Current Knowledge and Conservation Status of *Eriogonum lewisii* Reveal (Polygonaceae), the Lewis buckwheat.

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SUMMARY: *Eriogonum lewisii* was first discovered by Mont E. Lewis at what would become its type locality on White Elephant Butte in the Elk Mountains of north-central Elko County, Nevada. Reveal collected the type specimen from the same site in 1976 and named it as a new species in 1985. It is a mounded or matted perennial herb with crowded grayish basal leaves, leafless flowering stems to 15 cm high, and dense yellow balls of flowers. *Eriogonum lewisii* remains endemic to north-central Elko County and northern Eureka County, Nevada, in the Bull Run, Independence, and Tuscarora Mountains and the Jarbidge Mountains complex. A report from Box Elder County, Utah was later retracted. *Eriogonum lewisii* intergrades with *E. desertorum* where the two taxa overlap northwest of the Humboldt River, and appears to be a taxonomic variety of that species or of *E. brevicaule*. As a variety, however, it remains a distinctive genetic and geographic entity worthy of separate conservation concern.

As of the end of 1993, *Eriogonum lewisii* was known from 11 populations in the Independence and Jarbidge Mountains complex between 6960 and 9720 feet (2120-2960 meters) elevation. Four of these sites were within about 3 km of an active and expanding open-pit gold mining operation, and most had already been impacted by road-building, livestock trampling, fire suppression activities, and mineral exploration. Because of these impacts and its rarity and continued vulnerability, *Eriogonum lewisii* was designated a category-2 candidate for federal listing on 21 February 1990. Responding to this concern, the U. S. Fish and Wildlife Service, Nevada Natural Heritage Program, and Humboldt-Toiyabe National Forest sponsored and conducted extensive field surveys in 1991-1995 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 and recovery 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 lewisii* by 22 populations (200%) and 84.9 acres (34.4 ha; 256%). As now documented, *Eriogonum lewisii* is known worldwide from 33 populations in about 10 scattered areas, totalling roughly 665,000 plants and covering about 118 acres (47.8 ha) of National Forest (73.0%), private (21.9%), Bureau of Land Management (5.1%), and Elko County (0.1%) lands between 6470 and 9720 feet (1970-2960 meters) elevation. *Eriogonum lewisii* was restricted to dry, open, convex ridge-line knolls and crests underlain by siliceous carbonate rock types on all aspects. The habitat supports a sparse to moderately dense vegetation usually dominated or codominated by *Eriogonum lewisii* in association with low sagebrush, green rabbitbrush, squirreltail grass, and indian ricegrass. Recent surveys focusing on about 15,000 acres (6070 ha) of additional potential habitat in western Elko County have revealed no further populations of *Eriogonum lewisii*, but at least 8900 acres (3600 ha) of potential habitat remain unsurveyed. Because of the remaining potential for undiscovered populations, and the uncertain taxonomic boundaries, the true global population of the species is estimated to be 1.5-4 times larger than that now documented.

The ridge-line habitat of *Eriogonum lewisii* makes the sites convenient and attractive for access roads, off-road vehicle use, livestock supplementation and resultant trampling, transmission facilities, and

fire suppression activities, and also makes populations vulnerable to rapid climatic warming. Most of the species' range 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 22 (66.7%) of the known populations, although the viability of most did not yet appear compromised. Without these impacts and threats, *Eriogonum lewisii* would probably now be too widespread and common to merit conservation concern. *Eriogonum lewisii* is capable of recolonizing moderate disturbances within its specific habitat if adjacent undisturbed populations remain to act as a source, but appears incapable of surviving severe or sustained disturbance, or of spreading to other habitats on disturbed or undisturbed substrate. The species likely depends on insect pollinators for at least part of its reproductive success, but nothing is known about the identity, specificity, rarity, status, current effectiveness, and viability trends of these pollinators. Currently *Eriogonum lewisii* is managed as a "sensitive species" by the U. S. Forest Service and the Bureau of Land Management, but has no other legal status or protective designation.

Based on the best available scientific evidence, *Eriogonum lewisii* 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 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 and recovery measures which, if successfully implemented, offer the best chance to eliminate any future need to list *Eriogonum lewisii* as threatened or endangered. Primary among these are long-term monitoring, continued surveys of potential habitat, development of cooperative management plans, restrictions on placement of livestock supplements, careful design and mitigation of any future roads, electronic sites, fire suppression sites, and mineral exploration or development 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 lewisii* Reveal (1985a, p. 277).

Type Specimen: NEVADA, Elko County: White Elephant Butte, south of Elk Mountain, on a steep, open, gravelly slope, associated with *Cercocarpus* and *Senecio*, T46N R61E S4, 2530 m (8300 ft), 30 July 1976, *J. L. Reveal & C. G. Reveal 4596* (holotype: US; isotypes: BRY, CAS, F, GH, MARY, MEXU, MICH, MO, NY, OKL, RENO, RSA, TEX, UC, UTC 165417) (Reveal 1985a, Smith and Curto 1995, Tiehm 1996).

Synonym(s): No synonyms or synonymy are known to have been proposed for *Eriogonum lewisii*.

Vernacular Name(s): Lewis buckwheat.

Family: Polygonaceae (buckwheat family).

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

Review of Alternative Taxonomic Treatments: While discussed as a distinct species for purposes of this report, *Eriogonum lewisii* and its apparent closest relative, *E. desertorum* (Maguire) R.J. Davis, appear instead to be only varietally distinct from each other and possibly from Welsh's (1984) *Eriogonum brevicaule* Nuttall complex, particularly var. *laxifolium* (Torrey & A. Gray) Reveal. Nevertheless, the strong correlation between its restricted geographic distribution and its usually distinctive morphology suggests that *Eriogonum lewisii* is a genetically significant variant worthy of separate recognition within this group of taxa, and is therefore an appropriate subject for conservation management.

In preparing a treatment of Polygonaceae for Utah, Welsh (1984) reduced several species previously recognized by the acknowledged monographer for *Eriogonum*, James L. Reveal, to varieties of *Eriogonum brevicaule*, noting that:

> "*The brevicaule complex typifies the problematical nature of interpretation of perennial members of the genus. Floral morphology is sufficiently reduced and uniform as to lack definitive diagnostic criteria in most instances. Inflorescence structure is only somewhat more useful, but is often variable within a population, ranging from capitate to branched. Flower color is useful in a general sense only, often varying from white to yellow or even pink within a population. Pubescence appears, at first, to be of substantial value, but the use of this criterion fails also. The attempt here is to bring together those members of the group as they occur in Utah . . . [and] should be regarded as tentative at best.*"

This included the one taxon with which *Eriogonum lewisii* appears to intergrade, *E. desertorum*, which he recombined as *E. brevicaule* var. *desertorum* (Maguire) Welsh. Welsh observed that part of the wide variation found in the *Eriogonum brevicaule* complex resulted from local hybridization with *E. corymbosum* Bentham, *E. lonchophyllum* Torrey & A. Gray, *E. microthecum* Nuttall, and possibly others. Only *Eriogonum desertorum* appeared to be involved in the variation observed in a few *Eriogonum lewisii* populations during surveys for this report.

Reveal (1989b) published a taxonomic summary of the subfamily Eriogonoideae as he then understood it, in which he appeared to reject Welsh's (1984) treatment of *Eriogonum brevicaule* without comment. He maintained *Eriogonum lewisii*, *E. desertorum*, and many other relatives of the *E. brevicaule* complex as distinct species, but offered no alternate explanation for the patterns of variation and intergradation observed by Welsh. At the same time, Reveal (1989a) segregated and named three more species, one with three varieties, related to the *Eriogonum brevicaule* complex and formerly included in *E. chrysops* Rydberg. He admitted that the differences separating the new taxa were slight, but based their recognition on being "geographically isolated and locally consistent." This combination of criteria for separating species (with which I agree while noting that it could apply equally well to some of Reveal's varieties) was probably the basis for recognition of *Eriogonum lewisii*, but now no longer appears to apply to that taxon. As discussed further below, several populations now appear to intergrade between *Eriogonum lewisii* and *E. desertorum*. Of particular note are the extensive Charleston road summit populations (sites 22-23) surveyed for this report, which contain roughly equal proportions of forms assignable to both taxa, along with an even larger number of intermediates (appendix 1, table 1; appendix 2, figures 6-7; appendix 3, map 10).

