

**The Habitat of *Astragalus pycnostachyus* var. *lanosissimus* (Ventura
marsh milk-vetch) and an
Assessment of Potential Future Planting Sites**



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I. Executive Summary

Astragalus pycnostachyus var. *lanosissimus* (Ventura marsh milk-vetch) is a short-lived perennial member of the pea family (Fabaceae) that once ranged from Ventura County south to Orange County. *A. pycnostachyus* var. *lanosissimus* was believed to be extinct from 1967 to 1997, when it was rediscovered growing near Oxnard on a site that continues to be slated for development. The main goals of this project were to gain a better understanding of the habitat of *A. pycnostachyus* var. *lanosissimus* with the goal of selecting a minimum of three sites where future (re-)introduction efforts have a high likelihood of being successful. The scope of this project included the examination of published sources of information, communication with individuals having knowledge of the species and visits to the one natural population and the experimental plantings of *A. pycnostachyus* var. *lanosissimus*. Sixteen sites identified by various sources as having potentially-favorable habitat for *A. pycnostachyus* var. *lanosissimus* were visited during October and November of 2006. These site visits lead to the selection of three areas (the South Carpinteria Salt Marsh (SCSM) in Santa Barbara County, McGrath State Beach (MSB) in Ventura County and the Bolsa Chica Ecological Reserve (BCER) in Orange County where future plantings of *A. pycnostachyus* var. *lanosissimus* are likely to be successful. Additionally, this project identified and examined factors that have limited the success of past plantings of *A. pycnostachyus* var. *lanosissimus* with the hope of avoiding these mistakes in future planting efforts. While there can be no guarantee that any experimental planting will be successful, a commitment to monitoring and active management at planting sites is an important component of any re-introduction attempt. The project was funded by the Channel Islands Chapter of the California Native Plant Society.

II. Overview of the Biology of *Astragalus pycnostachyus* var. *lanosissimus*

General Description:

Astragalus pycnostachyus var. *lanosissimus* is a short-lived perennial herb in the Fabaceae (pea family). This variety is densely, white silky-tomentose (Munz 1974) with hollow, erect stems measuring four to nine decimeters in height. However, recently, one plant was recorded at a height of 227 centimeters (cm) (7.5 feet) during the 2003 growing season, a size much larger than reported in historical literature (Meyer 2005). *A. pycnostachyus* var. *lanosissimus* has compound leaves with 27-39 leaflets per leaf (Barneby 1964) and has lower stipules that are fused around the stems of the plant forming a sheath (Hickman 1993). *A. pycnostachyus* var. *lanosissimus* has inflorescences that consist of numerous greenish-white or cream colored flowers. The flowers are fairly large with the banner and wing each measuring 7 to 10 millimeters (mm) long and the keel measuring 7 to 9 mm long (Barneby 1964). Fruits consist of lightly-inflated pods (Barneby 1964) that are green and papery with a persistent, stiff 5 to 8 mm beak, and 7 to 9 ovules (Hickman 1993, Wilken and Wardlaw 2001). See figures 1-4 for photos of *A. pycnostachyus* var. *lanosissimus*.

Reproductive Biology:

Data from the 23 plants at the North Shore Site (NSS) that produced flowers in 2000 indicate the first flower buds occur on *A. pycnostachyus* var. *lanosissimus* plants in mid-June, with peak flowering occurring in mid-July, and the latest flowers in early September (Wilken and Wardlaw 2001). Impact Sciences (1998) reported finding only four of 37 flowering individuals as late as August of 1997, with peak flowering in July. Additionally, during field work in 2006, *A. pycnostachyus* var. *lanosissimus* plants at McGrath State Beach (MSB) were observed to be in flower in late October. These observations contrast somewhat with historical observations that indicate a flowering period from August to October (Ikeda and Meyer 2000). Average plants produce approximately 26 inflorescences with an average of about 3 inflorescences per shoot; while inflorescences produce an average of about 37 flowers, most of which mature into fruit (Wilken and Wardlaw 2001).

Fruits are semi-persistent and weakly dehiscent (Wilken and Wardlaw 2001). Individual fruits contain an average of approximately 3 seeds per fruit, with some containing as many as 6 to 7 seeds (Wilken and Wardlaw 2001). Flowers that were bagged with mesh to exclude insects

produce an average of two (1.7 fully developed and 0.3 incompletely developed) seeds per fruit. Open-pollinated inflorescences produce an average of approximately 3 (1.9 fully developed and .9 incompletely developed) seeds per fruit. The lack of significant difference in seeds produced in bagged versus “open-pollinated” flowers indicates that *A. pycnostachyus* var. *lanosissimus* is self compatible and likely autogamous. The percentage of damaged fruit in bagged and open-pollinated inflorescences was 20 and 50 percent respectively. Damaged fruit and incompletely developed seeds are attributed to predation by weevils from the family Bruchidae (the seed weevil family) (Wilken and Wardlaw 2001).

Individual seeds possess hard seed coats that resist the absorption of water, thus impeding germination (Soza, *et al.* 2003). Seed coats are naturally broken down and removed through mechanical abrasion and the activities of microorganisms known as scarification. This allows seeds to imbibe water and subsequent germination to occur (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) speculate that the seed coats of all seeds produced during a single growing season are unlikely to be abraded sufficiently enough in the time between dispersal (during the fall) and the next period of germination (probably during the following spring) for germination of all seeds to occur. This indicates that a portion of seeds produced may remain in the soil prior to germination. In a survey performed by D. Wilken at the North Shore Site (NSS) (pers. comm. 2006), ample amounts of milk-vetch seeds were present in the soil beneath several adult *A. pycnostachyus* var. *lanosissimus* plants. This, coupled with evidence that other species of *Astragalus* have germinated after a period of dormancy of over 40 years, indicates that the seed bank of *A. pycnostachyus* var. *lanosissimus* is likely significant (Ikeda and Meyer 2000). Little detailed information exists about the overall production of seeds at occurrences of *A. pycnostachyus* var. *lanosissimus*, but Meyer (2005) estimated that 29 plants growing in one location at MSB produced as many as 3.7 million seeds during the 2003 growing season.

In terms of pollinator activity, Wilken and Wardlaw (2001) observed few insects (one bee and two butterflies) visiting *A. pycnostachyus* var. *lanosissimus* plants at the Oxnard site, even on days exhibiting weather typically associated with high levels of insect activity. In contrast, fieldwork in 2006 and observations from past years indicate that flowers at the experimental plantings of *A. pycnostachyus* var. *lanosissimus* are frequently visited by bumblebees (likely of the genus *Bombus*) and other insects (M. Meyer, pers. comm. 2006).

Root System Characteristics:

Much of what is known about the root system of *A. pycnostachyus* var. *lanosissimus* comes from a root excavation done by the Sunburst Plant Disease Clinic at the NSS (Impact Sciences 1998). In their excavation of the root system of one *A. pycnostachyus* var. *lanosissimus* plant, investigators observed that the plant had a horizontally oriented root system. This contrasts with the deep, taproot-based morphology associated with the root systems of other *Astragalus* species. The horizontal root system at the NSS appears to be caused by a layer of soil contaminated with petroleum and other chemicals that occurs approximately three to five centimeters below the soil surface in which roots cannot survive. This is almost certainly a function of the roots staying above, or dying when entering, the oil waste contaminated soil beneath the plants (D. Magney, pers. comm. 2007). This horizontal root orientation at the NSS results in a much smaller root volume than is expected for similar *Astragalus* species. This growth habit appears to be site-specific, as plants at the Santa Barbara Botanic Garden typically exhibit a taproot-based system when grown in cultivation (D. Wilken, pers. comm. 2006).

Nitrogen-fixing root nodules are present in many members of the pea (Fabaceae) family. However, researchers with Sunburst Plant Disease Clinic observed a lack of nitrogen-fixing root nodules in *A. pycnostachyus* var. *lanosissimus*. It is presumed that *Astragalus* species will not enter into this symbiotic relationship with nitrogen-fixing microorganisms when soil nitrogen levels are high and additional nitrogen fixation is unnecessary. In addition, Parker (2006) found no evidence of root nodules during the excavation of a single dead *A. pycnostachyus* var. *lanosissimus* plant that was growing at Coal Oil Point Reserve in Santa Barbara County. However, lack of root nodules may also be site-specific, as Ikeda and Meyer (2000) reported that three plants being cultivated at Rancho Santa Ana Botanic Gardens exhibited mycorrhizal root nodules that apparently had been formed as a result of a natural, airborne source of inoculum. The other variety of *A. pycnostachyus*, *A. pycnostachyus* var. *pycnostachyus* (northern marsh milk-vetch), is reported to have root nodules associated with nitrogen fixation (Baye 1998).

Life History Observations:

In the most detailed study to date of *A. pycnostachyus* var. *lanosissimus*, Wilken and Wardlaw (2001) looked at the life history of plants at the NSS in Ventura County near Oxnard. In their study they identified 80 “adult” plants that had been growing on the site prior to the 1999-2000 growing season. From February through September 2000, 39 of these plants (49 percent) survived to produce shoots greater than 30-40 cm in length. The death of the other 41 plants (51 percent) is attributed to herbivory by nonnative snails. Of the 39 living plants, 22 produced reproductive shoots and 17 produced vegetative shoots only. Wilken and Wardlaw (2001) determined that three plants were at least three to four years old, 13 plants were at least two years old, and 23 plants were at least one year old.

Impact Sciences (1998) reported that out of 112 “mature” individuals present in 1997, 66 individuals showed signs of reproduction. At least six of these plants were probably decadent, showing signs of flowering and reproduction in the past only (Impact Sciences 1998). Evidence indicates that only about 50 percent of *A. pycnostachyus* var. *lanosissimus* plants flower in their second summer following germination, and 100 percent of plants over three years old produce flowers (Wilken and Wardlaw 2001). In contrast, most of the plants at the experimental planting sites at McGrath State Beach (MSB) and Carpinteria Salt Marsh Reserve (CSMR) flower during the first growing season following planting (actual age at the time of flowering is typically 11 months) (Meyer 2005). The factors contributing to this difference in time required to reach maturity is not currently known.

It also appears that milk-vetch seeds are capable of germinating whenever environmental conditions are favorable. The number of seedlings/juveniles present in a given year at the NSS, based on data from 1997 to 2001, varies from 144 to 192, with 187 seedlings present in 2000 (Ikeda and Meyer 2000, Wilken and Wardlaw 2001). In 2000, only 46 out of 187 seedlings (about 25 percent) survived through mid-October. However, due to the fact that plants begin to senesce in October, it is difficult to determine survival of juvenile plants until the following growing season (Wilken and Wardlaw 2001).

Distribution:

A. pycnostachyus var. *lanosissimus* is distinguished from its nearest relative *A. pycnostachyus* var. *pycnostachyus* by a number of somewhat-subtle characteristics dealing

mainly with the length of the calyx tooth and fruit pod, as well as the number of ovules (Table 1, Comparison of the Two Varieties of *Astragalus pycnostachyus*). In addition to differences in morphology, the two varieties are separated geographically by a large distance (approximately 500 kilometers), with *A. pycnostachyus* var. *lanosissimus* occurring historically from Ventura County in the north to Orange County in the south (CNDDDB 2006) and *A. pycnostachyus* var. *pycnostachyus* occurring farther north historically from Humboldt County in the north to San Mateo County in the south (CNDDDB 2006). However, a recent collection of *A. pycnostachyus* var. *pycnostachyus* made in 2003 was from near San Simeon in San Luis Obispo County, making this geographic separation less distinct (Consortium of California Herbaria 2006). In addition, it should be noted that this San Luis Obispo County collection may be a misidentification, as *A. nuttallii* is the only *Astragalus* species known to occur in this area (P. Baye, pers. comm. 2006). If the San Luis Obispo County specimen is verified as *A. pycnostachyus* var. *pycnostachyus*, habitat information should be gathered from this location in order to further characterize the habitat and distribution of the two varieties of *A. pycnostachyus*.

III. The History of *Astragalus pycnostachyus* var. *lanosissimus*

Historical Information (pre-1997):

Astragalus pycnostachyus var. *lanosissimus* was collected historically from six locations. Populations of *A. pycnostachyus* var. *lanosissimus* ranged discontinuously from near the City of San Buenaventura (Ventura) (Ventura County) in the north to near Huntington Beach (Orange County) in the south (CNDDDB 2006). Most historical collections were made in the early part of the twentieth century and have vague locality descriptions associated with them (Consortium of California Herbaria 2006). Rydberg (1929) lists the type specimen locality as “La Bolsa, Los Angeles County.” This specimen is attributed to the Bolsa Chica area, between Sunset and Huntington Beaches in western Orange County. Ikeda and Meyer (2000) note that the range of *A. pycnostachyus* var. *lanosissimus* was probably always narrow and never widespread. This type of distribution is common in many species of rare *Astragalus* (Wilken and Wardlaw 2001) and many coastal wetland and coastal dune-inhabiting species.

Based on historical collection information, populations of *A. pycnostachyus* var. *lanosissimus* are believed to have grown at a minimum of six locations in three counties. In Ventura County, *A. pycnostachyus* var. *lanosissimus* was collected from a nondescript location labeled as “Ventura”, as well as from Silver Strand Beach near Point Hueneme and directly across Harbor Boulevard and near McGrath State Beach near the city of Ventura. In Los Angeles County, specimens were collected from near Santa Monica and from the extensive Ballona Wetlands near the modern-day Playa del Rey and Marina Del Rey. In Orange County, *A. pycnostachyus* var. *lanosissimus* was only collected from the large Bolsa Chica Wetland (CNDDDB 2006, Consortium of California Herbaria 2006). Table 2, Historical and Current Natural Populations of *A. pycnostachyus* var. *lanosissimus*, provides a summary of historical collection locations.

Five of the six historical populations are listed as either extirpated or possibly extirpated by the California Natural Diversity Database (CNDDDB 2006). The sixth historical location (the collection from Silver Strand Beach near Point Hueneme) is listed as “presumed extant”, but is only known from a single specimen collected in 1927 and is likely extirpated (CNDDDB 2006). Habitat for this species in the Silver Strand Beach area was eliminated by development by the early 1960s (D. Magney, pers. comm. 2007). The last observation of the species prior to its rediscovery in 1997 was from a location near McGrath State Beach in Ventura County in 1967.

In 1967, a staff member of the Ventura County Agriculture Commissioner's Office found the remains of plants growing near the entrance of McGrath State Beach that had been mowed and killed by California Department of Parks and Recreation maintenance staff (D. Magney, pers. comm. 2007). From 1967 to 1997, *A. pycnostachyus* var. *lanosissimus* was considered extinct until its rediscovery in June of 1997 growing near Oxnard in Ventura County.

Rediscovery (post-1997):

In 1997, *A. pycnostachyus* var. *lanosissimus* was rediscovered growing on private property in the City of Oxnard on a locality now known as the North Shore Site (NSS) by Kate Symonds, a U.S. Fish and Wildlife Service biologist at the time (Ikeda and Meyer 2000). This new population is situated on a highly degraded property located on secondary dunes at the western edge of the Oxnard Plain. The property was used as a site for disposal of oil field wastes between 1955 and 1982 (Impact Sciences 1998), on land leased from the McGrath family. Aerial photo imagery from 1985 (Ikeda and Meyer 2000) and site history indicate that the area was devoid of vegetation when the disposal operations ceased in 1982. This indicates that all vegetation (including the *A. pycnostachyus* var. *lanosissimus*) became established at the site sometime between 1982 and the mid-1990s (Impact Sciences 1998). Various hypotheses exist for the occurrence of *A. pycnostachyus* var. *lanosissimus* on the NSS. Ikeda and Meyer (2000) hypothesize that (1) seeds of *A. pycnostachyus* var. *lanosissimus* could have been introduced onto the NSS from another location in Ventura County, (2) seeds may have always been present on the site, or (3) seeds may have been present in the site's vicinity and distributed to the site after 1982. D. Magney (pers. comm. 2007) believes that the NSS population originated from seeds transported from the MSB area sometime after 1982 by the McGrath family (or a representative thereof) after the oil waste disposal site was closed by the County of Ventura.

