I. SPECIES	**1. *Lasthenia californica* DC. ex Lindl. subsp. *californica*** **2. *Lasthenia gracilis* (DC.) Greene**
NRCS CODES: **1. LACAC2** **2. LAGR10** **Two taxa are covered in this plant profile because they were considered to be the same species until 2001.**	Tribe: **Heliantheae** Family: **Asteraceae** Order: **Asterales** Subclass: **Asteridae** Class: **Magnoliopsida**    *Lasthenia gracilis* (photos: A. Montalvo)
A. Taxonomic issues	*L. gracilis* was treated as a part of *L. californica* for many years. Until recently, most published literature and unpublished reports have used only the name *L. californica.* These two taxa are part of a variable species and subspecies complex with edaphic (soil) and chemical races. The taxonomy of *L. californica* subsp. *californica* was only recently narrowed to exclude populations of the cryptic species *L. gracilis* based on molecular genetic, morphological, and ecological data (Chan 2001, Chan et al. 2002). The two species overlap in distribution in northern CA, but they can be told apart by pappus morphology most of the time. Some individuals lack a pappus in which case it is very difficult to tell the species apart. The separation into northern and southern related groups (clades) and naming of *L. gracilis* as a cryptic species is consistent with population genetic studies by Desrochers & Bohm (1995) that found strong geographic differentiation within what was previously known as *L. californica* . Our main references (Chan & Ornduff 2017, FNA 2017, Jepson eFlora 2017, USDA PLANTS 2017) and most recent authors of local floras and checklists for southern CA follow Chan (2001) and apply the name *L. gracilis* to the populations in southern CA that were previously considered to be *L. californica* in Hickman (1993) (e.g., San Diego Co: Rebman & Simpson (2006), western Riverside Co: Roberts et al. (2004); Orange Co: Roberts (2008); Santa Ana River Watershed: Clarke et al. (2007); Orange Co and Santa Ana Mountains: Allen & Roberts (2013).
B. Subspecific taxa of: **1. *L. californica*** **2. *L. gracilis***	1. a. *L. californica* subsp. *californica* The following two subspecies of *L. californica* are included in this table and where cited in this profile for the species. These were only recently included as a part of *L. californica* by Chan (2001). b. *L. californica* subsp. *bakeri* (J. T. Howell) R. Chan c. *L. californica* subsp. *macrantha* (A. Gray) R. Chan 2. none
C. Synonyms of: **1. *L. californica*** **2. *L. gracilis***	1. a. *Baeria chrysostoma* Fisch. & C.A. Mey.; *B. chrysostoma* Fisch. & C.A. Mey. subsp. *hirsutula* (Greene) Ferris; *B. hirsutula* (Greene) Greene; *Lasthenia chrysostoma* (Fisch. & C.A. Mey.) E. Greene b. *Baeria bakeri* J.T. Howell; *B. macrantha* (A. Gray) A. Gray var. *bakeri* (J.T. Howell) D.D. Keck; *Lasthenia macrantha* (A. Gray) Greene subsp. *bakeri* (J.T. Howell) Ornduff c. *L. macrantha* (A. Gray) Greene subsp. *macrantha* 2. *Lasthenia californica* DC. ex Lindl., in part (missapplied), *L. chrysostoma* (Fischer & C. A. Meyer) E. Greene, in part, *Baeria chrysostoma* Fisch. & C.A. Mey, in part, *B. c.* subsp. *gracilis* (DC.) Ferris, in part, *Burrielia gracilis* DC.
D. Common name **1. *L. californica*** **2. *L. gracilis***	1. a. **California goldfields** (Painter 2016a, Calflora 2017, USDA PLANTS 2017), coastal goldfields, valley goldfields, common goldfields, dwarf goldfields b. Baker's goldfields (Calflora 2017, USDA PLANTS 2017); c. perennial goldfields (Calflora 2017, USDA PLANTS 2017); 2. **slender goldfields** (Clarke et al. 2007, Painter 2016b), needle goldfields (Painter 2016b, Calflora 2017, USDA PLANTS 2017), coastal goldfields (Roberts et al. 2004, Allen & Roberts 2013), common goldfields (Rebman & Simpson 2006, Jepson eFlora 2017).

