Eriastrum densifolium subsp. *sanctorum* (Santa Ana River woolly-star)

5-Year Review: Summary and Evaluation

U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, CA

October 29, 2010

5-YEAR REVIEW

Eriastrum densifolium subsp. *sanctorum* (Santa Ana River woolly-star)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

Eriastrum densifolium subsp. *sanctorum* (Santa Ana River woolly-star) is a short-lived, perennial subshrub of Polemoniaceae (phlox family). It has a basally branched, generally erect or spreading form, reaching 75 centimeters (cm) (30 inches (in)) in height. The entire plant, including the blue to violet-blue inflorescence, is covered with woolly pubescence, giving it a silvery-white appearance. Each inflorescence is dense and spiny-bracted with about 20 flowers (Patterson 1993, p. 826). *Eriastrum densifolium* subsp. *sanctorum* is endemic to the Santa Ana River watershed in San Bernardino, Riverside, and Orange Counties in California (CDFG 2010). It is one of five subspecies of *E. d.*, distinguished from other subspecies by its long corolla (the collective petals) tube (Harrison 1972, p. 5). The known range is comprised of 21 extant occurrences dispersed across private and local government lands (CNDDB 2010).

Eriastrum densifolium subsp. *sanctorum* was listed as endangered under the California Endangered Species Act (CESA) in 1987. The subspecies was listed as endangered under the Act in 1987.

Methodology Used to Complete This Review:

This review was prepared by Todd Archer at the Carlsbad Fish and Wildlife Office (CFWO), following the Region 8 guidance issued in March 2008. We used survey information from experts who have been monitoring *Eriastrum densifolium* subsp. *sanctorum* and data on known element occurrences (EOs) in the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game (CDFG). We received no information relative to

E. d. subsp. *sanctorum* from the public in response to our **Federal Register** notice initiating this 5-year review. This 5-year review contains updated information on the subspecies' biology and threats, and an assessment of information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the subspecies attributable to one or more of the Act's five listing factors. This review synthesizes this information to evaluate the listing status of the subspecies and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we herein recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Federal Register (FR) Notice Citation Announcing Initiation of This Review:

A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the **Federal Register** on March 25, 2009 (USFWS 2009, p. 12878). No information relevant to the species reviewed here was received.

Listing History:

Original Listing
FR Notice: 52 FR 36265
Date of Final Listing Rule: September 28, 1987
Entity Listed: *Eriastrum densifolium* subsp. *sanctorum*, a plant subspecies.
Classification: Endangered

State Listing
Eriastrum densifolium subsp. *sanctorum* was listed by the State of California as endangered in January 1987.

Associated Rulemakings: None

Review History:

A notice of a 5-year review of status information of *Eriastrum densifolium* subsp. *sanctorum* was published on November 6, 1991 (USFWS 1991, pp. 56882–56900). This review was not published, though our recommendation was for no change in status. Subsequently, no reviews were initiated until the March 25, 2009, **Federal Register** notice for this 5-year review.

Subspecies' Recovery Priority Number at Start of 5-Year Review:

The recovery priority number for *Eriastrum densifolium* subsp. *sanctorum* is 6C according to the Service's 2010 Recovery Data Call for the CFWO, based on a 1–18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (USFWS 1993, pp. 43098–43105). This number indicates the subspecies faces a high degree of threat, a low potential for recovery, and conflict between the subspecies' recovery efforts and economic development.

Recovery Plan or Outline: No recovery plan or outline has been released for *Eriastrum densifolium* subsp. *sanctorum*.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

The Act defines "species" as including any subspecies of fish, or wildlife, or plants, and any distinct population segment (DPS) of any species of vertebrate. This definition of species under the Act limits listing as DPSs to species of vertebrate fish or wildlife. Because the subspecies under review is a plant, the DPS policy is not applicable, and the application of the DPS policy to the species' listing is not addressed further in this review.

Information on the Subspecies and its Status:

Subspecies Description and Life History

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Eriastrum densifolium subsp. *sanctorum* is a subshrub occasionally reaching 1 meter (m) (3.3 feet (ft)) in height. *Eriastrum densifolium* subsp. *sanctorum* plants have an average life span of approximately 5 years with some plants surviving at least 10 years (Burk *et al.* 1988, p. 21). Plants have gray-green stems and leaves. The light gray-green leaves generally curve upward. The leaves are irregularly divided to the midrib in 2 to 6 narrow lobes and are up to 50 millimeters (mm) (2 in) long (Patterson 1993, p. 826). The bright blue funnel-shaped flowers are usually longer than 25 mm (1.0 in), but may be up to 30 mm (1.4 in) long or occasionally as short as 20 mm (0.8 in) (Figure 1). The petals of the flower (corolla) are lavender-blue becoming pinkish-purple with age (Muñoz 1991, p. 22). The congested inflorescences (flower stalks) contain 20 flowers each. The seeds, which become sticky with mucilage when wetted, are contained in capsules that may persist for more than one season.

Four other subspecies of *Eriastrum densifolium* have been recognized. A key feature that distinguishes *E. d.* subsp. *sanctorum* from other subspecies is the length of the tube forming the

base of the corolla that is up to 30 mm (1.2 in); corolla tube lengths in the other subspecies do not exceed 20 mm (0.8 in) (Patterson 1993, p. 828).

Reproductive Strategies:

Eriastrum densifolium subsp. *sanctorum* flowers between May and August but most heavily in June (Muñoz 1991, p. 22). The amount and timing of seasonal rainfall may affect the time of flowering. Fruiting can extend from mid-July to mid-October (J. M. Porter, CGU-RSABG, pers. comm., 2010). Available information indicates that *E. d.* subsp. *sanctorum* is an obligate outcrosser (i.e., is not readily self-fertile) (Muñoz 1991, p. 23). The flowers of *E. d.* subsp. *sanctorum* are protandrous, meaning the anthers release pollen prior to the maturation and receptivity of the stigma (Muñoz 1991, p. 44). This condition commonly prevents self-pollination within the same flower and implies that *E. d.* subsp. *sanctorum* is dependent on one or more pollinators. In artificial crossing experiments, self-pollination produced negligible fruit or seed set, indicating that *E. d.* subsp. *sanctorum* is self-incompatible (Muñoz 1991, p. 9; Brunell 1999, p. 250).

Pollinators:

Many species of insects and birds visit *Eriastrum densifolium* subsp. *sanctorum* flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (*Micranthophora flavocincta*), giant flower-loving fly (*Rhaphiomidas acton* subsp. *acton*), California bumblebee (*Bombus californicus*), white-lined sphinx moth (*Hyles lineata*), black-chinned hummingbird (*Arhilochus alexandri*), and Anna's hummingbird (*Calypte anna*) (Muñoz 1991, p. 59). The relative importance of these pollinators appears to vary with location (Muñoz, 1991, p. 44).

Dispersal:

Dispersal of *Eriastrum densifolium* subsp. *sanctorum* seed is limited in the absence of flooding. The majority of seeds fall within 0.3 m (1 ft) of the parent plant and the wetted seed coat forms a mucilaginous mass that readily attaches the seed to the surrounding soil particles (Burk *et al.* 1989, p. 21). Those seeds not immediately shed from the fruits are retained within capsules that may remain on the plant for several seasons (Wheeler 1991, p. 116). In times of flooding, seeds or capsules may be transported down the floodplain for some distance, thereby facilitating some gene flow between populations. There is no evidence that *E. d.* subsp. *sanctorum* plants resprout vegetatively following flood events. Demographic studies found seedlings at all study plots germinated simultaneously with the first major autumn storms (Wheeler 1991, p. 111).

Seeds germinate within 48 to 72 hours following fall storms (after roughly 25 mm (1 in) of rain is deposited). Little above-ground growth is visible for the first weeks following germination because seedlings generate a primary taproot (Wheeler 1991, p. 55). Seedling survivorship is highest in areas with lower cover of annual plants, grasses, and litter, and areas of more bare ground or those surfaces created by flooding (Wheeler 1991, p. 56). Burk *et al.* (1989, p. 21) also found that both seedling establishment and adult mortality are lower in areas with fewer competing annuals or in areas where flooding is inhibited on surfaces with higher percent cover

of annuals, grasses, litter, and areas of less bare ground. Stands of plants occurring on surfaces with higher vegetative cover are comprised chiefly of mature plants with few juveniles, whereas stands on surfaces with less vegetative cover (more bare ground) exhibit a higher percentage of young plants. Therefore, the inhibition of natural hydrological regime processes of flooding and scouring may result in lower seedling establishment and eventual general decline in occurrences of *Eriastrum densifolium* subsp. *sanctorum*.