Despite the presumably anthropogenic origin of this population, it is treated as a "native, natural and wild" population by all regulatory agencies. As a result of this rediscovery, *A. pycnostachyus* var. *lanosissimus* was state listed as endangered in 2000 and federally listed as endangered in 2001 (Federal Register 2001, Fish and Game Commission 2000). It is also on the CNPS List 1B (plants rare, threatened, or endangered in California and elsewhere).

Despite being the only known "wild, natural" population of *A. pycnostachyus* var. *lanosissimus*, the NSS, a developer has received approval for residential development on the site

by the City of Oxnard. In order for development activities to proceed, the developer must complete remediation (removal) of the oil waste present on the site. Oil waste remediation, as well as activities associated with residential development on the site, have the potential of causing great harm to the *A. pycnostachyus* var. *lanosissimus* growing at the NSS. The California Department of Fish and Game (CDFG) and the developer (North Shore at Mandalay Bay, L.L.C.) have entered into a Memorandum of Understanding (MOU) that includes a number of actions of mitigation and protective measures intended to compensate for potential loss of habitat critical to the existence of *A. pycnostachyus* var. *lanosissimus* (See Appendix E of Ikeda and Meyer 2000). Protective measures on the NSS include the establishment of a 5.2-acre area free from residential development surrounding the milk-vetch population. Approximately 100 feet surrounding the colonies of *A. pycnostachyus* var. *lanosissimus* are fenced and will be protected from oil remediation activities (Ikeda and Meyer 2000).

As part of required mitigation for the project, North Shore at Mandalay Bay, L.L.C. is required to establish two off-site populations of *A. pycnostachyus* var. *lanosissimus*. Currently there are plans to establish one of the populations at the Ballona Wetlands Ecological Reserve and the other on private property immediately south of McGrath State Beach near McGrath Lake west of Harbor Boulevard (M. Meyer, pers. comm. 2006). As part of the MOU, North Shore at Mandalay Bay, L.L.C. is also required to provide an endowment totaling \$50,000 intended to provide the funds needed for long-term maintenance of the established *A. pycnostachyus* var. *lanosissimus* off-site populations (see Impact Sciences 1998, Ikeda and Meyer 2000). Oil remediation activities began during the winter of 2006-2007 and were observed on the NSS in April 2007.

Due to the fact that plants have persisted at the NSS for a number of years (perhaps 20 years) with little or no supplemental maintenance or management, this population is vital to the continued existence of the species. The number of individual plants at this site has fluctuated on a yearly basis, but the number of reproductive individuals generally ranges from 30 to 50 adults, with more individuals present in wet years (Center for Plant Conservation 2006). The population at the NSS provides a great deal of information about the habitat requirements of *A. pycnostachyus* var. *lanosissimus* plants, and from the perspective of conservation this location should be preserved. Unfortunately, oil remediation and development activities at this site may result in the eventual decline or extirpation of this population. A primary concern is what will

happen to the subsurface hydrology within the *A. pycnostachyus* var. *lanosissimus* population at the NSS once oil is removed from surrounding areas. A high water table is, hypothetically, one of the primary factors contributing to the success of experimental populations of *A. pycnostachyus* var. *lanosissimus*. The oil waste under the milk-vetch population is so thick that it probably creates an aquitard that does not allow precipitation to penetrate soil layers below the oil waste. This results in an artificially created, shallow, perched water table. Any alteration of the hydrology at the NSS could prove to be disastrous to the *A. pycnostachyus* var. *lanosissimus* population. In addition, there is no guarantee that off-site populations of *A. pycnostachyus* var. *lanosissimus* will persist indefinitely, making the NSS population extremely valuable and important for the continued existence of the species.

Experimental populations of *A. pycnostachyus* var. *lanosissimus* have been established at sites in Ventura and Santa Barbara Counties in order to assess habitat requirements and safeguard against extinction should the “wild” site decline or become extirpated. Additionally, seeds from a number of maternal lines have been collected from both the wild site and experimental sites and are stored at several locations for use in future conservation/planting activities. The eventual goal is to establish a number of self-sustaining populations of *A. pycnostachyus* var. *lanosissimus* within its historical range that will be protected, monitored and maintained in perpetuity.

IV. Experimental Planting Efforts

Experimental plantings of *Astragalus pycnostachyus* var. *lanosissimus* have been attempted at five sites in Santa Barbara and Ventura Counties with varying degrees of success. These sites include the Coal Oil Point Reserve (COPR) and Carpinteria Salt Marsh Reserve (CSMR) in Santa Barbara County and McGrath State Beach (MSB), Mandalay State Beach (Mandalay), and Ormond Beach in Ventura County (see Map 6, Selected Locations in the *Astragalus pycnostachyus* var. *lanosissimus* Project Area). Currently, *A. pycnostachyus* var. *lanosissimus* plantings exist at each of these sites with the exception of Ormond Beach, where the planting was unsuccessful due to prolonged inundation from flooding in winter of 2005 (M. Meyer, pers. comm. 2006) Table 4, Status Summary of Experimental Plantings, provides for a summary of experimental planting sites and their current status.

Coal Oil Point Reserve (COPR):

General Location. The Coal Oil Point Reserve (COPR) is located west of the town of Isla Vista near the intersection of Storke Road and El Colegio Road in southern Santa Barbara County. The COPR is part of the University of California Natural Reserve System (UCNRS) and is managed by UC Santa Barbara. Within the site, experimental planting locations are present west of Devereux Slough (COPR Lagoon), and west and east of the “Pond Trail” (COPR Pond) (see Map 2 and Table 4, Locations of Existing *A. pycnostachyus* var. *lanosissimus* Planting Sites).

Planting History. At COPR, eight container-grown plants were installed in January 2003 in an herb-dominated meadow just south of the “Pond” and two small plots were directly seeded with 200 *A. pycnostachyus* var. *lanosissimus* seeds. Supplemental container-grown plants in the vicinity of the original COPR-Pond site were planted in May of 2004 (Meyer 2005). These new experimental plantings were given the names COPR Pond-A (10 plants), COPR Pond-B (5 plants), COPR Pond-C (8 plants) and COPR Pond-D (17 plants) (Meyer no date). COPR Pond-A was located in the same approximate location as the original COPR Pond site and was, functionally, merged with that planting.

The experimental plantings at COPR located on the west side of Devereux Slough (COPR Lagoon), are in an upland area and originally consisted of eight, container-grown plants that were planted in January 2003 and two small plots (named Plot 1 and Plot 2) were direct-

seeded with 200 *A. pycnostachyus* var. *lanosissimus* seeds each (Meyer, no date). (COPR Lagoon, Meyer 2003). In April 2004, a supplemental installation of 54 container-grown plants was planted in this location (Meyer 2006a).

In addition to the COPR Pond and COPR Lagoon sites, two additional direct seeded plots were installed in January 2003 in a low swale within sandy dunes south of the “Pond”. Six container-grown plants were installed in April 2004 in a shaded patch of *Jaumea carnosa* located about 100 feet south of the Lagoon site on the west edge of Devereux Slough (Meyer, no date).

Results. The COPR-Pond site originally suffered from a sudden drop in the subsurface water table during the summer of 2004 (M. Meyer, pers. comm. 2006). Plants were reported to be in “severe decline” at the end of summer 2004 (Meyer 2006c). The area was then subjected to several periods of heavy rainfall from October 2004 through February 2005 that resulted in prolonged periods of inundation at this site. In the summer of 2005, 42 naturally recruited seedlings were observed in the COPR Pond site and several individuals survived to flower and fruit during that growing season (Meyer 2006a). However, this site continued to suffer from the unpredictable behavior of the water table during the 2006 growing season and the site now contains few plants. In October 2006, one adult plant was observed in the vicinity of COPR Pond-D (M. Meyer, pers. comm. 2006) and three natural recruits were observed in the vicinity of COPR Pond-A. Additionally, during 2006 surveys, two large adult, naturally recruited plants have been found growing away from the original COPR Pond planting locations.

The four COPR Lagoon sites had varied success (COPR Lagoon, COPR Jaumea, and direct-seeded plots 2 and 4). No plants were reported from the COPR-Jaumea site as of April 2005. The COPR Lagoon planting site is considered moderately successful and supported a mix of seedlings, juveniles, and adults as of October 2006. This is the only somewhat-stable planting location at COPR. As of 2005 no plants were present in any of the direct seeded plots due to various causes including the nesting activity of meadow voles and drought (M. Meyer, pers. comm. 2007).

Carpinteria Salt Marsh Reserve (CSMR):

General Location. A total of five planting sites were established at the Carpinteria Salt Marsh Reserve (CSMR) located near the city of Carpinteria in southern Santa Barbara County.

The CSMR is part of the UC Natural Reserve System and is managed by UC Santa Barbara. The planting sites were located on the northeastern edge of the reserve accessed via Estero Way, just west of Santa Monica Creek and immediately south of the railroad tracks (see Map 3 and Table 4) (Soza *et al.* 2003).

Planting History. In April 2002, 31 container grown seedlings were planted at each of five sites (CSMR-1 through CSMR-5) for a total of 155 plants (Meyer 2006b). The five sites were established in an area trending east to west, with the most west site being CSMR-1 and the most east site being CSMR-5 (Soza *et al.* 2003). In April 2004, 15 additional container-grown plants were planted west of the original CSMR-5 and 25 container-grown plants were planted east of the original CSMR-5 (Meyer 2006a).

Results. The only planting location at CSMR that has persisted is CSMR-5. In February 2003, approximately one year after the original planting, only 44 percent of 155 original plants were still alive at CSMR (Meyer 2003). Plants at CSMR-1 apparently succumbed to gopher damage during the first growing season and were almost completely eliminated by spring 2003 (Meyer 2006a). Most plants in CSMR-2 and CSMR-3 apparently succumbed to saline conditions, possibly associated with a high tide in April 2003 (Meyer 2006c). As of summer 2003, only two plants were observed at CSMR-4, and neither of these persisted into 2004 (M. Meyer, pers. comm. 2006). The decline of plants in CSMR-2, CSMR-3 and CSMR-4 is attributed to the saline conditions present at these sites (Meyer 2005). It is likely that *A. pycnostachyus* var. *lanosissimus* is only capable of tolerating brackish conditions, with salinity less than that of seawater.

Plants at CSMR-5 have persisted and were observed to be in fairly good health and vigor in October of 2006. In 2006, seedlings, juveniles and adults were observed in the CSMR-5 area (including the original 2002 planting site and the supplemental planting sites from 2004) (personal observation, October 2006). In 2005, seedling recruitment at CSMR-5 and survival was reported to be very low with herbivory and excessive competition with adjacent plant species the likely cause of mortality (Meyer 2005). In contrast, many juveniles (estimated at over 300 individuals) were observed at this site in 2006 and many survived into the fall. CSMR-5 remains the only successful planting site at CSMR.

McGrath State Beach (MSB):

General Location. McGrath State Beach (MSB) is located between the cities of Ventura and Oxnard in Ventura County and is bordered by the Pacific Ocean to the west and Harbor Boulevard to the east. MSB is managed by the California Department of Parks and Recreation. Planting sites at MSB are located near the southeastern margin of McGrath Lake and several hundred meters to the west of Harbor Blvd (see Map 1 and Table 4) (Soza, *et al.* 2003).

Planting History. In April 2002, around 33 container-grown plants were planted in each of five sites (MSB-1 through MSB-5) in the vicinity of McGrath Lake. Two of these sites (MSB-1 and MSB-2) were located in drier areas in low dunes to the north, while MSB-4 was located just south of MSB-3, and MSB-5 was located the farthest south (at approximately 200 meters from MSB-3, Soza *et al.* 2003).

Results. Plants at the drier planting sites, MSB-1 and MSB-2, performed poorly, exhibiting low vigor and no flowering (M. Meyer, pers. comm. 2006). As of August 2004, no plants were observed at either of these two planting sites (Meyer 2006b). Plants at MSB-3, MSB-4 and MSB-5 performed quite well during the 2003 growing season and were estimated to have produced millions of seeds (Meyer 2005). However, the 2004 growing season was extremely dry and plants were subjected to heavy herbivory (Meyer 2005). In August 2004, approximately 24 percent of the original plants were alive in MSB-3, 39 percent were alive in MSB-4 and 47 percent were alive in MSB-5 (Meyer 2006c). In October and December 2004 heavy periods of rainfall initiated the germination of “carpets of seedlings” at each of the remaining planting sites. These seedlings disappeared and were likely subjected to heavy herbivory (likely by snails or rabbits) and most did not survive.

Then, in January 2005, abnormally heavy rainfall caused McGrath Lake to overflow its banks. This caused the inundation of MSB-3, MSB-4 and MSB-5 and the subsequent death of all of the original “founder” plants, naturally recruited plants and remaining seedlings. What followed during the 2005 growing season was the natural recruitment of plants from seed that was produced by the original plantings and transported to their present location by the 2005 flood (M. Meyer, pers. comm. 2006). Plants at MSB-3 and MSB-4 are now growing just beyond the original planting sites at locations exhibiting lower cover of competing vegetation. Good recruitment and survival of seedlings, juveniles and adult plants has been observed at these two

sites under a host of management activities undertaken by the CDFG (M. Meyer, pers. comm. 2006). As of October 2006, adults, juveniles and seedlings were observed to be in good health at MSB-3 and MSB-4. In contrast, plants at MSB-5 are suffering from competition with other plants, primarily the aggressive growth of *Salix exigua* and *S. lasiolepis*. As of October 2006, few juvenile plants were present at this site and adult plants appeared to be in a state of decline (personal observation, October 2006).

Mandalay State Beach (Mandalay):

General Location. Planting sites were established in three locations at Mandalay State Beach (Mandalay), located near the City of Oxnard in Ventura County. While this property is owned by the State of California, the property is managed by the Ventura County Parks Department. The planting sites were located in an area north of West Fifth Street, bounded by the beach dunes to the west and Harbor Boulevard to the east (see Map 1 and Table 4).

Planting History. In February 2003, container-grown plants that were over one-year old were planted at three locations at Mandalay (Mandalay-1, Mandalay-2, and Mandalay-3). A total of 20 plants were established at Mandalay-1, located just north of West Fifth Street (Meyer 2006a); 20 plants were established at Mandalay-2, located in the northwest portion of the Mandalay property; and 15 plants were established at Mandalay-3 located in the northeast portion of the Mandalay property (Meyer no date). In April 2004, supplemental plantings were installed in the proximity of Mandalay-1. These plantings were named Mandalay-1A, Mandalay-1B and Mandalay-1C, and contained 10, 15, and 10 container-grown plants, respectively (M. Meyer, pers. comm. 2006).

Results. Mandalay appears to be a marginal site for growth of *A. pycnostachyus* var. *lanosissimus* with little natural recruitment observed at all planting sites. Mandalay-1 had six adults present in August 2006 (Meyer 2006d) and natural recruitment was only observed during the 2005 growing season when precipitation was well above normal (M. Meyer, pers. comm. 2006). Only a single adult plant (located about three meters from Mandalay-1) survives at Mandalay-1A. At Mandalay-1B, both adults and juveniles were observed in October 2006 but with very low survival of seedlings (personal observation, October 2006). Mandalay-1C was located in the shade of large willows and no plants were observed at this site as of summer 2005 (Meyer 2006d).

As of June 2005, only one adult and eight juveniles were observed at Mandalay-2. At Mandalay-3, three drought-stressed adults and three juveniles were observed in June 2005 (M. Meyer, pers. comm. 2006). No observations have been made at the Mandalay-2 and Mandalay-3 planting sites since the summer of 2005 and the status of these sites is currently unknown.

