold Tiehm, unpublished data). Once any pollinators of *Eriogonum robustum* become known, any that prove to visit this or other rare plant species exclusively could also be regarded as sensitive.

**Land Management:** (Appendix 1, Table 1) 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.

**Private lands:** Roughly 50.1% of the global *Eriogonum robustum* 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 *Eriogonum robustum* or its habitat. The region occupied by *Eriogonum robustum* includes the urban interface areas around Reno, Sparks, and Virginia City, and many patches of habitat have already been impacted by urban and residential development. A number of additional occurrences appear to be located on desirable homesites, and some were posted with real estate sale signs during surveys for this report. If the sterile, highly acid nature of the soils on these sites were advertised also, they would probably become much less desirable, but this does not yet appear to be common knowledge.

**Bureau of Land Management (BLM), Carson City District, U. S. Dept. of Interior:** About 23.0% of the global *Eriogonum robustum* 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. No known protective withdrawals currently apply to these lands. Nevada BLM actively pursues opportunities to exchange public lands for private lands to consolidate public holdings and simplify management. Nevada

BLM also pursues requests for sale of public lands into private ownership where such lands have been identified a suitable for disposal. Most lands so identified are found near existing urban areas such as the Reno-Sparks and Virginia City area, where many of the BLM populations of *Eriogonum robustum* are located.

Land exchange projects are of potential conservation benefit to *Eriogonum robustum*. The proposed LaBorde land exchange currently approved by BLM (U. S. D. I. Bureau of Land Management 2000) would transfer six partially or wholly private *Eriogonum robustum* sites in the Jumbo Falls, Cedar Hill Canyon, and Fivemile Flat areas of the Virginia Range (sites 2, 93, 109-112; 82.77 acres, 33.50 ha; 46260 estimated plants) into public ownership. In exchange, seven other wholly or partially publicly-held sites on the east flank of Red Hill on the north edge of Reno (sites 12, 42-46, 133; 21.81 acres, 8.83 ha; 85160 estimated plants) would be transferred into private ownership, but with deed restrictions that limit development and help maintain the area as open space (Pope, BLM Carson City, personal communication, November 2000). The exchange approval is currently under appeal, and its implementation is not yet certain. Exchanges and sales of public lands can also lead to losses of populations if the lands they occupy leave public ownership and become subject to development or other habitat losses. No recent such losses are yet known to have resulted from public-land disposals, but they remain a possibility. *Eriogonum robustum* is designated as a Sensitive Species by BLM, and this may reduce the likelihood that such losses would be approved.

Public lands in urban interface areas, such as those occupied by *Eriogonum robustum*, are also subject to increased threat of fire, and to aggressive suppression activities when fires occur.

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

**Dept. of Agriculture:** Roughly 17.4% of the global *Eriogonum robustum* population occurs on public lands managed by HTNF. Most of these lands are currently open to multiple uses, and overall management is similar to that for the BLM lands discussed above. Among the most popular uses harmful to *Eriogonum robustum* and its habitat is recreational off-road vehicle use. This has even affected the one HTNF site (#127) located within the Mount Rose Wilderness Area in Hunter Creek canyon. *Eriogonum robustum* is proposed for addition to the HTNF sensitive species list, and HTNF personnel are becoming aware of and interested in its management needs (Zamudio, several personal communications, 2000).

**Nevada Department of Transportation rights-of-way:** Roughly 6.4% of the global *Eriogonum robustum* populations are on, cut by, or adjacent to state road and highway corridors. Almost all of these are along Nevada highway 341 from Geiger Grade to just south of Virginia City. During a 1999 grading and maintenance project on Geiger Grade, NDOT personnel actively sought advice from the Nevada Natural Heritage Program for managing and protecting the species. A joint field reconnaissance resolved most issues and helped avoid or minimize project impacts. 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.

