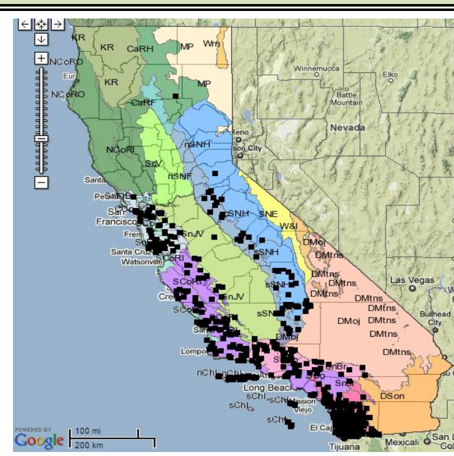
SPECIES	***Eriophyllum confertiflorum* (DC.) A. Gray var. *confertiflorum***
NRCS CODE: ERCOC12  © 2006 Steve Matson	Family: **Asteraceae** Order: **Asterales** Subclass: **Asteridae** Class: **Magnoliopsida**  seedling, A. Montalvo 2009   A. Montalvo 2004
Subspecific taxa	Of the two varieties, the focus of this profile is on var. *confertiflorum* . 1. *E. c.* var. *confertiflorum* 2. *E. c* . (DC.) A. Gray var. *tanacetiflorum* (Greene) Jeps. (FNA 2010, JepsonOnline 2010)
Synonyms	*E. c.* (DC.) A. Gray var. *discoideum* (Rydb.) Munz, *E.c.* (DC.) A. Gray var. *latum* H. M. Hall, *E.c.* (DC.) A. Gray var. *laxiflorum* A. Gray, *E. c.* (DC.) A. Gray var. *tridactylum (* Rydb.) Munz (USDA PLANTS 2010).
Common name	golden-yarrow, yellow yarrow, long-stemmed golden yarrow
Taxonomic issues	The FNA (2010), USDA PLANTS (2010), and JepsonOnline (2010) all recognize two varieties of *Eriophyllum c.* for North America. However, FNA lists only *E . c.* var. *latum* and *E. c.* var. *laxiflorum* as synonyms of var. *confertiflorum,* and JepsonOnline reports that the name *E. c.* var. *latum* is unresolved. Hybridization may make identification and classification difficult in this morphologically variable species.
Taxonomic relationships	Based on studies of between-taxon crossability and progeny fertility, *E. confertiflorum* is hypothesized to be most closely related to *E. lanatum* (Pursh) Forbes, which shares the same base number of chromosomes (n=8) and with which it hybridizes, and to *E. staechadifolium* Lag., n=19 (Mooring 1997). Constance (1937) also identified the more northern and coastal *E. staechadifolium* (Channel Is. northward) as a close relative based on shared morphological traits, including perennial habit, heads with short peduncles, and several other traits of the inflorescence.
Related taxa in region	*E. confertiflorum* var. *tanacetiflorum* (= *E. tanacetiflorum* Green), an octoploid (Mooring 1994), is native to oak woodlands of the central Sierra Nevada foothills and differs from *E. c.* var. *c.* primarily by having only 1-10 heads per inflorescence, longer disk flowers (3.5-4 mm), and wider involucres (5-7 mm) (JepsonOnline 2010). The low-stature annual species, *E. multicaule* (DC.) A. Gray and *E. wallacei* (A. Gray) A. Gray overlap in distribution with var. *confertiflorum* in southern California where they can co-occur in alluvial scrub habitat.
Other	Extremely variable in degree of compactness and leaf traits (Munz & Keck 1968, Munz 1974).
GENERAL	
Map	Data provided by the participants of the Consortium of California Herbaria represent 708 records for var. *confertiflorum* with coordinate data out of 1267 records retrieved; accessed 9/25/10; Some specimens may be misidentified. Berkeley Mapper: http://ucjeps.berkeley.edu/consortium note: the northernmost specimen was collected in 1874 by an unknown collector and with no number. An annotation by L. Constance in 1933 says "!Locality doubtful!" 

Geographic range	California, south into Baja CA (Hickman 1993, FNA). It is possible that range extensions have occurred due to its use in roadside seeding projects.