Spatial Distribution

Eriastrum densifolium subsp. *sanctorum* is endemic to the Santa Ana River drainage of southern California. This subspecies was formerly a conspicuous shrub in the alluvial fan sage scrub community on the higher floodplain terraces of the Santa Ana River and its tributaries in Orange, Riverside, and San Bernardino Counties. Historically, *E. d.* subsp. *sanctorum* occupied about 110 kilometers (60 miles) of habitat along the Santa Ana River from elevations of about 150 m (500 ft) in the vicinity of Santa Ana Canyon in Orange County up to about 600 m (2,000 ft) at the base of the San Bernardino Mountains, through Riverside County (USFWS 1987, p. 36266). *Eriastrum densifolium* subsp. *sanctorum* may have occupied alluvial fan sage scrub habitats in Orange County as far downstream as Santiago Canyon (Craig 1934, p. 390; Mason 1945, p. 75; Zembal and Kramer 1984, p. 2). The subspecies is considered extirpated from Orange County and Riverside County (Zembal and Kramer 1985, p. 3; USFWS 1987, p. 36268).

At listing, *Eriastrum densifolium* subsp. *sanctorum* occurred in isolated stands along the Santa Ana River in San Bernardino County between 360 and 600 m (1,200 and 2,000 ft) in elevation. There were 11 extant occurrences known, including (from headwaters down): Mill Creek Wash (EO 17); Verdemont (EO 18), and Institution Road South (EO 4) in Cajon Creek Wash; Frisbee Park (EO 19), Highland Avenue (EO 3), and Line Avenue (EO 20) in lower Lytle Creek Wash; and the Santa Ana River Canyon (EO 28), Santa Ana River Powerhouse (EO 10), Santa Ana Wash (EO 5), Boulder Avenue (EO 1), and Canyon Road (EO 2) on the Santa Ana River mainstem (See Figure 2 and Appendix 1) (CNDDB 2010). Devore (EO 15), at the mouth of Cajon Canyon, was extirpated by discing in 1985 before listing (CNDDB 2010) (Figure 2).

Since listing, 12 new occurrences were detected, and *Eriastrum densifolium* subsp. *sanctorum* was also rediscovered within Riverside County just downstream of the border with San Bernardino County. These new occurrences include: Cajon Junction (EO 32) and Institution Road North (EO 33) in Cajon Creek Wash; Plunge Creek (EO 26), Tippecanoe Avenue (EO 25), Mt. Vernon Avenue (EO 23), La Cadeña Drive (EO 29), La Loma Hills (EO 30), Riverside Avenue (EO 21), Alamo Street (EO 22), Fairmount Park Golf Course (EO 24), Jensen Quarry (EO 27), and Temescal Avenue (EO 31) on the Santa Ana River mainstem (Figure 2) (CFWO internal GIS 2010; CNDDB 2010).

Subsequent to listing, two occurrences were extirpated (EO 3 and EO 27). Highland Avenue (EO 3) was extirpated by construction of State Route 210 when this occurrence was examined in 2005 (CNDDB 2010) and Jensen Quarry (EO 27) was extirpated with the construction of the Oak Quarry Golf Club, which opened in 2000 (OQGC 2010). Additionally, the current status of two occurrences is unknown (EO 18 and EO 2), although they are considered extant for the

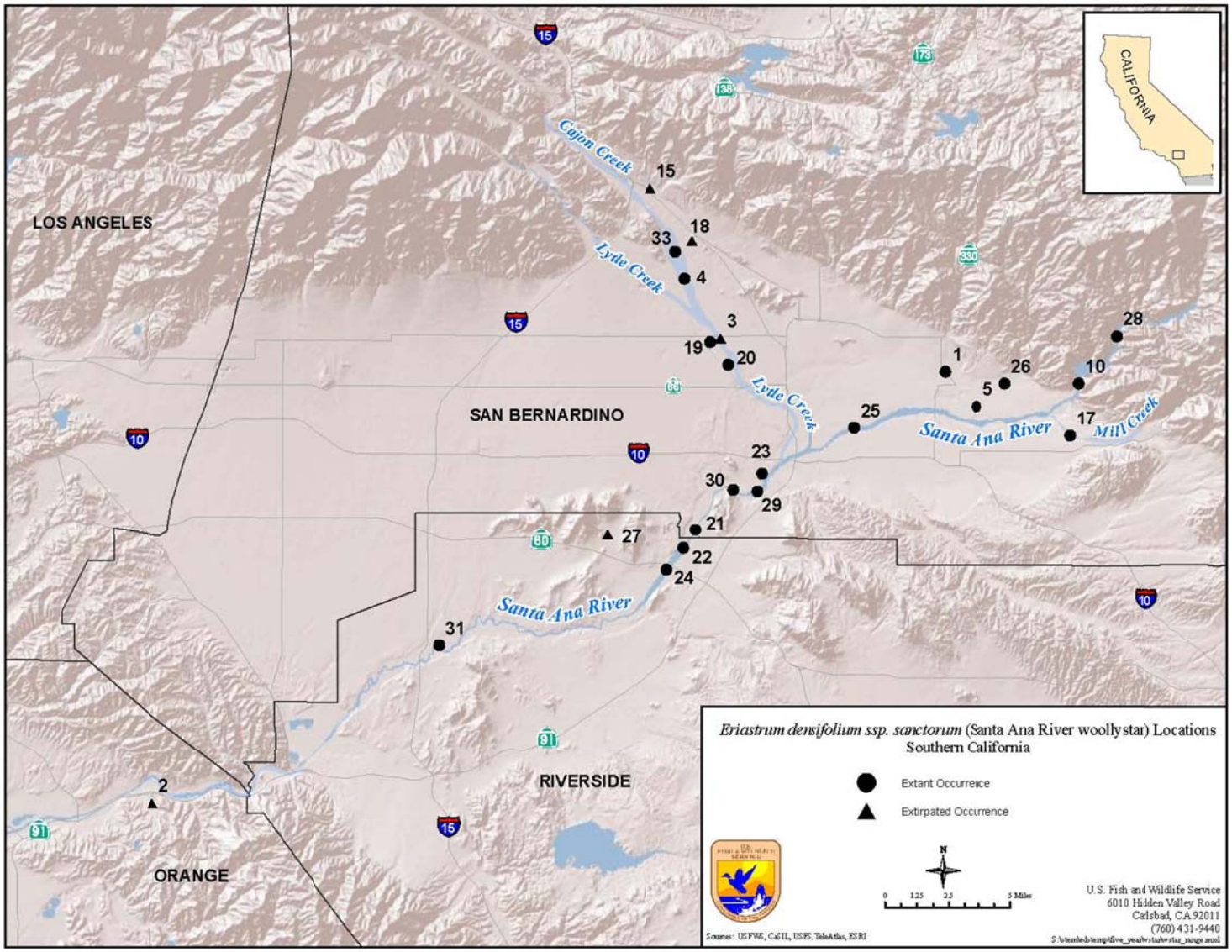

Figure 2: Distribution of *Eriastrum densifolium* subsp. *sanctorum* (Santa Ana River woolly-star) occurrences; prepared for 2010 5-Year Review.

purpose of this review. Brush clearing and discing in 2005 possibly extirpated Verdemont (EO 18) and development may have eliminated Canyon Road (EO 2) (CNDDB 2010). At the time of this review, there are 21 extant or presumed extant occurrences of *Eriastrum densifolium* subsp. *sanctorum*.

Abundance

At listing, *Eriastrum densifolium* subsp. *sanctorum* was known to occur patchily on the higher floodplain terraces. Little is known of pre-listing counts of *E. d.* subsp. *sanctorum*, though CNDDB counts at some of the known occurrences record less than a few dozen plants (e.g., Verdemont (EO 18), Line Avenue (EO 20), and Santa Ana River Powerhouse (EO 10)). An exception was Santa Ana Wash (EO 5) where thousands of plants were documented in 1986 (CNDDB 2010).