E. Taxonomic relationships	Generic placement of the *Lasthenia* species treated here has been variable over the years. Hall (1915) noted *Baeria* and *Lasthenia* species were separated by a single trait: *Lasthenia* having a fusion of involucral bracts into a cup-like structure, and *Baeria* having essentially distinct bracts. The widely used *A Manual of the Flowering Plants of California* (Jepson 1925)and *A California Flora* (Munz 1958) treated the subject taxa of this profile as part of *Baeria.* The (Munz & Keck 1968) supplement to Munz (1958), and the treatment in Hickman (1993) combined all California species of *Baeria, Lasthenia* and *Crokeria* under *Lasthenia* following a comprehensive monograph by Ornduff (1966). Chan (2001) incorporated DNA sequence data into his analysis and included both species in *Lasthenia* section *Amphichaenia.* In this section, *L. gracilis* is so similar to *L. californica* that it was previously included as part of *L. californica* subsp. *californica.* Other species in the same section are: *L. leptalea* (A. Gray) Ornduff, and *L. ornduffi* R. Chan. A study of habitat affinities and phylogenies of *Lasthenia* (Emery et al. 2012) grouped *L. gracilis* with terrestrial *L. lepalea,* while the three subspecies of *L. californica* grouped most closely with the terrestrial species *L. ornduffii.* In a study of leaf morphology in relation to habitats, Forrestel et al. (2015) found the same groupings.
F. Related taxa in region	*L. coronaria* (Nutt.) Ornduff (southern goldfields) has free phyllaries, is glandular, and has pinnately lobed leaves; *L. glabrata* subsp. *coulteri* (A. Gray) Ornduff (Coulter's goldfields, 2n = 14) of vernal pools and saline areas is rare (Roberts 2008) and has fused phyllaries, no pappus, and papillate achenes; *L. glabrata* Lindl. subsp. *glabrata* (2n = 14) is reported by Roberts (2008) to occur in Orange Co. as an uncommon escape from restoration seeding mixtures and also has fused phyllaries and no pappus, but has glabrous achenes; *L. glaberrima* A. DC (2n = 10) vernal pool species, in San Diego Co. (Hickman 2003, Roberts 2008) has pappus and fused phyllaries.
G. Other	*Lasthenia* includes several rare taxa. Three are endemic to coastal northern CA including *L. c.* subsp. *bakeri* which is on the CNPS list 1B.2 (CNPS 2010) and is becoming rarer due to habitat destruction (Chan 2001); the narrow endemics, *L. burkei* (Greene) Greene (Burke's baeria) and *L. conjugens* Greene (Contra Costa goldfields), are federally endangered and on CNPS list 1B.2 and 1B.1, respectively. *L. glabrata* subsp. *coulteri* is on CNPS list 1B.1 (seriously endangered in CA), and occurs primarily in southern CA. Its habitat is rapidly disappearing along the San Jacinto River in western Riverside Co. (F. Roberts, pers. com.)

II. ECOLOGICAL & EVOLUTIONARY CONSIDERATIONS FOR RESTORATION

A. Attribute summary list (based on referenced responses in full table)	Taxonomic stability - low Longevity - short, ephemeral Parity - monocarpic Stress tolerance - moderate (stress avoider) Environmental tolerance - wide Reproduction - obligate seeder Fragmentation history - historical and recent Habitat fragmentation - high Distribution - widespread, broad Hybridization potential - intermediate Seeds - limited longevity/seed bank potential (several yr) Seed dispersal distance - short, local Pollen dispersal - short to intermediate Breeding system - outcrossed (self-incompatible) Population structure - high F_{ST}, G_{ST} Adaptive trait variation - present at small spatial scales Chromosome number - variable Genetic marker polymorphism - intermediate to high Average total heterozygosity - intermediate for both species
B. Implications for seed transfer (summary based on referenced responses in full table)	Genetically based adaptive specialization occurs over relatively small spatial scales in edaphically heterogeneous environments. Although overlapping in geographic distribution, the two taxa often occur in different microsites within regions of overlap. Selecting seed sources from within or adjacent ecological subsections from similar elevations, together with matching edaphic conditions of source site and planting location would help to control the risk of maladaptation. The high levels of genetic variation may help to counter the negative effects of rapid climate change, but migration important to adding new genetic material over time is expected to be low, especially in fragmented landscapes. The multiple threats of a rapidly changing climate, competition from invasive species, high levels of habitat fragmentation from urban and agricultural development, and increasing exposure to shortened fire intervals will be difficult for these locally adapted taxa with poor dispersal abilities to overcome. Migration corridors that cross ecological gradients to allow gene exchange among populations may be especially important. If migration corridors are insufficient, sourcing seeds from mixtures of nearby populations with matching edaphic qualities may be needed on a case by case basis.

III. GENERAL

A. Geographic range

(numbered as in I. B. above)

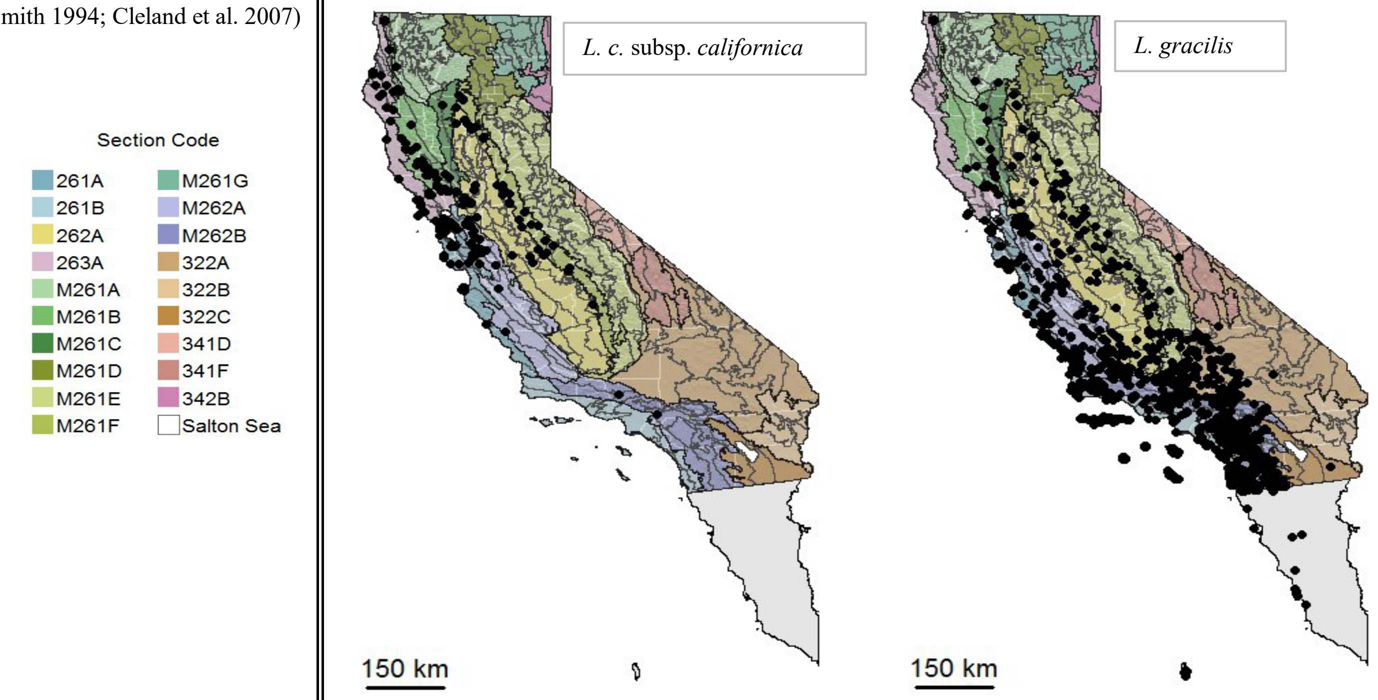
The genus *Lasthenia* occurs throughout most of the California Floristic Provence (Chan et al. 2001) and into the southeastern deserts, but it is known primarily from the Mediterranean climate regions with short, mild wet winters and long dry, warm to hot summers. Seeding goldfields along roadsides may have extended the distributions of the species covered in this profile.