Welsh (1984) separated *Eriogonum brevicaule* var. *desertorum* from other varieties of the species by its flat or slightly curled, non-revolute leaf margins, unbranched capitate inflorescences, and strict absence of leaves on the stems above the caudex, but also noted that most of these features occur in various combinations in var. *laxifolium*. Reveal (1985a) compared *Eriogonum lewisii* most closely to *E. desertorum*, from which it differed by its higher elevation ridge-top habitat, smaller leaf blades, subtle differences in flower cup texture, and sparser cobwebby hairs on the flowering stems and flower cups which, on the flowering cups, was restricted to the lobes by late anthesis. He also compared it to *Eriogonum brevicaule* var. *laxifolium* in Utah and Idaho, which had much narrower leaves relative to their length, capitate or branched inflorescences, and denser tomentose hairs on the involucres as in *E. desertorum*. He did not discuss criteria separating *Eriogonum desertorum* from *E. brevicaule*, and apparently was not aware of populations intermediate between any of these three taxa in 1985 or 1989.

Smith and Curto (1995) essentially agreed with Welsh (1984) that the various taxa related to *Eriogonum brevicaule* exhibited too much overlap in diagnostic character states, both within and among populations, to regard them as separate species. They included in their analysis *Eriogonum lewisii* and a number of additional taxa from outside Utah that Welsh

did not consider, and concluded that *E. lewisii* and its relatives might best be "lumped" into *E. brevicaule*, though they did not suggest whether varietal status might be appropriate. They examined specimens of the various taxa at the herbaria of Utah State University (UTC) and the Humboldt-Toiyabe National Forest, noting several specimens labeled *Eriogonum desertorum* but exhibiting characteristics of *E. lewisii* and possibly representing populations intermediate between the two (appendix 1, tables 2 and 6, site 22 and potential sites P14, P17, P19, P20).

Smith and Curto (1995) also analyzed the major characters used to distinguish species in the *Eriogonum brevicaule* complex, noting that many of the quantitative measurements, particularly lengths of involucres and perianths, frequently exceeded the limits usually found in the literature. This agrees with my observations as well, although part of the problem in using perianth length may result from the need to measure it at anthesis, after which it often elongates by 0.5-1 mm. Smith and Curto also observed that each of the major qualitative characters exhibited multiple character states in at least one taxon (for example, stem hairs varying from glandular to cobwebby to absent within *Eriogonum ochrocephalum* S. Watson), concluding thereby that these characters were of no diagnostic value anywhere else in the complex. I disagree that variability of a character in one taxon necessarily invalidates that character as a diagnostic tool for other related taxa. Characters cannot be evaluated in isolation, but instead must be viewed in correlation with all other characters for each taxon. Unique, discrete combinations of character states, particularly when correlated with geographic and/or ecologic isolation, strongly imply the presence of distinct species, even when some of the same character states vary or occur in different combinations in other taxa.

Otherwise, my field observations, along with examination of specimens in the herbaria at the University of Nevada in Reno (NESH and RENO) and the Nevada State Museum (NSMC), forced me to the same conclusion as Smith and Curto (1995) that *Eriogonum lewisii* is not a distinct species. I also noted specimens apparently representing populations intermediate between *Eriogonum lewisii* and *E. desertorum* (appendix 1, tables 2 and 6, site 22 and potential sites P15, P16 and P18), along with one collection of *E. brevicaule* var. *laxifolium* possibly intermediate with *E. lewisii* (potential site P13). The specimens I saw from Elko County and adjacent areas appeared to represent three different taxa, as Smith and Curto (1995) also observed. All higher-elevation specimens from about the east third of the county appeared to be a phase of Welsh's (1984) *Eriogonum brevicaule* var. *laxifolium*, characterized by dense silvery-gray pubescence and linear to oblong-elliptic leaf blades all with strongly curled, revolute margins. This apparently does not intergrade with the other two taxa except possibly at potential site P13. Smith and Curto (1995) also noted variation approaching *Eriogonum brevicaule* var. *laxifolium* at site 22, but I did not detect any during surveys for this report. Lower-elevation forms on volcanic ash/clay slopes from about the southeast half of the county mainly fit *Eriogonum desertorum*, exhibiting dense silvery-gray pubescence and broadly elliptic to ovate, obovate, or nearly circular leaf blades mostly 15-30 mm long with margins all flat or a few slightly curled. Higher-elevation forms on carbonate ridge lines from about the northwest third of the county mainly fit *Eriogonum lewisii*, with sparser greenish-gray pubescence and leaf blades like *E. desertorum* except mostly less than 15 mm long.

Populations intermediate between *Eriogonum lewisii* and *E. desertorum* are found mainly in the northeast-southwest band of overlap between the two taxa, from the bases of the Tuscarora and Independence Mountains and the Jarbidge Mountains complex south and east to just south of the Humboldt River trend. The various intermediate specimens corresponded with *Eriogonum lewisii* in having sparse, greenish-gray pubescence (site 22, potential sites P13, P16, and P18), or in small leaf blade size (site 22 [about 25% of plants], potential site P15). The specimens from potential site P15 also resemble *Eriogonum argophyllum* in some respects, and James L. Reveal (personal communication, 24 September 1996) believes they may represent a variant related to *E. kingii* Torrey & A. Gray. The duplicates I saw of the specimens cited by Smith and Curto (1995) from potential sites P14 and P17 appeared to match *Eriogonum desertorum* in all respects.

In conclusion, I agree with Smith and Curto (1995), although not for all of the reasons they gave, that the available character data do not demonstrate a sharp boundary between *Eriogonum lewisii* and other related taxa, as also noted by Welsh (1984) for other members of the *E. brevicaule* complex. It appears to represent a good variety, maintaining its geographic and ecologic isolation and a unique syndrome of morphologic character states in most populations, but sometimes intergrading with characteristics of *Eriogonum desertorum*, particularly at the Charleston road summit populations (sites 22-23) and potential sites P14-P20. If *Eriogonum desertorum* can eventually be defended as a species distinct from *E. brevicaule*, *E. lewisii* probably would best be treated as a northwestern, high-elevation variety within *E. desertorum*. Otherwise, it should probably be considered a variety of *Eriogonum brevicaule*. Carefully correlated morphometric, genetic, and geographic data are needed to determine the best taxonomic treatment for these taxa.

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 1989c). 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 lewisii*, are known to exist. Within the genus, *Eriogonum lewisii* is placed in the subgenus *Eucycla* Nuttall (Reveal 1985a, 1989c), a complex group of sometimes intergrading perennial species with many narrow endemics scattered throughout the interior western United States, many specializing on volcanic ash/clay and/or calcareous ridge-line habitats. In his treatment of *Eriogonum* for Nevada, Reveal (1985b) placed *Eriogonum lewisii* in sequence between *E. prociduum* Reveal and *E. crosbyae* Reveal, two northwestern Great Basin endemics to which it bears close resemblance, but compared it most closely to *Eriogonum desertorum* and *E. brevicaule* var. *laxifolium* in his original description (Reveal 1985a). In his checklist of subfamily Eriogonoideae, Reveal (1989b) placed *Eriogonum lewisii* in sequence between *E. desertorum* and *E. ochrocephalum*.

Field observations for this report suggest that *Eriogonum lewisii* probably shares its most recent ancestry with, or is currently diverging from, *E. desertorum*, and that both may have originated from forms ancestral to *E. brevicaule* var. *laxifolium*. The rampant and rapid range fragmentation and isolation, habitat specialization, and speciation apparently ongoing in subgenus *Eucycla*, as long-term climatic fluctuations continue throughout its range, make it impossible to speculate further as to the more ancient origins of *Eriogonum lewisii* and its relatives.

