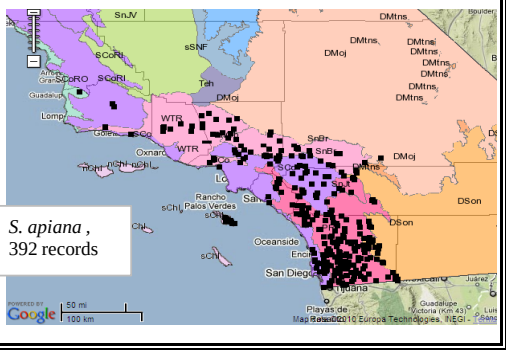
SPECIES	***Salvia apiana* Jepson**
NRCS CODE: SAAP2  1st season seedlings, mid April 2009, western Riverside Co.	Family: **Lamiaceae** Order: **Lamiales** Subclass: **Asteridae** Class: **Magnoliopsida**  mature plants, A. Montalvo, Riverside Co.  in fruit, persistent calyx, Sept. 2010   flowers with exerted stigmas
Subspecific taxa **1. SAAPA** **2. SAAPC**	1. *S. apiana* Jeps. var. *apiana* 2. *S. apiana* Jeps. var. *compacta* Munz [recognized by USDA PLANTS 2010]
Synonyms (numbered as above)	1. *Audibertia polystachya* Benth., *Ramona polystachya* Briq., *Audibertiella polystachya* Briq., *Salvia californica* Jeps., but not the *S. californica* Brand. described by Brandegee (Epling 1938).
Common name (numbered as above)	1. white sage; also called bee sage (Keator 1994) 2. compact white sage
Taxonomic relationships	*Salvia* is a large genus of nearly 1000 species distributed over most continents. White sage belongs to section *Audibertia* which is restricted to the California Floristic Province and adjacent deserts (Walker & Sytsma 2007). The alignment of white sage with species traditionally classified in *Salvia* section *Audibertia* has been supported by a combined analysis of DNA molecular data and stamen morphology (Walker & Sytsma 2007). Their data supported a monophyletic group of 20 species in *Audibertia* and that the most closely aligned group of species is in the subgenus *Calosphace*.
Related taxa in region	*S. apiana* overlaps with a number of other *Salvia* species in Section *Audibertia* in southern California, primarily the subshrubs: *S. clevelandii* (A. Gray) Greene, *S. eremostachya* Epling ex Munz, *S. leucophylla* Greene, *S. mellifera* Greene, *S. munzii* Epling, *S. pachyphylla* Epling, and *S. vaseyi* Parish; and the annual herbs *S. columbariae* Benth and *S. caduacea* Benth. (Epling 1938, Munz 1974).
Taxonomic issues	The designation of varietal status for *S. apiana* var. *compacta* is briefly noted in the online Jepson Manual (JepsonOnline, 2nd ed. 2010) as used for Baja California plants with condensed panicles. However, the name has also been used for such plants on the edges of California deserts (see map below).
Other	White sage is an important aromatic subshub of inland and coastal sage scrub vegetation that has decreased substantially in Riverside Co. in the past 50 years (Roberts et al. 2004).
GENERAL	
Map	Data provided by the participants of the Consortium of California Herbaria for SAAP2 represent 392 records with coordinate data out of 788 records retrieved; data accessed 9/28/10. See Berkeley Mapper: http://ucjeps.berkeley.edu/consortium  *S. a.* var. *compacta*, 11 records  *S. apiana*, 392 records