L. californica is an abundant and widespread species; it ranges from sw Oregon into central and northern CA (Chan 2001).

1. a. *L. c.* subsp. *californica*, the most widespread subspecies, occurs from southwestern Oregon south to southern California and into the Channel Islands.
   b. *L. c.* subsp. *bakeri*: North Coast and South Coast Ranges from Mendocino Co. to San Luis Obispo Co.
   c. *L. c.* subsp. *macrantha*: North Coast and Central Coast along immediate coast.
2. *L. gracilis* is the most common and widespread *Lasthenia* in California. Unlike all the other *Lasthenia*, it is common in southwestern California, the Channel Islands, northern Baja California; reported from Arizona.

B. Distribution in California; Ecological Section and Subsection (*sensu* Goudey & Smith 1994; Cleland et al. 2007)

Data downloaded from of the Consortium of California Herbaria (CCH 2017): *L. c.* subsp. *c*. includes 330 points with coordinate data (left); *L. gracilis* includes 1568 points with coordinate data (right); accessed 5/5/2017.



to see mapped subsection labels see: http://web.archive.org/web/20070826132132/http://www.fs.fed.us/r5/projects/ecoregions/ca_sections.htm, then click on various map sections.

1. *L. c.* subsp. *californica.* (Jepson eFlora 2107): Northwestern California, (excluding High North Coast Ranges), Cascade Range Foothills, Sierra Nevada Foothills, and the Great Valley, Central Western California, south to northern portion of California's South Coast and Western Transverse Ranges. For Ecological Section/Subsection CCH specimens mapped within the: Central Calif. Coast (261A: a-g,j); Great Valley (262A: a,g,h,j,l,o,q,s,t,u,); Northern California Coast (263A: e,f,g,j, l,m); western Jurassic and Gasquet Mountain Ultramaphics of the Klamath Mountains (M261A: a,b); Northern Calif. Coast Ranges (M261B: a,b,d,f); Northern Calif. Interior Coast Ranges (M261C: a,b); norther portion of the Sierra Nevada Foothills (M261F: a,b,c); Central Calif. Coast Ranges (M262A: a,b,c,e); and the Southern California Mountains and Valleys (M262B: c,j).

2. *L. gracilis.* (Jepson eFlora 2017): California Floristic Province (excluding High North Coast Ranges, High Cascade Range, High Sierra Nevada) and western Mojave Desert. For Ecological Section/Subsection CCH specimens mapped within the: Central Calif. Coast (261A: a,c,e-h,j-l); Southern Calif. Coast (261B: a-e,g-j); Great Valley (262A: c,d,g,i,j,o,q,s-u,w-z); Northern Calif. Coast (263A: l,m); western Jurassic and Gasquet Mountain Ultramaphics of the Klamath Mountains (M261A: b,c, i); Northern Calif. Coast Ranges (M261B: a,b,d,f); Northern Calif. Interior Coast Ranges (M261C: a); Sierra Nevada (M261E: g,m,o,p,r,s); Sierra Nevada Foothills (M261F: a-e); Central Calif. Coast Ranges (M262A: a,c-k); Southern Mountains and Valleys except high elevations (M262Ba-p); and Mojave Desert High Desert Plains and Hills (322A: f-h,n,o); Colorado Desert (322C: a,b,d); Mono (341D: i).