**County Parks:** Roughly 3.1% of the global *Eriogonum robustum* population occurs on or adjacent to Hidden Valley County Park in Washoe County and Virginia City Highlands County Park in Storey County. Pedestrian and equestrian recreation are the major habitat

uses associated with these parks, and have not yet significantly impacted any sites. Future development of park facilities is a more serious threat on these lands, and county personnel are not yet aware of the presence and management needs of *Eriogonum robustum* on park lands.

## VIII. BIOLOGY AND ECOLOGY

**Population Summary:** Based on the information gathered for this report, the total known global population of *Eriogonum robustum* was estimated to be 1,613,458 individuals, and to occupy about 808 acres (327 ha) of habitat divided among 129 sites in about 14 scattered groups, containing 265 total patches or stands, in the mountains and foothills surrounding the Reno-Sparks and Virginia City areas of western Storey County and southern Washoe County, Nevada, between 4410 and 7325 feet (1345-2235 meters) elevation. The most distant two occurrences are separated by about 25 miles (40 km), and the number of extant occurrences is reduced to 25 if a 1 km minimum separation distance is imposed. Based on the probable extent and occupancy rate of unsurveyed potential habitat, the true total population of *Eriogonum robustum* is estimated to be no more than 25% greater than now documented.

**Demography:** Long-term monitoring has not been conducted for *Eriogonum robustum* populations to determine demographic trends. Absence of the species from numerous apparently suitable sites provides circumstantial evidence that the species may have undergone population declines at least during prehistoric times, and/or that it may have limited ability to disperse and to establish new populations in unoccupied habitat.

The surface area covered by the root crown of each individual probably increases each year according to the resources available for new production and its ability to process those resources, providing a rough measure by which age classes could be separated within a population. There is no known way to precisely age an individual, however, or to compare age class distributions between different populations. The majority of plants at most populations assessed were mid-sized and at least several years in age. Most populations had between 5% and 30% of the largest size classes, with up to about 15% of the smallest (first year) sizes. Occasional populations had up to 70% of the largest size classes, or up to 25% of first-year plants. At least in undisturbed populations, plants of *Eriogonum robustum* appear to be moderately long-lived, with good apparent rates of recruitment of new individuals from seed.

From estimates of the total individuals within total occupied habitat (see population summary, above), an average density of 1883 plants per acre (4653/ha) can be estimated. However, individual site estimates ranged from about 8 plants per acre (20/ha; site 62) to about 23,529 plants per acre (58,141/ha; site 121; Appendix 1, Table 1), and the maximum density measured at site 58 was 23.2 plants per square meter, or about 93,888 per acre (232,000/ha).

**Phenology:** New leaves and flowering stems probably emerge soon after snow cover is gone and soil and air temperatures are sufficiently high. The years in which populations were surveyed for this report had relatively cold and wet springs, and emergence was delayed until early May, with flowers opening by late May and anthesis continuing through August at some sites. Depending on elevation and the annual timing of precipitation and temperature changes, flowering probably begins sometime between late April and early June and continues sporadically to sometime in August. The fruit probably mature by about 6-8 weeks after flowering, between mid June and mid October.

**Genetics:** No studies of the genetic structure in *Eriogonum robustum* are known. Most *Eriogonum* species appear to reproduce from seed produced by insect-mediated pollen exchange between flowers of the same or different plants. The inflorescence of *Eriogonum robustum* is particularly large and showy for a buckwheat, and flies and butterflies of several species were observed visiting its flowers in abundance during surveys for this report (Appendix 2, Figure 5). Morphologic variation within and among populations was observed to be relatively low, however, suggesting that *Eriogonum robustum* populations are probably only moderately diverse genetically. Several of the major concentrations of *Eriogonum robustum*, such as the Sixmile Canyon, Jumbo Falls, Hidden Valley, Washington Hill, Lockwood, Steamboat, and Hunter Creek areas are isolated enough from one another to generally preclude pollen or seed transport, and each area could have developed its own unique genetic makeup as a result. Some reproduction in *Eriogonum robustum* may also occur vegetatively by division of the root crowns, which would result in lower genetic diversity within populations. The abundance of seedlings and young plants observed at many sites, however, suggests that recruitment is largely from seed. If major disturbances or other impacts to *Eriogonum robustum* or its habitat become a critical threat to population viability in the future, the genetic structure of the species and its populations should be studied in order to guide the most effective possible conservation strategies.

