I. SPECIES	*Lepidospartum squamatum* (A. Gray) A. Gray

NRCS CODE: LESQ

Family: **Asteraceae**
Order: **Asterales**
Tribe: **Senecioneae**
Class: **Magnoliopsida**

Discoid head (top). Whitish pappus of ripe achenes (bottom).

Scale leaves (top); mature plant in early April before active growth resumed (bottom); flowering plant and plant in fruit in fall (right). (photos, A. Montalvo)

A. Subspecific taxa	None currently recognized (Jepson eFlora 2016, FNA 2016).
B. Synonyms	*L. squamatum* var. *palmeri* (A. Gray) A. Gray L. C. Wheeler. (FNA 2016) *L. squamatum* (A. Gray) A. Gray var. *obtectum* Jeps. (Munz & Keck 1968, Munz 1974) *Linosyris squamata* A. Gray *Tetradymia* s. A. Gray (Munz 1974) *Baccharis sarothroides* A. Gray var. *pluricephala* Jeps. (JepsonOnline)
C. Common name	Scalebroom; also scale-broom, California broomsage, broomscale (Calflora 2016, Painter 2016)
D. Taxonomic relationships	Phylogenetic work shows *Lepidospartum* is most closely allied with *Tetradymia* (Pelser et al. 2007). There are three species of *Lepidospartum* in North America (FNA 2016). *Lepidospartum latisquamum* S. Watson occurs in desert washes and fans in eastern California, Utah, and Nevada from about 3,000 to 8,200 ft (915 to 2,500 m). *L. burgessii* B. L. Turner is a rare taxon associated with gypsum soils in desert basins of New Mexico, Texas, and Mexico.
E. Related taxa in region	*L. latisquamum* potentially overlaps in distribution with *L. squamatum* in the Mojave Desert region and lower edges of the San Gabriel Mountains from the Cajon Pass area northward. It differs from *L. squamatum* in having fewer (only 4–6) flowers per head, corollas extending well beyond the involucre, tomentose phyllaries, and much longer, thread or needle like leaves (20–30 mm).
F. Taxonomic issues	The previously recognized variant, *L. s.* var. *palmeri* occurs in more arid regions near Twentynine Palms and the head of the Coachella Valley from Palm Canyon to Whitewater and Morongo washes in Riverside Co. (Wheeler 1938, Munz & Keck 1968). This same variant was recognized by Jepson (1925) as *L. s.* var. *obtectum. L. s.* var. *palmeri* continues to be listed for sale by seed companies in California (NSN 2016).
G. Other	The name *Lepidospartum* originates from the Greek words *lepis* (for scale) and *sparton* (rope, cable) which together refer to broom-like branches with small scale-like leaves (McMinn 1939). Scalebroom is an indicator species of alluvial scrub vegetation and the *Lepidospartum squamatum* Alliance. This vegetation alliance has a CNPS global listing of G3 and state listing of S3, but some associations within this alliance are rare and listed as G1, S1.1 (Sawyer et al 2009). The G1, S1 ranking is for natural communities at high risk of extinction or elimination and the .1 stands for very threatened status (Evens 2011). This includes Riversidean Alluvial Fan Sage Scrub as classified by Holland (1986). *L. squamatum* can form spreading clones and should not be planted in gardens or close to homes in areas where its underground spreading rhizomes can send up shoots and potentially crack concrete foundations. The plant is a good indicator of episodic scouring floods, so avoiding development in habitat occupied by scalebroom makes sense for multiple reasons.

II. ECOLOGICAL & EVOLUTIONARY CONSIDERATIONS FOR RESTORATION

A. Attribute summary list (based on referenced responses in full table)

Taxonomic stability - high
Longevity - medium to long-lived
Parity - polycarpic
Flowering age - ~ 2 years
Stress tolerance - moderate to high
Environmental tolerance - narrow
Reproduction - facultative seeder, clonal
Fragmentation history - historical and recent
Habitat fragmentation - high at low elevations
Distribution - restricted, alluvial deposits low to mid-elevations

SDM projected midcentury habitat gain - gain highly variable (7–329 %); gain > loss under 4 of 5 future climate scenarios (assuming unlimited dispersal)

Seeds - non-dormant, short lived
Seed dispersal distance - far
Pollen dispersal - intermediate to far
Breeding system - outcrossed
Population structure - unknown; low in congeners
Adaptive trait variation - unknown
Chromosome number - variable
Genetic marker polymorphism - unknown; but high in related congeners
Average total heterozygosity - unknown; high in related congeners
Hybridization potential - low

SDM projected midcentury suitable habitat - 12–100 % stable (highly variable)

B. Implications for seed transfer (summary)

Scalebroom has low seed set similar to the other two species of *Lepidospartum* studied by Williams et al. (2016) and factors determining seed set are likely similar. If inbreeding among relatives or insufficient numbers of S-alleles are responsible for the low seed set, combining seeds from different subpopulations or watercourses within Ecological Subsections may be beneficial to sexual reproduction within restored populations and agricultural seed increase fields by alleviating inbreeding depression and augmenting S-allele variation which can increase compatible matings. Seed collections should be well spaced through populations to ensure collection from multiple clones.