Geographic range	White sage ranges from Santa Barbara Co., California south to the middle of Baja California and east to the western edge of the Colorado desert (Epling 1938, Munz & Keck 1968).
Distribution in California; Ecological section and subsection	Peak abundance is in Riverside, Orange, San Bernardino, and San Diego Counties. Jepson general areas of CA: South Coast, Western Transverse Ranges, San Gabriel Mountains, San Bernardino Mountains, Peninsular Ranges, San Jacinto Mountains, Mojave Desert, and Sonoran Desert. Ecological Section/subsection (http://www.fs.fed.us/r5/projects/ecoregions/ca_sections.htm): Southern California Coast (261B, in most subsections except the highest ones), Southern California Mountains and Valleys (M262B, most subsections except the high ones such as h).
Life history, life form	Polycarpic, subshrub, woody at the base (suffrutescent shrub). Reproductive range 2 to 50 years (Sawyer et al. 2009).
Distinguishing traits	White sage is a rounded, 1 to 2.5 m tall shrub that has highly aromatic, 3 to 9 cm long, whitish to pale gray-green leaves, many of which persist throughout the year. The thick and petioled, lance-oblong leaves are opposite, have crenulate margins (having small rounded teeth) and are covered with short appressed hairs and oil glands that give the leaves a silvery sheen; the leaf blades taper into the petiole. The attractive white to pale lavender flowers with short greenish calyx are clustered in compact cymose branches of a tall graceful, often pink-tinged inflorescence (thyrsoid panicle) that extends from 0.5 to 1.5 m above the foliage (Munz & Keck 1968). The lower lip of the two-lipped corolla is long and ruffled and obstructs the corolla tube, whereas the upper lip is reduced to a small lobe. The long style ends in a stigma that protrudes forward about 15 mm beyond the floral tube (modified from Montalvo 2004). *S. apiana* var. *compacta* is distinguished by its condensed and more spike-like panicle and distribution along the desert edge (Munz 1974).
Root system, rhizomes, stolons, etc.	Branched, fibrous root system that extends further laterally than deep (Hellmers et al. 1955). Feeder roots were concentrated in the top foot of soil around the root crown but also extended along major lateral roots.
Rooting depth	Roots tend to penetrate less than 1.5 m deep (Hellmers et al. 1955).
HABITAT	
Plant association groups	Occurs in many plant communities including chaparral, coastal sage scrub, yellow-pine forest, and the upper edges of desert scrub (Munz & Keck 1968). Extensive stands occur on alluvial fans in alluvial scrub vegetation in San Bernardino Co., especially in the Etiwanda and Cajon Pass, Cable Canyon areas (A. Montalvo, pers. obs.). White sage tends to occur as a dominant or co-dominant plant in shrublands with species such as *Artemisia californica* Less., *Encelia farinosa* A. Gray ex. Torr., *Eriogonum fasciculatum* Benth., *Mimulus aurantiacus* Curtis, *Yucca whipplei* Torr., and *Malacothamnus fasciculatus* (Torr. & A. Gray) Greene (Sawyer et al. 2009).
Habitat affinity and breadth of habitat	Plants occupy dry slopes and low gradient deposits along streams (Munz & Keck 1968, Sawyer et al. 2009). In an extensive study of coastal sage scrub vegetation, plants occupied north and south-facing slopes, and slopes of gentle (0 - 5º), medium (6 - 15º) and steep gradients (16 º and above) nearly equally; plants occupied rocky as well as unconsolidated substrates (Kirpatrick & Hutchinson 1980).
Elevation range	Generally from 300 - 1500 m but up to 1600 m (Sawyer et al. 2009, JepsonOnline 2nd ed. 2010).
Soil: texture, chemicals, depth	Plants occur on coarse to loamy soils derived from sandstone, conglomerate and sandstone, shale, granitic/dioritic rocks, and volcanic rocks (Westman 1981a). In western Riverside Co., plants also occur on serpentine soil (Montalvo 2004).
Drought tolerance	Drought tolerant; plants often thrive in droughty soils and in habitats with high summer temperatures (Montalvo 2004). The crowded, whitish leaves are often held vertically and become folded during drought, likely adaptations for keeping leaves cool. In addition, many leaves dehisce late in the dry season. In a desert wash in Baja California during summer drought, leaf conductance, transpiration rates, and turgor potentials were high and plants did not show signs of drought stress (Schmitt et al. 1993). In chaparral, white sage had higher water potentials throughout the day well into the summer drought than did most of the evergreen shrubs measured (Poole & Miller 1975). Water potentials decreased late in the dry season and recovered after November at the end of the seasonal drought. Within a natural hybrid zone, Gill and Hanlon (1998) found that xylem pressure potential was significantly higher in white than in black sage, hybrids were intermediate to the two parental species, and white sage drops fewer leaves during drought. These data support that white sage is more drought adapted than black sage.
Precipitation	White sage occupies areas ranging from desert edges with less than 10 in annual precipitation to coastal areas and foothills with over 25 in of precipitation.
Flooding or high water tolerance	Generally not flood tolerant. Plants occur in alluvial scrub vegetation on benches and fans that flood rarely (Sawyer et al. 2009).