Ormond Beach:

General Location. One planting site was established within the Ormond Beach area located southwest of the city of Oxnard in Ventura County. The planting site was in an area south of McWane Road and west of Edison Drive on a parcel owned by the California State Coastal Conservancy.

Planting History. In March 2004, 40 container-grown plants were installed in the Ormond planting site (Meyer no date).

Results. About one-third of the plants at this site succumbed to herbivory by rabbits within one week of planting in March 2004. Other individuals growing within moist salt marsh vegetation died fairly quickly due to salinity. Out of the 40 original transplants, only a few individuals in poor health survived the summer. During the subsequent abnormally wet winter of 2005, the Ormond Beach planting site became inundated with water for a period of time (M. Meyer, pers. comm. 2006). This, coupled with the lack of a seed bank at this location, eliminated the potential for survival or natural recovery at Ormond Beach.

V. The Habitat of *Astragalus pycnostachyus* var. *lanosissimus*

Very little detailed information is available about the original habitat of *Astragalus pycnostachyus* var. *lanosissimus*. Early botanists that described and collected this variety usually provided only nondescript information about the habitat of *A. pycnostachyus* var. *lanosissimus* and often recorded non-specific locality data. However, even if exact location information did exist for historical collections, this may not be extremely useful as the vast majority of the original habitat of *A. pycnostachyus* var. *lanosissimus* has been severely altered or completely eliminated; mostly due to urban development, conversion to agriculture and various industrial activities (e.g. water diversion and oil extraction).

By looking through historical literature and collections, examining the habitat of the closely-related *A. pycnostachyus* var. *pycnostachyus*, studying the single “wild” population at the North Shore Site near Oxnard, and looking at the successes and failures at experimental introduction sites in Santa Barbara and Ventura Counties; the habitat requirements of *A. pycnostachyus* var. *lanosissimus* can be hypothesized.

Literature:

Little detailed information about the habitat of *A. pycnostachyus* var. *lanosissimus* exists in historical published literature. In *A Manual of the Flowering Plants of California* (Jepson 1925), Jepson described the habitat of *A. pycnostachyus* as, “along the coast from Los Angeles to Humboldt Co.” In the *Illustrated Flora of the Pacific States* (Abrams and Ferris 1944), Abrams reported *A. pycnostachyus* from, “coastal marshes, Transition and Upper Sonoran zones.” The “Transition and Upper Sonoran zones” refer to broad biogeographic zones used historically to describe patterns of species across North America (Merriam 1895). In *A California Flora and Supplement* (Munz and Keck 1959), Munz lists the habitat of the species as “coastal marshes, now very rare or extinct, Ventura and Los Angeles County.” In *A Flora of Southern California* (Munz 1974), Munz describes the habitat of *A. pycnostachyus* var. *lanosissimus* as from “coastal marshes...if surviving at all.” In *North American Flora* (Rydberg 1929), Rydberg simply includes the broad distribution information, “Southern California.” Lastly, the most useful information comes from *Atlas of North American Astragalus* (Barneby 1964), where Barneby, stated that *A. pycnostachyus* var. *lanosissimus* grows in the, “habitat of the species...(and the) habitat of var. *pycnostachyus*.” He described the habitat of *Astragalus pycnostachyus* as, “highly

modified morphologically and uniquely adapted to the environment of coastal seeps and marshland.” More specifically for *A. pycnostachyus* var. *pycnostachyus* he listed, “salt marshes within the reach of high tide or protected by barrier beaches, more rarely near seeps or sandy ocean bluffs, or (according to Jepson) in springy spots along creeks opening to the ocean, 0 to 100 feet.”

Herbarium Collections:

Historical collections were made from at least six locations from Orange County north to Ventura County. These collections are attributed to the following areas: the Bolsa Chica wetlands (between Huntington and Sunset Beaches in Orange Co.), the Ballona Wetlands (Los Angeles Co.), near Santa Monica (Los Angeles Co.), Silver Strand Beach (near Port Hueneme in Ventura Co.), the McGrath State Beach vicinity (Ventura Co.), and a nondescript location in Ventura County labeled simply as “Ventura”, probably at the mouth of the Ventura River (CNDDDB 2006, Consortium of California Herbaria 2006, D. Magney, pers. comm. 2007). The extent to which each of the locations might serve as reference habitats is discussed.

Ventura. The herbarium label associated with this 1911 collection contains very little information (“Ventura” is listed as the locality) (Consortium of California Herbaria 2006). D. Magney (pers. comm. 2006) hypothesized that there are several locations in the Ventura area that might have previously hosted habitat for *A. pycnostachyus* var. *lanosissimus*. Among these possibilities are the vicinity of Pierpont Beach and Alessandro Marsh (D. Magney, pers. comm. 2006). Pierpont Beach no longer supports any potential reference habitat since houses are built almost directly on the beach itself in this location; however, the suitability of Alessandro Marsh as potential habitat is not currently known. The area is currently bounded by U.S. Highway 101 on the west and a little-used paved road situated below steep coastal bluffs (D. Magney, pers. comm. 2007). This collection was made from the broad “Oxnard Plain” area, a vast flat plain that was likely to have once hosted extensive back dune habitat and wetlands and probably contained ideal habitat for *A. pycnostachyus* var. *lanosissimus* (D. Magney, pers. comm. 2006). Indeed, the only extant, “natural” occurrence occurs in this broad area (the North Shore Site). Unfortunately, the majority of the Oxnard Plain now hosts vast housing developments (the Cities

of Ventura and Oxnard occupy this area), industrial activity, and areas of intensive commercial agriculture.

McGrath State Beach. Prior to the rediscovery of plants at the North Shore Site, the last recorded collection of *A. pycnostachyus* var. *lanosissimus* was made from plants growing directly across Harbor Boulevard from McGrath State Beach, roughly near the mouth of the Santa Clara River (CNDDDB 2006). Additional plants growing in a lawn area (directly across Harbor Boulevard) at McGrath State Beach were mowed and no longer occur at this location (Critchfield 1978). Much of the habitat on the east side of Harbor Boulevard has now been converted to agriculture and little exists as potential reference habitats.

Areas west of Harbor Boulevard consist of degraded sand dunes, dense stands of *Salix lasiolepis* (arroyo willow), freshwater wetlands (surrounding McGrath Lake), and coastal scrub (personal observation, October 2006). The exact original habitat at the entrance to the McGrath State Beach campground on the west side of Harbor Boulevard (including the area of lawn where *A. pycnostachyus* var. *lanosissimus* was observed in 1967) is heavily impacted by recreation activity (a large campground), as well as by exotic plants, and no longer serves as a good reference habitat. Similarly, areas near the mouth of the Santa Clara River contain dense patches of *Arundo donax* (giant reed) and therefore also do not serve as a good reference habitat for *A. pycnostachyus* var. *lanosissimus* (personal observation, October 2006).

Silver Strand Beach. One collection was made from this location near Port Hueneme in 1927 from habitat listed on the herbarium label as “brackish marshes” (Consortium of California Herbaria 2006). Little information exists about the historical habitat in the vicinity of Silver Strand Beach. The area is now completely surrounded by urban development and has been for quite some time (D. Magney, pers. comm. 2006). There is little habitat left in this location that might serve as a reference for *A. pycnostachyus* var. *lanosissimus*.

Santa Monica. Three collections of *A. pycnostachyus* var. *lanosissimus* were made near Santa Monica where, at least in one instance, plants were growing in a “meadow near the seashore” (CNDDDB 2006). B. Henderson (pers. comm. 2006) indicates that the early explorers often referred to the “pools of Santa Monica” as a place name. The area was apparently home to a series of spring-driven wetlands and vernal pools that possibly could have hosted *A. pycnostachyus* var. *lanosissimus*. Additionally, collections that simply state “Santa Monica” as their location may actually have been referring to the nearby Ballona Wetlands or possibly to

wetlands that once existed at the mouth of Santa Monica Canyon (B. Henderson, pers. comm. 2006). The area is now wholly urbanized and none of the former habitat still exists.

Ballona Wetlands. Approximately 200 years ago, the Ballona Wetlands consisted of a complex of sand islands and freshwater and saltwater marshes that amounted to approximately 2120 acres (The California Resources Agency Wetlands Web 2003). Additionally, a system of freshwater springs (often labeled as “Cienegas” on old maps) extended for some distance up Ballona Creek (B. Henderson, pers. comm. 2006). One collection labeled as “Cienega” in Los Angeles County from 1904 suggests that habitat for *A. pycnostachyus* var. *lanosissimus* may have extended for some distance inland. Unfortunately, starting in 1934, Ballona Creek in its entirety was channelized and lined with concrete, eliminating much of the freshwater input to the marsh (The California Resources Agency Wetlands Web 2003). The Ballona Wetlands may have been the most important original habitat for *A. pycnostachyus* var. *lanosissimus* judging from the number of historical collections from this location (about nine). *A. pycnostachyus* var. *lanosissimus* was last collected from this area in 1902 (Consortium of California Herbaria 2006). Today, little of the freshwater and brackish marsh, and associated margin habitat still exists in this area. The habitat left in this area today is not likely to serve as much of a reference habitat for *A. pycnostachyus* var. *lanosissimus*.

Bolsa Chica. Three collections, including the type collection, for *A. pycnostachyus* var. *lanosissimus* are attributed to the Bolsa Chica (“Bolsa Bay”) area located between Huntington and Sunset Beaches. This area once consisted of approximately 2300 acres of wetlands containing extensive freshwater and brackish marshes (The California Resources Agency Wetlands Web 2003) that would have most likely served as ideal habitat for *A. pycnostachyus* var. *lanosissimus*. Very little freshwater or brackish marshes, and the associated transition zones, now exist in this area. Most of the habitat at Bolsa Chica is now salt marsh and mudflats that are not considered good habitat for *A. pycnostachyus* var. *lanosissimus*.

Habitat of *A. pycnostachyus* var. *pycnostachyus*:

A. pycnostachyus var. *pycnostachyus* is the closest relative of *A. pycnostachyus* var. *lanosissimus* and examination of its habitat requirements may help elucidate the habitat requirements of *A. pycnostachyus* var. *lanosissimus*. However, in spite of their close relationship, major differences exist between the habitats of the Northern and Southern

California varieties of *Astragalus pycnostachyus*. *A. pycnostachyus* var. *pycnostachyus* is known from approximately 25 current and historical occurrences in Northern California from San Mateo County in the south to Humboldt County in the north (CNDDDB 2006).

Northern California *Astragalus pycnostachyus* populations are subjected to a wetter and cooler climate than plants growing in Southern California. D. Wilken (pers. comm. 2006) commented that *A. pycnostachyus* var. *pycnostachyus* sometimes grows in quite dense vegetation and does not seem to have as much of a problem competing with other plants as does *A. pycnostachyus* var. *lanosissimus*. This may be due to the availability of more moisture during the course of the growing season. In fact, *A. pycnostachyus* var. *pycnostachyus* plants (if they were transplanted) may not be able to survive in the habitat now present in coastal Southern California (D. Wilken, pers. comm. 2006).

A. pycnostachyus var. *pycnostachyus* grows in several habitat types along the immediate coast of Northern California from San Mateo County in the south to Humboldt County in the north. There is only one historical record of a population growing at an inland site near Crystal Springs Reservoir in San Mateo County (CNDDDB 2006). *A. pycnostachyus* var. *pycnostachyus* generally grows at very low elevations, with only two locations growing significantly above sea level (one growing at 98 feet (30 meters) and the other growing at 300 feet (90 meters) in elevation) (CNDDDB 2006). *A. pycnostachyus* var. *pycnostachyus* often grows in moist sites, especially on the margins of coastal salt marshes and tidal marshes, as well as near coastal stream mouths. It is also thought to be associated with the “uppermost tidal flooding zone of sheltered estuaries” (Baye 1998). There is a single population known to grow on a coastal bluff that is associated with a seep (Baye 1998).

A. pycnostachyus var. *pycnostachyus* populations often occur in gaps in vegetation and are sometimes associated with disturbances in upland habitats (P. Baye, pers. comm. 2006). Wilken and Wardlaw (2001) visited several upland locations of *A. pycnostachyus* var. *pycnostachyus* and described the general habitats of these populations as “eroded slopes, both sides of State Highway 1”, “small bluff, above beach”, and “steep slope adjacent to State Highway 1.” Notes from field surveys indicate that some *A. pycnostachyus* var. *pycnostachyus* populations “thrive(s) in disturbed or eroded areas like old road cuts, gullies, landslides, cliffs, and trails” (CNDDDB 2006).

Other populations of *A. pycnostachyus* var. *pycnostachyus* occur at the boundary between two adjacent habitats, specifically the ecotone between saline areas that are flooded periodically and non-saline areas that are typically not subjected to floods (Baye 1998). Ikeda and Meyer (2000) reported that *A. pycnostachyus* var. *pycnostachyus* typically grows in areas where salt or brackish water rarely stands for a long period of time. This is observed in several populations occurring at the ecotone between coastal salt marsh and shrubland or grassland (CNDDDB 2006). Baye (1998) noted that several historical specimens were collected from wet depressions in back dune systems (several collections made from Bolinas Bay, Marin County, and one collection near Samoa, Humboldt County) and while they are no longer extant, this habitat is within the realm of potential habitats for *A. pycnostachyus* var. *pycnostachyus*. Several other habitats have been reported to host colonies of *A. pycnostachyus* var. *pycnostachyus* including coastal shrubland, brackish marsh, and fresh to brackish riparian vegetation (Baye 1998).

A. pycnostachyus var. *pycnostachyus* grows in association with a wide variety of species, including salt tolerant species (halophytes) and species intolerant of soil salinity (glycophytes). Halophytes that are associated with soils that are either frequently inundated or waterlogged with saltwater are never associated with *A. pycnostachyus* var. *pycnostachyus* (Baye 1998). Wilken and Wardlaw (2001) noted that populations of *A. pycnostachyus* var. *pycnostachyus* growing in coastal estuarine systems were typically associated with genera such as *Grindelia*, *Frankenia*, *Distichlis* and *Salicornia/Sarcocornia* spp. Ikeda and Meyer (2000) note that estuarine populations of *A. pycnostachyus* var. *pycnostachyus* are often associated with the *Distichlis spicata*-*Frankenia salina*-*Jaumea carnosa* vegetation association. In contrast, upland populations of *A. pycnostachyus* var. *pycnostachyus* growing on coastal slopes and bluffs are associated with species such as *Baccharis pilularis* (coyote bush), *Eriogonum latifolium* (coast buckwheat) and *Eriophyllum staechadifolium* (seaside wooly sunflower) (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) estimated overall vegetation cover values to be quite high in areas containing *A. pycnostachyus* var. *pycnostachyus*, with the majority of populations examined prior to 2001 having cover values from 50 percent to 75 percent.

In addition, *A. pycnostachyus* var. *pycnostachyus* appears to be fairly non-specific about soil texture requirements. Soils associated with the species are generally well-drained and are typically formed through hydrological processes (e.g. tides and flooding) associated with coastal wetlands and riparian areas (Baye 1998). Wilken and Wardlaw (2001) sampled the soils at eight

A. pycnostachyus var. *pycnostachyus* sites and reported substrates ranging from “sandy clay mixed with small rocks” to “compact sand and fine clay” to substrates “composed of fill obtained nearby, including oyster shells.” A major factor that appears to affect *A. pycnostachyus* var. *pycnostachyus* is a limited tolerance to soil salinity. Baye (1998) reports that even brief periods of inundation by saltwater during the growing season results in “acute injury, dieback, and death” of *A. pycnostachyus* var. *pycnostachyus* plants. Saltwater inundation during dormancy (i.e. associated with the high tides along with winter storms) apparently causes little harm to *A. pycnostachyus* var. *pycnostachyus* individuals. *A. pycnostachyus* var. *pycnostachyus* is apparently highly tolerant of salt spray, likely due to the hairiness of leaf surfaces (Baye 1998).