**Reproduction and Dispersal:** No studies of reproduction or dispersal are known for *Eriogonum robustum*. As discussed above under Genetics, insect-mediated outcrossing is most likely the dominant reproductive mode in *Eriogonum robustum*. The large numbers of seedlings and young plants observed at many sites suggests that recruitment occurs largely or wholly from seed. Because its seeds fall enclosed by the light, papery flower parts, and because of the high winds prevalent in many of its sites, wind transport of seeds is probably the primary dispersal agent for the species, and occasionally may be capable of moving seeds up to a few miles. Gravity and water probably also play an important role in moving seeds downhill, permitting occupation of all suitable contiguous habitat nearby. Because the flowers and seeds form large masses above the ground, occasional capture and transport of seeds by birds or mammals may also occur.

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

**Pathology:** A rust fungus was observed heavily infesting the leaves of *Eriogonum robustum* at sites 118 and 119 (Appendix 3, Map 7). Both of these sites occurred on old stabilized mine dumps in Virginia City, and the rust was not noted at any other site in the vicinity. Other than the fungus infestation, these two sites appeared quite healthy with dense, robust plants. This suggests that some chemical factor in these particular mine spoils may be rendering *Eriogonum robustum* physiologically susceptible to infection, or possibly that the fungus itself is unable to survive on other soils. Beyond these two sites, no other disease affecting *Eriogonum robustum* has been observed or reported.

**Predation:** At a few sites, occasional plants were found with most or all of their main flowering stems missing (Appendix 2, Figure 10). The inflorescences had been clipped and left around the base of the plant, and the main stems had been clipped at the base and removed. No evidence was present to indicate the agent of this harvest. It may have been the result of selective herbivory, or possibly of birds gathering nesting material. The overall health of the plant did not appear affected by this stem harvesting. No other significant herbivory or other predation was observed at any other site. Rabbits and other native fauna probably graze the leaves and flowering stems on an occasional basis without significant impacts. A band of sheep moving directly across a population could cause significant predation impacts, but seems relatively unlikely due

to the sparse and (to sheep) unattractive vegetation. Impacts from cattle and wild horse use appear to result primarily from substrate disturbance rather than predation.

**Competition:** At all sites *Eriogonum robustum* was found only in open, often nearly barren plant associations where competition for light and moisture with other zonal species was minimal. It was absent from adjacent areas where deeper soils and taller, denser zonal vegetation had developed, and as noted by Billings (1992), the boundary between such habitats was frequently very sharp. The species did appear to compete moderately well with itself, with smaller plants and seedlings occurring in local densities up to about 25 per square meter on unshaded north exposures such as at site 58, where light and soil-moisture conditions were presumably optimal. This does not necessarily foretell its ability to compete with other species in the same habitat though.

DeLucia and Schlesinger (1990) hypothesized that *Eriogonum robustum* and its associates are excluded from the surrounding, more fertile soils by competition with other species for water, while other species are excluded from *Eriogonum robustum* habitat by physiologic intolerance of the extreme nutrient deficiency, primarily of phosphorus, found there. Gallardo and Schlesinger (1996) demonstrated the latter for sagebrush (*Artemisia tridentata*). The apparent preference of *Eriogonum robustum* for low-competition conditions, however, could also be a secondary effect of its physiologic dependence on the particular soil chemistry or other environmental condition(s) peculiar to its habitat. *Eriogonum robustum* has never been found in low-competition situations on other soil types, and to my knowledge no one has successfully cultivated the species on any other soil type.

**Response to Disturbance:** At several sites, *Eriogonum robustum* has been observed to colonize and reproduce on recent, recovering disturbances such as road banks and mine dumps. I have observed this to be true of many, if not most, rare plant species in the arid west, and this is often interpreted by some to suggest that the species in question is not threatened by habitat disturbance, but instead is able to survive or even thrive with continual disturbance. This is usually a misinterpretation of plant ecologic responses based on short-term observation.