II. TAXON HISTORY

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

pre-1976: Discovered and first collected at the eventual type locality by Mont E. Lewis.

1976: Type specimens collected in the Elk Mountains at White Elephant Butte by the Reveals on 30 July (Reveal 1985a).

1980: First collected in the Independence Mountains above Mahala Creek by Tiehm and Birdsey on 12 August.

1984: Welsh (1984) treated its closest relative, *Eriogonum desertorum*, as *Eriogonum brevicaule* var. *desertorum*.

1985: Formally described as a distinct species by Reveal (1985a), who reported it in error from Box Elder County, Utah.

1987: Included and recognized in Kartesz's (1987) flora of Nevada, based on Reveal (1985b).

1989: Treated as a distinct species in Reveal's (1989b) checklist of Eriogonoideae, who appeared to reject Welsh's (1984) treatment without comment.

1990: Designated a category-2 candidate for listing under the Endangered Species Act on 21 February (U. S. D. I. Fish and Wildlife Service 1990).

1991: Designated a sensitive species by the Humboldt National Forest (Anderson *et al*. 1991).

1992-1995: Surveys conducted by Humboldt-Toiyabe National Forest (HTNF), Nevada Natural Heritage Program (NNHP), and Smith and Curto (1995).

1995: Independence Mining Co., Inc., proposed gold exploration and open-pit mining operations immediately adjacent to the Mahala Creek populations (sites 2, 4-6) (Bell 1995, Warder and Anderson 1995, White 1995).

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).

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, 1 being the most vulnerable and 5 the most secure. *Eriogonum lewisii* was most recently ranked 1 by the Nevada Natural Heritage Program at all levels (Morefield and

Knight 1992). The results of this report show 3Q to be the more appropriate rank at all levels (the "Q" indicating its uncertain taxonomic status).

Federal: Until very recently *Eriogonum lewisii* was designated 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 as threatened or endangered is possibly appropriate, but for which sufficient data on biological vulnerability and threats are not currently available to support proposed rules*" (U. S. D. I. Fish and Wildlife Service 1993). Use of that category has been discontinued by the U. S. D. I. Fish and Wildlife Service (1996). *Eriogonum lewisii* is on the sensitive species lists of the U. S. D. A. Forest Service Region 4 (Anderson *et al*. 1991) and the U. S. D. I. Bureau of Land Management (1996). This report recommends no changes to these designations.

State: No formal status has been designated at the state level. *Eriogonum lewisii* is on the Northern Nevada Native Plant Society's Watch list (Morefield and Knight 1992). This report recommends no changes to this designation.

IV. DESCRIPTION

Non-technical: Herbaceous, perennial, compact to slightly spreading mats or mounds to 4 dm across and 1.5 dm high; **root crown** much-branched, woody, arising from a stout, gnarled taproot; **overall color** greenish-gray with bright- to pale-yellow balls of flowers, the whole plant becoming reddish-tinged late in the season. **Stems** annual, up to about 150, upright, rounded, unbranched, leafless above base, to 10(-15) cm long, slender, hairs tufted, cobwebby. **Leaves** annual, many in crowded circles at base, upright to lying flat, unlobed; **stipules** none; **leaf stalks** 8-20 mm long, woolly; largest **leaf blades** football- to egg-shaped, 10-15 × 4-7 mm, thickened, edges smooth and flat or slightly curled-under through < 140°, surfaces grayish woolly, hairs of upper surface thinning with age, becoming cobwebby and appearing greener. **Flower groups** 1 at each stem tip, dense, ball-shaped, about 1 cm across; **flower cups** about 3-6 per group, stalkless, conic to bell-shaped, 2.5-3 × 2-2.5 mm, thickened, stiff, hairs outside scattered, cobwebby (only near teeth in age), inside none, teeth at tip 5, pointing outward, 1-1.5 mm long, flower stalks extending well outside the cup. **Flowers** (May-July) each with male and female parts, about 30-100 per stem, upright to pointing downward, jointed to stalk and falling together with the mature fruit, bright to sometimes pale yellow, reddening outward from the middle veins with age, radially symmetric, narrowly bell-shaped, base above joint broadly and evenly tapered to rounded; **flower parts** remaining attached after opening, 6, in 2 circles of 3, united into a tube in the lower ¼, narrowly oval, all about the same size and shape, (2-)2.5-3 mm long when first open, up to 3.5 mm long in early fruit, papery, smooth, hairless; **stamens** 9, extending far outside the flower, falling off in fruit, stalks 3-4 mm long, hairy at base, anthers yellow, oval, 0.4-0.5 mm long; **ovary** attached above the surrounding flower parts, 1-chambered, **styles** 3. **Fruit** (June-August) dry, hard, enclosed by and falling with the flower parts, light brown, 3-3.5 mm long, base narrow, rounded, apex long, tapered, 3-angled, minutely bristly. ***Chromosome number*** unknown, probably derived from a multiple of 10 or 20 [modified from Reveal (1985a, 1989c)].

Technical: Herbaceous, perennial, compact to slightly spreading mats or mounds to 4 dm across and 1.5 dm high; **caudex** much-branched, woody, arising from a stout, gnarled taproot; **overall color** greenish-gray with bright- to pale-yellow heads of flowers, the whole plant becoming reddish-tinged late in the season. **Stems** annual, up to about 150, erect, terete, simple, scapose, to 10(-15) cm long, slender, floccose. **Leaves** annual, many in crowded basal rosettes, erect to spreading, simple; **stipules** none; **petioles** 8-20 mm long, tomentose; largest **blades** broadly elliptic to ovate or obovate, 10-15 × 4-7 mm, thickened, entire, planar or margins of some slightly revolute through < 140°, grayish tomentose, upper surface with age thinning to arachnoid to floccose and appearing greener. **Inflorescence** dense, capitate, subglobose, ca. 1 cm; **involucres** ca. 3-6, sessile, turbinate-campanulate, 2.5-3 × 2-2.5 mm, thickened, rigid, floccose without (only distally in age), glabrous within, lobes 5, spreading, 1-1.5 mm long, pedicels exserted. **Flowers** (May-July) bisexual, ca. 30-100, erect to deflexed, jointed to pedicel and falling together with the mature fruit, bright to sometimes pale yellow, reddening outward from the midribs with age, radial, narrowly campanulate, base above joint broadly cuneate to truncate; **tepals** persistent, 6, in 2 whorls of 3, basally connate about ¼ their length, oblong, about equal, (2-)2.5-3 mm long at anthesis, up to 3.5 mm long in early fruit, papery, smooth, glabrous; **stamens** 9, long-exserted, deciduous in fruit, filaments 3-4 mm long, pilose basally, anthers yellow, oblong, 0.4-0.5 mm long; **ovary** superior, of 3 united carpels, unilocular, **styles** 3. **Fruit** (June-August) an achene enclosed by and falling with the perianth, light brown, 3-3.5 mm long, base narrow, subglobose, apex long, tapered, 3-angled, minutely bristly. ***n*** unknown, probably based on $x = 10$ or 20 [modified from Reveal (1985a, 1989c)].