Scalebroom is expected to have medium to high dispersal capacity within local watersheds owing to its wind dispersed seeds, growth in open areas, ability for stems and roots to disperse and establish downstream by flood waters, and pollen dispersal by bees. Habitat connectivity and dispersal within stream corridors and local watersheds is likely to be much higher than across local watersheds because lateral habitat connectivity can be restricted by other plant communities, steep topography, and development. Within drainages, it is reasonable to mix seeds from adjacent Ecological Subsections.

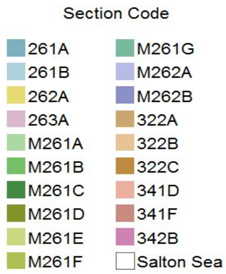
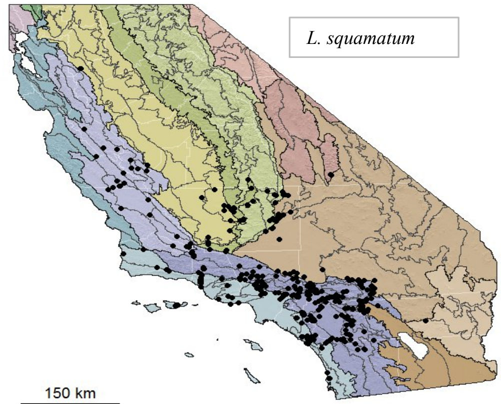
Scalebroom is restricted to alluvial habitats and should only be planted in areas that have the fluvial processes and substrates to which the plant is adapted. Populations occur along washes that flow from the coast ranges westward and along washes that flow from inland mountains northward andeastward into the Mojave Desert. Wash habitats often cross the boundaries of adjacent Ecological Subsections and sometimes Sections. There have been no studies to quantify the effects of moving plants among similar vs. dissimilar ecoregions, such as among coastal areas, inland valleys, and deserts. Therefore, Ecological Sections should not be combined when mixing seeds from populations within different stream channels.

Results of Species Distribution Modeling are highly variable. Three of five models together predict 93% stability of suitable habitat. However, the highest potential gain is predicted for a hotter, wetter future, while high potential loss of suitable habitat is predicted for the two hottest futures.

III. GENERAL

A. Geographic range

Widespread in central and southern California deserts, inland valleys and foothills, Arizona, and Baja California in alluvial deposits along washes, river terraces, and alluvial fans. McMinn (1939) described the distribution of scalebroom as primarily cismontane southern California in sandy washes and gravelly places below 5000 ft (~1,500 m), mostly inland away from the immediate coast. McMinn noted collections from as far north as the upper San Joaquin Valley and the drier, inner South Coast Ranges of Alameda County, but such northerly records have been sparse. Collections from the eastern portion of the Mojave Desert and the Colorado Desert need to be verified, as do a few collections from the southern Great Basin in the vicinity of *L. latisquamum.*