Most rare plant species are rare because they are adapted to and depend upon rare habitat types. Many of these habitat types impose harsh growing conditions that exclude most other plant species, thus creating relatively low-competition conditions for the few remaining species that are able to adapt. Disturbance also creates a temporary low-competition situation of which rare species, already adapted to such conditions, frequently are able to take short-term, opportunistic advantage. Almost always, though, this is observed only if the disturbance occurs within or immediately adjacent to a source population occupying the rare soil or other habitat type that the species requires for long-term survival, and only when the disturbance is temporary and has begun to stabilize. Almost never has a rare plant species been observed to continue spreading onto disturbances farther outside its rare habitat type, or to persist where disturbance is severe and continuous. If rare species had the biologic and ecologic characteristics of invasive weeds, they would not now be rare. No plant population can withstand severe, uninterrupted disturbance of its habitat, and rare plants are no exception.

Thus, while *Eriogonum robustum* may be seen thriving for a few generations on disturbed sites, all my observations indicate that its long-term survival depends upon the continued availability of undisturbed or recovering altered andesite materials with low pH. *Eriogonum robustum* has never been observed spreading off such sites along disturbance corridors or into other low-

competition habitats. Permanent loss of plants is evident where disturbance has been continuous and severe, such as on roadbeds bisecting the habitat (Appendix 2, Figures 6-7).

**Other Interactions:** No other interactions have been noted.

## IX. EVIDENCE OF THREATS TO SURVIVAL

Causes of impacts and threats observed or reported for the known sites are summarized in Appendix 1, Table 1.

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

Permanent habitat losses totaling 51.40 acres (20.80 ha) were documented at 26 (20.2%) of currently extant sites during surveys for this report. This represents 6% of the total currently and previously known population area of *Eriogonum robustum*. Most of these losses had resulted from roads, off-road vehicle use, mineral exploration and development, urban and residential development, and water developments. All impacts observed are discussed in more detail below, in approximate order of greatest to least current significance.

**Road development and maintenance and off-road vehicle use:** Noticeable impacts from roads and off-road vehicle use were observed at 61 (47.3%) of the extant *Eriogonum robustum* sites. Nevada highway 341, the Virginia City Highway, cuts through numerous sites from Geiger Grade southeast to just past Virginia City. The Nevada Department of Transportation has been managing the highway right-of-way to avoid or minimize further impacts. However, the permanent habitat losses from this highway, and from the historic toll road paralleling Geiger Grade to the south, are already considerable. The open soils and ridgeline positions of many additional *Eriogonum robustum* sites have made attractive routes for numerous authorized and unauthorized roads and trails as well. Because of their proximity to the Reno-Sparks-Virginia City metropolitan area, these roads and trails are heavily used by recreational and off-road vehicle enthusiasts, creating and maintaining additional habitat losses at many sites. The viability of the great majority of these sites does not yet appear to have been compromised, but that possibility will continue as long as these uses remain widespread and unregulated.

**Mineral exploration and development:** Significant impacts from mineral-related activities were noted at 24 (18.6%) of extant sites. In discussing the specialized habitat of *Eriogonum robustum*, Billings (1992) noted that "because of their mineralization, almost all such altered-andesite outcrops have been prospected, and some have been mined." The historic Comstock Mining District encompasses large areas of such habitat in the Virginia City area, and the intense mining activities there in the past may have extirpated one or more populations prior to their documentation. Ongoing mining in the Bonanza Mine and Washington Hill areas of Storey County may also be impacting habitat. Several of the extant sites in the Virginia City area occur exclusively on old mine dumps, suggesting both that suitable habitat may have been mined and destroyed in creating those dumps, and that *Eriogonum robustum* is also highly resilient and can recolonize suitable soils when those soils are permitted to stabilize. *Eriogonum robustum* habitat throughout its range continues to have a high mineral development potential and will remain vulnerable to such development for the indefinite future. Because of provisions of the mining law of 1872 (30 U.S.C. 21 *et seq.*; see further below), mining-related impacts are nearly impossible to prevent without cooperation of the developers. Mineral development in most of the species' range has recently become much less likely, however, as urban and

residential areas have expanded, creating greater incompatibility with large mining operations.