Since listing, there are counts of many of the new occurrences, which highlight occurrences with just a few individuals and some with several thousand. Some occurrences support very few individuals: Riverside Avenue (EO 21) supported only 2 plants in 1994, Alamo Street (EO 22) had 3 plants in 2007, Fairmont Park Golf Course (EO 24) had 11 plants in 2007, and Temescal Avenue (EO 31) had only 1 plant in 2006. Also, no plants were counted at two occurrences (Verdemont (EO 18) and Canyon Road (EO 2)) in recent years, but are still considered extant because some suitable habitat remains (CNDDB 2010). At the other extreme, the occurrences at Institution Road North (EO 33) and Institution Road South (EO 4) had a combined count of 5,325 plants in 2008, the Santa Ana Wash (EO 5) supported 5,140 plants that same year, and the last count at Mt. Vernon Avenue (EO 23) in 1998 was about 2,000 plants. In all cases, consistent counts have not occurred so it is difficult to identify individual occurrence trends, though it appears there are a few well-established occurrences in addition to several diminished occurrences.

Habitat or Ecosystem

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Eriastrum densifolium subsp. *sanctorum* thrives in open, well-lighted areas of sandy alluvial terraces, where shrublands persist between infrequent flood events (Zembal and Kramer 1984, p. 8; Wheeler 1988, p. 3; Burk *et al.* 1988, p. 20). The perennial vegetative cover where *E. d.* subsp. *sanctorum* occurs is relatively low (seldom over 50 percent); annual cover is also fairly low (Zembal and Kramer 1984, p. 4). *Eriastrum densifolium* subsp. *sanctorum* is found in disjunct stands within this habitat and tends to occupy areas with slight surface disturbance (Zembal and Kramer 1984, p. 4) (Figure 3).

Eriastrum densifolium subsp. *sanctorum* is a pioneer subspecies (i.e., a species that takes over previously uncolonized habitat) that colonizes washed sand

deposits created by sporadic stream flow action. Between major flood events, these deposits typically exist as terraces above the high water mark of the river and associated tributaries (Zembal and Kramer 1984, p. 8).

Eriastrum densifolium subsp. *sanctorum* habitat is maintained by periodic flooding, scouring, and sediment deposition (Wheeler 1988, p. 16). In absence of flooding, alluvial terraces succeed through three distinctive seral (successional) phases referred to as the pioneer, intermediate, and mature phases. The pioneer phase exists for some time following a flood event. Barring recurrent scouring events, the alluvial fan sage scrub changes from pioneer phase, in which total vegetative cover at sites supporting *E. d.* subsp. *sanctorum* ranges from 42 to 48 percent, through the intermediate phase, and on to the mature phase in which vegetative cover is 66 to 88 percent (Wheeler 1991, p. 33). Smith (1980, p. 130) similarly puts the respective vegetation cover at 10 percent for the pioneer phase, 51 percent for the intermediate phase, and 66 percent in the mature phase.

The subspecies thrives in the nutrient poor sands of early (pioneer) seral stage habitat that have more than 97 percent sand particles (i.e., 0.5 to 2 mm (0.02 to 0.08 in)). The dominant species pioneer phase include *Eriogonum fasciculatum foliolosum* (California buckwheat), *Lepidospartum squamatum* (scale broom), *Heterotheca sessiliflora* subsp. *fastigiata* (fastigiate golden aster), and *Croton californicus* (California croton). *Eriastrum densifolium* subsp. *sanctorum* also remains competitive in intermediate phase habitats that have between 90 and 97 percent sand particles. In intermediate phase habitats, the dominant species include *Eriogonum fasciculatum foliolosum* (California buckwheat), *Lepidospartum squamatum* (scalebroom), *Juniperus californica* (California juniper), *Cylindropuntia californica* (valley cholla), and *Opuntia littoralis* (coastal prickly pear) (USFWS 2004, p. 357). Riversidean alluvial fan scrub has now been included in the description of scale broom scrub (Sawyer *et al.* 2009, p. 573-574). This vegetation is characterized by the presence of less than 1 percent cover of *Lepidospartum squamatum* in an alluvial environment.

In the few study locations where *Eriastrum densifolium* subsp. *sanctorum* occurs in mature seral stages, plants are relatively few and appear to be declining in vigor, probably because competition from shrubs and annual herbs limits the establishment of the subspecies. The dominant species in mature seral stages include *Rhus ovata* (sugar bush), *Prunus ilicifolia* (holly-leaved cherry), and *Adenostoma fasciculatum* (chamise) (USFWS 2004, p. 357). *Eriastrum densifolium* subsp. *sanctorum* populations located on mature terraces are relatively small and comprised chiefly of older individuals (Wheeler 1991, p. 2). Seedling establishment becomes inhibited in mature habitat as the cover of annuals and grasses increase and consequently there is less bare ground available (Burk *et al.* 1988, p. 20; Wheeler 1991, p. 3). Suitable habitat conditions for *E. d.* subsp. *sanctorum* are maintained by water transporting coarse sediments out of the mountains, depositing sediments on the fan, and scouring vegetation to create a patchwork of pioneer, intermediate, and mature conditions. Flood control and water spreading and channeling structures (spillways) significantly alter the natural hydrological regimes by decreasing the magnitude and distribution of flooding, scouring, sand transport, and sand deposition. In the absence of flood scouring, sediments and organic matter accumulate over time and pioneer phases of alluvial fan sage scrub are not often restored. Eventually, these

communities tend to mature and become more dense, thereby eliminating the early and intermediate seral stages favored by *E. d.* subsp. *sanctorum*.

Changes in Taxonomic Classification or Nomenclature

There have been no changes in the nomenclature or taxonomic classification of *Eriastrum densifolium* subsp. *sanctorum* since it was listed.

Genetics

There are five taxonomically identified subspecies of *Eriastrum densifolium*: *E. d.* subsp. *austromontanum* (many-leaved woolly-star), *E. d.* subsp. *mohavense*, *E. d.* subsp. *elongatum* (giant woolly-star), *E. d.* subsp. *densifolium*, and *E. d.* subsp. *sanctorum*. These subspecies are based on floral dimensions and geographic and elevational distribution (Patterson 1993, pp. 826–827). The key feature that distinguishes *E. d. sanctorum* from other subspecies is a corolla tube length up to 30 mm (1.2 in) long. Corolla tube lengths in the other subspecies do not exceed 20 mm (0.8 in) (Patterson 1993, p. 828).

Other morphological features of the subspecies are also unique when compared to *Eriastrum densifolium* subsp. *sanctorum*. *Eriastrum densifolium* subsp. *sanctorum* occurs at elevations below 600 m (2,000 ft), reaches a height of 1 m (3.3 ft), has densely woolly foliage, and corolla tube lengths of 25 to 32 mm (1.0 to 1.3 in). *Eriastrum densifolium* subsp. *austromontanum* occurs at elevations from 1,200 to 1,800 m (4,000 to 8,000 ft), reaches a maximum height of only 40 cm (16 in), has only slightly woolly foliage, and has corolla tubes of 15 to 19 mm (0.6 to 0.8 in) in length. *Eriastrum densifolium* subsp. *mohavense* occurs in the Mojave Desert at elevations of 760 to 2,600 m (2,500 to 8,500 ft), attains a maximum height of 30 cm (12 in), with shorter, finer pubescence, and paler corolla tubes about 15 mm (0.6 in) long. *Eriastrum densifolium* subsp. *densifolium* occurs on dunes along the south central California coast, reaches a height of 90 cm (35 in), has generally glabrous (smooth) leaves, and a broad corolla tube. *Eriastrum densifolium* subsp. *elongatum* is found below 1,300 m (4,300 ft), reaches a height of 90 cm (35 in), has shorter, finer pubescence, and corolla tubes of 15 to 16 mm (0.60 to 0.63 in) (Patterson and Tanowitz 1989, p. 707; Patterson 1993, pp. 826–828).