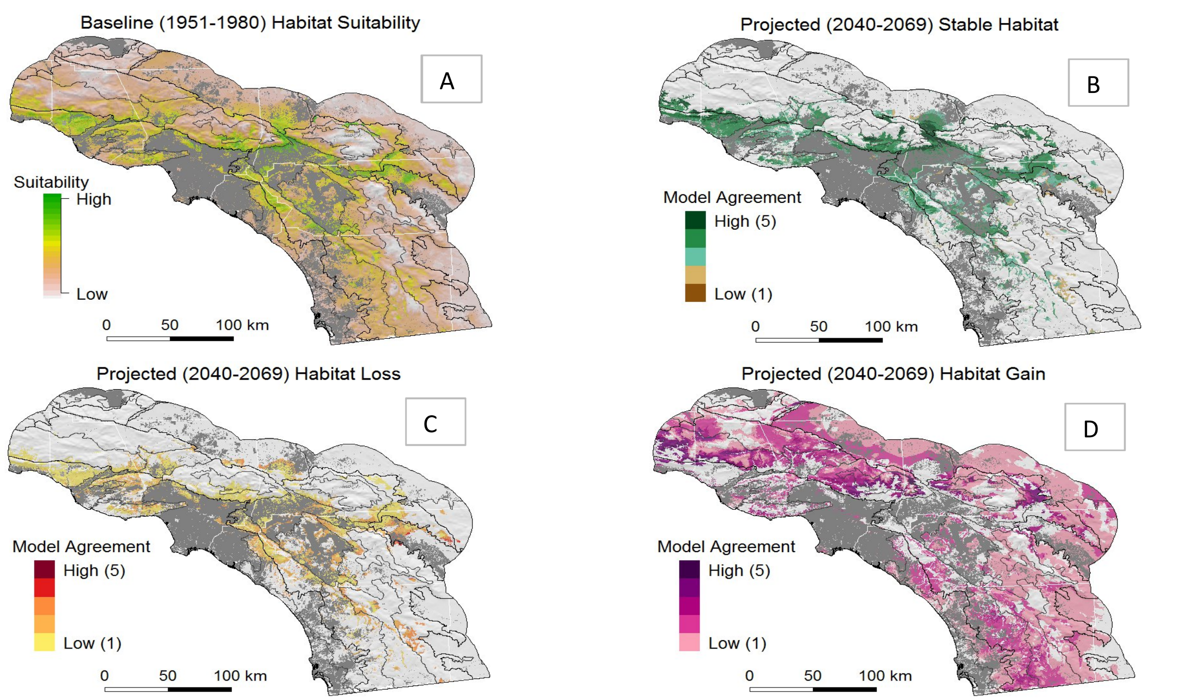
B. Distribution in California mapped onto ecological section/subsection (*sensu* Goudey & Smith 1994; Cleland et al. 2007)  	Map includes validated herbarium records (CCH 2016) as well as occurrence data from CalFlora (2016) and field surveys (Riordan et al. 2018). Legend has Ecological Sections; black lines are subsections  Sierra Nevada M261E: r,u Sierra Nevada Foothills M261F: d,e Great Valley 262A: g,q,w,y,z Central California Coast 261A: l Central California Coast Ranges M262A: c-h,j Southern California Coast 261B: a-g,i,j Southern California Mountains and Valleys M262B: a-l,n,o,p Mojave Desert 322A: f,g,h,n,p Sonoran Desert 322B: e
C. Life history, life form	Long-lived perennial, clone-forming shrub. In the wild, may live over 70 years (Sawyer et al. 2009). Under cultivation at Rancho Santa Ana Botanic Garden, plants lasted about 15 years (Everett 2012).
D. Distinguishing traits	One to two meter high erect to spreading broom-like shrub with alternate, entire, scale-like leaves (McMinn 1939, Munz 1974, Keil & Barkley 2016). The heads occur singly at the tips of branches and bear 9–17 disk flowers subtended by three to four series of closely imbricate involucre bracts (phyllaries) that are unequal in size. The receptacle lacks chaff. The achenes produce a whitish pappus of finely scabrous capillary bristles. Seedlings and juvenile plants produce linear to oblanceolate leaves that are canescent (whitish with dense, appressed hairs). New resprouts can also produce some juvenile leaves. The juvenile leaves give way to glabrous scale leaves as the plant matures (see X. C. Horticulture and agriculture for photo). Older shrubs can accumulate many fine, dead branches.
E. Root system, rhizomes, stolons, etc.	Forms lateral, suckering roots. Plants spread horizontally very slowly but resprout rapidly from underground structures after disturbance.  Prenda Wash, Riverside Co. (A. Montalvo) 
F. Rooting depth	Rooting depth is relatively shallow, but can be laterally extensive. Roots and rooted stems may be deep in fluvial deposits. No measurements were found.

IV. HABITAT

A. Vegetation alliances, associations	In southern California, alluvial scrub communities with scalebroom are diverse in composition and structure (Smith 1980, Hanes et al. 1987, Burk et al. 2007, Barbour & Wirka 1997, Buck-Diaz et al. 2011). Scalebroom commonly occurs with the subshrubs *Eriogonum fasciculatum* (var. *polifolium* or var. *foliolosum*), *Ericameria* (*linearifolia* and/or *pinifolia*), *Artemisia californica, Salvia mellifera, Salvia apiana, Acmispon glaber (* var. *glaber* or var. *brevialatus*), and/or *Hesperoyucca whipplei*. Depending on location, scattered larger shrubs may be present, such as *Rhus ovata, Malosma laurina*, *Rhamnus crocea, Toxicodendron diversiloba,* and *Baccharis salicifolia*. The large, suffrutescent perennials *Eriodictyon trichocalyx* or *Eriodictyon crassifolium* and *Romneya coulteri* and a large number of ephemeral annuals can also occur with scalebroom, depending on geographic location and frequency of flooding. The trees *Quercus agrifolia* and *Platanus racemosa* may also be scattered in alluvial scrub habitat with scalebroom. Because many of the associated shrubs are key components of sage scrub, Kirkpatrick & Hutchinson (1977) considered alluvial scrub with scalebroom to be a form of coastal sage scrub. Some of the named plant communities are as follows: Manual of California Vegetation - MCV2 (Sawyer et al. 2009): *Lepidospartum squamatum* shrubland alliance (membership rule >1% cover in alluvial environments): major associations in our region include *L. squamatum-Artemisia californica* scrub, *L. squamatum-Eriogonum fasciculatum* scrub, *L. squamatum-Atriplex canescens* scrub, *L. squamatum-Eriodictyon crassifolium-Hesperoyucca whipplei* scrub, *L. squamatum-Eriodictyon trichocalyx-Hesperoyucca whipplei* scrub, and *L. squamatum*/ephemeral annuals scrub. Holland system (Holland 1986): Alluvial fan chaparral, Mojave Desert wash scrub, Riversidean alluvial fan sage scrub.