C. Life history, life form	Both *Lasthenia californica* subsp. *californica* and *L. gracilis* are annual herbs; the other two subspecies of *L. californica* (see III. D. Distinguishing traits) are perennial herbs (rarely annual) (Chan 2001).
D. Distinguishing traits	Both *L. gracilis* and *L. californica* have free phyllaries and leaves that are mostly entire and linear to oblanceolate as opposed to the deeply dissected leaves of *L. coronaria* with which they may co-occur. Pappus can be absent or of 1 to 7 linear to subulate, aristate scales; they are usually 7 translucent, brown, linear, and awn-tipped in *L. californica* subsp. *c* . and usually 4 flared, opaque, and white in *L. gracilis* (FNA 2017, Jepson eFlora 2017). The subspecies of *L. californica* can be separated by leaf and root traits: 1. subsp. *californica* is annual with fibrous roots 2. subsp. *bakeri* is perennial, sometimes annual, with fleshy roots and narrow leaves (< 2mm) (Jepson e Flora 2017) 3. subsp. *macrantha* is perennial, sometimes annual, with fibrous roots and wider leaves (> 2 mm) (Jepson eFlora 2017).
E. Root system, rhizomes, stolons, etc.	*L. gracilis* and *L. californica* subsp. *californica* : roots are fibrous from a branched taproot. *L . c.* subsp. *bakeri* has fleshy, clustered roots whereas the roots of *L. c.* subsp. *macrantha* are not fleshy or clustered (FNA 2017).
F. Rooting depth	Shallow root system, with most roots <0.25m.
IV. HABITAT	
A. Vegetation alliances, associations	Sawyer et al. (2009) report that it will be difficult to separate out differences in vegetation affinities between *L. californica* and *L. gracilis* owing to the fact that these two species have been recorded as *L. californica* in many vegetation assessments. As such, their manual combines the species as *L. californica* . The taxon, as treated, occurs in many different plant alliances and associations, and most commonly as a co-dominant in the *Lasthenia californica –Plantago erecta – Festuca microstachys* herbaceous alliance which occurs throughout cismontane California. Affinities to major plant communities are often noted on herbarium specimens that have been annotated to *L. californica* vs. *L. gracilis* and these can be cross referenced with notations in older floras. Both species are known from Coastal Sage Scrub, Chaparral, Coastal Prairie, Oak Woodland, Valley Grassland, and Foothill Woodland. *Lasthenia gracilis* also occurs in Creosote Bush Scrub, Shadscale Scrub, and Joshua Tree Woodland within the Mojave and Sonoran deserts (Munz & Keck 1968, Munz 1974, CCH 2016). A recent study of vegetation communities on Tejon Ranch in the Tehachipi Mountains and foothills, found *Lasthenia gracilis* to be an important component a Lupine-small fescue-goldfields (*Lupinus bicolor–Festuca microstachys–Lasthenia gracilis*) assemblage found repeatedly on gently sloping alluvial fans and bajadas.
B. Habitat affinity and breadth of habitat	1. a. *L. californica s* ubsp. *californica* : Many habitats within foothills and valleys below 1500 m. Generally in grasslands, forblands, and openings in coastal sage scrub and woodlands. 2. *L. gracilis* : Abundant in many habitats within coastal and inland foothills and valleys below 1500 m. Generally occurs in grasslands, forblands, and openings in shrublands and woodlands. Also occurs on open flats and in open scrub of southwestern deserts.
C. Elevation range	1. a. *L. californica* subsp. *californica* : below 1500 m (Chan 2001). 2. *L. gracilis* : below 1720 m (Calflora 2014)
D. Soil: texture, chemicals, depth	Both species occur on a variety of soil types ranging from sandy loams to silty clay loams. *L. gracilis* is also found on sandy, gravely, to clay soils in the southwestern deserts (California Consortium of Herbaria data). Different races occur on soils associated with ionic stress, including alkaline soils, salt flats, and serpentine soils (Rajakaruna & Bohm 1999, Rajakaruna et al. 2003c). In both species, race A plants are more tolerant than race C plants of Mg^{2+} and Na^{+} ions. In *L. gracilis* , race A plants were found to have less tolerance to droughty soils than race C plants (Rajakaruna et al. 2003b).
E. Precipitation	1 a. In areas generally with at least 10 inches to more than 30 inches annual precipitation. 2. In areas that range from less than 10 inches to more than 30 inches annual precipitation.
F. Drought tolerance	Drought tolerance varies with population (Rajakaruna et al. 2003a). Others have considered the plants to be "drought avoiders" because plants grow in the rainy season and complete their life cycle prior to the hot, dry summer (Batten et al. 2006).

G. Flooding or high water tolerance	Some populations occupy vernal pool habitats. Given the diversity of edaphic races and drought tolerance within these species, there may be differences among populations in tolerance to flooding.
H. Wetland indicator status for California	*L. californica* : Facultative upland for Arid West, otherwise upland (Lichvar et al. 2014, USDA PLANTS 2016). *L. gracilis* was not specifically listed in the 2014 update.
I. Shade tolerance	Full sun required (Newton & Claassen 2003).

V. CLIMATE CHANGE AND PROJECTED FUTURE SUITABLE HABITAT

A. Species Distribution Models (SDM with climate forecasts)	None found. Emery et al. (2012a, b) note the complex web of environmental relationships among lineages of *Lasthenia.* Modeling to project spatial shifts in suitable habitat with projected shifts in climate will be difficult for these taxa. Defining a baseline habitat suitability will be a complex task that may require environmental data on smaller spatial scales than currently available, especially regarding soil traits.