The fact that *A. pycnostachyus* var. *pycnostachyus* inhabits such a wide variety of habitats serves to strengthen the belief that, at least the Northern California variety of this species, it is capable of thriving in a wide variety of environmental conditions. Whether this holds true for the Southern California variety of *A. pycnostachyus* remains to be seen.

Habitat of the Natural Population at the North Shore Site (NSS)

Plants of *A. pycnostachyus* var. *lanosissimus* grow at the North Shore Site (NSS) near the corner of West Fifth Street and Harbor Boulevard in a disturbed, secondary dune area approximately 0.75 kilometers (km) from the ocean at about 8 meters (m) in elevation (Ikeda and Meyer 2000, Soza, *et al.* 2003). The site was used for the disposal of oil waste from 1955 to 1982, when it was capped with soil/fill from the surrounding area that contains unnatural debris including concrete and building materials (Impact Sciences 1998). Consequently, the site hosts approximately 8 inches of oil-free soil on the surface. This oil-free soil rests on top of a 5 to 6 foot layer of silty-loam, contaminated with oil and other oilfield waste products that are impermeable to water. This creates a perched water table slightly below the soil surface during times of precipitation that may mimic the historical hydrologic regime experienced by *A. pycnostachyus* var. *lanosissimus* when it grew in natural conditions (Ikeda and Meyer 2000). The population of *A. pycnostachyus* var. *lanosissimus* at the NSS occurs on relatively level terrain on a slight west-facing slope and likely receives all of its moisture from rainfall or coastal fog (Wilken and Wardlaw 2001, Impact Sciences 1998).

Historical aerial imagery from 1985 and knowledge of prior site history indicates that the NSS was devoid of vegetation in 1982. This indicates that all vegetation now present must have

become established on the site between 1982 and present (Ikeda and Meyer 2000). The vegetation in which *A. pycnostachyus* var. *lanosissimus* occurs has been characterized as Coyote Brush Scrub (Impact Sciences 1998), Palustrine Scrub-Shrub Mixed Deciduous, and Evergreen Seasonally Saturated or Phreatophytic Dune Swale Wetland (Ikeda and Meyer 2000). The fact that the site is so anthropogenic in nature accounts for the fact that the vegetation there is unique and difficult to characterize.

The vegetation architecture within the *A. pycnostachyus* var. *lanosissimus* population amounts to a shrub overstory consisting of *Baccharis pilularis* and *Baccharis salicifolia*, with scattered *Rhus ovata*, and an understory dominated by *Carpobrotus edulis*, *Lotus scoparius*, *A. pycnostachyus* var. *lanosissimus*, and scattered annuals (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) report that the site has adjacent stands and scattered individuals of *Myoporum laetum*, *Salix lasiolepis* as well as natural dune vegetation. Other exotic plants that continue to be present on the site, and within the *A. pycnostachyus* var. *lanosissimus* population, include *Melilotus albus*, *Centaurea melitensis* and *Cortaderia selloana*. The overall vegetation cover (including overlap) is estimated at about 60 percent, with bare ground accounting for about 40 percent (Ikeda and Meyer 2000). Total vegetation cover has increased gradually on a yearly basis since the plant was rediscovered in 1997 (M. Meyer, pers. comm. 2006).

A. pycnostachyus var. *lanosissimus* at the NSS typically grows in open areas adjacent to large shrubs (e.g. *Baccharis pilularis*) (Wilken and Wardlaw 2001). Presumably, this type of microsite provides some degree of shade, helping to alleviate heat stress while avoiding strong competition for light, water, and nutrients. Additional fog drip may occur at locations beneath or adjacent to larger shrubs. Wilken and Wardlaw (2001) report that seedlings are typically not found far out in the open away from large shrubs. Impact Sciences (1998) observed that seedlings and juveniles growing in the shade of other plants were more robust than individuals growing out in the open.

Soil texture within the *A. pycnostachyus* var. *lanosissimus* population is generally fine-grained, consisting mostly of sand, with some clay and silt content (Wilken and Wardlaw 2001). At the time of sampling, Impact Sciences (1998) reported that soil was very dry (moisture content 12-25 percent). Soil within the *A. pycnostachyus* var. *lanosissimus* population is above average in the amount of elements, nutrients, and cation exchange capacity and has very high levels of potassium, calcium, magnesium and nitrates. One hypothesis for the high levels of soil

nutrients found at the NSS is that the fill used to “cap” the site in 1982 may have been removed (dredged) from drainage canals in the area that receive a large amount of nutrient-laden runoff from nearby agricultural fields. Impact Sciences (1998) and Wilken and Wardlaw (2001) took soil samples from within the *A. pycnostachyus* var. *lanosissimus* habitat at NSS and have reported values for macronutrients, micronutrients, pH, cation exchange capacity, and soil salinity. Of particular interest is the level of soil salinity, which appears to play a limiting factor in where populations of *A. pycnostachyus* var. *lanosissimus* can survive. Wilken and Wardlaw (2001) took soil samples from five locations inside and outside of *A. pycnostachyus* var. *lanosissimus* “colonies” (a total of ten samples at a depth from 2 to 3 cm) and reported mean soil salinity of 7.9 mmhos/cm (millimols per centimeter) inside the colonies and 3.8 mmhos/cm outside of the colonies.

Habitat at Experimental Planting Sites:

The numerous successes and failures at the experimental introduction sites in Ventura and Santa Barbara Counties provide some very useful information about the habitat preference and environmental tolerances of *A. pycnostachyus* var. *lanosissimus*. Information about the habitat in which experimental plantings were installed varies from site to site with the most detailed descriptions coming from the Carpinteria Salt Marsh Reserve and McGrath State Beach sites. Past successes and failures of reintroduction attempts will greatly assist in the selection of sites that will contain the most suitable habitat for future (re-)introductions of this species. The identification and analysis of limiting habitat and environmental factors at past planting sites will help inform future planting site selection. The following discussion examines the various habitat elements at each planting location that are believed to have played important roles in the fate of experimental plantings in Santa Barbara and Ventura Counties.

Coal Oil Point Reserve (COPR):

The original planting area at the COPR Pond site consists of a fairly open area adjacent to a pond that supports dense growth of freshwater wetland species such as *Bulboschoenus* or *Schoenoplectus* spp. Meyer (2006e) described the general habitat as an “herbaceous dune hollow” at the transition zone between foredunes and a pond. Associated vegetation where *A. pycnostachyus* var. *lanosissimus* grew successfully at this location included *Ambrosia*

psilostachya and *Polypogon monspeliensis*. Areas with dense growth of *Distichlis spicata* were not favorable for the growth of *A. pycnostachyus* var. *lanosissimus* (Meyer 2006d). The habitat at this location appears to be favorable except for the unpredictable hydrologic regime. Since the species was planted in 2003, the site has experienced flooding and one instance in which there was a sudden drop in the water table. Both of these conditions proved to be very unfavorable for the growth of *A. pycnostachyus* var. *lanosissimus* and led to the death of most plants at the COPR Pond site.

The COPR Jaumea site plantings consisted of a few plants in an area dominated by *Jaumea carnosa*. At the COPR Lagoon site, *A. pycnostachyus* var. *lanosissimus* typically grew at the edge of areas that host *Jaumea carnosa*. *Jaumea carnosa* is an upper salt marsh species and occurs in areas that are subject to periodic tidal inundation. This habitat is generally thought to be unfavorable for the growth of *A. pycnostachyus* var. *lanosissimus* and it is likely why the area no longer contains a sustainable population of *A. pycnostachyus* var. *lanosissimus*.

The COPR Lagoon planting site exists at the transition zone between the Devereux Slough estuary and upland areas of coastal prairie and shrubland. Species associated with the successful growth of *A. pycnostachyus* var. *lanosissimus* at this site include *Baccharis pilularis*, *Ambrosia psilostachya*, and *Polypogon monspeliensis* (Meyer 2006d); however, areas associated with dense *Distichlis spicata* and *Jaumea carnosa*, such as COPR Lagoon, proved to be unfavorable for the growth of *A. pycnostachyus* var. *lanosissimus*. No soil test or hydrologic information was available for any of the planting sites at COPR.

From the plantings at COPR, we can conclude that sites dominated by upper salt marsh species, such as *Jaumea carnosa* and *Distichlis spicata*, are generally poor habitat for *A. pycnostachyus* var. *lanosissimus*. Transitional sites between foredune areas and wetlands, such as ponds, are likely to provide adequate habitat if the subsurface water regime is stable and the area is not subject to frequent flooding. Highly favorable habitat for *A. pycnostachyus* var. *lanosissimus* is likely to exist at the ecotone between estuarine vegetation and uplands dominated by grasses and shrubs, as these areas have the greatest likelihood of containing vegetation composition and subsurface hydrology that is favorable to the *A. pycnostachyus* var. *lanosissimus*.

Carpinteria Salt Marsh Reserve (CSMR):

Out of five original planting sites at the Carpinteria Salt Marsh Reserve (CSMR) only one site, CSMR-5, still contains *A. pycnostachyus* var. *lanosissimus* plants. Out of the four sites that ultimately failed, three sites, CSMR-2, CSMR-3 and CSMR-4, failed due to the absence of environmental conditions favorable for the growth of *A. pycnostachyus* var. *lanosissimus*. The single factor that has been attributed to the failure of these three sites was saline conditions associated with the tidal salt marsh habitat. The other site, CSMR-1, failed quickly due to herbivory by gophers, although it is unlikely that this site would have persisted as it also has saline conditions similar to CSMR-2 through CSMR-4.

The three planting sites, CSMR-1, CSMR-2 and CSMR-3, were located in areas described as *Polypogon*-associated depressions within larger stands of *Arthrocnemum subterminale* (Parish) Standley (*Salicornia subterminalis* Parish) (Soza *et al.* 2003). These areas are described as sparsely vegetated, slight depressions located within a “vegetated, irregularly flooded, estuarine intertidal emergent persistent wetland” (Soza *et al.* 2003). The CSMR-1 and CSMR-2 planting sites were located within the transition zone between estuarine wetland and grassland ecosystems. Each of these sites exhibited a dense cover of grasses (80 percent) dominated by species such as *Polypogon monspeliensis*, *Lolium multiflorum*, *Bromus diandrus*, *Bromus hordeaceus* and *Distichlis spicata*. On the other hand, CSMR-3 had a dominant cover comprised mostly of *Arthrocnemum subterminale* (45 percent) as well as grasses, such as *Parapholis incurva* and *Polypogon monspeliensis* (35 percent). Of the three sites, only CSMR-1 had significant cover of shrubs, specifically, a high cover of *Isocoma menziesii* (45 percent). Overall vegetation at all three sites was estimated between 80 and 90 percent cover.

Soil at CSMR-1 was described as a, “moist, sandy loam”, while soil at CSMR-3 was described as “clay and relatively dry.” All three sites had high salinity levels with CSMR-1 having 38.6 mmhos/cm, CSMR-2 having 27.3 mmhos/cm and CSMR-3 having 111 mmhos/cm. Two of the three sites (CSMR-2 and CSMR-3) had relatively high levels of soil moisture (25.3 and 24.2 percent, respectively) and one site (CSMR-1) had a moderate level of soil moisture (15.3 percent) (See Table 3, Soil Salinity and Moisture Measured at CSMR and MSB Planting Sites, Soza *et al.* 2003).

CSMR-4 was located in an area described as a “grassland transition zone from salt flat at lower elevations to coastal scrub and disturbed coastal habitat at higher elevations.” The overall

vegetation cover at the site was 100 percent, with no shrub cover and approximately 90 percent cover of *Lolium multiflorum*. Soil was described as a loose, relatively dry loam. Both soil salinity (20.4 mmhos/cm) and moisture levels (15.7) were relatively moderate at this location.

CSMR-5 was established within a historical delta associated with the historical Santa Monica Creek and was in an area of scrub vegetation occurring at the transition from salt marsh to upland plant communities (Meyer 2006d) (see Figure 5). In 2003, the overall vegetation cover at this site was 75 percent with the dominant cover (70 percent) attributed to grasses, primarily *Bromus diandrus*. Shrub cover (35 percent) was primarily attributed to *Baccharis pilularis* and *Isocoma menziesii* with additional overall cover attributed to *Ambrosia psilostachya*. In 2006, *A. pycnostachyus* var. *lanosissimus* was observed to grow successfully at CSMR-5 with *Euthamia occidentalis*, *Polypogon monspeliensis* and *Heliotropium curassavicum* as associates (Meyer 2006d). Soil at this site was described as “non-saline, comprised of dry sandy loam” (Soza *et al.* 2003). Compared with other locations at CSMR, soil salinity (6.15 mmhos/cm) and moisture (8.3 percent) were relatively low.

From the CSMR plantings, it can be concluded that areas subject to periodic inundation within tidal salt marshes are not likely to serve as good potential habitat for *A. pycnostachyus* var. *lanosissimus*. These areas can easily be identified by the presence of upper salt marsh species, especially *Arthrocnemum subterminale*. High salinity levels in soil tests are likely to identify areas that experience the saline conditions and help to identify the areas with conditions that *A. pycnostachyus* var. *lanosissimus* cannot tolerate. Areas with high cover of grasses are also likely to be unsuitable for the planting of *A. pycnostachyus* var. *lanosissimus* due to the highly competitive nature of these sites. From CSMR-5, we can conclude that transition zones between wetland areas and upland scrub communities dominated by shrubs, such as *Baccharis pilularis*, are likely to serve as good potential reference habitat for *A. pycnostachyus* var. *lanosissimus*. *A. pycnostachyus* var. *lanosissimus* at this site typically grows in open sites with little to no canopy cover of shrubs. In addition, at least part of the success of the experimental plantings at CSMR-5 was likely due to the lower salinity levels associated with this upland habitat.

McGrath State Beach (MSB):

Three of the five planting sites, MSB-3, MSB-4 and MSB-5 at McGrath State Beach (MSB) in the vicinity of McGrath Lake have proven to be favorable for the growth of *A. pycnostachyus* var. *lanosissimus*. Two of the planting sites, MSB-1 and MSB-2, occurred in drier locations in low sandy dunes and ultimately failed within the first two years after planting.

MSB-1 was located in the upper portion of a small coastal dune that was sparsely vegetated. In 2002, the dominant species observed at this location, with approximately 15 percent cover, was *Ericameria ericoides* (Soza *et al.* 2003). The overall cover at this site was estimated at 25 percent with the remainder of the cover being composed of other coastal sand dune species, such as *Ambrosia chamissonis* and *Camissonia cheiranthifolia*, and exotic species, such as *Carpobrotus edulis*, and *Bromus* sp. Soil at this site was reported to be dry and sandy with low moisture content (5.8 percent) and very low salinity (0.43 mmhos/cm) (Soza *et al.* 2003).

MSB-2 was located in an open, flat, sandy area dominated by exotic grasses. The overall vegetation cover was estimated at approximately 80 percent with the majority (65 percent) attributed to the exotic grasses *Bromus hordeaceus*, *B. madritensis*, and *Vulpia myuros*, and 15 percent attributed to the perennial *Croton californicus* (Soza *et al.* 2003). The soil was characterized as silty sand with low moisture (7.6 percent) and low soil salinity (0.82 mmhos/cm) (Soza *et al.*).