B. Habitat affinity and breadth of habitat	Low gradient alluvial deposits along intermittently to episodically flooded washes, streams, stream terraces, and fans (McMinn 1939, Sawyer et al. 2009).
C. Elevation range	30–1600 m (FNA 2016)
D. Soil: texture, chemicals, depth	Well-drained alluvial deposits. In a study in the upper Santa Ana River flood plain, Burk et al. (2007) found scalebroom tolerated a range of alluvial substrates from fines to gravel as well as accumulated organics. The sediments can be derived from a variety of parent materials, including granitic substrates and various sedimentary rocks.
E. Precipitation	Precipitation falls primarily from November through May during the cool season in most of scalebroom's range; summer monsoon rains are common in portions of the Mojave Desert where scalebroom is less common. Though rainfall is variable across its range, scalebroom tends to grow in areas with a total annual precipitation of 10 to 30 in (25 to 75 cm). In southern California, annual precipitation normals range from 10 to 40 in for interior Southern California Mountains and Valleys (M262B), 14 to 50 in for areas along the Southern California Coast (261B), and 20 to 40 inches for the Sierra Nevada Foothills (M261F). The total annual precipitation may be less important than the amount of water that flowsthrough occupied habitat.
F. Drought tolerance	Appears tolerant of summer drought, but may partially escape drought by growing in sandy channels.
G. Flooding or high water tolerance	Adapted to areas having dynamic fluvial processes(Sawyer et al. 2009) tolerating episodic to intermittent flooding events and areas that receive scouring floods. Bendix (1999) found *L. squamatum* associated with a 20-year flood zone recovered quickly after flooding.
H. Wetland indicator status for California	For Arid West Region = FACU (facultative upland); for Western Mountains, Valleys, and Coast = FACU (USDA Plants 2016).
I. Shade tolerance	Full sun.

V. CLIMATE CHANGE AND PROJECTED FUTURE SUITABLE HABITAT



A. Species Distribution Models (SDM forecasts, Riordan et al. 2018) Map descriptions	Modeled habitat suitability under (A) baseline (1951–1980) and (B–D) projected midcentury (2040–2069) climate conditions. Projected future habitat suitability maps show agreement across five different climate model scenarios: (B) stable = suitable under both baseline and future conditions; (C) loss = suitable under baseline but unsuitable under future conditions; (D) gain = unsuitable under baseline and becoming suitable under future conditions. In all maps, land area that has already been converted to urban and agriculture land uses is masked in dark gray (FRAP 2015 Assessment; https://map.dfg.ca.gov/metadata/ds1327.html).

B. SDM summary

Species distribution model predictions of future suitable habitat for scalebroom under 21st century climate change are variable. Assuming a future of continued high greenhouse gas emissions, Riordan et al. (2018) predicted 12–100% of baseline habitat in southern California would remain suitable (stable) under mid-century conditions across future climate scenarios from five different general circulation models (GCMs) (SDM maps Fig. B). Predicted gain in suitable habitat exceeded loss under four of the five climate scenarios (SDM maps Figs. C-D), but predictions varied widely among climate scenarios (7–329%; SDM maps Fig. D). The greatest gain in suitable habitat was predicted under the wettest scenario considered, while the greatest loss (88%) in suitable habitat was predicted under the driest scenario considered. Contrasting modeling work by Principe et al. (2013) predicted that most of the currently suitable habitat for scalebroom would remain suitable by mid-century. Their models also differed in the geographic distribution of habitat suitability with a greater area of San Diego Co. predicted to be suitable under current climatic conditions.

SDM predictions should be interpreted with caution. Scalebroom is sensitive to the substrate and fluvial dynamics of alluvial fans and outwashes, factors that are not well captured in the environmental predictors of the SDMs (Riordan et al. 2017). An overlay of fans and streams with alluvial deposits would provide more resolution as to where the plants might grow within the predicted suitable habitat. In some cases, the correlative approach used to relate distributional data with environmental conditions may not correlate with the population-level processes driving species' persistence, as when extinction risk is sensitive to life history traits (Fordham et al. 2012). Additionally, other threats, such as human land use, invasive species, and fire, may interact with climate change. The high degree of habitat conversion and fragmentation in southern California creates a considerable barrier to dispersal and gene flow that could negatively affect the ability of the species to respond to changing conditions.

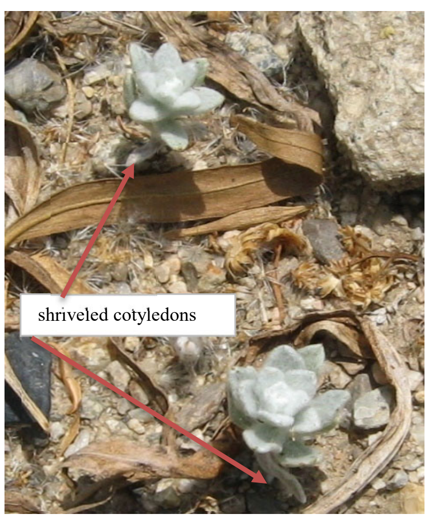
C. Modeling caveats (concerns)

The five general circulation models (GCMs) used to predict future habitat suitability assume a 'business-as-usual' scenario of high greenhouse gas emissions that tracks our current trajectory (IPCC scenario RCP 8.5). They show how climate may change in southern California and highlight some of the uncertainty in these changes. The true conditions at mid-21st century, however, may not be encompassed in these five models. Predictions of current and future habitat suitability should be interpreted with caution and are best applied in concert with knowledge about the biology, ecology, population dynamics and demographics of the species. They are best interpreted as estimates of exposure to projected climate change. Our models characterize habitat suitability with respect to climate and parent geology but do not include other factors, such as biotic interactions or disturbance regimes, that may also influence species distributions. Additionally, they do not include the adaptive capacity of a species, which will affect its sensitivity to changes in climate. See Riordan et al. (2018) for more information on SDM caveats.