Field Characters: *Eriogonum lewisii* is distinguished by its combination of perennial, mounded or matted growth form; smooth hairless yellowish flowers 2-3 mm long forming a tight ball at the tip of each leafless, unbranched stem, the 6 flower parts of about equal size and shape; sparse cobwebby hairs on the stem and on the 3-6 thick, rigid flower cups; greenish-gray, entire, broadly elliptic to rounded leaf blades less than 15 mm long and 8 mm wide with flat or slightly curled edges. The following artificial, idealized key is synthesized mainly from Hickman (1993b), Reveal (1985a, 1985b, 1989a), and Welsh (1984), and will separate typical *Eriogonum lewisii* from typical members of similar or co-occurring taxa. Specimens for which the key is ambiguous may represent intergradient populations:

1. Plants annual *or* shrubby *or* not forming mounds or mats *or* flowering stems leafy or branched above base *or* flowers in 2 or more groups on each stem *or* flower cups 1 per flower group
   ..... ***Eriogonum brevicaule, caespitosum, douglasii***, etc.
1' Plants perennial, forming mounds or mats, not shrubby; flowering stems leafless, unbranched; flowers in a single tight ball of (2-)3-10 flower cups at stem tip.
   2. Flowers with non-glandular hairs outside *or* flower parts of two distinct sizes
      ..... ***Eriogonum ovalifolium, shockleyi, villiflorum***
   2' Flowers hairless or rarely glandular-hairy outside, the 6 parts about equal in size.
      3. Flowering stem hairs glandular, not cobwebby or woolly..... ***Eriogonum beatleyae, capistratum, gracilipes, ochrocephalum* var. *ochrocephalum, rosense***
      3' Flowering stems hairless or cobwebby to woolly, not glandular.

4. Flowering stems hairless.....***Eriogonum brevicaule, capistratum, kennedyi, ochrocephalum* var. *ochrocephalum, prociduum, verrucosum***

4' Flowering stems cobwebby to woolly.

5. Flowers white, drying white to pink or reddish
.....***Eriogonum anemophilum, brevicaule, holmgrenii, kennedyi, mancum***

5' Flowers bright to pale yellow, drying yellowish.

6. Flower cups thin, papery, often with minute glands outside
.....***Eriogonum argophyllum, capistratum, kingii, mancum, meledonum***

6' Flower cups thick, rigid, with no glands outside.

7. Flower parts rough outside with pustules or scattered glands
..... ***Eriogonum chrysops, tiehmii, verrucosum***

7' Flower parts smooth outside with no glands.

8. All leaf blades broadly linear to narrowly elliptic or oblong, edges strongly curled-under through > 170°, hairs often dense, silvery-gray
.....***Eriogonum brevicaule* var. *laxifolium***

8' Largest leaf blades broadly elliptic to nearly round, edges flat or gently curled-under through < 140°, hairs various.

9. Flower cups 3.5-5 mm long; longest leaf blades 1.5-3 cm
.....***Eriogonum ochrocephalum* var. *alexanderae***

9' Flower cups 2-3 mm long; leaf blades various.

10. Longest leaf blades 1.5-3 cm; leaf, flowering stem, and flower cup hairs dense, woolly, all silvery-gray ..... ***Eriogonum desertorum***

10' Longest leaf blades < 1.5 cm; upper leaf surface, flowering stem, and flower cup hairs sparse, cobwebby, greenish-gray, on flower cups usually absent below the teeth.

11. Flowers 2-3 mm long; widest leaves 5-7 mm..... ***Eriogonum lewisii***

11' Flowers 1.5-2 mm; leaves < 5 mm wide..... ***Eriogonum crosbyae***

Photographs and Line Drawings: A line drawing by Kaye H. Thorne, published in Anderson *et al*. (1991), was reproduced by Smith and Curto (1995, p. 13), and is reproduced again in appendix 2, figure 1 of this report. Photographs of *Eriogonum lewisii* and its habitat appeared in Anderson *et al*. (1991) and Smith and Curto (1995). Photographs made for this report are reproduced in appendix 2, figures 2-9, and are filed with the Nevada Natural Heritage Program.

V. SIGNIFICANCE OF TAXON

Natural: The many rare, geographically restricted, very similar and closely related forms specializing on volcanic ash/clay and/or calcareous ridge-line habitats in the subgenus *Eucycla* of *Eriogonum* suggest that evolution of these forms is relatively recent, rapid, and ongoing. As one of these forms, *Eriogonum lewisii* may be a significant link in studies of evolution, biogeography, and autecology. It and related taxa are unusual in their preference for and frequent restriction to exposed, high-elevation ridge-line knolls with dispersive drainage. Like other plant species growing in such habitats, it aids in soil formation and retention, nutrient cycling, and biomass production. The relatively showy flowers may serve as an important source of pollen or nectar for insects in the region.

Human: No studies of medicinal or other qualities of potential human benefit are yet known to have been performed on *Eriogonum lewisii*. As a member of the buckwheat family, it is closely related to crops such as buckwheat (*Fagopyrum*) and rhubarb (*Rheum*), as well as certain timber and ornamental species (Reveal 1989c). Some species of *Eriogonum* are reported to make excellent bee fodder (Hickman 1993b). Its demonstrated tolerance of harsh soils and 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. Many other species of *Eriogonum* are already in the horticultural trade, and are easily grown from seed in well-drained soils (Hickman 1993b, Reveal 1989c).

VI. GEOGRAPHIC DISTRIBUTION

Geographic Range: (appendix 1, tables 1-3; appendix 3 maps). Globally, *Eriogonum lewisii* has been documented from 33 populations in about 10 scattered groups in the mountain ranges of north-central Elko County and northern Eureka County, Nevada, on Humboldt-Toiyabe National Forest (about 73.0% evenly split between the Jarbidge and Mountain City ranger districts), private (21.9%), Bureau of Land Management (5.1%), and Elko County (0.1%) lands. A single specimen cited in the original description (Reveal 1985a) from Box Elder County, Utah, was later re-identified by Reveal as *Eriogonum desertorum* (Ben Franklin, personal communication 25 January 1995). But because of the imprecise taxonomic boundaries between the close relatives of *Eriogonum lewisii*, further study could show this or other specimens from outside the species' currently known range to represent populations containing *Eriogonum lewisii*. It is fairly likely that *Eriogonum lewisii* will eventually be documented in extreme southern Idaho and possibly in northwestern Utah.

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. Nevada Natural Heritage Program element occurrence numbers have been updated to reflect incorporation of all sites documented in this report into the Nevada Natural Heritage Program database.

Some of the site information 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 small populations 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 population 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. Most of the inconsistencies among surveys probably resulted from differences in mapping precision and techniques used to estimate numbers of individuals in large populations.

At the sites (2, 4-6, 9, 15-17, 19-26, and 33) surveyed for this report, population boundaries were mapped to the greatest precision possible in the field. Counts for large populations were estimated by taking the average density of plants observed in several square-meter areas representative of the population, and applying it to the entire mapped area of the population. Because they were extrapolated from very small, subjectively chosen density samples, these 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.

Some of the other surveys compiled herein 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. This appeared particularly true of the Jarbidge Ranger District sites (table 1), which collectively harbored 22.6% of the total reported individuals of the species on 47.9% of the total surface area, and all of which were surveyed by other agencies. This discrepancy could also reflect a real decrease in average density for these populations, which comprise the northern fringe of the species' range. Because of these uncertainties, the percentages given above for each surface management status are averages of the percentages based on surface area and population counts, and should be considered very rough estimates.

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, *Eriogonum lewisii* had been documented or reported from 11 populations (sites 1-11), which are here considered to be the historical sites for this species. All but three of these were subsequently rediscovered and further documented. Sites 3, 10, and 11 could not be accessed during surveys for this report, but can still be presumed extant. The historical populations are now estimated to comprise 201,375 individuals covering about 33.1 acres (13.4 ha) of National Forest and private lands between 6960 and 9720 feet (2120-2960 meters) elevation. All other sites are considered new and are discussed below. The Charleston road summit populations (sites 22-23) were known, but not reported to include *Eriogonum lewisii*, prior to 1993.

New site(s) discovered: (appendix 1, table 1) From 1994 on, 22 new populations (sites 12-33) were discovered and documented, comprising about 463,450 individuals, and covering about 84.9 acres (34.4 ha) of National Forest, private, Bureau of Land Management, and Elko County right-of-way lands between 6470 and 9082 feet (1970-2768 meters) elevation. Fifteen of these sites were discovered

by Humboldt-Toiyabe National Forest personnel, six during surveys for this report, and one by Smith and Curto (1995).