Hybridization:

Eriastrum densifolium subsp. *elongatum* has long been thought to hybridize with *E. d.* subsp. *sanctorum* in lower Cajon Creek Wash (Verdemont (EO 18), Institution Road North (EO 33), and Institution Road South (EO 4) and near its confluence with Lytle Creek Wash (Frisbee Park (EO 19) and Line Avenue (EO 20) (Craig 1934, p. 390; Brown 2009, p. 1; Burk *et al.* 1989, p. 20). The upper reaches of those washes seem to support *E. d.* subsp. *elongatum* while the listed entity is found downstream toward the Santa Ana River. *Eriastrum densifolium* subsp. *austromontanum* has also been thought to hybridize with *E. d.* subsp. *sanctorum* at La Cadeña Drive (EO 29) and Lytle Creek Wash (La Loma Hills (EO 30)) (DeGroot 2008, p. 1; Brunell and Whitkus 1997, p. 545). The analyses of these populations do not identify whether the studied plants have morphological similarities due to common genetics or are the result of similar adaptations (Porter, 2009, p. 2). Though gene flow between populations in the Santa Ana River

and Lytle Creek Wash likely took place in the recent past (150 years), they now appear isolated (Brunell and Rieseberg 1993, p. 5).

Subspecific Genetics:

The Santa Ana River *Eriastrum densifolium* and those at Lytle Creek occurrences are virtually identical genetically (Brunell and Whitkus 1999b, p. 351). Brunell and Riesenberg (1999, p. 5) did not detect a genetic difference between the two occurrences, but did find the morphometric difference of longer corolla tube length in *E. d.* subsp. *sanctorum*. *Eriastrum densifolium* subsp. *sanctorum* was found to be a genetically distinct taxon (Brunell and Whitkus 1999b, p. 364).

Subspecies-specific Research and/or Grant-supported Activities

We are not aware of any current research or grant-supported activities related to *Eriastrum densifolium* subsp. *sanctorum*.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

The final listing rule (USFWS 1987, pp. 36265–36270) identified the following threats to *Eriastrum densifolium* subsp. *sanctorum*: encroaching developments within the floodplain, sand and gravel mining, and herbicide spraying. As the species was thought to be extirpated in Orange and Riverside Counties, these threats were considered rangewide for the remaining occurrences in San Bernardino County. The following five-factor analysis describes and evaluates the current threats to *E. d.* subsp. *sanctorum* relative to the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Historically, *Eriastrum densifolium* subsp. *sanctorum* occurred on the higher floodplain terraces along the Santa Ana River and its tributaries in Orange, Riverside, and San Bernardino Counties (USFWS 1987, p. 36268). The Orange County habitat for *E. d.* subsp. *sanctorum* was lost to urban development, citrus groves, horse stables, and urban parks on the banks of the Santa Ana River. The occupied habitat in Riverside County was lost to urban neighborhoods, ranches and agriculture, and aggregate mines (USFWS 1987, p. 36268). At listing, urban and agricultural development within the floodplain and aggregate mining were identified as threats impacting habitat occupied by *E. d.* subsp. *sanctorum* (USFWS 1987, p. 36268). Potential threats identified at the time included the physical alteration of flooding conditions arising from the construction of proposed dams on the Upper Santa Ana River Canyon (Seven Oaks Dam) and Lytle Creek Canyon. Additionally, the then-proposed Habitat Management Plan for Bureau of Land Management (BLM) lands included aggregate mining and shooting ranges, and the relaxation of floodplain zoning restrictions was cited as a potential indirect threat from a proposed flood-control dam (Seven Oaks Dam) on the Santa Ana River (USFWS 1987, p. 36269).

Since listing, floodplain development (urban and agricultural), aggregate mining, and alterations of hydrological regimes continue to be rangewide threats to *Eriastrum densifolium* subsp. *sanctorum* occurrences (Appendix 1). Principle among these is the alteration of hydrological regimes associated with the construction of Seven Oaks Dam. Additionally, the use of off-highway vehicles (OHVs) is an emerging threat at some occurrences. Impacts to *E. d.* subsp. *sanctorum* and its habitat are discussed below under the headings of Floodplain Development, Altered Hydrology, and Off-Highway vehicles (OHVs).

Floodplain Development

At listing, urban and agricultural development was identified as a threat impacting habitat occupied by *Eriastrum densifolium* subsp. *sanctorum* (USFWS 1987, p. 36269). Prior to listing, the Devore occurrence (EO 15) was extirpated by agricultural development and discing (CNDDB 2010a, p. 9). Since listing, additional mainstem and tributary occurrences across the species distribution in San Bernardino, Riverside, and Orange Counties have been directly impacted or extirpated by development related activities: Verdemont (EO 18) in Cajon Creek Wash may have been eliminated when disced in 2005; Highland Avenue (EO 3) in Lytle Creek Wash was extirpated by construction of California Freeway 210 (Foothill Freeway); Jensen Quarry (EO 27) in Sunnyslope was extirpated by construction of the Oak Quarry Golf Club; and the sole Orange County occurrence, Weir Canyon Road (EO 2), may have been extirpated by construction of a nearby subdivision (CNDDB 2010a, p. 220). Adverse effects from development continue to be a threat to *E. d.* subsp. *sanctorum* occurrences, and impacts from current and planned development projects in the Santa Ana River floodplain habitat are discussed below.

Numerous urban development projects continue to threaten *Eriastrum densifolium* subsp. *sanctorum* throughout the Santa Ana River floodplain. These developments within the floodplain impact the species by displacing it from limited suitable habitat. Floodplain development projects also affecting the hyrdrological regime are again summarized under the **Alteration of Hydrology** section below.

Current and planned urban development projects are located throughout the range of *Eriastrum densifolium* subsp. *sanctorum*. Six of the 21 occurrences are threatened by impacts from floodplain development. In Lytle Creek Wash, Frisbee Park (EO19) will be dissected by the Pepper Avenue extension (Ferguson 2010, p. 1). Mt. Vernon Avenue (EO 23) may be impacted by the recharge facility planned for construction on the Santa Ana River mainstem. La Cadeña Drive (EO 29) is likely to be adversely impacted by the Santa Ana River Crossing Water Main Relocation Project. The proposed routes for the California High Speed Rail could impact occurrences on the Santa Ana River mainstem at Tippecanoe Avenue (EO 25), Mt. Vernon Avenue (EO 23), La Cadeña Drive (EO 29), La Loma Hills (EO 30), and Temescal Avenue (EO 31) (CHSRA 2009, p. 6); this rail project is in the preliminary planning stages and a preferred route has not been selected. Currently, urban floodplain development poses a threat to 6 occurrences spread across 2 of the 4 known occupied watersheds. Although agricultural development in the floodplain was identified as a threat to the species at the time of listing, it does not currently appear to be a significant threat to the species.

Aggregate Mining

At listing, aggregate mining was identified as a threat impacting habitat occupied by *Eriastrum densifolium* subsp. *sanctorum* (USFWS 1987, p. 36268). Aggregate mining activities directly eliminate habitat and can degrade or fragment suitable habitat. Mining operations were quite active at the time of listing and impacted over 1,500 acres (ac) (600 hectares (ha)) of the Santa Ana River wash according to accounts shortly after listing (USFWS 1998, p. 3837).

Since listing, threats associated with aggregate mining remain a threat at many mainstem and tributary occurrences. There are mining activities indicated as threats near 4 of the 21 occurrences: Institution Road North (EO 33), Institution Road South (EO 4), and Line Avenue (EO 20) in Cajon Creek Wash, and Santa Ana Wash (EO 5) on the Santa Ana River mainstem (CNDDB 2010). Though no new aggregate mining is currently planned for the Santa Ana River mainstem, the level of impact to *Eriastrum densifolium* subsp. *sanctorum* associated with ongoing aggregate mining is unknown.

Alteration of Hydrology

At listing, it was predicted that Seven Oaks Dam would greatly reduce peak flow volumes and sediment loads that would drastically reduce the frequency of scouring and depositional events in the floodplain and allow most of the alluvial fan sage scrub communities on the Santa Ana River Wash to succeed to a uniform mature phase, reducing the seedling establishment of *Eriastrum densifolium* subsp. *sanctorum* in downstream habitats (USFWS 2008, p. 3). Absence of these scouring and depositional events could preclude all but the mature seral stages in the alluvial fan sage scrub. As discussed above, this mature (late successional) stage is characterized by the persistence of relatively few *E. d.* subsp. *sanctorum* individuals. The dominant species in mature seral stages include *Rhus ovata*, *Prunus ilicifolia*, and *Adenostoma fasciculatum*. Competition from these shrubs in addition to annual herbs limits the establishment of *E. d.* subsp. *sanctorum* and this type conversion is the manifestation of the altered hydrology.