VI. GROWTH, REPRODUCTION, AND DISPERSAL

A. Seedling emergence relevant to general ecology

Seedlings emerge in openings in alluvial scrub vegetation on alluvial substrates. The cotyledons are green, glabrous, and linear. The first true leaves are broadly ovate and whitish with dense woolly hairs (canescent). Branches with scale leaves start to grow within 5 months. The timing of emergence appears to vary with temperature and moisture conditions but is typically in late winter to early spring.



Approximately 1.5 cm wide seedling on 5/12/2009. Seedlings are less than two months old. Photo, A. Montalvo, RCRCD.

Juvenile plant on 8/2/2011 establishing in flood-carried sediments. Seedling about 5 months old. Photo, A. Montalvo.

B. Growth pattern (phenology)	Growth patterns in southern California are more similar to species that grow in riparian environments than to plants typical of sage scrub and chaparral shrublands. Seedlings typically emerge in safe sites in outwash deposits during the winter rainy season or after episodic flood waters have receded. In the field, plants can take several years to reach reproductive maturity. Most vegetative growth occurs from early spring to mid-summer. Flowering occurs primarily from mid-summer into the fall, peaking September–October (Jepson eFlora 2016, map of CCH collections by month). Most seeds disperse in the late fall after which plants appear inactive and dormant until late winter or spring. In western Riverside County, after unusual early summer rainfall events, plants may flower and disperse seeds earlier than usual (A. Montalvo pers. obs.). In a study of Mojave Desert shrubs from April 2006 to April 2007, maximum stomatal conductance for *L. squamatum* was observed in November and minimums were observed in the cold winter months of December and March (Jacobsen et al. 2008). The maximum (least negative) seasonal water potentials were observed in August during the dry summer period, which coincides with flowering. The authors noted that the distribution of this species extends eastward into summer rainfall regions of the eastern Mojave Desert and Arizona where summer rainfall events are common. Plants may have the capacity to respond to different rainfall patterns.
C. Vegetative propagation	Plants can be propagated from underground runners (Everett 2012). Pieces of plants are able to travel downstream during floods and sprout from under the sediments (Sawyer et al. 2009). The extent and diversity of clones (size and distribution of genotypes) has not been studied.
D. Regeneration after fire or other disturbance	Plants resprout readily from underground root/stem structures after shearing from flood scour, after being buried by sediments, or after fire (Sawyer et al. 2009, A. Montalvo pers. obs.) They can sprout from stems and root crowns after burial by deep flood sediments or after disturbance from grading for development purposes. Plants have thin bark and a canopy structure that is considered fire sensitive(Sawyer et al. 2009), despite ability to resprout postfire.  Damaged stems resprouting from roots after scouring flood waters in Freemont Canyon Wash, Orange Co., California. Photo, A. Montalvo.
E. Pollination	Flowers are visited by a variety of bees, wasps, flies, and butterflies (Moldenke 1976). Moldenke lists many visitors, especially Halictid bees, *Xylocopa* , and what he refers to as the "guild of Compositae-specific bees of diverse families". See slide share site http://www.slideshare.net/cvadheim/promoting-pollinators-2010). The larger bees, such as *Xylocopa* and honey bees are known to forage over substantial distances of over 1,000 to 10,000 km (Zurbuchen et al. 2010).
F. Seed dispersal	Wind dispersed. The single-seeded achenes (regarded as seeds) have a long pappus and are readily carried away by wind. Strong Santa Ana winds often occur during seed dispersal season in Riverside County.
G. Breeding system, mating system	Genus listed as self-incompatible (Moldenke 1976) and primarily outbreeding. Scalebroom heads produce perfect flowers (both male and female parts) with an unspecialized pollination mechanism allowing insects to transfer self pollen to stigmas of flowers within a plant. Studies of the closely related, rare plant *Lepidospartum burgessii* show that self-pollen fails to germinate on its stigmas indicating possible sporophytic incompatibility, a trait possessed by many plants in the Asteraceae (Ladyman 2004). In clonal plants, such incompatibility can result in many flowers failing to develop seeds (Rogers & Montalvo 2004, Williams et al. 2016).
H. Hybridization potential	There are no studies of hybridization potential and hybrid compatibility, but the primarily allopatric (non-overlapping) distribution of taxa within *Lepidospartum* suggests hybridization potential is low. Taxa might occasionally overlap in the Mojave Desert region.