The original MSB-3 planting was located between the wetland margin of McGrath Lake and a low dune in a sparsely-vegetated area (Soza *et al.* 2003, Meyer 2006e) (see Figure 6). In 2003, the dominant species was observed to be *Ambrosia psilostachya* (20 percent), with additional cover (5 percent) attributed to *Baccharis pilularis*. Surrounding patches of vegetation included areas dominated by species such as *Baccharis pilularis*, *Artemisia douglasiana* and *Carpobrotus edulis* (Soza *et al.* 2003). The original MSB-3 planting site was flooded in 2005 and few, if any, plants now occur at this location. Plants at MSB-3 now occur away from the original planting beyond the edge of denser vegetation. The dominant plants at sites where *A. pycnostachyus* var. *lanosissimus* are now growing near the original MSB-3 are *Artemisia douglasiana*, *Ambrosia psilostachya*, *Oenothera elata* subsp. *hookeri* and *Euthamia occidentalis* (Meyer 2006d). The soil at the original planting site was characterized as sandy loam with the

highest level of moisture (16.6 percent) and salinity (3.22 mmhos/cm) for any site at MSB (Soza *et al.* 2003).

The original MSB-4 planting was located in a low dune area dominated by herbaceous vegetation and shrubs along the margin of McGrath Lake (Soza *et al.* 2003). Meyer (2006d) described this site as an “herbaceous dune hollow merging with the margin of McGrath Lake.” In 2003 the overall cover of this site was estimated at 95 percent, with the majority of this cover being comprised of *Ambrosia psilostachya*, *Distichlis spicata* and *Baccharis pilularis* (Soza *et al.* 2003). Much like the situation at MSB-3, none of the plants at the original planting location remains and the vegetation where it is growing now is in a state of change. In fall of 2006, many of the plants at this location were growing in quite thick vegetation with *Baccharis pilularis*, *Ambrosia psilostachya*, *Polypogon monspeliensis* and *Juncus* sp. (Meyer 2006d). Soil at the original planting site was described as “dry to moist” and “silty to loamy” with low moisture (5.6 percent) and high salinity (2.83 mmhos/cm) compared to other MSB sites (Soza *et al.* 2003).

The original planting at MSB-5 was located in a shrub-dominated transition zone between the margin of McGrath Lake and a dune swale. In 2003, the overall cover of vegetation was estimated to be approximately 65 percent with *Salix exigua* and *Baccharis pilularis* the dominant species. Adjacent areas near the planting site were dominated by *Salix lasiolepis* and *Oenothera elata* subsp. *hookeri* (Soza *et al.* 2003). Following the winter of 2004-2005, no plants remained in this original location. Plants at this location currently are in a state of decline and are not expected to persist much into the future due to the area being overgrown with *Salix lasiolepis*, as well as *Carpobrotus edulis*. At this site, Meyer (2006d) found the species *Baccharis pilularis*, *Anemopsis californica* and *Oenothera elata* subsp. *hookeri* to be favorable for *A. pycnostachyus* var. *lanosissimus* growth, and sites amongst *Salix exigua* to be only moderately favorable. At the original planting site, soil was reported to be dry and sandy with the lowest moisture (1 percent) of any of the sites at MSB (samples taken in 2002 at the end of a very dry year) and with a salinity of 0.92 mmhos/cm (Soza *et al.* 2003).

The plantings at MSB help to emphasize the point that due to their ever-changing condition, plant communities cannot be viewed as existing in a stable state. No plants are growing in the exact location of the original plantings at MSB, yet *A. pycnostachyus* var. *lanosissimus* has found suitable habitat in the vicinity of the original plantings of MSB-3 and MSB-4. From the successes and failures at this location some definite conclusions about the

habitat preferences of *A. pycnostachyus* var. *lanosissimus* can be made. Sites that are very dry and associated with sand dune areas akin to MSB-1 do not provide suitable habitat for *A. pycnostachyus* var. *lanosissimus*. Likewise, dry areas that are dominated by dense growth of grasses, like MSB-2, do not provide suitable habitat for *A. pycnostachyus* var. *lanosissimus*. *A. pycnostachyus* var. *lanosissimus* appears to prefer sites at transition zone between wetland and upland habitats that host a variety of species including *Baccharis pilularis*, *Ambrosia psilostachya*, *Oenothera elata* subsp. *hookeri* and *Euthamia occidentalis*. Areas that contain dense, competitive growth of vegetation such as *Salix* spp., like MSB-5, are not likely to support *A. pycnostachyus* var. *lanosissimus* indefinitely. MSB-5 site illustrates that in evaluating proper habitat for *A. pycnostachyus* var. *lanosissimus*, one needs to not only assess the conditions that are currently present, but also take into consideration how vegetation architecture and species composition might change in the future.

Mandalay State Beach (Mandalay):

Plantings at Mandalay State Beach (Mandalay) have been only marginally successful, presumably due to the lack of suitable subsurface water regimes. Generally speaking, adult plants have performed adequately at the Mandalay-1 planting site, but little natural recruitment has occurred despite ample seed production. No current information exists about the status of the Mandalay-2 and Mandalay-3 planting sites.

The general habitat of Mandalay-1 was characterized as near an “arroyo willow dune swale” (Meyer 2003). The general area of this planting site is on the edge of a dense *Salix lasiolepis* thicket directly north of a secondary dune area. This general area also hosts patches of scattered *Baccharis salicifolia*, as well as dense patches of exotic annual grasses and *Distichlis spicata* (Wilken and Wardlaw 2001). No specific soil data were available for this site, but the water table was measured at about 48 inches (120 cm) below the soil surface with the soil being very sandy.

Little specific information exists about the conditions at planting sites Mandalay-2 and Mandalay-3. The general habitats of these two sites were characterized by Meyer (2003) as, “low areas/sparsely vegetated dune swale(s).” The water table at these sites was measured to be at about 48 inches (120 cm) below the soil surface, similar to the Mandalay-1 site (Meyer, pers. comm. 2006).

The hypothetical reason for the lack of natural recruitment at Mandalay is that seedlings perish before they obtain access to the soil moisture they require for survival (Wilken, pers. comm. 2006). Only during the very wet winter of 2004-2005 was any natural recruitment observed. Presumably, if the subsurface hydrology was closer to the surface, the habitat would be more favorable at certain sites in the vicinity of Mandalay-1. From this site, we can conclude that areas with a relatively deep water table during the growing season, and sandy soils that retain little moisture, do not serve as good potential habitat for *A. pycnostachyus* var. *lanosissimus*. Furthermore, one can hypothesize that the general habitat (near the edges of willow thickets) at this site is potentially provides good habitat for *A. pycnostachyus* var. *lanosissimus*.

Ormond Beach:

The planting at Ormond Beach was unsuccessful for a variety of habitat-related factors. Some of the original plants succumbed to herbivory by rabbits, while others suffered from saline conditions and prolonged inundation.

This planting site was located in an area close to a freshwater spring. Part of the planting was situated within vegetation associated with a moist salt marsh habitat containing the species *Jaumea carnosa* and *Distichlis spicata*. The best survival occurred at planting locations near *Ambrosia psilostachya*; however, even this portion of the planting area was inundated in 2005. No information was available about the hydrology or soils at this site, although conditions are thought to have been quite wet and saline.

The failed plantings at Ormond Beach further illustrate that saline conditions and prolonged inundation are unfavorable for the growth of *A. pycnostachyus* var. *lanosissimus*. Plants grew poorly at Ormond Beach and set little seed, which minimized the likelihood for recovery of this site following inundation during the 2005 winter. The results from this site further support the assumption that sites where vegetation is dominated by upper salt marsh species such as *Jaumea carnosa* and *Distichlis spicata* provide poor habitat for *A. pycnostachyus* var. *lanosissimus*.

VI. Summary of Field Work

In order to gain an understanding of the habitat of *Astragalus pycnostachyus* var. *lanosissimus*, field visits were made to all of the sites where this species is currently known to occur. This included a visit to the “wild” population at the North Shore Site (NSS), as well as visits to the existing experimental plantings at Coal Oil Point Reserve (COPR Pond-A, COPR Lagoon), Carpinteria Salt Marsh Reserve (CSMR-5), McGrath State Beach (MSB-3, MSB-4, MSB-5) and Mandalay State Beach (Mandalay-1, , Mandalay-1B). Additionally, observations were made of the current conditions at the failed planting sites from Carpinteria Salt Marsh Reserve (CSMR-1, CSMR-2, CSMR-3, CSMR-4), McGrath State Beach (MSB-1, MSB-2), Mandalay State Beach (Mandalay-1C), and the vicinity of the Ormond Beach planting. Visits were not made to the plantings at Mandalay-2 and Mandalay-3 and no known visits have been made to these sites since the summer of 2005 and the status of these two populations is currently unknown.

A variety of methods were used in order to select sites to visit where (re-)introduction of *A. pycnostachyus* var. *lanosissimus* might be successful. First, historical observations and herbarium specimen labels were examined to determine the areas where *A. pycnostachyus* var. *lanosissimus* once occurred. Second, aerial imagery available online at the California Coastal Records Project (<http://www.californiacoastline.org>) and the US Geological Service’s Seamless Data Distribution website (<http://seamless.usgs.gov>) was reviewed to help identify potential areas along the coast, from Santa Barbara County in the north to Orange County in the south, where significant tracts of coastal habitat still exist. In addition, communications and discussions were conducted with a number of individuals who were knowledgeable about coastal habitats in Southern California. Lastly, recent literature, technical reports, and websites were reviewed to provide additional information about the presence of and current conditions at coastal habitats in the geographic region where *A. pycnostachyus* var. *lanosissimus* once occurred. Using these methods, a list of areas that may be suitable habitat for *A. pycnostachyus* var. *lanosissimus* were identified for site visits.

In October and November of 2006, visits were made to a total of 16 potential (re-) introduction sites within and slightly beyond the historical range of *A. pycnostachyus* var. *lanosissimus*. In addition, visits were made to areas surrounding the failed and existing experimental *A. pycnostachyus* var. *lanosissimus* plantings, as well as to areas where the species

occurred historically and areas where potential habitat may exist. In Santa Barbara County, sites visited included the Coal Oil Point Reserve, Carpinteria Salt Marsh Reserve and a parcel in the southern portion of Carpinteria Marsh owned by the Land Trust for Santa Barbara County. In Ventura County, visits were made to McGrath State Beach, Mandalay State Beach, the Hedrick Ranch Nature Area, Ormond Pointe, the Ormond Beach Area, and Navy Base Ventura County (Point Mugu). In Los Angeles County, Malibu Lagoon State Beach, the Ballona Wetlands Ecological Reserve, the Ballona Freshwater Marsh, Madrona Marsh and Ken Malloy Harbor Regional Park were all visited. In Orange County, Bolsa Chica Ecological Reserve, Upper Newport Bay, and the San Joaquin Freshwater Marsh Reserve were visited.

A number of sites that were identified by various sources to contain potential habitat for *A. pycnostachyus* var. *lanosissimus* were not visited. Based on published literature and personal communication Emma Wood State Beach in Ventura County was considered as a potential site but ruled out due to a lack of suitable habitat (D. Magney, pers. comm. 2006, R. Burgess, pers. comm. 2006, Wilken and Wardlaw 2001). The historical collection location of “Silver Strand Beach near Point Hueneme” was not visited due to the lack of natural habitat remaining, based on the observation of aerial photos and through communication with local experts (M. Meyer pers. comm. 2006, D. Magney, pers. comm. 2006). Potential habitat at Seal Beach (Anaheim Bay) administered by the U.S. Fish and Wildlife Service and the U.S. Navy, was not visited due to restricted public access to this area. Lastly, the Los Cerritos Wetlands in Long Beach was not visited due to the fact that most land at this location is privately owned and public access is prohibited.

VII. Survey and Evaluation of Potential (Re-) Introduction Sites

Site visits focused on a qualitative evaluation of potential habitats available based on current understanding of the preferred habitat of *Astragalus pycnostachyus* var. *lanosissimus* gained by observing plants in the wild and at experimental planting sites. Additionally, communication with various experts on *A. pycnostachyus* var. *lanosissimus* and coastal habitats and a survey of information contained in various publications provided valuable insight used during site assessments. These experts also were present during the field site visits in order to expedite the identification of areas that contained suitable habitat. Some sites were simply too large (e.g. Bolsa Chica Ecological Reserve, the Ballona Wetlands) to be surveyed completely during the available time, so areas with the best apparent habitat were targeted during these visits.

Coal Oil Point Reserve (COPR):

Location. The Coal Oil Point Reserve (COPR) is located west of the town of Isla Vista in Santa Barbara County and is accessed via Storke Road off of U.S. Highway 101. The Reserve is part of the UC Natural Reserve System and is administered by UC Santa Barbara.

Areas Surveyed. The two main areas visited at COPR included the vicinity of the two planting sites, COPR Lagoon and COPR Pond, located near Devereux Slough. Areas to the south of COPR Lagoon, where large amounts of exotic shrubs (e.g. *Myoporum laetum*, *Tamarix* sp.) will be removed, were also surveyed. Additionally, a suggested potential planting site toward the south side of Devereux Slough along Slough Road near a small bridge was assessed for potential habitat.

Habitat. Habitat similar to the somewhat successful planting site, COPR Lagoon, exists at other locations around Devereux Slough. The most desirable sites along Devereux slough consist of areas of relatively open vegetation where upper salt marsh species, such as *Distichlis spicata* and *Jaumea carnosa*, transition to coastal grassland or shrubland. Much of the habitat along Devereux Slough is occupied by exotic species, such as *Myoporum laetum* and *Tamarix* sp., which are likely to be removed in the near future. Additionally, much of this area is occupied by dense vegetation or on banks with steep slopes that results in a narrow band of transition vegetation between wetland and upland vegetation.

The habitat around the COPR Pond planting site consists of low shrub vegetation and grassy areas, some of which have high vegetation cover. The COPR Pond planting site showed quite a bit of promise prior to its failure due to water table fluctuations and flooding. A better understanding of the fluctuations of the water table and flooding regimes at this site would be quite desirable. The small planting site that was suggested on the south side of Devereux Slough is quite small and located in the shade of large *Eucalyptus* trees. This site consists of a relatively open upper salt marsh transition zone.

Carpinteria Salt Marsh Reserve (CSMR):

Location. The Carpinteria Salt Marsh Reserve (CSMR) is located in Santa Barbara County near the City of Carpinteria and is accessed from Estero Way off of Carpinteria Avenue. The property is part of the UC Natural Reserve System and is administered by UC Santa Barbara. The Reserve is closed to public access.

Areas Surveyed. The main area visited at the reserve consisted of the CSMR-5 planting site and surrounding areas.

Habitat. Much of CSMR consists of tidally influenced salt marsh that is similar to where the failed planting sites, CSMR-1, CSMR-2, CSMR-3, and CSMR-4, were located. Areas where salt marsh vegetation transitions to upland vegetation dominated by coastal scrub vegetation is limited in the area of the reserve that was surveyed. The only observed area that contains this habitat type is currently occupied by the fairly-successful CSMR-5 planting site. Additional areas at CSMR should be further surveyed for habitat similar to the CSMR-5 planting site. Upland portions of the reserve in the vicinity of CSMR-5, contain dense vegetation and exotic species, such as *Conium maculatum* and *Ricinus communis*, limiting the availability of suitable habitat.

South Carpinteria Salt Marsh, Land Trust for Santa Barbara County (SCSM):

Location. The South Carpinteria Salt Marsh (SCSM) property consists of 40 acres located immediately south of the Carpinteria Salt Marsh Reserve near the city of Carpinteria in Santa Barbara County. The property is located immediately south of Santa Monica Creek and is accessed via Sandyland Cove Road off of Carpinteria Avenue. The property is owned by the Land Trust for Santa Barbara County.

Areas Surveyed. The main area surveyed at the SCSM is located west of Sandyland Cove Road and east of Santa Monica Creek. An additional area east of Sandyland Cove Road along the fence that borders the railroad tracks is slated for restoration and was suggested as a possible planting site. Lastly, an area close to the “fence” location being developed as an interpretive overlook of Carpinteria Marsh has been suggested as a possible planting site for *A. pycnostachyus* var. *lanosissimus*.