Historical site(s) searched for but not rediscovered: The Marys Mountain NE sites (sites 10-11) were imprecisely located in the historical records, and searches of the general area in 1995 did not relocate them. Likely locations for these populations were observed in 1995, but could not be accessed or viewed at close enough range. There were no major new disturbances near these locations, though, so these populations are presumed extant until further documentation can be obtained (see above).

Other site(s) searched where not discovered: (appendix 1, table 3) Sites U1-U18, comprising about 15,000 acres (6070 ha) between 6070 and 9119 feet (1850-2780 meters) elevation, have been surveyed at various times by the Humboldt-Toiyabe National Forest and the Nevada Natural Heritage Program without encountering *Eriogonum lewisii*. Smith and Curto (1995) surveyed another 14 sites comprising about 200 acres (81 ha) between 7050 and 10434 feet (2150-3180 meters) elevation in the same region, also without finding new populations. Much potential habitat remains unsurveyed in northeastern Nevada and southern Idaho, and complete surveys probably would increase the known population by about 1.5-4 times, depending on interpretation of taxonomic boundaries. (see Potential Sites below).

Historical site(s) known or suspected to be erroneous reports: As mentioned elsewhere, a specimen collected by Cottam on 13 June 1928 in Box Elder County, Utah, was cited in the original description of *Eriogonum lewisii* (Reveal 1985a), but was later re-identified by Reveal as *Eriogonum desertorum* (Ben Franklin, personal communication 25 January 1995).

Historical site(s) known or assumed extirpated: No extirpations of *Eriogonum lewisii* populations are known or suspected to have occurred. Several large open-pit mines exist on or near historically appropriate habitat for the species (for example, the Jerritt Canyon Mine, appendix 2, figure 9), and their construction could have extirpated one or a few populations prior to knowledge of conservation concerns for the species.

Historical site(s) where present status unknown: The Slide Rock Ridge population (site 3) has not been visited since 1985, but is located at high elevation in the Jarbidge Wilderness, and can be presumed extant. It needs better documentation as to its precise location and boundaries, population size and condition, and geologic substrate.

Potential site(s) meriting future field surveys: (appendix 1, table 2). Sites P1-P20, comprising over 8900 acres (3600 ha) between about 5000 and 10,300 feet (1525-3140 meters) elevation in Elko and Eureka counties, Nevada, were identified through visual inspection, correlation of geology (Coats 1987) with other habitat factors, or analysis of herbarium specimens, as further potential habitat for

Eriogonum lewisii, but could not be visited during surveys for this report. Additional unidentified potential habitat probably exists in northeastern Nevada and southern Idaho. Surveys of all remaining potential habitat would probably increase the existing population estimates by about 1.5-4 times.

VII. HABITAT CHARACTERISTICS

Environment and Habitat Summary: (appendix 2, figures 3 and 6-8) In the field and on Coats' (1987) geologic map, *Eriogonum lewisii* appears nearly restricted to limestone or other carbonate rock types with a significant silt or other siliceous component, usually where it crops out and forms shallow rocky residual soils on high, dry, exposed, relatively barren, relatively undisturbed ridge-line knolls and crests on all aspects between 6470 and 9720 feet (1970-2960 meters) elevation. Two apparently anomalous sites are discussed below under Geology. The habitat supports a sparse vegetation usually dominated by *Eriogonum lewisii* or low sagebrush (*Artemisia arbuscula*) in association with green rabbitbrush (*Chrysothamnus viscidiflorus*), indian ricegrass (*Achnatherum hymenoides*), squirreltail grass (*Elymus elymoides*), and several other species (appendix 1, table 4).

Physical Characteristics:

Physiography: The range of *Eriogonum lewisii* lies in the northeast corner of Holmgren's (1972) Central Great Basin section of the Great Basin Division of the *Intermountain Flora* region. This corresponds to Fenneman's (1931) Great Basin Section of the Basin and Range Province. The Central Great Basin Section is a high mountainous region characterized by sagebrush-dominated valley floors generally elevated above 5000 feet (1520 meters), and mountain ranges dominated by non-calcareous rock types (Holmgren 1972). The Great Basin Division consists of a series of mostly north-south-oriented ranges and basins block-faulted from rocks that age progressively toward the northwest and that have been arched upward in the middle.

Climate: Hidy and Klieforth (1990) aptly describe the climate of the Great Basin as ". . . one of the most extreme and variable climates on earth." This high variation occurs along horizontal and elevational gradients and at all time scales: hourly, daily, seasonally, annually, and over the tens of thousands of years of glacial cycles. The region's latitude, interior continental position, and high mountainous borders combine to create a generally arid climate. As in most arid regions, evapotranspiration greatly exceeds precipitation at all elevations, producing an average net loss of surface moisture (Hidy and Klieforth 1990). Most annual precipitation falls from about November through April in Pacific storm systems from the west. The Great Basin also lies within the influence of sub-tropical summer moisture, which originates in the Gulfs of Mexico and California and spreads over most of Arizona during July and August. This "monsoonal" influence produces a secondary peak of precipitation particularly toward the eastern and southern parts of the region, averaging about a quarter to half of the annual total, and 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 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).

The elevations where *Eriogonum lewisii* populations occur presently experience warm to cool, dry summers and cold moist winters. Annual precipitation averages about 14-24 inches (355-610 mm), with about half or more falling as snow. Temperatures average about 50-64°F (10-18°C) in July and 9-21°F (-13 to -6°C) in January. No unusual temperature or precipitation anomalies occurred during surveys for this report.

Geomorphology, aspect, and slope: All populations are restricted to crests or rounded, convex knolls along ridge lines, on flat to moderately steep slopes of all aspects. There is a slight tendency for populations to be denser or more extensive on their southwest to southeast aspects. The knolls may be maintained by a slightly greater resistance to weathering and erosion of the siliceous carbonate rocks preferred by *Eriogonum lewisii*, or may simply provide optimal environmental conditions for the species, such as reduced competition [Gurevitch (1986), reviewed by Fowler (1986)].

Geology: The soils at all sites surveyed for this report were observed to be derived from limestone or other carbonate rock types with significant silt or other siliceous components. Rocks at the Charleston road summit populations (sites 22-23) had by far the highest siliceous content of any site; they were soft and easily weathered to silt and clay, and consisted of very silty limestone grading upward into calcareous siltstone. *Eriogonum lewisii* and *E. desertorum* intergrade at these sites, and showed definite differences in substrate preferences, with higher frequencies of *E. lewisii* forms on the lower, carbonate-rich portion of the rock sequence, and higher frequencies of *E. desertorum* on the higher portion where soils were dominated by silt and clay. This agrees with previous reports on herbarium specimens and in the literature (Reveal 1985b) that *Eriogonum desertorum* prefers clay-rich rather than carbonate-dominated soils.

All *Eriogonum lewisii* populations except the Slide Rock Ridge population (site 3) are shown by Coats (1987) to be underlain by Paleozoic and Mesozoic sedimentary rocks containing various amounts of limestone or other carbonates, with the balance

composed of siltstone and other siliceous rock types. Prominent among these is the Pennsylvanian Van Duzer Limestone underlying sites 7-8 and 24-33. Site 3 is underlain by the Tertiary Jarbidge Rhyolite, a highly siliceous rock type containing no carbonate. Site 3 is at about 9720 feet (2960 meters) elevation, the highest elevation known for any population, and about 650 feet (200 meters) higher than the next highest site. *Eriogonum lewisii* may require a different substrate chemistry in order to survive at its highest elevation limits. Another possible explanation is that carbonate rocks are present at site 3, but covered too small an area to show at the 1:250,000 scale of Coats' (1987) map. Small, fault-bounded areas of carbonate-containing formations are mapped by Coats (1987) within 2 miles (3 km) of site 3.

Rocks containing carbonates are frequent and widespread at the elevations occupied by *Eriogonum lewisii* in Elko County, and likely support much additional habitat for the species. Many of the potential sites in appendix 1, table 2 were identified based on Coats' (1987) map.