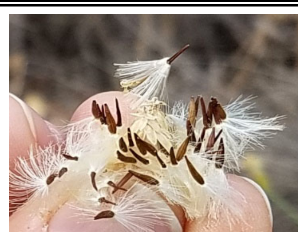
I. Inbreeding and outbreeding effects	Ability to form clones provides opportunities for increased receipt of self pollen, but the degree of inbreeding and inbreeding effects have not yet been studied. Research on scalebroom's relative *L. burgessii* noted that the rare endemic plant's low seed set may be the result of inbreeding and/or a lack of compatible mates because in rare, self-incompatible plants, populations with low genetic variation sometimes suffer from a low incidence of compatible mates (Williams et al. 2016). Inbreeding coefficients for two populations of *L. burgessii* (F_{IS} = 0.38 and 0.24) were relatively high but a bit lower than for the widespread *L. latisquamum* (F_{IS} = 0.44) (Williams et al. 2016). The high inbreeding coefficients suggest relatively high inbreeding among close relatives which could result in genetic drift influencing population structure if dispersal is limited. Given scalebroom's distribution and dispersal abilities, it is likely that inbreeding coefficents are lower than for these other species.

VII. BIOLOGICAL INTERACTIONS

A. Competitiveness	Plants tend grow in alluvial scrub vegetation communities with low cover relative to adjacent stands of chaparral, coastal sage scrub, oak woodland, or riparian scrub such as mulefat-willow scrub.Young seedlings are not likely to be good competitors.
B. Herbivory, seed predation, disease	Larvae of various insects feed on the flowers and developing fruits including the Typhridid fly *Neaspilota viridenscens* (Goeden 1989), the Lepidopteran moth *Lycomorpha regulus* (Comstock & Henne 1967), and the Hemipteran bug *Largus californicus* (Booth 1990).
C. Palatability, attractiveness to animals, response to grazing	The vegetative plant produces a strong, pungent odor that likely deters mammalian herbivores. Reported to be toxic and unpalatable to livestock (Keil & Barkley 2012). Plants produce abundant quantities of the sesquiterpine compound epoxydecompostin (Flamm et al. 1976).
D. Mycorrhizal? Nitrogen fixing nodules?	Bethlenfalvay et al. (1984) reported association with vascular arbuscular mycorrhizal fungi (VAM) in the genus *Glomus* with roots of *Lepidospartum squamatum* in a site in the desert (Anza Borrego State Park). The VAM fungi found are considered non-host-specific. No reports were found for alluvial sage scrub occurrences.

VIII. ECOLOGICAL GENETICS

A. Ploidy	2n = 60, 90 (FNA 2016). Ornduff et al. (1963) and Strother (1983) reported a base number of x = 10 and n = 30. No geographic patterns to the variation in ploidy have been reported.
B. Plasticity	No published studies that quantify plasticity or environmental variation. Leaf form can be variable within plants depending on age and sprouting status (see III. B. Distinguishing traits), and flowering time can vary depending on rainfall patterns.
C. Geographic variation (morphological and physiological traits)	No published studies of geographic variation. Wheeler (1938) noted two, localized morphological variants, but no substantial spatial patterns. There is a local form from the Whitewater area of the Coachella Valley he recognized as *L. s.* var. *palmeri* and a possible race in the Santa Anita Wash (Arcadia, Altadena) where the vegetative branches of mature plants tend to retain some leaves of the juvenile form.
D. Genetic variation and population structure	Population structure and the extent of clone formation have not been studied in *L. squamatum,* but studies on two congeners with many shared life-history traits provide some insight. Williams et al. (2016) used eight microsatellite loci to examine the extent of clone formation and pattern of genetic variation within and among populations of the rare, narrow endemic *L. burgessii* relative to the more common, widespread *L. latisquamum.* Over half the shoots in a patch of *L. burgessii* were likely from the same clone (genet) and clones identical in genotype were found up to 305 m away, corroborating vegetative spread. In contrast, there was no evidence for clonal spread in *L. latisquamum.* Diversity statistics were similar for the two species with both having relatively high heterozygosity (H_e averaged 0.32 for *L. b.* and 0.41 for *L. l.*). An analysis of population structure showed low structure for patches separated by 0.1–5 km relative to the total population of patches (*L. burgessii* F_{ST} = 0.180; *L. latisquamum* F_{ST} = 0.116), indicating that most variation was found within or among individuals rather than among patches. This level of structure is normally consistent with moderate levels of gene flow, but these plants also have high inbreeding coefficients (see VI. I. Inbreeding and outbreeding effects). The authors suggest that gene flow is lower than expected from the seed and pollen dispersal mechanisms. The low seed set in both species might be influenced by a combination of inbreeding and a deficiency of S-alleles needed for a well-functioning self-incompatibility system.
E. Phenotypic or genotypic variation in interactions with other organisms	No studies found.
F. Local adaptation	No studies found.