VI. GROWTH AND REPRODUCTION

A. Seedling emergence relevant to general ecology	Seedlings emerge early in the cool rainy season. Plant abundance at a site is strongly and positively correlated to rainfall (Hobbs & Mooney 1991). In a laboratory study, seeds of *Baeria californica* var. *gracilis* germinated within 24 hours of sowing and developed cotyledons within the next 24 hours (Sivori & Went 1944) indicating response to rains can be rapid. Timing of emergence depends on onset of sufficient rainfall under the appropriate photoperiod and temperatures. In a study at Jasper Ridge, CA, approximately 58% of germinated seedlings survived to flowering (Hobbs & Mooney 1985).
B. Growth pattern (phenology)	Plants grow in the cool rainy season and flower between February and June (Hickman 1993). Herbarium specimens of both *L. californica* and *L. gracilis* have been collected primarily from March through May, peaking in April (CCH 2017, Jepson eFlora 2017), which indicates flowering most commonly occurs in April. In southern California, most plants set seed by the end of April or early May. The timing of initiation of flowering depends on a combination of plant age (size) and photoperiod. In one study, plants less than 30 days old required long days whereas 57-day old plants flowered with as little as 8 hr days (Lewis & Went 1945). In another experimental study, plants also exhibited a plastic response in the number of days from emergence to first open flowers, ranging from about 42 to 55 days, depending on edaphic race and high, medium or low watering treatments (Rajakaruna et al. 2003b). The study also found that "race" A (*L. c.* subsp. *californica*) germinated 2–3 days later and flowered 7–10 days later than "race C" (*L. gracilis*), and they allocated more mass to roots than to shoots than *L. gracilis* . At Jasper ridge, the races correspond to the two different species, but in other parts of the species' ranges, different edaphic races may also occur *within* these two closely related species (Rajakaruna et al. 2003b) and the races may be expected to have phenological differences.
C. Vegetative propagation	None.
D. Regeneration after fire or other disturbance	Plant densities greatly are reduced by fire (Cave & Patten 1984) and disturbance by gophers (Hobbs & Mooney 1991). Soil seed banking may be limited (Rajakaruna & Bohm 1999), but plants have been observed to do well the second year after fire at Walker Ridge in Lake Co. (N. Rajakaruna pers. obs.).
E. Pollination	Insects. Pollination is primarily by solitary bees and beeflies (Moldenke 1976). Small flies, including gnats, are likely to move pollen shorter distances than solitary bees.  Various flies probing flowers of *L. gracilis* for nectar. A. Montalvo, 2009
F. Seed dispersal	Seed dispersal is very local and limited. Observations by Rajakaruna & Bohm (1999) indicate that much dispersal is within 8 cm of mother plants. Primary dispersal is by gravity and possibly aided by wind (Moore et al. 2011), and there may be some secondary dispersal by harvester ants. Almost half of the *L. californica* seed rain was trapped by gopher mounds in a study in California serpentine grasslands (Hobbs & Mooney 1985).

G. Breeding system, mating system	Obligate outcrossers (Ornduff 1966). Most other *Lasthenia* are also self-incompatible (Ornduff 1966, Desrochers & Dodge 2003).
H. Hybridization potential	*Lasthenia* has been divided into several sections. Ornduff et al. (1973) did experimental hybridizations to determine the genetics of various flavonoid pigments. Crosses between species from different sections of *Lasthenia* were almost all unsuccessful. Ornduff (1966) found that all crosses with *L. chrysostoma* failed or in one case, produced sterile hybrids. Natural hybridization of *L. californica* with other species or subspecies is not known to occur. Desrochers & Dodge (2003) report that most species of *Lasthenia* are reproductively isolated by a combination of geographic separation and strong sterility barriers. Many combinations of crosses were done by Ornduff (eg. Ornduff 1966, Ornduff et al. 1973) and most crosses among species failed. Although crosses within species were often fertile, crosses among races within a species were sometimes unsuccessful. Rajakaruna (2002) examined the crossability between races and species within this species complex. Seven populations were used in a reciprocal crossing study that included two races in each of the two species lineages (*L. c.* subsp. *californica* and *L. gracilis*). Crosses within species were significantly more successful than those among species of the same edaphic race, and crosses within edaphic races were much more successful than crosses among races (within or among species). The least successful crosses were those between different edaphic races of the two species. Research so far suggests hybrids may be uncommon in nature. Greenhouse crosses between species have produced fertile hybrids that show vigor when planted in the field (Jenn Yost pers. com.), however hybrid crosses have reduced seed set, pollen tube growth rates, and pollen fertility (Rajakurana & Whitton 2004, Jenn Yost pers. com.). In a field study that genotyped over 1000 plants sampled along a 60 m transect where populations of *L. californica* and *L. gracilis* overlapped in distribution along seven m (the most intensely sampled area), Yost et al. (2012) detected only two hybrids. However, more genetic markers or sequencing techniques may be needed to confirm natural hybridization rates between different races and species (Jenn Yost pers. com.). Hybridization in areas of overlap may also be limited by differences in the timing of flowering observed by Rajakaruna et al. (2003b), and other factors yet to be determined (Yost et al. 2012).
I. Inbreeding and outbreeding effects	Ornduff (1966) attempted a variety of crosses among populations of both diploid and tetraploid populations (reported as *L. chrysostoma*). For all combinations of crosses, about two thirds of the among population crosses resulted in less than 30% seed set. At the time, both *L. californica* subsp. *californica* and *L. gracilis* were included as *L. chrysostoma* , and populations from both southern and northern CA were used in the study. It is very likely that some of the cross combinations were among these two cryptic species. Crosses among tetraploid populations tended to have hybrids with normal looking pollen, likely because they were all from the same species. Work by Rajakaruna (2002) indicated strong outbreeding depression when different edaphic races were crossed (see V. H. Hybridization potential, above). There was evidence for the incompatibility existing at the pollen tube growth (prefertilization) and seed maturation (postfertilization) stages (Rajakaruna & Whitton 2004).