Soils: Almost all sites appear to have the shallow, poorly developed, very rocky residual soils expected of carbonate substrates on ridge-top sites, with some silt and clay content provided by siliceous impurities in the carbonate rock. Plants at some sites grew in crevices of outcrops. The very silty rocks underlying sites 22-23 have formed deeper, fine-grained soils with relatively high clay content.

Hydrology: *Eriogonum lewisii* is not associated with free water, and is entirely dependent on incident precipitation and its retention in the soil. Like low sagebrush (*Artemisia arbuscula*), with which it co-dominates at most sites, *Eriogonum lewisii* occurs on convex landforms such as low knolls along ridge lines, which serve to further disperse precipitation and result in some of the lowest soil moisture contents of any sites with similar elevation and substrate. Slight increases in plant size and population density were sometimes noted where moisture-accumulating microsites, such as areas receiving road bed runoff, occurred within the habitat.

Air and water quality requirements: No specific requirements or unusual tolerances are known.

Biologic Characteristics:

Community physiognomy: *Eriogonum lewisii* codominates its habitat with other, mostly dwarfed perennial herbs, grasses, shrubs, and rare succulents, with very occasional larger, emergent species, within the mountain sagebrush zone that characterizes the low- to mid-elevation slopes of Great Basin mountain ranges.

Vegetation type: Because *Eriogonum lewisii* and many of its closely related taxa dominate or codominate the vegetation cover within their carbonate ridge-line knoll habitats, it forms part of a unique and relatively rare climax plant association here referred to as **buckwheat carbonate balds**. It appears to be maintained within the more common low sagebrush (*Artemisia arbuscula*) and black sagebrush (*Artemisia*

nova) series (Sawyer and Keeler-Wolf 1995) of the mountain sagebrush (*Artemisia tridentata* var. *vaseyana*) steppe zone primarily via the influences of carbonate parent rock, interfluvial topographic position, and convex slope profile.

Associated plant species: (appendix 1, table 4) *Artemisia arbuscula* (and/or *A. nova*) and *Elymus elymoides* occurred at all sites where associates were documented. *Chrysothamnus viscidiflorus* var. *viscidiflorus* (or var. *puberulus*), *Achnatherum hymenoides, Chaenactis douglasii* var. *douglasii, Cryptantha interrupta, Physaria chambersii,* and *Stanleya viridiflora* were the other most frequently noted associates.

Other endangered, threatened, and sensitive species: At least 21 other sensitive plant and animal species are known in and near the range of *Eriogonum lewisii*, and are listed in appendix 1, table 5. Five of these are documented to occur within or adjacent to *Eriogonum lewisii* sites. Two populations of *Phacelia minutissima* were encountered and documented during surveys for this report (appendix 1, table 3). Once any pollinators of *Eriogonum lewisii* 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 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.

Humboldt-Toiyabe National Forest (HTNF), Mountain City and Jarbidge Ranger Districts, U. S. Dept. of Agriculture: About 73.0% of the global *Eriogonum lewisii* population occurs on public lands managed by HTNF, with this percentage about equally split between the Mountain City and Jarbidge Ranger districts. Most of these lands are currently open to and used for extractive activities such as mineral exploration and development (appendix 2, figure 9) and livestock grazing. Some vehicular recreation and access is associated with the ridge-line roads along which many populations occur (appendix 2, figure 3). Other uses are rare to absent due primarily to the remoteness of the region, but enforcement of any future management prescriptions or protective measures would be difficult for the same reasons. The Slide Rock Ridge population (site 3) is located within the Jarbidge Wilderness, where the primary management emphasis is protection of resources and wilderness values. HTNF has designated *Eriogonum lewisii* a Sensitive Species, has required avoidance of known populations during a recent mineral exploration project (Bell 1995), has attempted to prevent further degradation at some of the impacted sites, and has been very supportive in conducting or funding field surveys for this and other Sensitive Species in the region (White 1995, Warder and Anderson 1995).

Private lands: About 21.9% of the global *Eriogonum lewisii* 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 lewisii* or its habitat. Although the region occupied by *Eriogonum lewisii* is relatively remote, some of the more desirable and accessible sites could be subject to habitat destruction from development in the foreseeable future. All sites are probably subject to developments associated with livestock management.

Bureau of Land Management (BLM), Elko District, U. S. Dept. of Interior: The Warm Creek Ridge and Lone Mountain populations (sites 13 and 19) are at least partially on public lands managed by BLM, accounting for an estimated 5.1% of the global *Eriogonum lewisii* population. These sites appear to be similar to most of the HTNF sites in their management. *Eriogonum lewisii* is also designated as a Sensitive Species by BLM, but no special management for the species is known to exist.

Elko County right-of-way: The county road from south of Wild Horse to Charleston Reservoir bisects part of the *Eriogonum lewisii* population at site 22, permanently eliminating a portion of the population. Future road maintenance or expansion activities could further impact this population. The exact management plans for this right-of-way are not known, but likely do not include any conservation measures for *Eriogonum lewisii*. The adjacent lands are privately managed, making it even less likely that conservation measures could be pursued for this population.

VIII. BIOLOGY AND ECOLOGY

Population Summary: Based on the information gathered for this report, the total known global population of *Eriogonum lewisii* was estimated to be about 664,825 individuals, and to occupy about 118 acres (47.8 ha) of habitat divided among 33 populations in about 10 scattered locations in the Bull Run, Independence, and Tuscarora Mountains, and the Jarbidge Mountains complex, of northwestern Elko and northern Eureka counties, Nevada, between 6470 and 9720 feet (1970-2960 meters) elevation. Based on the probable extent of unsurveyed potential habitat and the uncertain taxonomic boundaries, the true total population of *Eriogonum lewisii* is estimated to be 1.5-4 times greater than now documented.

Demography: Long-term monitoring has not been conducted for *Eriogonum lewisii* 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. All populations observed appeared to consist mainly of large, well-established plants at least several years in age. No seedlings were observed, but would probably have been difficult to detect if present in small numbers.

At least in undisturbed populations, plants of *Eriogonum lewisii* appear to be relatively long-lived, with very low apparent rates of recruitment of new individuals.

From estimates of the total individuals within total occupied habitat (see population summary, above), an average density of 5634 plants per acre (13,922/ha) can be estimated. However, individual site estimates ranged from about 133 plants per acre (330/ha; site 28) to about 60,417 plants per acre (149,293/ha; site 15; appendix 1, table 1), and the maximum density measured at site 15 was 56.5 plants per square meter, or about 229,000 per acre (565,000/ha).

Phenology: New leaves and flowering stems appear to emerge soon after snow cover is gone and soil temperatures are sufficiently high. Populations in full flower were observed during the first week of June, and some flowers have been seen opening nearly throughout July. Depending on annual timing of precipitation and temperature changes, flowering probably begins sometime between the beginning of May and early July and continues sporadically to the end of July. The fruit probably mature by about a month after flowering, between early June and the end of August.

Genetics: No studies of the genetic structure in *Eriogonum lewisii* are known. Most *Eriogonum* species appear to reproduce from seed produced by insect-mediated pollen exchange between flowers of the same or different plants. Along with the variation observed in flower color, leaf size, etc., in most populations, this suggests that *Eriogonum lewisii* populations are probably relatively diverse genetically. The 10 areas in which the 33 known populations occur are isolated enough from one another to preclude pollen transport, and each area has likely developed its own unique genetic makeup as a result. This is particularly apparent in the Pennsylvania Hill populations (sites 24-26 and 33), where flower color is exclusively pale yellow; all other areas have bright yellow flowers with occasional pale yellow individuals. Some reproduction in *Eriogonum lewisii* may also occur vegetatively by division of the root crowns, which would result in lower genetic diversity within populations. If major disturbances or other impacts to *Eriogonum lewisii* 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 lewisii*. As discussed above under Genetics, insect-mediated outcrossing is the most likely dominant reproductive mode in *Eriogonum lewisii*. Because its seeds fall enclosed by the light, papery flower parts, and because of the high winds prevalent in its exposed, ridge-line habitats, wind transport of seeds is probably the primary dispersal agent for the species, and occasionally may be capable of moving seeds up to several miles. In the process, however, most of the seeds probably fall below the local ridge lines, making wind transport of seeds to other suitable habitats a rare occurrence. Gravity and water probably also play an important role in moving seeds downhill from the ridge lines, permitting occupation of all suitable contiguous habitat nearby.