Habitat. The area west of Sandyland Cove Road and east of Santa Monica Creek consists of a long, mostly upland, berm situated in a north to south orientation with a moderate to slight slope (see Figure 7). The berm previously consisted of vegetation dominated by *Carpobrotus* sp., *Brassica* sp., *Raphanus sativus* and *Carduus pycnocephalus*. In drier upland portions, the berm is occupied by coastal scrub species which transition to salt marsh species as the berm descends toward the more mesic surrounding areas. The upland portion of the berm is dominated by species such as *Baccharis pilularis*, *Atriplex lentiformis*, *Isocoma menziesii*, and *Phacelia ramosissima*. The adjacent salt marsh vegetation, and vegetation bordering the tidally-influenced Santa Monica Creek, is dominated by *Arthrocnemum subterminale*. Areas in the transition zone between the drier portions of the berm and wetter portions of the marsh/creek contain species such as *Leymus triticoides* and *Heliotropium curassavicum*.

The overall cover at this location is approximately 50-75 percent with numerous openings and gaps in the vegetation. There have been no tests of soil properties or analysis of the subsurface hydrologic regime at this location. The soil texture appears to be loamy sand with the potential for good moisture retention. According to J. Bowland (pers. comm. 2006) the water in the marsh and the creek rises quite high during high tides, probably creating a periodically high water table. The species present in the upland and transition areas suggest that the level of soil salinity is not very high at this location.

The area that was surveyed east of Sandyland Cove Road along the fence that borders the railroad tracks is essentially devoid of vegetation at this time. This area is part of a large restoration plan that is scheduled to be planted with coastal shrub species and is probably drier than past successful *A. pycnostachyus* var. *lanosissimus* planting efforts. The potential planting area at the overlook site occurs in an upland area that is also very dry. Both of these areas are likely to be subjected to some level of maintenance and horticultural treatments for a period of time if plantings are made in this area.

Hedrick Ranch Nature Area (HRNA):

Location: The Hedrick Ranch Nature Area (HRNA) consists of approximately 220 acres of riparian floodplain along the Santa Clara River near Santa Paula in Ventura County. The property is located north of South Mountain Road and south of the Santa Clara River, approximately four miles east of Santa Paula, and is administered by the Friends of the Santa Clara River (FSCR).

Areas Surveyed: The main area of habitat surveyed at the HRNA is located to the west of the parking area/visitor kiosk.

Habitat: The vegetation at the location surveyed at this site consists largely of stands of *Baccharis salicifolia* and *Salix* spp. A large amount of this property (48 acres) is in the process of being restored, with eradication of exotic plants to be followed by the planting of native species (J. Bowland, pers. comm. 2006). This site contains quite a bit of grasses in the understory, especially *Cynodon dactylon* and *Distichlis spicata*. The area is located approximately 12-14 miles inland from the immediate coast and the site is likely to be warmer and drier than past planting locations of *A. pycnostachyus* var. *lanosissimus*. The water table at this site is reported to be at approximately one meter (three feet) below the soil surface (J. Bowland, pers. comm. 2006) with fairly fine soil texture (likely loamy sand) and fairly high moisture retention. The presence of such species as *Heliotropium curassavicum* and *Atriplex* sp. indicates some level of soil salinity at this location; however, no known soil tests have been conducted.

McGrath State Beach (MSB):

Location. McGrath State Beach (MSB) is located between the Cities of Ventura and Oxnard in Ventura County. The property is accessed to the west of Harbor Boulevard. The site is operated by the California Department of Parks and Recreation and is open to the public.

Areas Surveyed. The main area at MSB surveyed for potential *A. pycnostachyus* var. *lanosissimus* habitat consisted of the area surrounding McGrath Lake in the southern part of the park. An additional area near the campground in the northern portion of the park was not visited but has been suggested as a potential place for planting.

Habitat. The southwest border of McGrath Lake contains many areas where riparian vegetation (e.g. *Salix* spp. and *Bulboschoenus* or *Schoenoplectus* spp.) transitions to more upland

vegetation associated with backdune areas. This general area contains the “successful” planting sites, MSB-3, MSB-4 and MSB-5. These transition zones, where *A. pycnostachyus* var. *lanosissimus* plantings have been successful to date, are typically occupied by species such as *Euthamia occidentalis*, *Ambrosia psilostachya*, and *Oenothera deltoidea* subsp. *hookeri*. M. Meyer (pers. comm. 2006) indicated that the hydrology present at the successful plantings near McGrath Lake probably exists in numerous locations around the lake. Many of these locations are now occupied by dense stands of *Carpobrotus edulis* that would have to be removed in order for this location to be suitable habitat for *A. pycnostachyus* var. *lanosissimus*.

Mandalay State Beach (Mandalay Beach Park, Mandalay):

Location. Mandalay State Beach (Mandalay) is located near the city Oxnard in Ventura County. The property is located north of West Fifth Street and west of Harbor Boulevard. The property is owned by the State of California, managed by the County of Ventura and is open to the public.

Area Surveyed. The main areas surveyed for potential planting of *A. pycnostachyus* var. *lanosissimus* at Mandalay included the vicinity of the Mandalay-1 experimental plantings and areas north of these plantings in a zone extending for some distance east of the sand dune habitat present at the site.

Habitat. The Mandalay site has many areas containing habitat similar to the somewhat successful plantings at Mandalay-1. The area hosts extensive *Salix lasiolepis* thickets that transition to drier sites associated with species such as *Baccharis pilularis*. Additionally, some areas on the edge of willow thickets are dominated by dense growth of species, such as *Juncus balticus*. The three experimental plantings that have been attempted in this area all possess a water table located at approximately 1.25 meters below the soil surface. Lack of groundwater close to the soil surface continues to be limiting factor for the establishment of *A. pycnostachyus* var. *lanosissimus* seedlings at this site. A better understanding of the subsurface hydrology at this location would be desirable prior to future plantings.

Ormond Beach:

Location. Ormond Beach is located south of the City of Oxnard in Ventura County. It is accessed from either Arnold Road or Edison Drive off of Hueneme Road. Portions of the

Ormond Beach area are owned by the Nature Conservancy, California State Coastal Conservancy (Coastal Conservancy) and private parties. Public access to The Nature Conservancy and Coastal Conservancy properties is unrestricted.

Areas Surveyed. The main areas surveyed at Ormond Beach are located west of Arnold Road and southwest of McWane Boulevard near the intersection of Edison Road.

Habitat. The area west of Arnold Road consists mostly of tidally influenced salt marsh vegetation dominated by species such as *Arthrocnemum subterminale*. The upland habitat at this site occupies a small amount of area and contains species that indicate a high degree of soil salinity. Thus, this area would likely be unfavorable for the planting of *A. pycnostachyus* var. *lanosissimus*.

The area visited off of McWane Boulevard does not appear to be under as much tidal influence as the Arnold Road site. Still, the dominant species here is *Arthrocnemum subterminale* with some patches of *Baccharis pilularis* in limited, drier upland habitat. Salinity in this area may be too high to support *A. pycnostachyus* var. *lanosissimus*. A small channel that appears to be less influenced by salt water, flows toward the ocean through this site. Species growing along the channel include *Baccharis salicifolia*, *Atriplex triangularis* and *Bulboschoenus* or *Schoenoplectus* spp. This channel may be subjected to seasonal flooding. Additionally, a small spring fed area located just behind a section of backdune habitat appears to be relatively saline and hosts species such as *Frankenia salina*, *Aster subulatus* and *Atriplex triangularis*. This area is probably more saline than areas where successful planting of *A. pycnostachyus* var. *lanosissimus* has occurred.

Navy Base Ventura County:

Location. Navy Base Ventura County (known commonly as “Point Mugu”) is located southeast of the city of Oxnard. The main entrance to the navy base is via Las Posas Road off of Highway 1 (Pacific Coast Highway). Access to the public is restricted and requires the escort of a base employee for entrance onto the base.

Areas Surveyed. A large portion of the navy base was visited on a driving tour with base biologists. The tour was relatively non-focused and provided a general overview of the habitat present at the base.

Habitat. Most of the habitat at the base consists of tidally-influenced wetlands dominated by salt marsh species such as *Arthrocnemum*. The most promising habitat that was observed was in the vicinity of 12th Street and Ronald Reagan Road. The vegetation in this area consists of coastal scrub dominated by *Baccharis salicifolia* bordering a tidally influenced marsh dominated by *Arthrocnemum subterminale*. In addition, an area of restored vegetation in the vicinity of “Pad Alpha” consists of large stands of relatively open *B. salicifolia* that might provide some *A. pycnostachyus* var. *lanosissimus* habitat. In general, there did not appear to be much potential habitat for *A. pycnostachyus* var. *lanosissimus*; however, a more complete and unrestricted survey of the base may yield areas with better *A. pycnostachyus* var. *lanosissimus* habitat.

Malibu Lagoon State Beach (MLSB):

Location. Malibu Lagoon State Beach (MLSB) is located in the city of Malibu in Los Angeles County. The site is located directly off of Highway 1 where Malibu Creek meets the Pacific Ocean. The property consists of approximately 22 acres and is open to the public.

Areas Surveyed. The areas surveyed at MLSB consisted of most of the state park property located to the west of the mouth of Malibu Creek. Suggested areas of potential *A. pycnostachyus* var. *lanosissimus* habitat to the east of the creek were not surveyed due to time limitations.

Habitat. Most of the habitat at MLSB consists of salt marsh vegetation, disturbed backdunes and dense coastal scrub that will likely undergo significant change within the next year. The entire state beach is scheduled to be restored under a comprehensive plan that will alter much of the habitat that currently exists in this location. Some of the goals of the restoration are to improve tidal circulation in the wetland and to improve upland habitat. The estimated completion date of the project is fall 2008. Considering the fact that much of this site will be restored in the near future, MLSB may eventually contain suitable habitat for *A. pycnostachyus* var. *lanosissimus*.

Ballona Wetlands Ecological Reserve (BWER):

Location. The Ballona Wetlands Ecological Reserve (BWER) is located near the Cities of Marina del Rey and Playa del Rey in Los Angeles County. The site is located in the vicinity

of Culver Boulevard and Lincoln Boulevard and is bisected by the channelized Ballona Creek. Most of the 600-acre ecological reserve is owned by the California Department of Fish and Game (CDFG), with a small portion owned by the State Lands Commission.

Areas Surveyed. Most of the BWER is under large-scale restoration planning and so only a few sites that will not be heavily altered in the near future were visited. The survey of potential habitat focused on two main areas. The first area is located east of Vista del Mar and north of Culver Boulevard near Playa del Rey. The second area is located south of Culver Blvd near where Nicholson Street meets Culver Boulevard.

Habitat. The potential site near Vista del Mar is located in an area of dense vegetation where sand dune habitat transitions to coastal wetlands dominated by *Arthrocnemum* spp. This area contains a mosaic of dense patches of *Salix lasiolepis*, *Distichlis spicata*, exotic annual grasses and *Juncus* spp., with some areas of less dense *Ambrosia psilostachya* and scattered *Myoporum laetum*. The CDFG intends to remove the *Myoporum laetum* from this site, possibly creating some open areas suitable for *A. pycnostachyus* var. *lanosissimus* (B. Henderson, pers. comm. 2006). The soil here is quite sandy with the water table residing at about 18-24 inches below the soil surface.

The potential site south of Culver Boulevard near Nicholson Street consists of mostly dense patches of *Carpobrotus edulis* growing at the base of a slope that is vegetated with dense growth of *Raphanus sativus* (See Figure 10). The area also hosts dense patches of *Anemopsis californica*, *Euthamia occidentalis* and *Distichlis spicata*. The water table at this site is reported to be quite high and the soil texture at this location is loamy sand. The soil salinity at this location is reported to be very low (B. Henderson, pers. comm. 2006). The most suitable habitat for *A. pycnostachyus* var. *lanosissimus* at this location exists in the transition zone between the weedy upland areas dominated by *Raphanus sativus* and the wetter habitat dominated by dense *Distichlis spicata* and *Anemopsis californica*. The removal of *Carpobrotus edulis* at this site would potentially open up some good habitat for restoration activities that could include the planting of *A. pycnostachyus* var. *lanosissimus*.

Ballona Freshwater Marsh Preserve (BFMP):

Location. The Ballona Freshwater Marsh Preserve (BFMP) is located near the City of Playa del Rey in Los Angeles County. The marsh is located south of West Jefferson Boulevard

and west of Lincoln Boulevard where these two roads intersect. The site consists of 26 acres of constructed freshwater marsh habitat adjacent to the Ballona Wetlands Ecological Reserve that is managed by the Center for Natural Lands Management (CNLM) and receives limited public access.

Areas Surveyed. The main area surveyed is located to the southeast of the pond that dominates the majority of the site.

Analysis and Description of Available Habitat. The BFMP consists of a large created freshwater marsh on the border of the ecological reserve. The marsh is not connected hydrologically to the Ballona Wetlands Ecological Reserve, but could possibly be in the future. This undoubtedly would change the nature of vegetation at this site. Much of the plantings at BFMP are being watered at this time, so it is difficult to ascertain what the natural state of vegetation would be if supplemental water were removed. At this time, the most favorable habitat exists at the transition zone between wetland species, such as *Typha* sp., *Salix* sp. and *Bulboschoenus* or *Schoenoplectus* spp. and upland species associated with drier areas. It is likely that vegetation (especially *Salix* sp.) will become thicker at many of these locations in the near future as the existing plantings mature.

Madrona Marsh Preserve (MMP):

Location. The Madrona Marsh Preserve (MMP) is located in the City of Torrance in Los Angeles County. The site is located north of Sepulveda Boulevard and west of Madrona Avenue where these two roads intersect. The preserve is owned by the City of Torrance and is open to the public.

Areas Surveyed. The site visit consisted of a general survey of most of the area at the MMP.

Habitat. Most of the MMP consists of backdunes, vernal pools and upland habitats. The preserve contains one large freshwater wetland that floods for a considerable portion of the year. Much of the land in the upland portion of this site is managed by mowing, presumably to control exotic annual grasses. One small area of habitat near an area that is dominated by *Distichlis spicata* has been suggested as a potential planting area. The entire site is reported to contain a layer of clay below the soil surface, which creates a perched water table that influences the habitat types present at MMP (e.g. wetlands and vernal pools) (T. Drake, pers. comm. 2006).

The soil texture is reported to be silty loam and the level of soil salinity is not likely to be very high. It is important to note that the Madrona Marsh is an “island” of natural habitat completely surrounded by dense urbanization.

Ken Malloy Harbor Regional Park (KMHRP):

Location. Ken Malloy Harbor Regional Park (KMHRP) is located within Harbor City in Los Angeles County. The park is located south of the Pacific Coast Highway and east of Vermont Avenue where these two roads intersect. The park is operated by the Los Angeles County Department of Parks and Recreation and is open to the public.

Areas Surveyed. The area surveyed consists of habitat on the south and east sides of Harbor Lake and a portion of the area directly south of the outlet (dam spillway) of the lake in the direction of West Anaheim Street.

Habitat. Much of the habitat on the immediate border of Harbor Lake consists of thick riparian vegetation dominated by species such as *Salix lasiolepis* and *Bulboschoenus* or *Schoenoplectus* spp. one area that was suggested for reintroduction at KMHRP is located to the west of the main trail around the lake, immediately east of the dam spillway. The area consists of a somewhat steep slope, dominated by *Baccharis salicifolia*, upslope from a failed planting of willows (*Salix* spp.). The area likely has a high water table and may be subjected to periodic flooding. The second area at KMHRP surveyed consists of a large area to the south of the dam spillway that recently burned in a wildfire. The area consists of some interesting habitat dominated by *Salix* spp. and *Baccharis* spp. that is probably subject to flooding during periods of high rainfall. There is a high cover of exotic species at this site and significant impacts from trash dumping and other vagrant activities. There is no available information about the hydrology or soil characteristics present at this site.