Since listing, this subspecies continues to be threatened rangewide by floodplain modifications that alter hydrology, which directly and indirectly eliminate or impair habitat function. The habitat of the Santa Ana River and its tributaries receives little natural disturbance. Sheet flood flows probably occur once every 100 to 200 years and the scouring of such flows appear to maintain the alluvial fan scrub vegetation (USFWS 1986, p. 12181). Flood events are now confined to trenches and channels in Lytle Creek and the Santa Ana River, replacing the alluvial floodplain and the associated alluvial terraces. Constructed flood control channels prevent water from flowing out onto adjacent banks, providing the scouring and redeposition needed by *Eriastrum densifolium* subsp. *sanctorum*. The deeper water in these channels serves to increase the flow velocity and increases channel incision with less alluvial deposition. Flood control channels serve to promote mature successional stages of alluvial fan sage scrub, which provides poor establishment potential for *E. d.* subsp. *sanctorum* (Wheeler 1991, p. 56). Six occurrences are affected by grading for flood control: Line Avenue (EO 20), Santa Ana Wash (EO 5), Riverside Avenue (EO 21), Alamo Street (EO 22), Fairmont Park Golf Course (EO 24), and Weir Canyon Road (EO 2). Additionally, the construction of Seven Oaks Dam has removed much of the fluvial dynamics from the mainstem of the Santa Ana River and precludes natural

scouring and deposition in the future. As discussed in the **Habitat** section above, the inhibition of flooding events allows for the seral maturation of the alluvial fan sage scrub. This mature scrub then inhibits the establishment of *E. d.* subsp. *sanctorum* seedlings, which could ultimately lead to local extirpations. All 14 occurrences on the Santa Ana River are adversely impacted by altered hydrology resulting from the Seven Oaks Dam. In all, 15 of the 21 extant occurrences are threatened by alterations of hydrology.

Off-Highway Vehicles (OHVs)

OHV use directly damages plant communities and the soil horizon of *Eriastrum densifolium* subsp. *sanctorum* occurrences, thereby degrading habitat. Large flat expanses of alluvial fan sage scrub habitat that support *E. d.* subsp. *sanctorum* are also attractive to recreationists for OHV use. Impacts from OHV use is known to occur throughout the species' range and specifically at 11 of the 21 occurrences in Cajon Creek Wash (EOs 33, 4), Lytle Creek Wash (EO 19), and the Santa Ana River mainstem (EOs 5, 1, 25, 29, 21, 22, 24, and 31) (CNDDB 2010).

Unauthorized OHV use continues to degrade alluvial fan sage scrub habitat areas within Cajon Creek Wash, Lytle Creek Wash, and the mainstem of the Santa Ana River. Control of these activities rests with local landowners and jurisdictions. Three occurrences are conserved and afforded protection under the Western Riverside County Multiple Species Habitat Conservation Plan (Western Riverside County MSHCP) (EOs 22, 24, and 31). We anticipate that some impacts from OHVs will be ameliorated through active management with future implementation of the Woolly-Star Preserve Area Multiple Species Habitat Management Plan (WSPA). Please see further discussion of the Western Riverside County MSHCP and WSPA in **Factor D** below.

Summary of Factor A:

Urban development within the floodplain, aggregate mining, and physical alteration of flooding conditions were identified as threats impacting habitat occupied by *Eriastrum densifolium* subsp. *sanctorum* (USFWS 1987, p. 36268). The rangewide threat of alteration of hydrology has been evidenced primarily from the construction of Seven Oaks Dam that has significantly altered the natural fluvial processes of the Santa Ana River mainstem. Flood control channels have similarly removed alluvial systems in Lytle Creek Wash. Since listing, OHV use has emerged as a threat to *E. d.* subsp. *sanctorum* habitat and plants, impacting more than half of the extant occurrences. The Western Riverside County MSHCP affords some protection to three covered occurrences in Riverside County and the WSPA provides special protections for one occurrence. Threats to the habitat of *E. d.* subsp. *sanctorum* impact 10 of the 21 extant occurrences. The alteration of hydrological regimes is now the primary rangewide threat to the species.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

At listing, overutilization of *Eriastrum densifolium* subsp. *sanctorum* was not a threat; however, it was noted in the 1987 listing rule that *E. d.* subsp. *sanctorum* is extremely attractive when in flower and could be sought by collectors. This reasoning was further used by the Service to find

that designation of critical habitat was not prudent (USFWS 1987, p. 36269), stating, "designation of critical habitat…would likely focus attention upon these plants and their rare and vulnerable status, and might encourage vandalism or taking for collections or commercial purposes."

Since listing, overutilization of *Eriastrum densifolium* subsp. *sanctorum* has not been identified as a threat to the subspecies.

FACTOR C: Disease or Predation

Disease

Disease was not known to be factor in the listing rule (USFWS 1987, p. 36268). No plant diseases are known to affect *Eriastrum densifolium* subsp. *sanctorum* and disease does not pose a threat at this time.

Predation

Grazing was identified as a long-standing threat to *Eriastrum densifolium* subsp. *sanctorum* occurrences at listing. Historically, cattle grazing affected many of the areas that once supported *E. d.* subsp. *sanctorum*. In some areas, plant species composition was undoubtedly altered significantly by grazing animals. Grazing was thought to have contributed to the extirpation of the species in some places. However, the listing rule indicated that grazing was not a threat at those areas that still supported *E. d.* subsp. *sanctorum* (USFWS 1987, p. 36268).

Since listing, grazing was identified in 1994 by a single observer at occurrences near Jurupa (Riverside Avenue (EO 21), Alamo Street (EO 22), and Fairmont Park Golf Course (EO 24)) though it has not been cited as a threat in subsequent visits to the same locations. Therefore, grazing does not appear to be a threat to *Eriastrum densifolium* subsp. *sanctorum* in those areas still supporting the species.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At listing, regulatory mechanisms that provided some protection for *Eriastrum densifolium* subsp. *sanctorum* included: (1) the Act in cases where *E. d. sanctorum* co-occurred with a listed species; and (2) CESA (the subspecies was listed as endangered in California in 1987). Also mentioned was the general prohibition against removing vegetation on BLM land without a permit and the practice of San Bernardino County requiring some aggregate operations to avoid populations of *E. d.* subsp. *sanctorum*, though these regulations were noted as ineffective (USFWS 1987, p. 36269). The listing rule analyzed the potential level of protection provided by these regulatory mechanisms (USFWS 1987, pp. 36265–36270).

The status of regulatory mechanisms with an impact on *Eriastrum densifolium* subsp. *sanctorum* remains largely unchanged since listing. Several additional state and Federal mechanisms provide a conservation benefit to *E. d.* subsp. *sanctorum*, as follows: (1) the California Environmental Quality Act (CEQA); (2) implementation of conservation plans pursuant to the

Natural Community Conservation Planning (NCCP) Act; (3) the Clean Water Act (CWA); and (4) the National Environmental Policy Act (NEPA). The potential levels of protection provided by current regulatory mechanisms are discussed below.

State Protections in California

The State's authority to conserve rare wildlife and plants is comprised of four major statutes: CESA, the Native Plant Protection Act (NPPA), CEQA, and the NCCP Act.

Native Plant Protection Act (NPPA) and California Endangered Species Act (CESA)

Under provisions of CESA (Division 3, chapter 1.5, section 2050 *et seq*. of CFG) and NPPA (Division 2, chapter 10 section 1900 *et seq*. of the California Fish and Game Code (CFG)), the CDFG Commission listed *Eriastrum densifolium* subsp. *sanctorum* as endangered in 1987. Both CESA and NPPA include prohibitions forbidding the "take" of *E. d.* subsp. *sanctorum* (Chapter 10, Section 1908 and Chapter 1.5, Section 2080, CFG code). However, sections 2081(b) and (c) of CESA allow the CDFG to issue incidental take permits for state-listed threatened and endangered species if:

1) The authorized take is incidental to an otherwise lawful activity;
2) the impacts of the authorized take are minimized and fully mitigated;
3) the measures required to minimize and fully mitigate the impacts of the authorized take are roughly proportional in extent to the impact of the taking on the species, maintain the applicant's objectives to the greatest extent possible, and are capable of successful implementation;
4) adequate funding is provided to implement the required minimization and mitigation measures and to monitor compliance with and the effectiveness of the measures; and
5) issuance of the permit will not jeopardize the continued existence of a State-listed species.