**Urban and residential development:** Three (2.3%) of the extant sites were found to be significantly impacted by clearing and building activities. Because of the proximity of most known sites to urban and residential areas, numerous additional sites are threatened by habitat conversion, and some sites may already have been covered by development before any documentation of their existence. 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 *Eriogonum robustum*.

**Trash dumping:** Impacts from illegal dumping were observed at five (3.9%) of the extant sites. This did not appear to have compromised viability at any of these sites, but was symptomatic of the potential for more destructive impacts from other related activities.

**Utility corridor development and maintenance:** Five (3.9%) of the known extant sites were directly affected by above-ground or underground utility corridors. Overhead transmission lines are generally of minimal impact to *Eriogonum robustum* habitat, and the ground supports are easily located to avoid impacts. Pipelines and buried cables can be more destructive if their installation is not carefully conducted and mitigated. Perhaps most destructive can be the access roads required for subsequent maintenance, and the new access to habitat that such roads create. During the 6-year period this report was in preparation, the Nevada Natural Heritage Program reviewed three major utility corridor projects crossing the range of *Eriogonum robustum*.

**Animal grazing or trampling:** Significant trampling impacts from animal use were noted at two (1.6%) of extant sites. Many of the public and private lands occupied by *Eriogonum robustum* still appear open to livestock grazing, and virtually all are roamed by feral horses. The very sparse vegetation of most sites makes them relatively unappealing for grazing, but a band of sheep moving across a population could inflict substantial herbivory and trampling damage. The palatability of *Eriogonum robustum* to livestock has not been determined. The sparse tree cover of most sites makes them appealing shading areas for livestock to congregate, and for placement of salt licks and other supplements.

**Water development or diversion:** One population (site 39) has experienced a major permanent habitat loss from construction of a water tank facility and associated access roads just north of the Desert Research Institute in Reno. Several additional populations occupy sites that would be attractive for constructing such facilities in the future. See also below under Flooding.

**Fire and fire suppression activities:** A single extant population (site 123) was recently impacted by a wildland fire (K. Zamudio, personal communication, 2000) on Forest Service lands on Peavine Mountain. A few plants were scorched where they grew in pine litter. Recent fires have also occurred around *Eriogonum robustum* habitat in the Geiger Grade area. The vast majority of known habitat, however, has much too low of a fuel load to carry any kind of a ground fire that could kill buckwheat plants, and fire itself is not considered a significant threat to the species. Because of the proximity of most populations to urban interface areas, though, wildland fires are aggressively suppressed, and these suppression activities pose a much greater threat to *Eriogonum robustum*. For

the same reasons discussed above for roads, open habitats in ridge-line areas make convenient sites for staging and conducting fire suppression activities that can potentially destroy *Eriogonum robustum* habitat. The roads already cutting through many populations may have originated during such activities.

**Electronic site development and maintenance:** Topographic high points provide the locations required for communication receivers and transmitters, and this use with its associated maintenance roads and traffic dominate the Red Hill area (Appendix 3, Map 13). To date, no known *Eriogonum robustum* sites have been directly impacted by such uses, but several exist in potentially desirable locations.

**Recreational use:** So far, no significant impacts have been observed from non-vehicular recreational use of *Eriogonum robustum* habitat. It is a factor mainly near Hidden Valley County Park and Virginia City Highlands County Park, and future development of facilities to support recreational use poses a greater threat in these limited areas.

**Flooding:** The Steamboat Springs population (site 16) exists in a shallow drainage immediately downhill from Steamboat Ditch. This historic ditch breaches frequently, and a major breach or flood event upstream from this site could inflict major damage to this population. No other extant sites are known to exist in flood hazard areas.