Wetland indicator status for California	None.
Shade tolerance	Plants require full sun (Keator 1994).

GROWTH AND REPRODUCTION

Seedling emergence relevant to general ecology	Seedling emergence and establishment in shrublands is associated with gaps in mature vegetation, and within grasslands in areas where herbs have been removed by gophers (DeSimone & Zedler 1999, 2001).
Growth pattern (phenology)	Most seedling and vegetative growth is in the cool rainy season between January and April and continues until the soil becomes dry in the late spring to early summer. Seedlings grow relatively fast, have little herbivore damage, and they fold their leaves in response to drought (DeSimone & Zedler 2001). Plants tend to mature in the second year but in good years may flower the first year. Inflorescences arise from the upper nodes in spring and produce flowers from late May to July, depending on location (Montalvo 2004). Leaf growth over the season results in a seasonal dimorphism in leaf size (Westman 1981b). Smaller leaves are produced on short shoots (brachyblasts) that develop from leaf axils along the main elongated stems (dolichoblasts) and are often retained when the older, longer dolichoblast leaves dehisce during drought. With the return of seasonal rains, the short shoots elongate into long shoots, and the retained short leaves continue to expand and subtend the next generation of short shoots and leaves.
Vegetative propagation	Plants resprout from the base after disturbance such as fire but otherwise do not typically spread vegetatively. In some instances prostrate stems develop roots in unburned sites and may be able to generate new plants (Gordon & White 1994).
Regeneration after fire or other disturbance	Considered to be a facultative seeder (Keeley et al. 2006). Fire is a normal disturbance factor of most plant communities within which white sage occurs. Following fire, this shrub frequently sprouts from distinct basal burls (Westman et al. 1981, Keeley 1998), but year old seedlings are killed by fire and repeated burning kills mature plants (Zedler et al. 1983). Seedlings can emerge from the seedbank in the first season after fire, but reported densities are low (Zedler et al. 1983, Keeley 1998), and high intensity fires can kill seeds (Keeley & Fotheringham 1998). In a study of many postfire plots, Keely et al. (2006) found that nearly twice as many white sage seedlings emerged in the third season after fire as in the first and second seasons. They also found many more seedlings in coastal sage scrub plots than in chaparral plots.
Pollination	Based on the floral morphology, only some of the larger bees are capable of transferring pollen to the highly exerted stigmas. Grant and Grant (1964) report three species of *Xylocopa* and a species of *Bombus* as effective pollinators. Hummingbirds, honeybees, bombyliid flies, and small species of native bees (primarily *Anthophora, Diadasia* , and *Osmia*) sometimes visit flowers (Grant & Grant 1964) but are thought to be ineffective as pollinators (modified from Montalvo 2004).
Seed dispersal	The small nutlets fall from the dried calyx but are secondarily dispersed by harvester ants and seed caching rodents. Seed traps revealed that seeds dispersed up to 3 m away and that there was a higher secondary removal rate of seeds in coastal sage scrub (80 percent) than in grassland (0 percent) or the ecotone of the two habitats (about 40 percent) (DeSimone & Zedler 2001).
Breeding system, mating system	Anthers release most pollen prior to maturity of stigmas (protandrous), and the stigma protrudes far beyond the anthers (Montalvo 2004). This configuration ensures that flowers receive pollen from other flowers; however, the inflorescences are large, and there can be many flowers of different stages open at the same time on a plant, making some transfer of pollen to flowers within the same plant possible. In general, the protandrous flowers and presence of interspecific hybrids with *S. mellifera* suggest that there is primarily an outcrossing breeding system (Montalvo 2004).
Inbreeding and outbreeding effects	Hybrids between black sage and white sage are fully viable but, on average, suffer reduced fertility relative to parental species (Epling 1947a, Meyn & Emboden 1987). There are also fewer seeds per flower in F_1 back crosses to both parental species (Grant & Grant 1964).