Furthermore, with regard to prohibitions of unauthorized take under NPPA, landowners are exempt from this prohibition for plants to be taken in the process of habitat modification. Where landowners have been notified by the state that a rare or endangered plant is growing on their land, the landowners are required to notify CDFG 10 days in advance of changing land use in order to allow salvage of listed plants.

California Environmental Quality Act (CEQA)

The State of California enacted CEQA in 1970 as the principal statute mandating environmental assessment of projects in California. The purpose of CEQA is to evaluate whether a proposed project may adversely affect the environment and, if so, to determine whether that effect can be reduced or eliminated by pursuing an alternative course of action or through mitigation. CEQA applies to projects proposed to be undertaken or requiring approval by state and local public agencies (*http://www.ceres.ca.gov/topic/env_law/ceqa/summary.html*). CEQA requires disclosure of potential environmental impacts and a determination of "significant" if a project has the potential to reduce the number or restrict the range of a rare or endangered plant or

animal; however, projects may move forward if there is a statement of overriding consideration. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species including *Eriastrum densifolium* subsp. *sanctorum* through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Natural Community Conservation Planning (NCCP) Act

The NCCP program is a cooperative effort between the State of California and numerous private and public partners with the goal of protecting habitats and species. An NCCP program identifies and provides for the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. The program began in 1991 under the State's NCCP Act (CFG Code 2800–2835). The primary objective of the NCCP program is to conserve natural communities at the ecosystem scale while accommodating compatible land uses (*http://www.dfg.ca.gov/nccp/*).

Many NCCPs are developed in conjunction with Habitat Conservation Plans (HCPs) prepared pursuant to the Act. On June 22, 2004, we issued a section 10(a)(1)(B) permit for the Western Riverside County MSHCP. The Western Riverside County MSHCP is a large-scale, multi-jurisdictional NCCP/HCP and *Eriastrum densifolium* subsp. *sanctorum* is a covered species under the plan. Regional NCCPs may provide protection to federally listed species, such as *E. d.* subsp. *sanctorum*, by conserving native habitats upon which the species depend. The specific measures under the Western Riverside County MSHCP that afford protection to *E. d.* subsp. *sanctorum* are discussed below under the Act.

Federal Protections

Endangered Species Act of 1973, as amended (Act)

Since listing, the Act is the primary Federal law that may provide protection for *Eriastrum densifolium* subsp. *sanctorum*. The Service's responsibilities include administering the Act, including sections 7, 9, and 10. Section 7(a)(2) of the Act requires Federal agencies, including the Service to ensure that actions they fund, authorize, or carry out do not "jeopardize" a listed species or result in the "destruction or adverse modification" of habitat in areas designated by the Service to be "critical." Critical habitat has not been proposed for this taxon. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 C.F.R. § 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project.

Under section 9(a)(2) of the Act, with respect to endangered plant taxa, it is unlawful to remove and reduce to possession (i.e., collect) any such taxon from areas under Federal jurisdiction; maliciously damage or destroy any such taxon on any such area; or remove, cut, dig up, or

damage or destroy and such species on any other area in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law.

Under section 10(a)(1)(A) of the Act, there are provisions for collection of plants or plant parts for scientific purposes or to enhance the propagation and survival of the species. Under section 10(a)(1)(B) the Service may issue "incidental take" (take is defined in section 3(18) of the Act) permits for listed animal species to non-Federal applicants. Take and therefore incidental take protections are not extended to plants. "Incidental take" refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved HCP that details measures to [avoid] minimize and mitigate the project's adverse impacts to listed species including listed plants. Although section 10(a)(1)(B) of the Act allows for exemptions to take prohibitions under section 9 for animals, it does not allow for similar exemptions for plants except in cases where the State issues an incidental take permit under section 2081(b) and (c) of CESA. Issuance of an incidental take permit by the Service is subject to section 7 of the Act; the Service is required to ensure that the actions proposed in an HCP are not likely to jeopardize the animal or plant species or result in the destruction or adverse modification of critical habitat. Therefore, HCPs may provide an additional layer of regulatory protection to animals as well as plants. The Western Riverside County MSHCP is a large-scale, multi-jurisdictional NCCP/HCP and is discussed below.

Western Riverside County Multiple Species Habitat Conservation Plan (Western Riverside County MSHCP):

On June 22, 2004, we issued a section 10(a)(1)(B) permit for the Western Riverside County MSHCP. The Western Riverside County MSHCP is a large-scale, multi-jurisdictional NCCP/HCP that addresses 146 listed and unlisted ''Covered Species,'' including *Eriastrum densifolium* subsp. *sanctorum* within a 1,260,000 ac (510,000 ha) Plan Area in western Riverside County. The Western Riverside County MSHCP was designed to establish a multi-species conservation program that minimizes and mitigates the expected loss of habitat and the incidental take of covered species (Dudek and Associates 2003). The Service concluded in a Biological Opinion that the Western Riverside County MSHCP would not jeopardize the continued existence of *E. d.* subsp. *sanctorum* (USFWS 2004).

Participants in the Western Riverside County MSHCP include 14 cities in western Riverside County, the County of Riverside, the California Department of Parks and Recreation, and the California Department of Transportation (Caltrans). We granted the participating jurisdictions take authorization of listed animal species in exchange for their contribution to the assembly and management of the Western Riverside County MSHCP Conservation Areas. Approximately 347,000 ac (140,426 ha) of existing natural and open space areas (e.g., State Parks, U.S. Forest Service, and County Park lands known as Public/Quasi-Public Lands) and an additional 153,000 ac (61,916 ha) of new conservation lands (Additional Reserve Lands) will form the 500,000 ac (202,343 ha) Western Riverside County MSHCP conservation area.

Eriastrum densifolium subsp. *sanctorum* is a species covered by the Western Riverside County MSHCP. Three occurrences are covered species: Alamo Street (EO 22), Fairmont Park Golf

Course (EO 24), and Temescal Avenue (EO 31). Regarding specific conservation and management measures for the species, the Western Riverside County MSHCP states:

> "Conservation for this species will be achieved by inclusion of at least 2,340 ac of suitable Conserved Habitat and the known extant localities (four occurrences) with connectivity along the Santa Ana River in the MSHCP Conservation Area. In addition, implementation of Objective 3 for this species will maintain alluvial processes (floodplain hydrology and flooding) upon which this species depends. Approximately 910 ac of potential Habitat in the Plan Area will not be conserved. No further Take is given for this species. Reserve Managers will manage the floodplain along the Santa Ana River in order to maintain alluvial processes that provide for the distribution of the species to shift over time as hydrologic conditions and seed bank sources change. Specifically, manage the natural river bottom and banks, with a 500 foot buffer zone (*e.g.*, alluvial terraces, riparian vegetation) of the Santa Ana River with a minimum of 0.5 mile upstream of the confluence of each of the tributaries to the Santa Ana River between the Riverside/San Bernardino County line and the Riverside/Orange County line. Tributaries include Sunnyslope Creek, Mount Rubidoux Creek, Arroyo Tequesquite, Anza Park Drain, Evans Lake Drain, Temescal Creek and Aliso Creek. Reserve Managers will maintain or improve existing water quality and flow levels in the Santa Ana River by the use and enforcement of current or better water quality standards and at a minimum maintenance of existing flows." (Dudek 2003, p. 9:129).

The Western Riverside County MSHCP protects habitat and occurrences while providing long-term management and monitoring. For the three *Eriastrum densifolium* subsp. *sanctorum* occurrences in Riverside County, the Western Riverside MSHCP provides conservation and management benefits.