**Invasion of exotic plant species:** Only minor covers of exotic plant species such as cheatgrass (*Bromus tectorum*) have been able to invade and establish within *Eriogonum robustum* habitat, and such invasions probably will never create a direct threat to any population of the species. By dramatically increasing the flammability of the surrounding vegetation, however, such invasions create indirect impacts by increasing the likelihood and frequency of fires and the need for the fire suppression activities discussed above.

**Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes:** The few scientific collections that have been taken to document populations (Appendix 1, Table 6) 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:** As discussed in more detail in the Pathology section on page 22, a rust fungus was observed fairly heavily infesting the leaves of *Eriogonum robustum* at two sites on old stabilized mine dumps in Virginia City. These two sites otherwise appeared quite healthy with dense, robust plants. At a few more sites, occasional plants were found with most or all of their main flowering stems clipped and missing (Appendix 2, Figure 10), and their inflorescences left on the ground (see Predation, page 22). This may have been the result of selective herbivory, or of birds gathering nesting material. The overall health of the plants did not appear affected by this activity either. Rabbits and other native fauna probably graze the leaves and flowering stems on an occasional basis without significant impacts. A band of sheep moving directly across a population could cause significant predation impacts, but seems relatively unlikely due to the sparse and (to sheep) unattractive vegetation. Impacts from cattle and wild horse use appear to result primarily from substrate disturbance rather than predation.

**Inadequacy of Existing Regulatory Mechanisms:** No enforceable protective designations, conservation agreements, or approved management plans are known to exist for *Eriogonum robustum* 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 (Forest Service, 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 Endangered Species Act 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.

The elimination of category-2 candidate status and tracking by the U. S. D. I. Fish and Wildlife Service (1996) removed a source of centralized and coordinated oversight for hundreds of species still considered potentially vulnerable, including *Eriogonum robustum*. Most of these species continue to be tracked and treated as sensitive by the Forest Service, the Bureau of Land Management, state natural heritage programs, and other agencies. The long term impact of this change remains unknown, but may be detrimental as agency policies and procedures go their separate ways, and budgets and priorities change. This could accelerate the need to list some former category-2 candidates as threatened or endangered over what would have occurred otherwise.

*Eriogonum robustum* is proposed for Sensitive Species status on the Humboldt-Toiyabe National Forest, and is already managed as such. U. S. D. A. regulation 9500-4 directs the Forest Service 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.*" Forest Service 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 *Eriogonum robustum* 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 Forest Service 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). Department regulation 9500-4 has the force of law at least until changed; specific provisions of written Forest Service policy implementing that regulation are of uncertain legal standing in specific cases.

U. S. D. I. Bureau of Land Management 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 *Eriogonum robustum* 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 *Eriogonum robustum* are known to exist, however, and the effectiveness of such plans would still depend upon adequate implementation and enforcement resources.

*Eriogonum robustum* 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, for either of which the current law does not provide. 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. Recently enacted regulations in Nevada Administrative Code (NAC) Chapter 527 greatly expanded and clarified the requirements and procedures for obtaining such a permit, and better ensured the long-term survival of state-listed plants in Nevada.

**Other Natural or Man-made Factors:** To the extent that *Eriogonum robustum* 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 *Eriogonum robustum*.