Hybridization potential	White sage hybridizes with other *Salvias* with the same chromosome number, including *S. mellifera* , *S. munzii* , *S. leucophylla* , *S. clevelandii* , *S. eremostachya* , *S. pachyphylla* , and *S. vaseyi* (Epling 1938). Hybrid zones between *S. mellifera* (black sage) and white sage are especially common (Montalvo 2004). Hybrids exhibit a range of intermediate floral and leaf traits (Epling 1947a, b; Anderson & Anderson 1954) and differ in leaf anatomy (Webb & Carlquist 1964). Most hybrids are thought to be F_1 crosses or backcrosses to black sage, and they tend to grow very close to the parental types. Although black sage and white sage overlap in range, they have different habitat affinities. Their ranges overlap in most of coastal southern California, but white sage is not found north of Santa Barbara Co., and it ranges further south into Baja California and eastward into the edge of the desert than does black sage. Both species can occur intermingled, but black sage tends to be found in flatter and wetter areas, while white sage is usually on drier slopes (Epling 1947a, Anderson & Anderson 1954, Grant & Grant 1964, Gill & Hanlon 1998). As such, most sites contain a single species, but hybrids are often present where the species co-occur (Meyn & Emboden 1987). The potential for reproductive isolation of the species within areas of overlap has been examined most thoroughly by Grant and Grant (1964), augmenting earlier observations (Epling 1947a, Anderson & Anderson 1954). White sage generally flowers later than black sage, and the short overlap in flowering time of one to several weeks limits hybridization. In addition, white sage has large, highly modified flowers that are pollinated almost exclusively by large carpenter and bumblebees (*Xylocopa* and *Bombus*), while black sage has smaller, unmodified flowers that are pollinated primarily by honeybees and small native solitary bees.

BIOLOGICAL INTERACTIONS

Competitiveness	In plots that were hand weeded and seeded in a twice-normal rainfall year, about a quarter of the seedlings survived to the second year (Storms 1999). Seedling survival is expected to be much lower in dry years and weedy areas (Montalvo 2004).
Herbivery, seed predation, disease	Urn-shaped insect galls form on leaves (Clarke et al. 2007).
Palatability, attractiveness to animals, response to grazing	The essential oils and terpenoid compounds found throughout the plants may deter many herbivores (Dentali & Hoffman 1992).
Mycorrhizal? **Nitrogen fixing nodules?**	The roots of white sage form associations with arbuscular mycorrhizal fungi that may also assist plants in low nutrient and droughty habitats (Volgelsang et al. 2004).

ECOLOGICAL GENETICS

Ploidy	Plants are considered diploid (2 n = 30); counts show a haploid count of n = 15 chromosomes (Epling et al. 1962).
Plasticity	No published data.
Geographic variation (morphological and physiological traits)	There is a north to south and east to west geographic gradient in floral morphology (Meyn & Emboden 1987). For example, the lip of the corolla and stamen filaments are longer toward the coast. Other than this and the more compact inflorescences on the desert edge for var. *compacta* , no other reports of geographic variation were found in the literature.
Genetic variation and population structure	No published data. Given the outcrossing potential of this species together with the restricted seed dispersal ability, it is likely that variation among nearby populations that flower at the same time is relatively low. When populations are connected by gene dispersal, variation in genetically-controlled morphological traits is likely to correlate with gradients in the environment, except under strong selection. Studies are needed to determine if the gradients in flower lip and fillament lengths are under genetic control.
Phenotypic or genotypic variation in interactions with other organisms	No published data.
Local adaptation	No published data. This species occupies sites that vary sufficiently in elevation and rainfall patterns to have developed differences in adaptive traits such as timing of flowering, leaf flush, tolerance to freezing, and water use efficiency. It is not known if the switch to a more compact form inflorescences in *S. apiana* var. *compacta* or the changes that occur in flower morphology from the coast to inland sites are adaptive traits, but it is not unusual for plants on the more arid end of an environmental gradient to develop adaptations that aid in reduction of water loss or water use efficiency. In addition, populations in desert scrub are likely to be more cold tolerant than those from coastal locations (Montalvo 2004).