G. Translocation risks	Not studied. There are no common garden, reciprocal transplant, or hybridization studies available. Risks of translocation are expected to be low within ecological regions and watersheds as long as planted within appropriate habitat.
IX. SEEDS	 Rancho Santa Ana Botanic Garden Seed Program: view image of seeds by John Macdonald at http://www.hazmac.biz/091214/091214 LepidospartumSquamatum.html
A. General	Seed lots can be highly variable in purity and germination among years and from different locations. Most bulk seed lots have a low percentage of PLS, from 3–6% (S&S Seeds 2016, Stover Seed Co. 2016) and in many populations and years, flowers produce a low percentage of filled seeds (A. Montalvo pers. obs.). Wild collections of seeds by Irvine Ranch Conservancy have averaged about 2% viability (M. Garrambone pers. com).
B. Seed longevity	Seeds are not expected to remain viable for more than a year in the soil. Seeds in warehouse storage at ambient conditions in coastal California experience steep losses in viability after one year (S&S Seeds, personal communication). Kay et al. (1984) found seed germination to be negligible at 30 months when stored under warehouse conditions. Longevity can be increased under cool, dry storage. At the RCRCD, cleaned seed lots dried to ambient conditions and stored in closed containers in a walk-in cold room (conditions ranging from 41 to 50ºF at 37– 45% relative humidity) remained viable and produced hardy plants for at least three full years (A. Montalvo pers. obs.).
C. Seed dormancy	Non-dormant. Seeds germinate without pretreatment (Emery 1988, Everett 2012).
D. Seed maturation	Seeds typically mature in phases in the fall and begin to disperse mid-fall to late fall.
E. Seed collecting and harvesting Unusually good seed-filling after a wet winter. (Photo by A. Montalvo 7 Nov. 2017, Temescal Wash, Riverside Co.)	 Achenes should be collected when they are dark brown to black and the pappus is dry and fluffy (when they are ready to disperse by wind). Ripe seeds can be collected by plucking or shaking the branches over open baskets or large buckets. Transfer to woven sacks or large containers with lids for transport to processing location. Remove lids after transport to allow aeration and avoid condensation. (IX. D-G. A. Montalvo pers. obs.)
F. Seed processing	Place collected material loosely in large open containers and remove any large stems. Allow seeds to dry in open containers away from wind in an area with good air circulation and away from full sun. After seeds are dry, screen out large impurities and insects before placing in cool, dry storage.
G. Seed storage	Store seeds under dry, cool conditions to increase longevity to more than one year (see IX. B. Seed longevity). Seeds stored under ambient conditions should be used within a year of collection. The long pappus and low seed filling result in large bags of seed for storage.
H. Seed germination	Germination occurs under a range of temperatures and is limited by moisture availability. **Nursery:** In the outdoor nursery at RCRCD in Riverside, California, successful germination occurs for seeds planted in flats from early December through early February when days and nights are cool. Most seeds begin to germinate six to seven days after planting and complete germination occurs within three weeks (Everett 2012, A. Montalvo pers. obs.). In a study of plants from the Mojave Desert, *L. squamatum* germinated best at 5°C with values of 47% and 58% for two different collections, whereas most other species germinated best at 15°C (Kay et al. 1984). Seeds have also been reported to germinate at 21°C (Graves et al. 1975). **Field:** In field studies by the Irvine Ranch Conservancy in Orange Co. California during a drought, seedlings emerged January through late March in irrigated plots and throughout March in un-irrigated plots following late rains (M. Garrambone & M. Major pers. com.). At sites in western Riverside County, seedlings emerged in March to April following soaking rains or receding floodwaters (A. Montalvo pers. obs.).
I. Seeds/lb	The average live seeds per bulk pound of commercial seed lots has been reported as 19,800 with the number of seeds in a PLS lb as 370,000 (S&S Seeds 2016). Others have reported 27,000 live seeds per lb (based on 20% purity, 30% germination, and 450,000 seeds per PLS lb (Stover Seed Company 2016).