## X. GENERAL ASSESSMENT AND RECOMMENDATIONS

**General Assessment:** As now known, the global population of *Eriogonum robustum* consists of about 1,613,458 individuals restricted to about 808 acres (327 ha) of private and public lands divided among 129 sites in about 14 scattered groups, containing 265 total patches or stands, in the mountains and foothills surrounding the Reno-Sparks and Virginia City areas of western Storey County and southern Washoe County, Nevada, between 4410 and 7325 feet (1345-2235 meters) elevation. The most distant two occurrences are separated by about 25 miles (40 km), and the number of extant occurrences is reduced to 25 if a 1 km minimum separation distance is imposed. *Eriogonum robustum* is very closely related to *E. lobbii* Torrey & A. Gray, of which it has been considered a taxonomic variety by some workers. Recent investigations, and fieldwork for this report, support recognition of *E. robustum* as a separate species. At either taxonomic rank, however, it remains a distinctive genetic and geographic entity worthy of separate conservation concern. The species is entirely restricted to shallow, rocky, highly acidic (pH 3.3-5.5) Smallcone soils derived from weathering of hydrothermal iron sulfide deposits formed mainly in andesite, and occasionally in rhyolitic or granitoid rocks, on dry, nearly barren ridges, knolls, and gentle to steep slopes on all aspects. All but the driest and warmest sites support a sparse and stunted relict woodland mainly of ponderosa and/or Jeffrey pine. About 667 acres (270 ha) of potential habitat remain unsurveyed, and the true total population of *Eriogonum robustum* may be up to 25% greater than now documented.

If not for the significant existing, ongoing, and threatened impacts to many of its known populations, *Eriogonum robustum* would now be too abundant and widespread to warrant special conservation concern. For now the species remains vulnerable to human-caused extinction in the long-term as pressures from urban growth continue in the region surrounding Reno, Nevada. Significant impacts from one or more sources are known at 71 (54.2%) of the known and historic populations, although only one of these sites had been extirpated and the viability of most did not yet appear compromised. Permanent habitat losses totaling 51.40 acres (20.80 ha), however, were documented at 26 (20.2%) of these sites during surveys for this report. This represents 6% of the total currently and previously known population area of *Eriogonum robustum*. Most of

these losses had resulted from roads, off-road vehicle use, mineral exploration and development, urban and residential development, and water developments. 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:** Until recently *Eriogonum robustum* was classified (as *E. lobbii* var. *robustum*) as a category-2 candidate for listing by the U. S. D. I. Fish and Wildlife Service (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, and be reviewed and monitored frequently by, the U. S. Fish and Wildlife Service, however. If present trends continue, *Eriogonum robustum* will eventually meet the definition of a threatened species as its viability becomes compromised. 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, and federal and/or state listing could become justified if more than about 10-20% of the known populations were lost to preventable causes.

The species is also designated a Sensitive Species by the Bureau of Land Management, is ranked 2-3 (imperiled to vulnerable) at the global and state levels by the Nevada Natural Heritage Program, and is on the Watch list of the Northern Nevada Native Plant Society (NNNPS). Because of the relatively high local abundance of the species, its small geographic range, and its continued susceptibility to widespread habitat degradation and loss, 2-3 remains the most appropriate heritage rank for *Eriogonum robustum*. Because of its documented occurrences and degradation on National Forest lands, the Humboldt-Toiyabe National Forest should add *Eriogonum robustum* to its sensitive species list. If populations continue to be degraded or lost, the Nevada Division of Forestry should consider adding *Eriogonum robustum* to the Nevada list of critically endangered flora under Nevada Revised Statutes 527.270. No other changes in status are recommended.