BLM South Coast Resource Management Plan – Area of Critical Environmental Concern (ACEC):

In 1994 the BLM, as part of their South Coast Resource Management Plan, designated three separate areas along the Santa Ana River as the Santa Ana River Wash Area of Critical Environmental Concern (ACEC) specifically to provide enhanced protection of sensitive habitats and populations of *Dodecahema leptoceras* and *Eriastrum densifolium* subsp. *sanctorum*. The ACEC encompasses 755 ac (306 ha) of the Santa Ana River and Plunge Creek. This area is a right-of-way avoidance area, unavailable for mineral material sales, closed to motorized vehicle use, and unavailable for livestock grazing (BLM 1994, p. 104). A portion of Santa Ana Wash (EO 5) and other nearby unverified plants are within the boundaries of the ACEC.

Upper Santa Ana River Habitat Management Plan (Plan B)

A Cooperative Agreement is under development that is known as the Upper Santa Ana River Habitat Management Plan (also known as Plan B). Participants include the U.S Army Corps of Engineers (Corps) and the Service. The purpose is to develop an agreement among these stakeholders for land use compatible with environmental resource needs. The conservation

strategy based on this cooperative agreement has not yet undergone review under CEQA or NEPA. Plan B addresses areas owned by private interests, sand and gravel mining operators, water conservation districts, as well as public owned lands, and land set aside for environmental purposes. Section 12 of the U.S. Geologic Survey Redlands quadrangle contains the primary land available for the plan to create, maintain, or enhance habitat for listed species. The land area addressed in Plan B covers approximately 5,200 ac (2,104 ha) in the Santa Ana River Wash. It is anticipated that Plan B or some alternate plan, once finalized, will coordinate and accommodate the existing ongoing and anticipated future planned activities, and establish habitat preserve areas. This area of section 12 does not encompass any CNDDB EOs, but may contain unverified *Eriastrum densifolium* subsp. *sanctorum* plants.

Woolly-Star Preserve Area

As part of the conservation measures proposed for the construction and operation of the Seven Oaks Dam on the Santa Ana River, the Corps and the flood control districts of Orange, Riverside, and San Bernardino Counties are funding the long-term management of a 764 ac (309 ha) conservation area known as the Woolly Star Preserve Area (WSPA), located in the Santa Ana River Wash in San Bernardino County (USFWS 2008b). We are working with the Corps and Seven Oaks Dam to prepare a multi-species habitat management plan for the benefit of federally-listed taxa: *Dodecahema leptoceras* (Slender-horned spineflower), *Eriastrum densifolium* subsp. *sanctorum* (Santa Ana River woolly-star), and San Bernardino kangaroo rat (*Dipodomys merriami parvus*). Currently, habitat has been acquired and the habitat management plan has been drafted (ACOE 2005, p. 1:1).

Clean Water Act (CWA)

Under section 404, the Corps regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). Any action with the potential to impact waters of the United States must be reviewed under the CWA, NEPA, and the Act. These reviews require consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts. *Eriastrum densifolium* subsp. *sanctorum* occurs within the Santa Ana River, Cajon Creek, and Lytle Creek water courses, requiring projects with watershed impacts to be addressed.

National Environmental Policy Act (NEPA)

NEPA (42 U.S.C. 4371 et seq.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. Because *Eriastrum densifolium* subsp. *sanctorum* is protected by state and Federal laws, any

projects over which a Federal agency has discretion must undergo the NEPA process to examine project impacts to the species.

Summary of Factor D

The Act remains the primary law providing protection for *Eriastrum densifolium* subsp. *sanctorum* since listing as an endangered species under the Act in 1987. Habitat management plans associated with the Act have provided for conservation of the species, though management planning is yet to be finalized for WSPA. In Riverside County, the species is covered by the Western Riverside County MSHCP, which addresses the conservation needs of the species on private lands and affords specific protections to covered occurrences. Other Federal and State regulations provide some discretionary protections, which we believe would be limited in absence of the Act.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

The 1987 listing rule did not identify other natural or manmade threats to *Eriastrum densifolium* subsp. *sanctorum*. However, it did specifically mention weedy nonnatives including *Bromus rubens* (red brome) and *Brassica geniculata* (summer mustard) as threats that likely do not co-occur with *E. d.* subsp. *sanctorum*. Since listing, two additional threats have emerged that provide potential impacts to *E. d.* subsp. *sanctorum*: hybridization among *E. d.* subspecies affecting three occurrences (EO 33, 4, and 29), and climate change may threaten the species rangewide.

Hybridization

Hybridization was not discussed in the listing rule as a threat to *Eriastrum densifolium* subsp. *sanctorum*. Though hybridization, or the occurrence morphological intermediates (with *E. d.* subsp. *elongatum* or *E. d.* subsp. *austromontanum*) had been suspected since the 1930s, genetic verification did not occur until the occurrences in Lytle Creek were compared to those in the Santa Ana River utilizing enzyme electrophoresis (Brunell and Rieseberg 1993). Similarly, hybridization was thought to occur with *E. d.* subsp. *elongatum* near the confluence of Lytle Creek and Cajon Creek (Verdemont (EO 18), Institution Road North (EO 33), and Institution Road South (EO 4)) (Craig 1934, p. 390; Burk *et al.* 1989, p. 20). The upper reaches of those washes seem to support *E. d.* subsp. *elongatum* while the listed entity is found downstream toward the Santa Ana River. *Eriastrum densifolium* subsp. *austromontanum* has also been thought to hybridize with *E. d.* subsp. *sanctorum* at La Cadeña Dr. and Lytle Creek (La Cadeña Drive (EO 29) and La Loma Hills (EO 30)) (DeGroot 2008, p. 1; Brunell and Whitkus 1997, p. 545). The analyses of these populations did not identify whether the studied plants have morphological similarities due to common genetics or are the result of similar adaptations (Porter 2009, p. 2). Though gene flow between *E. d.* subsp. *sanctorum* populations in the Santa Ana River and intermediates of Lytle Creek Wash likely took place in the recent past (150 years), they now appear isolated (Brunell and Rieseberg 1993, p. 5).

The extent of threat from hybridization remains unknown. Hybrids have been confined to lower Lytle Creek Wash and the Santa Ana River at its confluence with Lytle Creek. Additionally, it is

possible that, "these populations are stable entities, and just as old as the other subspecies, and are simply morphologically intermediate between described subspecies" (DeGroot 2009, p. 11). As mentioned in the **Genetics** section, the Service has recently directed consulting agencies to treat these hybrids as the listed entity at those locations. Hybridization is a potential threat at 7 of the 21 occurrences.

Climate Change

Global climate change was not addressed as a threat in the final listing rule for the *Eriastrum densifolium* subsp. *sanctorum*. Since listing, it has become apparent that potential threats exist to biota of the United States from ongoing, accelerated climate change (IPCC 2007). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying are predicted for the foreseeable future (Field *et al*. 1999, pp. 1–63; Cayan *et al*. 2005, pp. 1–47; IPCC 2007).

A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows. Increased summer heat may also increase the frequency and intensity of wildfires (IPCC 2007). Climate modeling for California indicates similar outcomes in temperature and precipitation. Recent assessments have been carried out running low and medium emission scenarios through the six models used in the 2007 International Panel on Climate Change assessment. The results predict a 1 to 3 degrees Celsius (1.8 to 5.4 degrees Fahrenheit) increase in average temperature by the year 2050 (Cayan *et al.* 2009, p. 16). Over the same period, a 12 to 35 percent decrease in precipitation is expected (Cayan *et al*. 2009, p. 17).

Significant temperature increases create a stressor for endemic species. This stressor enhances pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must somehow adapt to these pressures *in situ* (in place) or shift their geographic range (Cayan *et al*. 2009, p. 45). Such a shift in range for narrow endemic species such as *Eriastrum densifolium* subsp. *sanctorum* could exceed the tolerance of the subspecies. Additionally, there is very little available alluvial fan sage scrub habitat in the Santa Ana River basin to assist this subspecies with a range shift. Though we know little of the adaptive ability of *E. d.* subsp. *sanctorum*, climate change could potentially pose a significant rangewide threat to the subspecies.

Summary of Factor E

Potential Factor E threats to *Eriastrum densifolium* subsp. *sanctorum* include hybridization and climate change. The threat of hybridization is not well understood and impacts to *E. d.* subsp. *sanctorum* are unknown. Though difficult to quantify, change in climate may impact all occurrences and could pose a significant threat to this species in the future.