VII. BIOLOGICAL INTERACTIONS

A. Competitiveness	In a field experiment at Jasper Ridge, Reynolds et al. (1997) compared growth of *L. californica* (possibly was *L. gracilis*) under different nutrient additions, soil depths, plant densities, and when growing in a matrix with other native annual plants (*Plantago erecta* or *Calycadenia multiglandulosum*). *Lasthenia* showed a lower water use efficiency than the other species, but in mixed-species plots, water use efficiency varied only in *Plantago* and *Calycadenia.* *Lasthenia* plants were smaller in plots when mixed with *Plantago,* but not when mixed with *Calycadenia,* compared to when grown alone. Uptake of nitrogen by *Lasthenia* was lower when grown in competition with either species, but there was no significant difference in survival. Competitive performance was best when grown in its own native patch type. Correlation studies suggest that the altered bacterial community of soil in ecosystems invaded by barb goatgrass and yellow star-thistle may inhibit the establishment a number of species, including *L. californica* (Batten et al. 2006). Reduced growth and delayed flowering of *L. californica* occurred when seeds were planted in soil altered by goatgrass compared to controls in a pot study (Batten et al. 2008). In contrast to these studies, a seed addition experiment suggested that adding *Lasthenia* as an understory species along with shrubs of coastal sage scrub may help to lessen the growth of non-native species (Talluto et al. 2006).

B. Herbivory, seed predation, disease	Harvester ants and giant kangaroo rats eat seeds, post dispersal (Hobbs 1985, Olney 2008, Moore et al. 2011). The harvester ant (*Veromessor andrei* Mayr) preferred other species of seeds and foraged for *Lasthenia* seeds in late summer after harvesting preferred seeds (at Jasper Ridge, Hobbs 1985).
C. Palatability, attractiveness to animals, response to grazing	Kimball & Schiffman (2003) examined the response of native grasses and forbs, including *L. californica* (very likely *L. gracilis*), to cattle grazing at the Carrizo Plain National Monument in southern California. This species was essentially absent from grazed plots but common within ungrazed plots. In experiments, out of 12 native and two alien species, *L. californica* was the most adversely affected by clipping, owning in part to its upright stature and location of growing points (meristems).
D. Mycorrhizae or other symbionts	Hopkins (1987) reports most roots colonized by arbuscular mycorrhizal fungi in serpentine grassland. In a study in Orange Co., California, Vogelsang et al. (2004) found that *Lasthenia californica* (may have been *L. gracilis*) was significantly more abundant in seeded plots inoculated with *Glomus intraradices* than in control plots. Hilbig (2015) found plants (grown from seeds labeled as *L. californica,* but collected from the local region and likely *L. gracilis*), to be readily colonized by arbuscular mycorrhizal fungi.

VIII. ECOLOGICAL GENETICS

A. Ploidy	1. a. *L. c.* subsp. *californica* has both diploid and polyploid populations, with 2n = 16, 32, and 48 (Chan 2001). Diploid populations are more common (Chan et al. 2002). There was no geographic pattern in distribution of populations with different ploidy levels (Desrochers & Bohm 1995) b. *L. c.* subsp. *bakeri* are polyploid (2n = 48) (Chan 2001). c. *L. c.* subsp. *macrantha* are polyploid (2n = 48) (Chan 2001). 2. *L. gracilis* (2n = 16, 32); there are diploid and tetraploid populations.
B. Plasticity	Rajakaruna et al. (2003b) found that both species have similar plastic response to water availability. Plants differed in number of days to flowering, number of heads produced, and duration of flowering under different irrigation regimes. When under water limitation, flowering and seed production occurs earlier in the year.
C. Geographic variation (morphological/ physiological traits)	Populations differ in size, root to shoot ratios, flowering time, and number of flower heads (Rajakaruna, Baldwin et al. 2003c). Plants from low nutrient areas have higher root to shoot ratios and delayed growth (Rajakaruna et al. 2003b, c). Plants from drier locations flower earlier and exhibit faster growth to maturity (Rajakaruna et al. 2003b). In studies of *L. californica* over its entire geographic range, which at the time included *L gracilis* populations, flavonoid composition varied with population (Desrochers & Bohm 1993; Bohm et al. 1989). Population variation indicated geographical speciation (Desrochers & Bohm 1995), consistent with current taxonomy (Bohm & Rajakaruna 2006). They found geographic patterns to the distribution of allozymes, flavonoid types, and pappus shape. For example, linear pappus was associated with northern California and Oregon, whereas subulate and lanceolate pappus were found more southerly.
D. Genetic variation and population structure	In locations with heterogeneous soils, there is evidence that populations of both species can diverge genetically within close proximity even though plants are obligate outcrossers. Both species have developed two races (A and C) with different soil affinities. This provides evidence for genetic structuring of adaptive traits. Many of the traits that differ within and among populations of *Lasthenia* are known to be genetically determined, and a number of such traits have been examined to see if there is a pattern to their geographic distribution. Genetic structure was indicated by earlier studies of variation in isozymes, morphology, ploidy, and flavonoids for 36 populations of *L. californica* (which at the time included *L. gracilis*) over their geographic range, including populations from Arizona, Oregon, northern, central and southern California, and Baja California (Desrochers & Bohm 1995). The populations were grouped for analyses in different ways, but most groupings included both species and more than one edaphic race which would affect genetic diversity statistics. Expected heterozygosity was high and there was a high level of diversity within and among populations. Mean diversity within populations (H_S) ranged from 0.217 to 0.230; G_{ST} values ranged from 0.33 to 0.42 depending on grouping which suggests that at least a third of the variation was due to differences among populations. Obligate outcrosses usually have lower levels of structure; high G_{ST} is often associated with low gene exchange (gene flow) among populations. The observed pattern is consistent with strong selection influencing differentiation among edaphic races.