J. Planting	**Nursery:** Seeds should be planted shallowly and provided with ample sunlight. Plant seeds on the surface of the soil and cover lightly with soil or coarse sand. Keep seeds moist until germination is complete. Once root have grown into plugs, decrease watering to prevent damping off. **Field:** At wild field sites, seeds can be sown in sandy, gravelly soil, and sandy loams, gently raked, then tamped to ensure shallow planting(A. Montalvo pers. obs., M. Major pers. com.).
K. Seed increase activities or potential	Growing plants for seed increase is expected to supply higher quality seeds with greater seed filling if the genetic diversity of plantings is high. Seeds could be collected and sown within a few months of harvest, saving valuable cold storage space. The Irvine Ranch Conservancy in Orange Co. is actively working on methods to increase success of seed farm plantings for seed production of scalebroom at their seed farm in Irvine, Orange Co, California (see X. C. Horticulture or agriculture).
X. USES	
A. Revegetation and erosion control	Can be successful established from seeds or containers in disturbed wash habitats below 5,000 ft (~1,500 m) in the Southern California Mountains and Valleys Section (A. Montalvo, pers. obs.). Plants may be able to grow on loose hillsides adjacent to washes to help control erosion (Everett 2012).
B. Habitat restoration	Used in the restoration of alluvial scrub habitat in southern California. In the Temescal Valley area, both seeds and container plants have been planted by the Riverside-Corona Resource Conservation District with mixed success (A. Montalvo and S. Pynn pers. obs.). Most mortality of container plants appears shortly after outplanting from damage to plants. Survival of plants from 3" x 9" containers outplanted in January 2016 during a drought and drip irrigated two to four times a month until the fall, was 68% after eight months. In two other trials using similar irrigation, survival of plants from 3" x 9" and two gallon pots installed in February 2015 was 86% to 18 months, and survival of plants installed in March 2014 was 82.7% after 18 months (container sizes included 3" x 9", 4" x 10" and two gallon). In restoration trials by Irvine Ranch Conservancy in Orange Co., seedlings in irrigated seeded plots reached an average height of 7.3 cm after five months, while plants in unirrigated plots averaged 3.5 cm. In low water plots planted with liners at the same time, plant height averaged 8.3 cm after five months, while plants in high water plots averaged 6.4 cm (M. Major pers. com.). Watering of irrigated plots occurred every 2 to 3 weeks during spring, and every 3 to 5 weeks during summer. Observers noted differences in soil depth had a large influence on plant survival and growth. Plants in plots with at least 2 in of sandy loam over cobbly, rocky aggregate sublayers performed much better than in plots with less than 2 in of sandy loam. In the Mojave Desert, *L. squamatum* was one of the species seeded to restore the corridor used to bury a pipeline aqueduct. Transects in unseeded areas had limited natural recruitment. After 36 years, in 20 randomly placed transects over unseeded sites, only one *L. squamatum* was found (Berry et al. 2016). Abella & Newton (2009) noted survival of 8% for another desert seeding project.
C. Horticulture or agriculture  Canescent juvenile leaves on central axis; glaucous scale leaves on lateral branches.	**Nursery:** Can be grown easily from seed in containers and then outplanted. At the RCRCD nursery in Riverside, seeds are sown in plug flats. Plugs are shifted into larger pots after seedlings develop their first two sets of true leaves and roots reach the bottom of plugs. Plants start slowly but obtain quart size (3" x 9" square containers) within seven months and can remain in same pots for a year before shifting to larger pots or outplanting. A well-drained soil mix is necessary. After plants are transferred to the larger pots, watering is adjusted to allow soil to dry down between watering events. Once branches with scale leaves develop, shoots become brittle, so care must be taken not to break plants when moving pots and removing plants from pots for transplanting. **Agriculture:** In one planting trial, the Irvine Ranch Conservancy (IRC) outplanted seedlings in rose pots in December in a single row with 2.5 ft spacing, but fewer than 5% of plants reached reproductive maturity (M. Garrambone pers. com.). IRC will be trying larger-sized plants in their next trial.
D. Wildlife value	Provides cover for wildlife such as small mammals and nesting birds. Breeding areas of the Texas nighthawk (*Chordeiles acutipennis texensis*) in the Santa Clara Valley were associated with gravel beds at sites occupied by scale-broom (Pickwell & Smith 1938). In southern California, scale-broom scrub also provides habitat for a number of rare species including legless lizards, *Anniella* (Papenfuss & Parham 2013), San Bernardino kangaroo rat (Burk et al. 2007, RCA 2015), Dulzura kangaroo rat, and Los Angeles pocket mouse (RCA 2012 a, b). The plant also provides nectar and pollen for a variety of bees and butterflies in the late summer when few flowers are available (see VI. E. Pollination). Although the plant is toxic and unpalatable to livestock (Keil & Barkley 2016), the plant's rating as low value for wildlife by Conrad (1987) should be reconsidered.
E. Plant material releases by NRCS and cooperators	None reported. Not a likely candidate.
F. Ethnobotanical	None reported.

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XII. CITATION	Montalvo, A. M., E. C. Riordan, and J. L. Beyers. 2017. Plant Profile for *Lepidospartum squamatum.* 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	https://www.calflora.org//cgi-bin/species_query.cgi?where-calrecnum=4718
Calscape	https://calscape.org/Lepidospartum-squamatum-(Scale-Broom)?srchcr=sc5bca3ff0ecd64
Fire Effects Information System (FEIS)	https://www.feis-crs.org/feis/ (not treated)
Jepson Flora, Herbarium (JepsonInterchange)	http://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?3776
Jepson eFlora (JepsonOnline, 2nd ed.)	https://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?3776
USDA PLANTS	https://plants.usda.gov/core/profile?symbol=LESQ
Native Seed Network (NSN)	https://www.nativeseednetwork.org/
GRIN (provides links to many resources)	https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?id=466362
Native American Ethnobotany Database (NAE)	http://naeb.brit.org/
Rancho Santa Ana Botanic Garden Seed Program, seed photos	http://www.hazmac.biz/091214/091214LepidospartumSquamatum.html
Flora of North America (FNA) (online version)	http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=220007452
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. All other images by Arlee Montalvo (copyright 2017) unless otherwise indicated with rights reserved by the Riverside-Corona Resource Conservation District (RCRCD). Photos may be used freely for non-commercial and not-for-profit use if credit is provided. All other uses require permission of the authors and the Riverside-Corona Resource Conservation District.

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