Bolsa Chica Ecological Reserve (BCER):

Location. The Bolsa Chica Ecological Reserve (BCER) is located between the Cities of Sunset Beach and Huntington Beach in Orange County. The property is accessed directly east of the Pacific Coast Highway (PCH). The reserve consists of approximately 1200 acres held by the state of California (CDFG and State Lands Commission) and is open to the public.

Area Surveyed. The area of potential habitat surveyed at the BCER is located south of the south visitor parking lot, east of Bolsa Chica State Beach and immediately east of the Highway 1.

Habitat. The main area surveyed at BCER consists of approximately 0.8 km (0.5 mile) narrow strip of land bordered by the PCH to the west and tidal salt marsh to the east. The habitat in this area consists of backdune habitat that gradually transitions to salt marsh vegetation. Much of the area is currently dominated by *Carpobrotus edulis*, which is in the process of being removed. The transition zone vegetation, in addition to the area dominated by *C. edulis*, consists of a mosaic of patches of *Ambrosia psilostachya*, *Juncus acutus* subsp. *leopoldii*, *Typha* spp., *Salix lasiolepis*, *Distichlis spicata* and *Anemopsis californica*. The hypothetical hydrological conditions contributing to this band of vegetation is a zone of freshwater perched on top of the saltwater in the associated tidal marsh. This situation would also indicate that the water table at this location is probably fairly close to the soil surface. Additionally, this strip of vegetation contains an area dominated by *Baccharis salicifolia* and *Myoporum laetum*. The exotic species at this site are in the process of being completely removed, which could potentially open up a wide variety of sites in which native species can be planted. There is no available information about the soil or subsurface hydrological conditions at this location but the soil texture is likely to be sand to loamy sand with fairly high content of organic matter (personal observations, October 2006). When compared to all other sites visited, the habitat at this location is the most similar to the habitat observed at the “successful” experimental planting sites at McGrath State Beach. One potential site north of the south visitor parking lot was surveyed briefly but contained little of the desired wetland transition habitat found in the area south of the parking lot.

Upper Newport Bay Ecological Reserve (UNBER):

Location. The Upper Newport Bay Ecological Reserve (UNBER) is located, near the city of Newport Beach. One of the main access points for the reserve is near the Muth Interpretive Center located near the intersection of Irvine Avenue and University Drive in Newport Beach. The ecological reserve consists of approximately 752 acres of land, most of which is owned and managed by the CDFG. Much of the upland portion of the reserve, approximately 140 acres, is owned and managed by the Orange County Parks Department as the Upper Newport Bay Regional Park which is largely open to the public.

Areas Surveyed. The main portions of the UNBER that were visited are located south of the Muth Interpretive Center and southwest of Irvine Avenue.

Habitat. The main area of potential habitat surveyed, located directly south of the Muth Interpretive Center, consists of a wetland to upland transition zone. The area contains a large stand of *Arthrocnemum subterminale* that transitions to zones dominated by either *Anemopsis californica* or *Salix lasiolepis*, mixed with *Myoporum laetum*. These stands of vegetation transition to upland areas dominated by a variety of shrubs, as well as native and exotic annuals. Staff at the reserve plan to remove most of the *Myoporum laetum* that might provide potential habitat for *A. pycnostachyus* var. *lanosissimus* plantings in the future. A particularly interesting portion of the habitat at this location is at the edges of the stands of *Anemopsis californica*, which sometimes contains scattered *Heliotropium curassavicum*. The upland portion of this area contains a large amount of weeds including *Raphanus sativus*, *Foeniculum vulgare*, *Centaurea melitensis* and *Marrubium vulgare*, which could potentially invade any planting areas. The soil in this location has been characterized as sandy loam and some compaction has occurred in the past (J. Neagele, pers. comm. 2006). The water table and soil chemistry characteristics at this site are unknown; however, the species composition indicates that soil salinity is probably quite low.

Areas to the south of this location, farther away from the interpretive center, consist of much more dense vegetation with fewer of the openings desirable for the planting of *A. pycnostachyus* var. *lanosissimus*. The species composition in one suggested area consists of *Anemopsis californica* growing with dense *Distichlis spicata* and *Pulicaria paludosa*. The hydrology at this location is probably favorable, but the condition of vegetation and the lack of open sites make this area less desirable.

San Joaquin Freshwater Marsh Reserve (SJFMR):

Location. The San Joaquin Freshwater Marsh Reserve (SJFMR) is located within the City of Irvine in Orange County. The reserve is located southeast of Jamboree Road and southwest of Campus Drive in the area where these two roads intersect. The site is owned by the UC Natural Reserve System and is administered by UC Irvine. The property is closed to public access.

Areas Surveyed. The majority of the area occupied by the SJFMR was surveyed for potential *A. pycnostachyus* var. *lanosissimus* habitat.

Available Habitat. Most of the habitat at the SJMR consists of ponds and freshwater marshes with a small amount of riparian woodlands and upland areas. The majority of the vegetation in the areas surveyed consisted of open water and dense growth of *Typha* spp. and *Bulboschoenus* or *Schoenoplectus* spp. Very little wetland to upland transitional habitat exists at this site and what transitional habitat is present occurs mostly along roads and is dominated by dense growth of native and exotic species.

VIII. Recommendations for Future Plantings

Out of the sixteen sites visited during the course of this project, a number contain habitat where the planting of *Astragalus pycnostachyus* var. *lanosissimus* may be successful. Three locations, the Bolsa Chica Ecological Reserve, McGrath State Beach and the South Carpinteria Salt Marsh, are identified as preferred sites where future (or additional) plantings of *A. pycnostachyus* var. *lanosissimus* have a high likelihood of being successful. The Upper Newport Bay Ecological Reserve, Ballona Wetlands Ecological Reserve, Coal Oil Point Reserve, Ballona Freshwater Marsh and Hedrick Ranch Nature Area, are identified as alternate sites where future (or additional) plantings of *A. pycnostachyus* var. *lanosissimus* has a moderate potential of being successful. The Carpinteria Salt Marsh Reserve, Mandalay State Beach, Navy Base Ventura County, Madrona Marsh Preserve, Ken Malloy Harbor Park, San Joaquin Freshwater Marsh, Malibu Lagoon and Ormond Beach are identified as unsuitable sites for future (or additional) plantings of *A. pycnostachyus* var. *lanosissimus* as they have a low potential of being successful.

Several of these locations are in the process of (or undergoing planning for) large-scale restoration in which habitat for the planting of *A. pycnostachyus* var. *lanosissimus* could easily be created. Additional localities at these and at other, sites are likely to have suitable habitat for *A. pycnostachyus* var. *lanosissimus*; however, an exhaustive search for potential habitat was not feasible.

Preferred (High Quality) Sites

South Carpinteria Salt Marsh (SCSM):

The “berm” location at the southern portion of the Carpinteria Salt Marsh owned by the Land Trust for Santa Barbara County (LTSBC) contains good potential habitat for a future planting of *A. pycnostachyus* var. *lanosissimus* (See Figure 7). The area consists of a large amount of upland habitat that transitions into salt marsh habitat. This area contains some of the same species associated with the “successful” CSMR-5 planting site, which is located approximately 100 meters to the northwest of this location. This potential site is likely to have a relatively high water table which probably is influenced mostly by brackish water. Areas in the transition zone between the upland zone of the berm and either the salt marsh or Santa Monica Creek (depending on orientation) are likely to contain the most favorable planting sites for *A. pycnostachyus* var. *lanosissimus*. The berm is large enough in spatial extent that there would

potentially be a number of locations and microhabitats where *A. pycnostachyus* var. *lanosissimus* could be planted. Additionally, this would allow *A. pycnostachyus* var. *lanosissimus* to move around, should growing conditions and habitat suitability change over time. It is important to note that this site is a restored area in which native plants are still becoming established and the conditions of vegetation are likely to change in the future. In addition, little is known about the soil characteristics and hydrology at this site. As with all potential planting sites, the availability of long-term monitoring and maintenance will be extremely important for the persistence of any *A. pycnostachyus* var. *lanosissimus* planting. It should be noted that this site is located in Southern Santa Barbara County, which is slightly beyond the historical range of *A. pycnostachyus* var. *lanosissimus*.

McGrath State Beach (MSB):

The area of McGrath State Beach (MSB) southeast of McGrath Lake is already the location of successful plantings of *A. pycnostachyus* var. *lanosissimus*. The area contains numerous areas of habitat with desired vegetation composition and architecture, similar to the MSB-3 and MSB-4 planting areas where *A. pycnostachyus* var. *lanosissimus* has persisted for four years (See Figure 8). The hydrology in these areas is likely to contribute to the successful planting of *A. pycnostachyus* var. *lanosissimus*. Unfortunately, many of these potential planting locations are currently inhabited by dense growth of *Carpobrotus edulis*; however, if this species were to be removed, this would open up many more microsites for planting of *A. pycnostachyus* var. *lanosissimus*. Additional plantings at MSB would lessen the potential of stochastic events and natural perturbations to eliminate all *A. pycnostachyus* var. *lanosissimus* growing in this general area. In addition, the removal of much of the *Carpobrotus* might help with the problem of herbivory from snails, which are thought to live in the *Carpobrotus* and which feed on many naturally-occurring seedlings of *A. pycnostachyus* var. *lanosissimus*.

The area is open to the public but receives sporadic access due to inaccessibility. M. Meyer (pers. comm. 2006) indicates that one of the primary factors that will ensure the success of potential future plantings at this (and any) planting location is the availability of long-term maintenance and monitoring.

Bolsa Chica Ecological Reserve (BCER):

A portion of the Bolsa Chica Ecological Reserve (BCER) located to the south of the southern visitor parking lot contains habitat where the planting of *A. pycnostachyus* var. *lanosissimus* has a high likelihood of being successful. Staff with the Bolsa Chica Conservancy is currently in the process of removing exotic weeds (*Carpobrotus edulis* and *Myoporum laetum*) from this location with funding from a Coastal Recovery Grant (B. Nerhus, pers. comm. 2006). The vegetation composition and architecture at several locations in this general area mimics very closely the habitat at the successful planting sites at McGrath State Beach near McGrath Lake (See Figure 9). The species present at this location indicate the presence of a high water table and likely has brackish or freshwater influence. The BCER is open to public access, but the location described here is generally not visited by members of the public. The long, linear nature of this potential planting site would allow for multiple plantings with variation in microhabitat. This would also allow *A. pycnostachyus* var. *lanosissimus* plants to spread and/or relocate through natural processes of distribution. Staff at the reserve indicates that there would likely be very little opposition to planting of *A. pycnostachyus* var. *lanosissimus* at this location, especially since the Bolsa Chica area is considered the type locality of *A. pycnostachyus* var. *lanosissimus*.

Additionally, there is staff at the reserve in charge of performing maintenance/restoration activities, and a monthly volunteer effort, that could possibly be enlisted in monitoring/maintaining plantings of *A. pycnostachyus* var. *lanosissimus*. A possible consideration at this site surrounds how the native vegetation is likely to rebound after the competition from exotic species (mostly *Carpobrotus*) is removed. Future maintenance to maintain the habitat openness preferred by *A. pycnostachyus* var. *lanosissimus* may need to be undertaken. Additionally, areas near where *A. pycnostachyus* var. *lanosissimus* could potentially be planted contain populations of two endangered bird species, Belding Savannah Sparrow and Least Tern. This might interfere with maintenance and/or planting activities and needs to be taken into consideration before reintroduction of *A. pycnostachyus* var. *lanosissimus* occurs.

Alternate (Medium Quality) Sites

Coal Oil Point Reserve (COPR):

The two main potential areas for planting of *A. pycnostachyus* var. *lanosissimus* at the Coal Oil Point Reserve (COPR) are located near the COPR Pond planting sites and along

Devereux Slough in the vicinity of the COPR Lagoon planting site. In general, the banks along Devereux Slough are fairly steep and, as a result, the zone where the hydrology is likely to be favorable for the planting of *A. pycnostachyus* var. *lanosissimus* is very narrow. If planting were to occur at this location, an effort would need to be made in selecting planting sites in the transition zone between the upper salt marsh vegetation (dominated by species such as *Distichlis spicata* and *Jaumea carnosa*) and drier, upland areas. Much of this zone is currently densely vegetated or is dominated by exotic species, especially *Myoporum laetum*. However, the Devereux Slough area is very large and potential microsites available for planting could be numerous. Starting in spring of 2007, staff at the reserve has plans to begin the removal of much of the exotic woody vegetation growing along the slough. Potential planting sites may open up as the result of these restoration activities. At this point the areas around the COPR Pond site should probably be avoided due to the fact that experimental plantings in this location have failed in the past, presumably as a result of flooding and/or sudden drops in the water table.

Much of the reserve is open to public access, but it is unlikely that potential planting areas would be impacted by visitors. The site that was suggested on the south side of the slough contains a small amount of salt marsh to upland transition habitat that is would be desirable for the planting of *A. pycnostachyus* var. *lanosissimus*. The main limitation at this location is that the potential planting site would be very small. The staff at COPR is very much in favor of future plantings of *A. pycnostachyus* var. *lanosissimus* and is dedicated to restoration of native species on the site. The COPR area is the most northern site evaluated at in the course of this project and is located slightly beyond (approximately 65 kilometers, 40 miles) the historical range of *A. pycnostachyus* var. *lanosissimus*.

Ballona Freshwater Marsh (BFM):

The Ballona Freshwater Marsh (BFM) contains a large amount of freshwater wetlands and associated transition zones where the planting of *A. pycnostachyus* var. *lanosissimus* might be successful. Due to the fact that the marsh has been recently created, is currently being irrigated, and, in the future, may be connected hydrologically to the Ballona Wetlands Ecological Reserve, this area may not be a good place for planting of *A. pycnostachyus* var. *lanosissimus* at this time. Much of the vegetation at this site is still in the process of being established and many areas that are open now may become densely-vegetated in the near future. Once the vegetation

at the marsh exists in a more stable state and the possible connection with the wetlands is resolved, this site might provide good habitat for *A. pycnostachyus* var. *lanosissimus*.

The BFM has limited public access and a dedicated staff that could possibly help with the maintenance/monitoring of a planting of *A. pycnostachyus* var. *lanosissimus*. However, the BFM continues to be a highly-controversial and closely-watched project and the establishment of an endangered species population might prove to be very difficult. Efforts would need to be made to work closely with the staff at the marsh and the landowner in order to achieve the favorable political climate needed to establish a *A. pycnostachyus* var. *lanosissimus* population.

Ballona Wetlands Ecological Reserve (BWER):

Out of the two main areas surveyed at the Ballona Wetlands Ecological Reserve (BWER), only one location is, in reality, a potential future planting area. The area located to the north of Culver Boulevard and east of Nicholson Street is scheduled to be planted with *A. pycnostachyus* var. *lanosissimus* by the North Shore Site developer as part of the mitigation required for the approval of their project. The other potential site is located east of Vista del Mar near Playa del Rey and contains vegetation that is fairly thick with dense patches of exotic grasses. The habitat at this location looks very similar to the Mandalay-1 planting site, but with overall growth being more dense. The subsurface hydrology and soil properties at this location are believed to be favorable for the growth of *A. pycnostachyus* var. *lanosissimus*. The entire Ballona Wetlands area is in the process of planning a large-scale restoration project that will be implemented in the next couple of years. As a result, much of the current habitat that exists within this property will be heavily altered in the near future. Restoration activities are likely to open-up/create a number of locations with favorable habitat for the planting of *A. pycnostachyus* var. *lanosissimus* in the future. Considering the fact that the Ballona Wetlands was once the hypothetical epicenter of *A. pycnostachyus* var. *lanosissimus*, efforts should be made to work with the planners of the project to make sure habitat for this species is taken into consideration during restoration.