Hybridization: *Eriogonum lewisii* appeared to mix and hybridize with forms representing *Eriogonum desertorum* in the Charleston road summit populations (sites 22-23), producing an array of intermediate forms distinguished chiefly by leaf dimensions (appendix 2, figures 6-7). Whether these sites represented secondary contact between two previously distinct taxa, or an intermediate population in a zone of primary contact between two incompletely divergent forms, could not be determined. Occasional large-leaved plants resembling *Eriogonum desertorum* were noted in the Marys Mountain population (site 9) and a few others, but were restricted to road margins, bases of large rock outcrops, or other microsites with enhanced precipitation runoff and deeper soils, and appeared to represent environmentally induced forms rather than genetic influence from associated taxa. Pale yellow flower-color forms occurred in some of the higher-elevation populations either exclusively (Pennsylvania Hill sites 24-26 and 33) or as a few, scattered individuals in bright yellow-flowered populations (Upper Mahala Creek and Wheeler Mountain 8764; sites 2 and 17), but appeared to represent genetic variation within *Eriogonum lewisii* rather than evidence of hybridization. Welsh (1984) observed apparent hybridization of some Utah members of the *Eriogonum brevicaule* complex with *E. corymbosum, E. lonchophyllum, E. microthecum,* and possibly others. Other than with *Eriogonum desertorum* at sites 22-23, no hybridization was observed at any of the *Eriogonum lewisii* sites.

Pathology: No disease affecting *Eriogonum lewisii* has been observed or reported.

Predation: No evidence of significant herbivory or other predation has been observed. 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. Impacts from cattle use appear to result primarily from substrate disturbance rather than predation.

Competition: At all sites *Eriogonum lewisii* was found only in open plant associations where competition for light and moisture with other species was minimal. It was absent from adjacent, otherwise appropriate habitat where deeper soils and taller, denser vegetation had developed. Gurevitch (1986) documented restriction of a grass species to ridge-line sites due to interspecific competition (Fowler 1986), and this may be occurring with *Eriogonum lewisii* as well. The species does appear to compete very well with itself, occurring in locally high densities up to about 56.5 per square meter, but this does not necessarily foretell its ability to compete with other species in the same habitat. The species' apparent preference for low-competition conditions could also be a secondary effect of its dependence on a particular soil chemistry or other environmental condition peculiar to its habitat, since it has never been found in low-competition situations in other habitat types.

Response to Disturbance: At several sites, *Eriogonum lewisii* has been observed to colonize and reproduce on recent, recovering disturbances such as road banks. 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 lewisii* 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 high-carbonate substrates on ridge-line knolls and crests. *Eriogonum lewisii* has never been observed spreading off of such sites along disturbance corridors, and permanent loss of plants is evident where disturbance has been continuous and severe, such as on road beds bisecting the habitat.

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:

Mineral exploration and development: High levels of disseminated gold and other economically attractive minerals are known from the rocks underlying the range of *Eriogonum lewisii*, giving the region a high mineral development potential to which the habitat of *Eriogonum lewisii*, and of other rare species in the region, will remain vulnerable for the indefinite future. Mineral claim markers, and often evidence of past or present mining activity, have been observed in or near many of the populations (appendix 2, figure 9).

As of the conclusion of field surveys in 1995, intensive exploration and development of an open-pit mine for disseminated gold (the DASH project) was being conducted by the Independence Mining Co., Inc., immediately adjacent to the Mahala Creek populations (sites 2 and 4-6; Bell 1995, Warder and Anderson 1995). Despite the avoidance and mitigation measures required by the Humboldt-Toiyabe National Forest as part of this project (Bell 1995), the southwestern tip of the Lower Mahala Creek population (site 4) was observed during surveys for this report to have been

extirpated by recent construction of an exploration road on Forest Service lands. While this did not appear to have significantly impacted the viability of this population, it underscores the need for careful monitoring of mitigation compliance during project implementation. Large paper aerial survey markers, perhaps resulting from the need to survey the private portion of site 4 for the DASH project, were found covering many plants at two of the other Mahala Creek sites. A protective fence recommended by White (1995) and Warder and Anderson (1995) had been constructed along the ridge-line road through a different portion of site 4, and appeared to be effectively preventing impacts from off-road vehicular traffic, but off road tracks were visible in the other sites where fences had not been constructed.

The ridge-line position of *Eriogonum lewisii* populations generally protects them from impacts due to flow of drill effluent unless drill sites are placed directly within populations. Most other impacts associated with mineral exploration activities are relatively small and easily contained and mitigated as well, but habitat destruction from road construction or mine development are not. Any such events extirpating more than about 10-20% of *Eriogonum lewisii* populations could significantly impact the long-term viability of the species. 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.

Animal grazing or trampling: All known *Eriogonum lewisii* sites appear open to livestock grazing, which presently is the dominant land use within its range. The relatively sparse and low vegetation of most sites makes them relatively unappealing for grazing, but a band of sheep moving across a population could inflict substantial herbivory damage. The palatability of *Eriogonum lewisii* to livestock has not been determined. The ridge-top positions and proximity to ridge-line roads of most sites make them appealing for livestock to congregate and for operators to place salt licks, fences, and other range modifications likely to concentrate trampling activities. At the Independence Mountain population (site 18), Smith and Curto (1995) observed that a salt block placed within the population had "caused cattle to severely trample or extirpate several hundred plants." Placement of salt blocks and consequent livestock trampling have also been reported for at least two consecutive years in the Klondyke 8277, Sanovia Creek ridge, and Pennsylvania Hill E 8850 populations (sites 29, 31, and 33, respectively). In 1996 the Humboldt-Toiyabe National Forest fenced a 30×15 meter area around the salt block at site 18, and took steps to prevent future salt block placement at sites 29, 31, and 33 (Steve Anderson, personal communication, 15 October 1996). The long-term success of these measures in preventing further degradation needs to be monitored.

Road and electronic site development and maintenance: In the rugged and relatively inaccessible terrain surrounding many *Eriogonum lewisii* sites, ridge lines provide one of the most convenient means of access, and numerous ridge-line roads (for example, appendix 2, figure 3) now dissect the region and pass through many populations, creating the most severe impacts to date at several sites. The access

created by these roads encourages further off-road access through populations, and off-road vehicle tracks have been observed in many sites, creating potentially significant and long-term impacts to the thin and fragile soils. Topographic high points also provide the locations required for communication receivers and transmitters, and part of the Pennsylvania Hill E 9082 population (site 26) has already been extirpated by construction of an electronic site. To date, none of these impacts appear to have compromised population viability at any site, but maintenance or expansion of the roads or electronic sites, or heavy off-road vehicle use, could compromise viability in the future without careful planning and protection, and cooperation by land users. In 1996 The Humboldt-Toiyabe National Forest placed signs in the vicinity of site 26 requesting restriction to existing roadways, but these are not currently enforceable (Steve Anderson, personal communication, 15 October 1996).

Fire and fire suppression activities: The Rattlesnake Creek populations (sites 7-8) were first discovered during an August 1992 wildland fire that necessitated construction of fire lines and access roads through the populations and also burned a portion of them. For the same reasons discussed above for roads, ridge lines make convenient sites for staging and conducting fire suppression activities that can potentially destroy *Eriogonum lewisii* habitat. The roads cutting through many of the other populations may have originated during such activities.

Private development: Because of the remoteness of most of the privately held populations and of the region, habitat impacts from private development are considered unlikely at present. Most such impacts would probably be limited to range improvements associated with livestock management. A few of the most accessible and appealing sites could eventually be cleared for more intensive use.

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 lewisii* 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: Other than the livestock activity discussed above, no significant disease or herbivore damage has been noted at any of the sites.