Translocation risks	Based on what we do know about the variable environments of this plant, we do not recommend collecting and deploying seeds across Ecological Sections (see above, http://www.fs.fed.us/r5/projects/ecoregions/ca_sections.htm). In addition, avoid translocation across more than 1000 ft elevation bands within Sections and Subsections and from lower toward higher rainfall Subsections. Risks from hybridization among populations from different ecological sections are unstudied, but hybridization is very likely. Hybrids between white sage and black sage tend to be uncommon and better adapted to sites intermediate between the parental species (Anderson & Anderson 1954, Meyn & Emboden 1987, Gill & Hanlon 1998). Data on the inability of hybrids to spread suggests that it would be wise to avoid collecting seeds from hybrid zones for use in offsite restoration and revegetation.
SEEDS	see also Rancho Santa Ana Botanic Garden Seed Program, seed image: http://www.hazmac.biz/040329/040329SalviaApiana.html Seed image by Steve Hurst, ARS 
General	The four nutlets are about 2 to 3 mm long, somewhat rectangular, narrow in cross-section, keeled on one side, convex on the other side, and often grey-brown to light brown (Montalvo 2004). Seed lots often obtain 70 % purity and 50 % germination (Mirov & Krabel 1939; Jody Miller, S&S Seeds, pers. com.). A generic germination test for shrubby sages is incubation at 15/25 °C or 20/30 °C in the light, with first count at 7 days and last count at 21 days, followed by tetrazolium (TZ) staining of ungerminated seeds to determine if they are dormant (Meyer 2008).
Seed longevity	A dry seed lot (mostly stored in a Mason jar) tested at Rancho Santa Ana Botanic Garden after 24 years under variable storage conditions (transferred between room temperature, refrigeration, and freezing) had 43% germination (Michael Wall, pers. com.). Seeds are potentially long-lived in soil seed banks (Sawyer et al. 2009) and likely in dry storage (Meyer 2008).
Seed dormancy	Dormant seeds of *Salvias* may build up in the soil and form a persistent seed bank (Keeley & Keeley 1984, Meyer 2008).
Seed maturation	Seeds mature mid to late summer within the persistent calyx (Montalvo 2004). Within a site, seed filling tends to be higher on north compared to south-facing slopes (DeSimone & Zedler 2001). Seeds tend to be filled only in good rainfall years (Clarke et al. 2007).
Seed collecting and harvesting	Seeds are collected from the dry, fruiting inflorescences, usually in July and August, depending on site (Montalvo 2004).
Seed processing	Process seeds to remove chaff and insects. Wall and Macdonald (2009) report first rubbing the dry, ripened flower clusters with the persistent calyx over a medium screen, then lightly rubbing and sorting material through #14 and #25 sieves. A blower can then be used to remove the empty nutlets and chaff; blower speed set to 1.5–2.0 to separate chaff, and higher speed to remove sterile seed.
Seed storage	Cold dry storage. Seeds stored in sealed warehouse storage or at 4°C had little loss in viability during 5 to 7 years, but seeds in unsealed storage with fluctuating relative humidity had losses in viability; seeds also increased in germination (from 19 to 43%) after a year in warehouse storage, suggesting a dry after-ripening requirement (report by Kay & Young in Meyer 2008).
Seed germination	Keeley (1987) showed that exposure to 70ºC for 1 hour followed by incubation in light substantially increased germination over controls, that heat shock for 5 minutes at 100ºC had no effect, and that exposure for 5 min at 120ºC killed seeds. Leachate made from water and charred wood did not increase germination (Keeley 1987), but cool smoke treatment increased germination (Keeley & Fotheringham 1998). Liquid smoke products can also be used to significantly increase germination (Montalvo 2004).
Seeds/lb	341,000 seeds/lb (Mirov & Krabel 1939); 324,000 seeds/lb (Meyer 2008); 325,000 seeds/lb (S & S Seeds Database: http://www.ssseeds.com/database/db_testvv.php3?uid=437).