III. RECOVERY CRITERIA

No recovery plan or outline has been prepared for *Eriastrum densifolium* subsp. *sanctorum*.

IV. SYNTHESIS

At listing, *Eriastrum densifolium* subsp. *sanctorum* was threatened by habitat loss from encroaching development within the floodplain, and sand and gravel mining. The status of *E. d.* subsp. *sanctorum* has not changed significantly since its listing, though the threat of urban floodplain development and alteration of hydrology has continued. Additional threats impacting habitat occupied by *E. d.* subsp. *sanctorum* include aggregate mining and OHV use. Factor E threats identified since listing include hybridization and climate change. Nearly all of the historical occurrences (10 of 11 occurrences) have persisted, and 11 of the 12 occurrences identified since listing are extant. Though additional occurrences have been identified since listing, there are few plants at most occurrences. Impacts from development and altered hydrology in the Santa Ana River mainstem and its tributaries have reduced the amount of suitable habitat necessary for the establishment of *E. d.* subsp. *sanctorum* seedlings. Impacts at some occurrences in Riverside County are protected by the Western Riverside County MSHCP; 3 of the 21 extant occurrences are afforded protection by the plan. Other regulatory protections and conservation measures include the WSPA and the BLM ACEC.

Despite persistent threats, protection efforts provide some level of stability for *Eriastrum densifolium* subsp. *sanctorum*, which could potentially face extinction within the foreseeable future throughout its range. Therefore, we find that *E. d.* subsp. *sanctorum* still meets the definition of endangered, and recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
__X__ No Change

New Recovery Priority Number and Brief Rationale: No Change

We recommend no change in the recovery priority number of 6C at this time. The taxon is a species that still faces a high degree of threat and a low recovery potential. Few instances of habitat conservation and a poor outlook for seedling establishment with the onset of altered hydrology continue to put this subspecies in danger of extinction.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Work with partners, such as the Service's Partners for Fish and Wildlife Program to identify opportunities for conservation or preservation for *Eriastrum densifolium* subsp. *sanctorum* occurrences on private lands. Property easements or purchases of parcels could also be made through the Act's section 6 funding and other programs.

2. Ensure natural recruitment of *Eriastrum densifolium* subsp. *sanctorum* is sufficiently documented following extreme fluvial events (i.e., floods) to assure long-term sustainability.

3. Determine occurrences where genetic distinctness exists between occurrences in Cajon Creek, Lytle Creek, and the Santa Ana River mainstem that comprise the range of known hybrid of *Eriastrum densifolium* subsp. *sanctorum.*

4. Develop a final recovery outline for *Eriastrum densifolium* subsp. *sanctorum*.

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Appendix 1: Occurrences of *Eriastrum densifolium* subsp. *sanctorum* (Santa Ana River woolly-star); prepared for 5-year review, 2010.

Occurrence (Occurrence Alias)	**Element Occurrence**	**Count**	**County**	**New Since Listing**	**Status**	**Current Threat**	**Ownership/Conservation**
Mill Creek							
Mill Creek Wash	17	None	San Bernardino		Extant	Unknown	Unknown/Unknown
Cajon Creek Wash							
Cajon Junction/ Cajon Canyon	32	50 (06)	San Bernardino	Y		Unknown	USDA-FS SBNF?
Devore/Cajon Canyon	15	50(85)	San Bernardino		Extirpated	Extirpated by discing in '85	Extirpated
Verdemont/Cajon Wash	18	16 (87), 0 (05)	San Bernardino		Presumed extant	**Factor E:** Hybridization	Unknown/Unknown
Institution Road North/Cajon Wash	33	5325 (08)	San Bernardino	Y	Extant	**Factor A:** Aggregate mining; OHVs **Factor E:** Hybridization	San Bernardino County Flood Control District/Lytle Creek Ranch Mitigation
Institution Road South/Cajon Wash	4	5325 (08) for EOs 4/33	San Bernardino		Extant	**Factor A:** Aggregate mining; OHVs **Factor E:** Hybridization	San Bernardino County Flood Control District/Lytle Creek Ranch Mitigation
Lytle Creek Wash							
Frisbee Park/lower Lytle Creek Wash	19	100s (08)	San Bernardino		Extant	**Factor A:** Floodplain development; OHVs (impacted by 210 freeway in 2005) **Factor E:** Hybridization	SBCFCD/Unknown
Highland Ave/lower Lytle Creek Wash	3	444 (88), 0 (05)	San Bernardino		Extirpated	Extirpated by 210 freeway construction	Extirpated
Line Avenue/lower Lytle Creek Wash	20	20 (87)	San Bernardino		Extant	**Factor A:** Aggregate mining; Alteration of hydrology **Factor E:** Hybridization	Unknown/Unknown
Santa Ana River and Wash Mainstem							
Santa Ana River Canyon	28	Collection only	San Bernardino		Extant	**Factor A:** Alteration of hydrology	Unknown/Unknown
Santa Ana River Powerhouse	10	30 (87), 60 (92)	San Bernardino		Extant	**Factor A:** Alteration of hydrology	Private inholding in SBNF/Unknown
Plunge Creek @ Greenspot Rd/Santa Ana River/	26	120 (07)	San Bernardino	Y	Extant	**Factor A:** Alteration of hydrology	San Bernardino County Flood Control District /Mitigation land

Occurrence (Occurrence Alias)	**Element Occurrence**	**Count**	**County**	**Known at Listing**	**Status**	**Current Threat**	**Ownership Conservation**
Santa Ana Wash	5	1000s (86), 5140 (08)	San Bernardino		Extant	**Factor A:** Aggregate Mining; Alteration of hydrology; OHVs	BLM and San Bernardino County Flood Control District/BLM ACEC
Boulder Avenue	1	50 (85)	San Bernardino		Extant	**Factor A:** Alteration of hydrology; OHVs	Private/Unknown
Tippecanoe Avenue/NAFB/Santa Ana River	25	51 (03)	San Bernardino	Y	Extant	**Factor A:** Floodplain development; Alteration of hydrology; OHVs	Unknown/Unknown
Mt Vernon Avenue/Santa Ana River	23	2000 (98)	San Bernardino	Y	Extant	**Factor A:** Floodplain development; Alteration of hydrology	City of Colton/Unknown
La Cadeña Drive/Santa Ana River	29	300 (08)	San Bernardino	Y	Extant	**Factor A:** Floodplain development; OHVs **Factor E:** Hybridization	San Bernardino County Flood Control District?/Unknown
La Loma Hills/Santa Ana River	30	36 (02)	San Bernardino	Y	Extant	**Factor A:** Floodplain development; Alteration of hydrology **Factor E:** Hybridization	Unknown/Unknown
Riverside Avenue/Santa Ana River	21	2(94)	San Bernardino	Y	Extant	**Factor A:** Alteration of hydrology; OHVs	Riverside? County Flood Control District/Unknown
Alamo Street/Santa Ana River	22	3(07)	Riverside	Y	Extant	**Factor A:** Alteration of hydrology; OHVs	Riverside County Flood Control District/Western Riverside County Multiple Species Habitat Conservation Plan
Fairmont Park Golf Course/Santa Ana River	24	11 (07)	Riverside	Y	Extant	**Factor A:** Alteration of hydrology; OHVs	Riverside County Flood Control District/Western Riverside County Multiple Species Habitat Conservation Plan
Jensen Quarry/Sunnyslope	27	0 (00)	Riverside	Y	Extirpated	Extirpated by golf course construction	Extirpated
Temescal Avenue/Santa Ana River	31	1 (06)	Riverside	Y	Extant	**Factor A:** Floodplain development; Alteration of hydrology; OHVs	Unknown/Western Riverside County Multiple Species Habitat Conservation Plan
Weir Canyon Road (@ Monte Vista Rd)/Cajon Creek	2	None	Orange		Presumed extant	**Factor A:** Alteration of hydrology	Unknown/Unknown

**** unless otherwise noted, table references CNDDB 2010**

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Eriastrum densifolium* subsp. *sanctorum
(Santa Ana River woolly-star)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Review Conducted By: Carlsbad Fish and Wildlife Office

FIELD OFFICE APPROVAL:

ACTING **Lead Field Supervisor, U.S. Fish and Wildlife Service**

Approve _____ Date OCT 29 2010

Scott A. Sobiech