Distribution in California; Ecological section and subsection	Common in Northern Baja CA to n. CA except in the Central Valley, North coastal strand, deserts, and interior north west mountains (Munz 1974, Hickman 1993, JepsonOnline); Ecological Units and Subsections (http://www.fs.fed.us/r5/projects/ecoregions/ca_sections.htm): North coast ranges (263A), Northern California Coast Range (M261A), Central California Coast Ranges (M262A), Sierra Nevada (M261E) and Foothills (M261F), Central Western CA (M261B,C), SW CA (M261B,M262B), western edge of deserts (322A,C) (Hickman 1993).
Life history, life form	Polycarpic, subshrub; woody at base to slender stems (Munz 1974).
Distinguishing traits	The short, generally 2-6 dm tall, suffrutescent plants are generally tomentose, with soft whitish hairs flattened against the many erect stems that arise from a woody base. The undersides of the leaves are whitish-tomentose and the upper surface is greenish with sparse hairs. The blades are dissected into narrow, linear lobes with inrolled margins. The plants bear many dense heads of yellow flowers on short peduncles in compound corymbs born on leafy stalks, reminiscent of true yarrow in the genus *Achillea* ; each head bears 10-35 disk flowers and 4-6 ray flowers (sometimes 0), with corollas about 2-3 mm long. The 4 to 7 ovate and overlapping membranous bracts of the involucre (phyllaries) form an erect cup and are retained on the plant into the next flowering season (Munz & Keck 1968, Clarke et al. 2007).
Root system, rhizomes, stolons, etc.	Taproot (Clarke et al. 2007).
Rooting depth	Roots are generally < 0.5 m in depth (A. Montalvo, pers. obs., Andrew Sanders, curator, UCR Herbarium, pers. com.)
HABITAT	
Plant association groups	Coastal sage scrub, chaparral (Munz 1974). *E. c.* var. *c.* is considered to be an indicator of coastal sage scrub (Munz & Keck 1968) but it is also found in many other communities, sometimes as a co-dominant (Sawyer et al. 2009).
Habitat affinity and breadth of habitat	Dry slopes and washes near coast (Munz 1974) and dry slopes of inland valleys and foothills. Plants are a common component of postfire vegetation in coastal sage scrub and chaparral. Postfire populations tend to persist for up to five years (Keeley & Pizzorno 1986), but populations can persist in open areas and along roadsides. In a broad study of coastal sage scrub, Kirkpatrick & Hutchinson (1980) found plants primarily on slopes of northern aspect and more often on slopes under 5 degrees.
Elevation range	Below 3000 m (Hickman 1993).
Soil: texture, chemicals, depth	Disturbed, shallow, rocky soils (Mooring 1994); dry (Hickman 1993); granitic, unconsolidated soils, and other soils (Kirkpatrick & Hutchinson 1980). In the south Coast Ranges, it is associated with serpentine soils and may be an indicator for serpentine or other ultramaphic substrates (Kruckeberg 1984).
Drought tolerance	High (Mooring 1994).
Precipitation	Plants occur in areas that range from 10 to more than 25 inches annual precipitation.
Flooding or high water tolerance	Plants are not adapted to wet soils but do occur in middle to upper terraces of alluvial scrub where inundation is infrequent.
Wetland indicator status for California	None.
Shade tolerance	Withstands full sun to partial shade (O'Brien et al. 2006). Generally a full sun species, requiring at least some full sun in the day (Schmidt 1980).
GROWTH AND REPRODUCTION	
Seedling emergence relevant to general ecology	Seedlings are not found beneath the canopy of chaparral; following fire growth is from germinating seeds, not re-sprouts (Keeley et al. 1981). Seedlings emerge in the rainy season in mid winter.
Growth pattern (phenology)	Plants reach reproductive maturity (flowering) within two years and flower from May to August. Summer drought leads to leaf dormancy and a seasonal dimorphism in leaf growth (dry vs. growing season) (Westman 1981). Small leaves are produced on short shoots that grow from axillary buds along the main stem late in the growing season and persist through the dry season. Larger leaves are produced early in the growing season from the more elongated stems and tend to drop during summer drought. Plants become crowded out as taller shrubs develop in the years following fires (Keeley et al. 1981).