Planting	Plants can be established easily by direct seeding in the fall without irrigation. If seed germination tests show low germination but high seed viability, seeds can be treated with dry or liquid smoke before sowing. If liquid smoke is used, seeds must be air-dried prior to dry broadcasting. Keep in mind that dormant seeds can result in a beneficial seed bank and establishment over several years (Montalvo 2004). Seeds should be planted in the fall before the onset of winter rains. Hydroseeding can be very successful on steep slopes and road cuts. Shallow planting methods, such as hydroseeding and imprinting, are likely to produce higher germination than drilling because seed germination is improved with exposure to light (Montalvo 2004). The method of dry broadcasting seeds over a seed bed shallowly scarified with a springtooth harrow followed by dragging the harrow upside down has also been successful in Riverside Co. (A. Montalvo, pers. obs.). Based on seedling survival data (Storms 1999, DeSimone & Zedler 2001), even under well-weeded and rainy conditions, fewer than 25 % of seedlings should be expected to survive through their first year. Plants can also be established from container plants and using supplemental irrigation in the first year.
Seed increase activities or potential	The Irvine Ranch Conservancy planted a one-acre field with 2-inch liners in fall 2009 to establish a seed increase field (J. Burger, pers. com.). Plants received some supplemental irrigation and many individuals flowered by the end of the first spring. No seeds were harvested the first year.  Juvenile plant in seed increase field, J. Burger 2010,
USES	
Revegetation and erosion control	White sage is used in many restoration and roadside revegetation projects. Its fast growth helps to achieve vegetative cover quickly (Montalvo 2004).
Habitat restoration	This species is used frequently in the restoration of coastal sage scrub in southern California. White sage has decreased dramatically in percent cover in western Riverside Co. since the early 1930's (Minnich & Dezzani 1998). Successful restoration will depend on controlling the factors associated with its decrease, especially invasive plants and short fire intervals so that shrubs can establish, reach maturity, and build-up a seed bank (Montalvo 2004).
Horticulture or agriculture	Horticulture: The generally rounded form with attractive whitish leaves and long graceful, pink-tinged inflorescence stalks make this an attractive shrub for background areas of dry landscape gardens (Keator 1994, Clebsch 1997, Perry 2010). Plants require full to nearly full sun, well-drained soil, do not tolerate constantly damp conditions, and are sensitive to temperatures below –7 ºC (Keator 1994, Clebsch 1997). Nursery stock is readily produced from seeds. Cuttings may also be used, but for restoration plantings, seeds are recommended so that more genetic diversity is represented in the outplanted plants. Agriculture: Plant in fall or very early winter. Fields can be started from seeds or from plants started in containers (see seed increase potential, above)
Wildlife value	White sage leaves are an important browse of mountain sheep in the winter and spring (Perry et al. 1987).
Plant material releases by NRCS and cooperators	None.
Ethnobotanical	Leaves contain essential oils and a variety of diterpines and triterpenes, including carnosic acid, oleaolic acid, and ursolic acid, some of which have been linked to the medicinal use of white sage by native tribes (Dentali & Hoffman 1992). A tincture of the leaves has been used internally as a diaphoretic and diuretic and externally to wash skin. The tincture may have antimicrobial properties. Antibacterial and antifungal activity of several compounds have been verified in vitro (Dentali & Hoffmann 1992). In addition to medicinal use, the dried leaves have been used as a smudge and crushed as a soapless shampoo (Bean & Saubel 1972, Moore 1989). Seeds have been used as food and leaves for flavoring (NAE link below).
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CITATION	Montalvo, A. M. and J. L. Beyers. 2010. Plant Profile for *Salvia apiana*. 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: http://www.rcrcd.com/index.php?option=com_content&view=article&id=88&Itemid=190.

LINKS TO REVIEWED DATABASES & PLANT PROFILES (last accessed September 2010)	
Fire Effects Information System (FEIS)	No matches: http://www.fs.fed.us/database/feis/
Jepson Flora, Herbarium (JepsonOnline)	http://ucjeps.berkeley.edu/cgi-bin/get_cpn.pl?43038
Jepson Flora, Herbarium, 2nd Edition Review (JepsonOnline, 2nd ed.)	http://ucjeps.berkeley.edu/tjm2/review/treatments/lamiaceae_salvia.html#43038
USDA PLANTS	http://plants.usda.gov/java/profile?symbol=SAAP2
Native Plant Network Propagation Protocol Database (NPNPP)	http://nativeplants.for.uidaho.edu/Network/ViewProtocols.aspx?ProtocolID=3198,3199
Native Seed Network (NSN)	http://www.nativeseednetwork.org/viewtaxon?taxon_code=SAAP2
Germplasm Resources Information Network (GRIN)	http://www.ars-grin.gov/cgi-bin/npgs/html/taxgenform.pl
Wildand Shrubs	http://www.fs.fed.us/global/iitf/wildland_shrubs.htm
Flora of North America (FNA) (online version)	No matches: http://www.efloras.org/flora_page.aspx?flora_id=1
Native American Ethnobotanical Database (NAE)	http://herb.umd.umich.edu/
Woody Plant Seed Manual	http://www.nsl.fs.fed.us/nsl_wpsm.html
Calflora	http://www.calflora.org/
Rancho Santa Ana Botanic Garden Seed Program, seed photos	http://www.hazmac.biz/rsabghome.html

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