**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, along with any additional acid-soil habitat contiguous with those populations within, and 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. Critical habitat should not be formally designated in cases where it might subject *Eriogonum robustum* 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 *Eriogonum robustum*, 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. If monitoring (outlined in recommendation 7) 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 counties of Storey and Washoe should, to the extent possible, incorporate the recommendations from this section into their planning and permitting processes, and should avoid planning decisions that would contribute to a trend toward state or federal listing of *Eriogonum robustum* as an endangered species.
2. The Bureau of Land Management (BLM) and the Humboldt-Toiyabe National Forest (HTNF) should pursue all available opportunities to bring additional privately held *Eriogonum robustum* sites into public ownership and management. Any publicly held sites conveyed into private ownership should include deed restrictions sufficient to prevent destruction of *Eriogonum robustum* and its habitat on those lands. Existing and newly acquired public sites should be considered for protective withdrawal as ACECs, RNAs, or other categories providing a conservation management and research emphasis.
3. BLM and HTNF should immediately pursue closure and barrier blockage of all unauthorized roads on their lands that impact or provide access to *Eriogonum robustum* sites, and should provide sufficient enforcement resources to ensure compliance. HTNF should pay particular attention to the Hunter Creek canyon site (127) where vehicle damage has occurred within the Mount Rose Wilderness Area boundary.
4. BLM and HTNF should plan any future road development and maintenance to avoid or minimize impacts to known populations. Roads should avoid known habitat, and impacts from grading or other maintenance activities should be contained within the existing roadbed.
5. HTNF should immediately add *Eriogonum robustum* to its list of sensitive species, and manage it accordingly for all future project planning and implementation.
6. The U. S. Fish and Wildlife Service (USFWS), BLM, HTNF, the Nevada Department of Transportation (NDOT), and the counties of Storey and Washoe, should cooperatively develop, implement, and adequately fund a long-term species management plan and conservation strategy for *Eriogonum robustum*, to address at a minimum all the other recommendations above and below. The strategy should also include a public education component to increase awareness of the significance of *Eriogonum robustum* and its habitat. Participants should share implementation costs proportionately to their management responsibilities.
7. BLM, HTNF, USFWS, and any other parties interested in participating, should cooperatively field-check as many *Eriogonum robustum* 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. If extirpations or new significant impacts become likely for more than 10% of the known populations, yearly monitoring efforts should be initiated.
8. Studies of pollinator populations, and their effectiveness in the reproductive success of *Eriogonum robustum*, should be encouraged and supported. If found to play a significant role, pollinators should be monitored on the same schedule as *Eriogonum robustum* to detect any downward trends that could contribute to reproductive failure in *Eriogonum robustum*, and the cause(s) and possible remedies of any such declines should be assessed.

9. BLM, HTNF, and the Nevada Division of Forestry (NDF) should plan future fire-suppression actions and strategies, including identifying potential sites for fire breaks, access roads, landing pads, etc., to avoid or minimize impacts to known *Eriogonum robustum* populations and other sensitive resources.
10. BLM, HTNF, NDOT, and Storey and Washoe counties should aggressively manage and control invasions of exotic weeds within the range of *Eriogonum robustum*, 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 *Eriogonum robustum* habitat, and increasing public safety.
11. Any future artificial revegetation actions in and near the range of *Eriogonum robustum* should only use plant species native to the local area. HTNF, BLM, NDF, 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. NDOT should continue to manage and maintain their rights-of-way carefully to avoid or minimize any further impacts to *Eriogonum robustum* and its habitat. Any new road corridors should be planned to avoid this and other sensitive habitats.
13. The parks departments of the counties of Storey and Washoe should plan existing and new recreational facilities, patterns, and uses carefully to avoid or minimize impacts to *Eriogonum robustum* and its habitat, and to take advantage of interpretive opportunities for same.
14. All appropriate entities should aggressively manage wild horse populations and domestic livestock to avoid or minimize trampling impacts in *Eriogonum robustum* habitat.
15. When no longer of use, the Steamboat Ditch should be decommissioned and drained to eliminate further flooding impacts to *Eriogonum robustum* and other sensitive resources.
16. If impacts to populations on non-federal lands begin significantly impacting species viability, the Nevada Division of Forestry should add *Eriogonum robustum* to the Nevada list of critically endangered flora under NRS 527.270, and should act to minimize further impacts through landowner contacts, through its permitting process, and if necessary through law enforcement actions.

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### **Map Sources:**

#### USGS 1:24,000 scale Topographic Series:

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Chalk Hills, Nevada (1967, photorevised 1982, minor revision 1993)  
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Fraser Flat, Nevada (1980)  
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Carson City, Nevada (1979)  
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Carson City, Nevada (1996)  
Reno, Nevada (1990)

**Field Research:** Field surveys for this report were conducted from 20 May to 10 June 1994, from 1 June to 29 June 1995, on 21 September 1995, and on 12 July 1996 by James D. Morefield, Nevada Natural Heritage Program.

**Specimens:** All specimens known to document *Eriogonum robustum* sites are listed by site in Appendix 1, Table 6. 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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