Vegetative propagation	None.

Regeneration after fire or other disturbance	Fire stimulates seed germination and plants become most abundant, sometimes in mass, after wildfire in coastal sage scrub and chaparral (Keeley & Nitzberg 1984, Keeley & Pizzorno 1986, Zammit & Zedler 1994).
Pollination	Pollen is dispersed by a diverse assemblage of insects, many of which are generalists. Mooring (1994) reports "bees and beetles" while Moldenke (1976) reports a diverse assemblage of insects, including butterflies, wasps, and many kinds of bees as flower visitors and potential pollinators.
Seed dispersal	Seeds (achenes) are very small and autodispersed over the summer (Keeley 1991).
Breeding system, mating system	Self-incompatible (Mooring 1975, 1994). Flowers that were enclosed in bags produced very few fruits, and only 0.2% germinated. Artificial self-pollinations were not attempted.
Hybridization potential	High; natural hybridization with *E lanatum* var. *arachnoideum* (Hickman 1993; Mooring 1994; Mooring 2001). Visitation by generalist pollinating insects may increase potential for hybidization in areas where related taxa overlap in flowering.
Inbreeding and outbreeding effects	Crosses among geographically distant, diploid populations of *E. c.* var. *confertiflorum* resulted in outbreeding depression, with more distant crosses having lower seed germination than close crosses (Mooring 1994). However, germination of first generation (F_1) seeds and pollen viability of progeny (an indicator of hybrid sterility) did not differ significantly between intra- and inter-variety crosses between *E. c.* var. *confertiflorum* and *E. c.* var. *tanacetiflorum* (Mooring 1994). Hybridization with the related *E. lanatum* yielded on the average, <65% pollen viability in offspring while intra-variety hybridization yielded 75% pollen viability.
BIOLOGICAL INTERACTIONS	
Competitiveness	Although frequent after fire, plants die out as the canopies of lager, woody shrubs close in (A. Montalvo, pers. obs.).
Herbivory, seed predation, disease	"Insect larvae" consume ~25% of fruits (Mooring 1994). A tephritid fly, *Paroxyna genalis*, consumes ovules and achenes of *Eriophyllum lanatum* and other Asteraceae in southern California, presumably including *E. confertiflorum* (Goeden et al. 1994).
Palatability, attractiveness to animals; response to grazing	
Mycorrhizal?	Plants are thought to be associated with vesicular mycorrhizal fungi (L. Legerton-Warburton, pers. com), and the closely related *E. lanatum* has been shown to be colonized (Ingham & Wilson 1999).
ECOLOGICAL GENETICS	
Ploidy	Ploidy is variable but generally consistent within a single population. The base chromosome number is n=8 (Mooring 1966); diploids and tetraploids can be equally frequent and hexaploid and octoploid populations have been reported (based on 130 populations, Mooring 1994, 2n = 16, 32, 48, 64).
Plasticity	Seeds are polymorphic: 25% from a given pool will germinate readily while the other 75% require stimulation (Keeley & Pizzorno 1986). Plants are seasonally dimorphic and produce two kinds of leaves through the growing season (Westman 1981).
Geographic variation (morphological and physiological traits)	Plants are highly variable across the species range. Height, size, leaf, and flower differences tend to be similar within locations and may be influenced by light and soil variability (Mooring 1994). There are geographic patterns in diploid vs. tetraploid chromosome number (Mooring 1994). In the south, diploid populations are associated with xeric sites in coastal sage scrub, chaparral, and woodland. North of Santa Barbara and the Tejon Pass, xeric diploid populations extend northward in the Interior Coast Ranges, but in Coast Live Oak and Blue Oak Woodlands, diploid populations tend to be associated with more mesic sites. Tetraploid populations are concentrated in northern California, where they are found in the more xeric sites. Mooring (1994) hypothesized that the formation of polyploids may be induced in harsh conditions and that this may explain the segregation of the two types in the north, but not in the south. Constance (1934) mentions the possibility of genetic races at higher elevations.