D. Genetic variation and population structure (continued)	Rajakaruna (2002) used RAPD markers to study genetic variation in 25 populations of *L. californica* sensu Ornduff (representing populations of both *L. c.* subsp *c* . and *L. gracilis* and both races of each species); nine of the populations were determined to species. He also examined ITS markers from 16 *L. g.* and 17 *L. c.* subsp. *c* . populations, representing both edaphic races. *L. californica* populations had higher levels of polymorphic loci than *L. gracilis* (77% vs. 64% polymorphic loci respectively; and average heterozygosity of 0.16 vs. 0.14, respectively). Regardless of species, race A populations were more diverse than race C populations. In an analysis of the RAPD markers, values of F_{ST} were highest for comparisons among species, and lowest for comparisons among races within species.
E. Phenotypic or genotypic variation in interactions with other organisms	No information found.
F. Local adaptation	Genetically based adaptive specialization occurs over relatively small spatial scales in edaphically heterogeneous environments (Yost et al. 2012). Findings are consistent with the evolution of local adaptation in both taxa. Populations adapted to water limitation performed better under drought conditions than those from locations with increased water availability (plants collected from Jasper Ridge, San Mateo Co., CA; Rajakaruna et al. 2003b); and tolerance of Na and Mg ions differs by population (Rajakaruna et al. 2003c). Barry (2013) conducted reciprocal transplant experiments with *L. californica* and *L. gracilis* within a serpentine outcrop at Jasper Ridge, CA. The *L. c.* population had higher survival and reproduction in its home soils at the base of a slope where concentration of Ca was lower and Mg was higher; and *L. g.* had higher survival and reproduction in a transition zone and at the top of the slope where conditions were drier. Other work examining the differences between edaphic races within species also indicates local adaptation (see IV. D. Soil, above). For both species, race A plants were associated with habitats of ionic stress (Rajakaruna (2002). The flavonoid profile (sulfated flavonoids) of race A plants was also distinct from that of race C plants (non-sulfated flavonoids). In addition, there was a low but significant correlation between genetic distance (determined from DNA markers) and ecological distance (based on soil features). Furthermore, in an experiment that reciprocally transplanted seedlings of *L. californica* and *L. gracilis* into the others home habitat at several locations along an ecological gradient, Yost et al. (2012) found differences in survival and seed production consistent with each species being best adapted to its home environment.
G. Translocation risks	There are potential maladaptation risks to translocation of populations into different edaphic, precipitation, and day length environments. In addition, mixing races and especially different races of the two species (and possibly populations with different chromosome numbers) may result in substantial depression in seed production and very likely in maladaptation of any hybrid progeny. Ecological distance was more negatively correlated with crossing success than was genetic distance (Rajakaruna 2002), suggesting that ecological distance is a better predictor of translocation risk than genetic distance in this species complex.
IX. SEEDS	RSABG Seed Program seed images by John Mcdonald: http://www.hazmac.biz /030623a/030623aLastheniaCalifornica.html (photo labeled as *L. californica* is from specimen annotated to *L. gracilis*)  Achenes of *Lasthenia gracilis* with characteristic
A. General	Seed production in a serpentine grassland has been reported as 49,200 seeds/m^2, with 20 seeds produced per plant (Hobbs & Mooney 1985). This is likely highly variable due to plastic response of plant growth and head numbers to water availability.
B. Seed longevity	Average seed viability has been reported as 72.8% in the first year, 69.5% in the second year, and 42% in the third year under ambient warehouse storage in coastal Carpentaria, CA (Jody Miller, S&S Seeds pers. com.).
C. Seed dormancy	Three month "after ripening period" was required for germination and seeds were stratified for one week at 5ºC to improve seed germination (Rajakaruna & Bohm 1999). In later studies, seeds were stratified for three days (Rajakaruna, Bradfield et al. 2003b).