Inadequacy of Existing Regulatory Mechanisms: No enforceable protective designations, conservation agreements, or approved management plans are known to exist

for *Eriogonum lewisii* 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 recent 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 lewisii*. 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, however, remains unknown but potentially 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.

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). *Eriogonum lewisii* is on the sensitive species list of the Humboldt-Toiyabe National Forest, which identifies 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 lewisii* 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 lewisii* are known to exist, however, and the effectiveness of such plans would still depend upon adequate implementation and enforcement resources.

Eriogonum lewisii 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. Nevada law does not mandate the continued survival of any plant species which it declares to be in danger of extinction.

Other Natural or Man-made Factors: The ridge-line habitats of *Eriogonum lewisii* populations make especially the lower-elevation sites highly vulnerable to natural or human-caused climatic warming, since there are usually no immediately adjacent, higher-elevation sites for the populations to colonize and thereby escape increasing temperatures. To the extent that *Eriogonum lewisii* 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 lewisii*.

X. GENERAL ASSESSMENT AND RECOMMENDATIONS

General Assessment: As now known, the global population of *Eriogonum lewisii* consists of about 665,000 individuals restricted to about 118 acres (47.8 ha) of public and private lands divided among 33 populations occupying about 10 scattered areas in the Bull Run, Independence, and Tuscarora Mountains, and the Jarbidge Mountains complex, of northwestern Elko and northern Eureka counties, Nevada. *Eriogonum lewisii* is probably only varietally distinct from closely related buckwheat species such as *E. desertorum* or *E. brevicaule*, but as a variety would still constitute a unique and geographically significant genetic variant worthy of separate conservation management. The species is restricted to usually thin, dry, open, rocky soils derived from siliceous limestone or other carbonate rock types on exposed ridge-line knolls and crests, and is dependent entirely on incident precipitation. It forms one phase of a unique and uncommon plant community of which it usually is the dominant or codominant species. Several thousand acres of potential habitat are believed to remain unsurveyed, and the true total population may be about 1.5-4 times larger than that now documented.

If not for the significant existing, ongoing, and threatened impacts to many of its known populations, *Eriogonum lewisii* would now be too common and widespread to warrant special conservation concern. For now the species remains vulnerable to human-caused extinction in the long-term, but vulnerability appears very low and easily managed in the short-term. Existing impacts to the species affect 22 (66.7%) of the populations, and may have compromised the viability of at least one (3.0%) where concentrated livestock trampling has occurred. The entire range of the species is high in mineral interest and potential, and continuing expansion of Independence Mining Co., Inc.'s Jerritt Canyon Mine complex (appendix 2, figure 9) could eventually result in partial or complete loss of another four populations. Electronic site development and climatic warming are also significant threats to many populations. 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 lewisii* was classified as a category-2 candidate for listing by the U. S. D. I. Fish and Wildlife Service (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. With further surveys, appropriate long term monitoring, and cooperation in management of habitat disturbance, human-caused extirpation or extinction can be avoided. Absent such management, the long-term possibility of extinction or major declines will remain, and federal 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 U. S. Forest Service and the Bureau of Land Management, is ranked 1 (critically imperiled) 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 expanded geographic range and number of populations, the uncertainty of its taxonomic position in the *Eriogonum brevicaule* complex, but continued presence of significant threats to some populations, the Nevada Natural Heritage Program's Global and Nevada ranks for *Eriogonum lewisii* should be changed from 1 to 3Q, the Q indicating its uncertain taxonomic status. 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 carbonate ridge lines 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 ridge lines. Critical habitat should not be formally designated in cases where it might subject *Eriogonum lewisii* 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 lewisii*, 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 2) indicates that preventable declines in viability of the species are occurring, more aggressive conservation and recovery measures should be identified and pursued.

1. The Humboldt-Toiyabe National Forest (HTNF) and Bureau of Land Management (BLM) should conduct or require additional surveys, following recognized professional standards (Nelson 1994), for undocumented *Eriogonum lewisii* populations prior to implementation of projects within potential habitat of the species, and any new populations found should be thoroughly documented. Impacts to new populations should be avoided or minimized during project implementation. Whenever funding and personnel permit, similar surveys should be continued outside of the project evaluation process as well.

2. HTNF and BLM should field-check all non-Wilderness *Eriogonum lewisii* sites at least every 5 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. 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, the survey efforts outlined in item 1 above should be intensified until all potential habitat has been examined.

3. HTNF and BLM should develop, implement, and adequately fund a long-term species management plan and conservation strategy for *Eriogonum lewisii*, to address at a minimum all the other recommendations above and below. Independence Mining Co., Inc., Elko County, the U. S. Fish and Wildlife Service, and any other interested parties should pursue partnership in this plan and strategy. Participants should share implementation costs proportionately to their management responsibilities.

4. HTNF should work with any future mineral exploration or development proponents to avoid destruction of *Eriogonum lewisii* sites by requiring use of lateral drilling, underground mining techniques, etc., to the maximum extent possible, and to ensure use of 100% native species in any revegetation activities (see below).

5. HTNF and BLM should work with grazing permittees to ensure that only dispersed grazing activity occurs in and near known populations. Placement of salt blocks, watering sources, or other range supplements likely to concentrate animals in small areas, should be prohibited within 0.25 mile of any known population as part of permit requirements. Close compliance monitoring should be conducted where

supplement placement has been a problem in the past, since some permittees have been known to ignore such requests.

6. HTNF and BLM should plan road development and maintenance so as to avoid or minimize impacts to known populations. In and near known populations, roads should avoid ridge-line routes, and impacts from grading or other maintenance activities should be contained within the existing road bed.

7. Where monitoring or other information indicates that off-road vehicle use is significantly impacting a known population, impacts should be eliminated through placement of barriers, rerouting or closure of roads, or other effective means.

8. HTNF and BLM should locate and design any future electronic sites so as to avoid impacts to *Eriogonum lewisii* populations.

9. Studies of pollinator populations, and their effectiveness in the reproductive success of *Eriogonum lewisii*, should be encouraged and supported. If found to play a significant role, pollinators should be monitored at least every 2-3 years to detect any downward trends that could contribute to reproductive failure in *Eriogonum lewisii*, and the cause(s) and possible remedies of any such declines should be assessed.

10. HTNF and BLM 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 lewisii* populations.

11. HTNF and BLM should aggressively manage and control invasions of exotic weeds within the range of *Eriogonum lewisii*, 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 lewisii* habitat.

12. Any future artificial revegetation actions in and near the range of *Eriogonum lewisii* should only use plant species native to the local area. HTNF, BLM, and other agencies anticipating the need for artificial revegetation should plan in advance of 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.

13. If impacts to populations on non-federal lands begin significantly impacting its viability, the Nevada Division of Forestry should add *Eriogonum lewisii* to its list of protected species 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.

14. Further research into the taxonomy, systematics, and genetics of *Eriogonum lewisii* and closely related taxa should be supported to the maximum extent possible.

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Field Research: Recent field surveys contributing information to this report were conducted on 22 July 1991 and 4 June 1992 by Roy Price (BLM) and James D. Morefield (NNHP), 2-3 June 1992 by Leonard Lake (HTNF) and Morefield, 8 August 1992 by Lake, 8-11 June 1993 by Morefield, Janet Bair (USFWS), and Michael Strathdee (NNHP), 10-12 August 1993 by Joan Reynolds (Reno, NV), 7-22 July 1994 by Mitchel R. White (HTNF), 31 July-6 August 1994 by Morefield and White, 9-10 August 1994 by White, 30 June-3 August 1995 by Smith and Curto (1995) with Anderson and L. Allen, 20 July 1995 by Anderson and Jon Warder (HTNF), 21-26 July 1995 by Morefield and Anderson, 6-8 September 1995 by Anderson, 4 October 1995 by Anderson and Jon Warder (HTNF), and 10 October 1995 by Anderson and Catherine Jean (HTNF).

Specimens: All specimens known to document *Eriogonum lewisii* 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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