Genetic variation and population structure	
Phenotypic or genotypic variation in interactions with other organisms	

Local adaptation	This is a highly variable and widespread species in California that occurs over a large range of elevation and precipitation gradients. It is common for plants to develop adaptive genetic differences between populations along steep environmental gradients. The variation in ploidy that correlates with habitat suggests there may be other important genetic and adaptive differences among populations. However, the outcrossing nature of this plant and potentially high gene flow potential suggest that the scale of adaptive differences will be on the scale of ecological sections and possibly subsections when there are large steps in elevation among subsections. Studies are needed to examine the scale of genetic differentiation and how that may affect translocation within vs. among ecological sections.
Translocation risks	The observed drop in seed germination after experimental crosses among different varieties of *E. confertiflorum* and among geographically distant populations of diploid var. *confertiflorum* suggests that there is a risk to geographically distant translocations. The scale of the distances that are associated with losses in fitness have not been studied. It would be prudent to only move seeds within geographic regions of adaptation and to avoid mixing diploid and tetraploid populations in fields used for seed increase. In addition, avoid mixing *E. confertiflorum* and *E. lanatum* in the same plant palette for restoration except when planting in specific locations where they occur together naturally
SEEDS	Rancho Santa Ana Botanic Garden Seed Program, seed image: http://www.hazmac.biz/050314/050314EriophyllumConfertiflorum.html
General	Standards for minimum purity and germination have been supplied by various seed companies: 30% purity, 60% germination (S&S Seeds, pers. com.). For *Eriophyllum* taxa in CA, seed germination ranges from 50-95% (Mooring 1975). Achenes (one seeded fruit) are small (2-3 mm long). Each achene has a pappus of short (< 1mm long) paleae that vary in size (Munz & Keck 1968). Seeds accumulate in soil seedbank. In chaparral in San Diego Co., Zammit & Zedler (1994) found that seeds in the soil seed bank did not respond significantly to fire treatments and that soil seed densities increased significantly with crown cover of perennial shrubs.
Seed longevity	*Eriophyllum* taxa in CA, seeds stored at room temperature have germinated after 8 years (Mooring 1975). Unlike many Asteraceae, seeds are generally long-lived in soil seed banks of this fire-follower.
Seed dormancy	Up to 25% of seeds will germinate readily without pretreatment (Mirov & Kraebel 1939, Keeley et al. 1985, Keeley & Pizzorno 1986, Emery 1988). The other 75% require dormancy breaking treatment. Light stimulates germination, but is not necessary when seeds are exposed to extracts from charred wood, which can increase germination to over 80% (Keeley & Pizzorno 1986). Direct heating of seeds does not increase germination (Christensen & Muller 1975, Keeley & Keeley 1982), but application of charred wood extract (i.e., charate made by running water through powdered, charred *Adenostoma fasciculatum* stems) significantly increases germination. When heat (120°C five minutes) is combined with charate, there is a small synergistic effect (Keeley & Keeley 1982, Keely et al. 1985). Heated lignin and cellulose or tannic acid with pH of 7 also enhanced germination. Keeley and Nitzberg (1984) showed that simply heating wood to over 175°C produces water soluble compounds that significantly stimulate germination.
Seed maturation	Timing of seed maturity depends on location and the pattern of rainfall. Mirov and Kraebel (1939) report May-September for seed collection.
Seed collecting	When the phyllaries are dry, and achenes are ripe, the whole top of the inflorescence can be harvested with clippers and placed in open container or breathable bag (e.g., cloth, paper).
Seed processing	For seed banking, Wall and MacDonald (2009) recommend rubbing the dry flower heads over a medium screen, sifting through #18 and #25 sieves, and then using an Oregon Seed Blower unit at speed 1.5 to clean. The Bend Seed Extractory used a Hoffman Hand Debearder to open the capsule-like heads and then air screened to clean to 96% purity and 96% filled seeds (see NPNPP protocol link below). For direct seeding and bulk seed storage, the dry heads can be placed in a blender with tape over the blades to break up heads, then sieved to separate large chaff from the tiny seeds (Montalvo, pers obs.).
Seed storage	Seeds can be stored at room temperature several years (Mooring 1975). Cold, dry storage is likely to increase longevity in storage.