D. Seed maturation	Seed maturation is rapid. In late May to mid April, seeds mature within three to four weeks of anthesis.
E. Seed collecting	Whole heads can be collected into cloth or paper (breathable) bags when seeds are mature.
F. Seed processing	Wall and MacDonald (2009) recommend rubbing flower heads on a rubber mat to separate the fruits and then using a medium screen or sieve to remove stems and chaff, with an Oregon Blower Unit at a speed of lower than 1.0 (depends on particular blower and tube diameter).
G. Seed storage	Store under cool, dry conditions to increase longevity.
H. Seed germination	Germination begins after the first significant fall rains (Jasper Ridge, CA; Rajakaruna et al. 2003b). Seeds will continue to germinate into December, but germination is greatly reduced, and the seedlings that germinate late may not survive to flowering in some areas (Jasper Ridge, CA; Hobbs & Mooney 1985). Litter decreased germination in a study of serpentine grasslands (Gulman 1992).
I. Seeds/lb	1,750,000 average live seeds per bulk pound; *L. californica* listed as having 4,000,000 seeds per PLS lb (S&S Seeds 2014, *L. gracilis* treated as *L. californica* and noted as dwarf goldfields). 3,250,000 average seeds per PLS pound (Stover Seed Company 2010).
J. Planting	Seeds are frequently hydroseeded in southern CA. Seed imprinting done in 2000-2001 also worked well at a site by Diamond Valley Reservoir in western Riverside County and the seeded population has persisted as of spring 2015 (A. Montalvo, pers. obs.).
K. Seed increase activities or potential	Yes. For example, S&S Seeds has harvested successfully from seed increase fields. Stock seeds collected in 1998 from a large western Riverside Co. population (accession T1165, now known to be *L. gracilis*) were planted to produce over 3,300 lbs of G1 seeds (A. Montalvo pers. obs, S&S Seeds pers. com.) with PLS ranging from 25.1% to 29.6%.
X. USES	
A. Revegetation and erosion control	Good for early cover. Included in seeding mixtures along highways in s CA by CalTrans and in restoration projects (A. Montalvo pers. obs.). Recommended for rehabilitation of disturbed lands (Newton & Claassen 2003). The "Interagency Burned Area Emergency Stabilization and Rehabilitation Plan" for the 2003 southern California fires in San Diego and Riverside counties recommended inclusion of *Lasthenia californica* (dwarf goldfields) as 30% of the seeds in a seeding mix with *Lupinus bicolor, Nassella pulchra, Lotus scoparius, Artemisia californica, Salvia apiana,* and *Eriogonum fasciculatum* for about 55 acres of dozer lines that were cut during fire-fighting efforts on lands managed by the Department of Interior (this was before the separation into two taxa was well known).
B. Habitat restoration	Both species are included in restoration seed mixtures. *Lasthenia californica* (as labeled by seed company) was one of only two species that performed well in one study (Talluto et al. 2006), and performance was related to water availability.
C. Horticulture or agriculture	Goldfields are sometimes used in landscaping of open, park like spaces, and openings in natural, dry landscaping projects (A. Montalvo pers. obs.).
D. Wildlife value	Flowers provide nectar for insects (small bees and flies and some butterflies). Flowers may be utilized for nectar by adult Quino checkerspot butterflies (*Euphydryas editha quino*) (USFWS 2001 in Sawyer et al. 2009). Seeds are cached and eaten by harvester ants (Hobbs 1985, Moore et al. 2011) and kangaroo rats (Olney 2008).
E. Plant material releases by NRCS and cooperators	None listed (NSN 2014).
F. Ethnobotanical	Seeds of *Baeria chrysostoma* were noted as used for food by the Cahuilla (Bean & Saubel 1972). Seeds were parched, ground, and made into mush. This was very likely *L. gracilis* rather than *L. californica* given that the home territory of the Cahuilla does not overlap with the distribution of *L. californica* .
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XII. CITATION

Montalvo, A. M., E. C. Riordan, and J. L. Beyers. 2017. Plant Profile for *Lasthenia californica* and *L. gracilis.* Native Plant Recommendations for Southern California Ecoregions. Riverside-Corona Resource Conservation District and U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Riverside, CA. Online: https://www.rcrcd.org/plant-profiles

XIII. LINKS TO REVIEWED DATABASES & PLANT PROFILES

Calflora (for LACA2)	https://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=4577
Calflora (for LAGR10)	https://www.calflora.org//cgi-bin/species_query.cgi?where-calrecnum=9143
Calscape (for LAGR10)	https://calscape.org/Lasthenia-gracilis-(Common-Goldfields)?srchcr=sc5bca2996dd1b5
Calscape (for LACA2)	https://calscape.org/Lasthenia-californica-ssp.-californica-(California-Goldfields)?srchcr=sc5bca2a563f1f2
Fire Effects Information System (FEIS)	No matches: https://www.feis-crs.org/feis/
Jepson Flora, Herbarium Jepson Interchange, for LACAC2	https://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?79084
Jepson Flora, Herbarium Jepson Interchange for LACA10	https://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?79082
Jepson eFlora (for LACAC2)	https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=79084
Jepson eFlora (for LACA10)	https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=79082
USDA PLANTS (for LACAC2)	https://plants.usda.gov/core/profile?symbol=LACAC2
USDA PLANTS (for LAGR10)	https://plants.usda.gov/core/profile?symbol=LAGR10
Native Plant Network Propagation Protocol Database (NPNPP)	No matches: https://npn.rngr.net/propagation
Native Seed Network (NSN)	No matches for http://www.nativeseednetwork.org/releases
GRIN	https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch.aspx
Flora of North America (online version) (LACA2)	http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250067043
Flora of North America (online version) (LAGR10)	http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250067052
Native American Ethnobotany Database (NAE)	http://naeb.brit.org/uses/search/?string=Lasthenia
Rancho Santa Ana Botanic Garden Seed Program, seed photos	http://www.hazmac.biz/rsabghome.html

XIV. IMAGES

Seed images by John Macdonald used with permission from Rancho Santa Ana Botanic Garden Seed Program (RSABG Seed Program), with rights reserved by RSABG. Images may not be used for commercial purposes.

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