Seed germination	Seeds take about 11 days to germinate after moistened (Mirov & Kraebel 1939). Germination response varies with seed source and test conditions (Keeley & Pizzorno 1986), but about a quarter of seeds tend to germinate in light at 20°C with no treatment (Atwater 1980).
Seeds/lb	2,750,000 seeds/lb (S&S Seeds 2009) 2,600,000 seeds/lb (Mirov & Kraebel 1939)
Planting	The tiny achenes are planted shallowly or on the surface. They do well when hydroseeded or planted with shallow sowing methods.

Seed increase activities or potential	Rolle (2004) reported success with four fall plantings of the related *Eriophyllum lanatum*. Good seed crops were produced in the first year and for several years.
Recommendations for seed production	Data on outbreeding depression, variation in ploidy within species, and lowered pollen viability of among species (inter-specific) hybrids suggest that there would be undesirable consequences if populations from widely different habitats or locations were mixed for restoration or seed increase purposes. Due to ease of hybridization, fields of *E. confertiflorum* and *E. lanatum* (or different varieties of the same species) should not be placed in close proximity. These species are highly outcrossing and some of their pollinators can forage over long distances. We recommend that isolation distances between seed increase fields be large enough to discourage natural hybridization between fields of different species and different populations of the same species. This may require placing fields on different farms. Seeding with mixtures of genetically and geographically disparate populations is discouraged, especially if the planting site is on the drier end of the species range.
USES	
Revegetation and erosion control	This species germinates in the winter, grows rapidly, and is good for erosion control on slopes. Plants are frequently recommended and used successfully in seeding mixtures to stabilize dry slopes from northwestern California to southern California (Newton & Claassen 2003, A. Montalvo pers. obs).
Habitat restoration	Used widely in restoration seeding of coastal sage scrub vegetation (Montalvo pers. obs.) and other habitats (Newton & Claassen 2003). Seeds are easily collected from wildlands and are frequently available from native seed companies. This species is a good choice for planting on bare, sterile soils and for kick-starting the early successional stages of a restored shrubland community.
Horticulture or agriculture	Horticulture: The masses of golden-yellow flowers make it an attractive ornamental for home gardens and ecological landscaping and can provide color into the summer, especially in rock gardens and along borders (Schmidt 1980, Keator 1990, 1994, Clarke & Toogood 1994). Agriculture/Restoration: Plants can be easily cultivated from seed in well-drained soil and do best in full sun for at least part of the day (Schmidt 1980). Container plants are easy to produce from seeds, and plants transplant well (Montalvo pers. obs.).
Wildlife value	Flowers offer a food resource for many nectar-foraging insects (Moldenke 1976). In a study in the San Gabriel Mountains, *E. confertiflorum* made up 5.6% of the plants browsed by mountain sheep, as determined in fall fecal samples (Perry et al. 1987).
Plant material releases by NRCS and cooperators	None.
Ethnobotanical	Yaeger (1941) reported that southern California tribes used the white wooly hairs as a remedy for rheumatism by rolling the hairs into a ball, placing it on the affected part, and lighting it on fire. No verification of this has been found.
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LINKS TO REVIEWED DATABASES & PLANT PROFILES (last accessed September 25, 2010)	
Fire Effects Information System (FEIS)	No matches: http://www.fs.fed.us/database/feis/plants/index.html
Jepson Flora, Herbarium (JepsonOnline)	http://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?2814
Jepson Flora, Herbarium, 2nd Edition Review (JepsonOnline 2nd Ed.)	http://ucjeps.berkeley.edu/tjm2/review/treatments/compositae.html#2814
USDA PLANTS	http://plants.usda.gov/java/profile?symbol=ERCOC12
Native Plant Network Propagation Protocol Database (NPNPP)	http://www.nativeplantnetwork.org/Network/ViewProtocols.aspx?ProtocolID=3416

Native Seed Network	http://www.nativeseednetwork.org/viewtaxon?taxon_code=ERCO25&release_name=
GRIN	no matches: http://www.ars-grin.gov/
Flora of North America (FNA) (online version)	http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250066707
Calflora	http://www.calflora.org/
Rancho Santa Ana Botanic Garden Seed Program, seed photos	http://www.hazmac.biz/rsabghome.html
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