Upper Newport Bay Ecological Reserve (UNBER):

The area at Upper Newport Bay Ecological Reserve (UNBER) located to the south of the Muth Interpretive Center contains some locations where planting of *A. pycnostachyus* var.

lanosissimus could be quite successful. The area contains a small number of microhabitats (e.g. the edge of *Salix* or *Anemopsis californica* stands) where the vegetation architecture and composition are favorable. The species present at this location indicate that there is a high water table that is influenced by fresh or brackish water. This potential planting area is open to the public and could be impacted by recreational use (e.g. trampling). One of the main concerns at this location is the large presence of upland weeds in the vicinity of potential planting areas. Additionally, in the areas observed, there are relatively few planting sites and little variation in habitat that appears necessary for the expansion and movement of populations. On the other hand, there would probably be little opposition to the planting of *A. pycnostachyus* var. *lanosissimus* at UNBER and the possibility of maintenance and monitoring by park staff .

Low Potential (Low Quality) Sites

Carpinteria Salt Marsh Reserve (CSMR):

The prospect for successful planting of *A. pycnostachyus* var. *lanosissimus* at the Carpinteria Salt Marsh Reserve (CSMR) relies upon the availability of habitat similar to the habitat of the CSMR-5 planting site. In the area of the reserve that was visited, suitable habitat is restricted to the area near CSMR-5. Weed removal activities or other habitat modification might provide the opportunity for supplemental planting of *A. pycnostachyus* var. *lanosissimus* in the vicinity of the CSMR-5 site. Other areas of CSMR should be further surveyed for habitat similar to CSMR-5 as, if found, these areas would have the high likelihood of hosting successful plantings of *A. pycnostachyus* var. *lanosissimus*. The CSMR is closed to public access and future planting activities would likely be supported by reserve staff. Management of future plantings would probably not be provided by staff at the reserve (due to limited funding and staff time) and would have to be provided for by the entity responsible for the planting activity.

Hedrick Ranch Nature Preserve (HRNP):

The Hedrick Ranch Nature Preserve (HRNP) contains a large amount of riparian habitat dominated by *Salix lasiolepis* and *Baccharis salicifolia*. Generally speaking, this habitat could provide a variety of microsites where planting of *A. pycnostachyus* var. *lanosissimus* might be successful. However, the water table at the site is reported to be at approximately one meter below the soil surface, which is similar to the water table found at Mandalay State Beach in

which seedlings normally do not survive, presumably due to the lack of available water near the soil surface in the immediate time period following germination. In addition, most of the herbaceous vegetation at this site is dominated by dense growth of grasses, which is a very undesirable habitat for the survival of *A. pycnostachyus* var. *lanosissimus* and would have to be controlled prior to planting. HRNP is also located approximately 12-14 miles inland in an area that is warmer and drier than coastal areas where plantings of *A. pycnostachyus* var. *lanosissimus* have occurred in the past. Whether or not *A. pycnostachyus* var. *lanosissimus* could survive in this climate is unknown; however, it is possible that the HRNP might be too far outside the climatic tolerance of the species.

Nonetheless, there is a strong desire to do restoration at this site and the managers/owners would welcome the planting of *A. pycnostachyus* var. *lanosissimus* in this location. Additionally, there is a strong volunteer base at the HRNP and an ambitious plan for restoration at the preserve, which could both help in providing some of the maintenance that is required by plantings of *A. pycnostachyus* var. *lanosissimus*.

Mandalay State Beach (Mandalay):

In general, Mandalay State Beach (Mandalay) contains an ample amount of habitat that has been somewhat successful with regards to growing adult *A. pycnostachyus* var. *lanosissimus* plants. Natural recruitment at this site has been limited, most likely due to the inability of young *A. pycnostachyus* var. *lanosissimus* seedlings to obtain access to sufficient soil moisture soon after germination. A better understanding of the water table at potential planting sites at Mandalay needs to be gained prior to future plantings and areas where soil texture and subsurface hydrology is similar to the Mandalay-1 planting site should be avoided. An effort would need to be made to find areas at Mandalay where the soil retains more moisture later on in the growing season or where the water table is closer to the soil surface during the *A. pycnostachyus* var. *lanosissimus* growing season. If suitable sites for future planting are found at Mandalay, it is unlikely that there will be opposition from Ventura County.

Ormond Beach:

At this point, only marginal habitat for *A. pycnostachyus* var. *lanosissimus* exists at Ormond Beach. Much of the habitat has a tendency toward saline to hypersaline conditions, which is thought to have been a significant factor in the failed 2004 planting. The entire Ormond Beach area is under a large restoration planning effort spearheaded by the State Coastal Conservancy and good *A. pycnostachyus* var. *lanosissimus* habitat might be created as a result of the restoration. Efforts should be made to make sure that those involved in the planning process at this site do their best to create suitable habitat for *A. pycnostachyus* var. *lanosissimus*. Staff at the Nature Conservancy has expressed support for and interest in planting *A. pycnostachyus* var. *lanosissimus* at the properties that they administer. The best way to ensure that the State Coastal Conservancy includes *A. pycnostachyus* var. *lanosissimus* in the final restoration plan is to formally request that they do so through communication with the individuals guiding the project.

Naval Base Ventura County (NBVC):

Much of the habitat observed at the Naval Base Ventura County (NBVC) consists of salt marsh with minimal amounts of upland/wetland transition habitat. Only one area of potentially good habitat was observed containing upland habitat dominated by *Baccharis salicifolia* bordering a salt marsh. It is possible that other areas exist on the base where planting of *A. pycnostachyus* var. *lanosissimus* could be successful (see Wilken and Wardlaw 2001). According to base biologist M. Ruane (pers. comm. 2006), there is currently a policy barring the (re-)introductions of endangered species on Department of Defense lands. This policy is most likely a product of the current political climate and may change in the future. This policy, coupled with the marginal habitat observed during the site visit, suggests that NBVC is a planting site of low potential success at this time.

Malibu Lagoon State Beach (MLSB):

In 2007, the entire area of Malibu Lagoon State Beach (MLSB) is scheduled to undergo a comprehensive restoration project that will include the alteration of much of the habitat that now exists at this site. Little suitable habitat for *A. pycnostachyus* var. *lanosissimus* currently exists at this site, although it is possible that some may be created in the near future. Of particular interest is an area that is now a parking lot but that is scheduled to be turned into a restored upland area.

The proper hydrology and vegetation for an architecture and composition suitable for *A. pycnostachyus* var. *lanosissimus* plantings could be created in the near future at this location. State Park staff has expressed support for having a planting of *A. pycnostachyus* var. *lanosissimus* at this site (S. Goode, pers. comm. 2006). Efforts should be made to ensure that habitat for *A. pycnostachyus* var. *lanosissimus* is created wherever possible at MLSB.

Madrona Marsh Preserve (MMP):

Madrona Marsh Preserve (MMP) consists of a variety of habitats in a protected area that is completely surrounded by urban development and contains dense exotic grasses in many areas of the preserve. In addition, there appears to be little of the desired wetland to upland transitional vegetation at MMP. Planting of *A. pycnostachyus* var. *lanosissimus* at this location would likely require a great deal of maintenance, primarily to limit competition with grasses. Additionally, the MMP is an “island” that is not connected to any large swaths of intact habitat. This would make a planting of *A. pycnostachyus* var. *lanosissimus* at this site extremely vulnerable to catastrophic, stochastic events.

However, it is likely that the soil properties and the hydrology at MMP would be favorable for the growth of *A. pycnostachyus* var. *lanosissimus* and there is a strong likelihood that staff at the preserve would be able to maintain and monitor a planting of *A. pycnostachyus* var. *lanosissimus*. Staff at the preserve has expressed interest in having *A. pycnostachyus* var. *lanosissimus* at MMP and it is likely that the city of Torrance would support such activities (T. Drake, pers. comm. 2006).

Ken Malloy Harbor Regional Park (KMHRP):

The habitat at Ken Malloy Harbor Regional Park (KMHRP) is mostly marginal for the potential planting of *A. pycnostachyus* var. *lanosissimus*. The area near Harbor Lake that was suggested as a potential planting area could be successful (judging from species composition and hydrology), but the area is threatened by exotic species and recreational use. The area to the south of the dam also contains a broad area of habitat (*Baccharis* and *Salix* shrubland) where the planting of *A. pycnostachyus* var. *lanosissimus* could be successful; however, this area contains a large amount of invasive species and has a significant amount of illegal trash dumping occurring, as well as other human activities that may be detrimental to future plantings. Before planting at

this site, a more detailed study of the hydrology and soils in this area would be desirable. A planting of *A. pycnostachyus* var. *lanosissimus* at this location is not likely to receive any monitoring or maintenance support from Los Angeles County at this site.

San Joaquin Freshwater Marsh Reserve (SJFMR):

The San Joaquin Freshwater Marsh Reserve (SJFMR) consists of very little habitat where planting of *A. pycnostachyus* var. *lanosissimus* is likely to be successful. In the future, restoration activities could provide some suitable habitat, but no such activities are planned for this site in the near future and plantings of *A. pycnostachyus* var. *lanosissimus* at the San Joaquin Freshwater Marsh Preserve would not be advisable at this time.

IX. Management and Monitoring

Management Issues:

Observations at experimental planting sites and the North Shore Site (NSS) indicate that monitoring and management are essential in order for *Astragalus pycnostachyus* var. *lanosissimus* to grow successfully. Two factors that are thought to limit the success at experimental sites, where habitat and environmental conditions are favorable, are herbivory and competition with associated vegetation. Other factors that may play a role in the success of future plantings of *A. pycnostachyus* var. *lanosissimus* include insect predation and disease. These management issues are further discussed below. The presence of these limiting factors makes a regular monitoring regime a vital part of any future plans to (re-)introduce populations of *A. pycnostachyus* var. *lanosissimus*. An important component of any regular monitoring program is an adaptive management regime that would allow adjustments to be made to the monitoring program as issues arise.

Herbivory:

Snails. Herbivory from snails is a major factor affecting the survival of seedlings and the health of adult plants at milk-vetch populations. Damage from snails at *A. pycnostachyus* var. *lanosissimus* populations has, in the past, been attributed to the milk snail (*Otala lactea*) (Wilken and Wardlaw, 2001); however, at most sites, European brown garden snail (*Helix aspera*) are more frequently observed (M. Meyer, pers. comm. 2006). At experimental planting sites, these snails are associated with high levels of *A. pycnostachyus* var. *lanosissimus* seedling herbivory and reduced reproductive output caused by snails feeding on flowers and developing fruit (M. Meyer, pers. comm. 2006). Soza et al. (2003) considered snails, “the major pest threat to *A. pycnostachyus* var. *lanosissimus*” at Carpinteria Salt Marsh Reserve (CSMR) and McGrath State Beach (MSB) planting sites. Similarly, Ikeda and Meyer (2000) reported that, in 1998, snail herbivory caused most seedlings at the NSS to be eliminated and (in April 2000) approximately 75 percent of plants at NSS were impacted by snail herbivory (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) noted that populations of snails can appear rapidly and cause significant damage in short periods of time.

Because the damage caused by snails can appear rapidly and is likely a major factor affecting the survival of seedlings in some locations, control of snails may be required at

experimental planting sites. Wilken and Wardlaw (2001) found it necessary to control snail populations at the NSS during the 2000 growing season after significant damage was observed. Meyer (2006a) notes that control of non-native snails is required for the success of milk-vetch plantings. Various methods have been suggested as ways to control and minimize damage caused by snails including:

- the elimination of favorable snail habitat;
- hand removal of snails,
- use of traps (e.g. beer-baited traps),
- install barriers (e.g. copper bands around plants),
- introduce a biological control agent, such as the decollate snail (*Ruminia decollata*), and
- use pesticides (e.g. snail baits containing metaldehyde or iron phosphate as active ingredients) (University of California Agriculture and Natural Resources 2003).

Removal of snails by hand may be effective in controlling snails if done regularly at small plantings of milk-vetch (Soza et al. 2003, M. Meyer, pers. comm. 2006). Traps featuring beer as bait may also be effective, but are generally impractical on a large-scale basis. The control of habitat that harbors snails may be very effective in helping to protect *A. pycnostachyus* var. *lanosissimus* plantings from herbivory. Since *Carpobrotus edulis* (hottentot fig) is implicated in harboring snail populations (Wilken and Wardlaw 2001), removal of dense mats of *Carpobrotus edulis* in the vicinity of milk-vetch plantings may play a role in reducing snail damage. Removal of *Carpobrotus edulis* is also valuable from the perspective of overall habitat restoration. The introduction of decollate snails has proven to be effective in controlling brown garden snails in citrus orchards, but control tends to be successful starting 4 to 10 years following introduction (University of California Agriculture and Natural Resources 2005).

The most effective control agent of snails at *A. pycnostachyus* var. *lanosissimus* plantings is the application of snail baits containing pesticides (most commonly with metaldehyde as the active ingredient). Wilken and Wardlaw (2001) found repeated applications of metaldehyde-based snail baits within one meter of *A. pycnostachyus* var. *lanosissimus* plants at the NSS to be effective in reducing snail populations. Soza et al. (2003) applied a liquid, metaldehyde-based pesticide (e.g. Deadline) at six week intervals near the base of milk-vetch plants to control snail populations at CSMR and MSB. However, care should be taken to minimize the use of this

pesticide in order to reduce any unintentional consequences (e.g. the poisoning of wildlife and domestic animals) (University of California Agriculture and Natural Resources 2003). A less-toxic alternative to metaldehyde is iron phosphate, which is used as the active ingredient in snail bait products sold under trade names such as Escar-Go and Sluggo. To date, iron phosphate-based snail baits have not been used at *A. pycnostachyus* var. *lanosissimus* sites and the effectiveness of this treatment is unknown.

Mammals. Herbivory by mammals is reported to have both positive and negative influence on populations of *A. pycnostachyus* var. *lanosissimus*. Mammalian herbivory at milk-vetch populations is attributed mostly to rabbits; with gophers, meadow voles and ground squirrels playing less important roles (Meyer 2006a). Rabbits at some coastal locations have been reported to “clear” as much as 90 percent of the total vegetation growing in an area in a single year (Meyer, pers. comm. 2006) and, as such, can play an important role in maintaining the openness needed by many plant species, while at the same time causing damage to desirable plant species (Prins and Nell 1990).

Generally, grazing on *A. pycnostachyus* var. *lanosissimus* is only problematic when herbivores target the plants specifically. This type of grazing usually only happens periodically during the growing season and can be more prevalent in certain years than in others. Meyer (2005) reports that mammalian herbivory may be more severe in dry years following wet years. This can be explained by increased reproductive output of mammalian herbivores during years of high rainfall, resulting in the need to feed on perennial vegetation (e.g. *A. pycnostachyus* var. *lanosissimus*) in the following year if it is dry, due to a reduction in the amount of annual vegetation.

In 2004 (a dry year following a wet year), *A. pycnostachyus* var. *lanosissimus* experienced particularly heavy grazing by rabbits and meadow voles at several MSB planting sites. At MSB-3 in 2004, prior to plants being caged, all but six individuals were dead due to heavy grazing (M. Meyer, pers. comm. 2006). This grazing can be attributed mainly to rabbits based on the characteristic-feeding pattern whereby fleshy stems are selectively consumed while other herbage (covered with dense hairs) is not. Mammalian herbivory is inconsistent on a seasonal and yearly basis, but significant damage can occur in short periods of time. For example, harmful grazing by mammals at NSS has only occurred during one growing season

(relatively dry 1999 following the 97/98 El Nino). Interestingly, this lack of herbivory has, hypothetically, been attributed to *A. pycnostachyus* var. *lanosissimus* plants accumulating selenium where high levels of this chemical are present. The result is that these plants become unpalatable to herbivores. Selenium is present in large quantities in bentonite, a material that is used to cap areas used for oil waste disposal and may have been used at NSS (D. Wilken, pers. comm. 2006).

Since damage by rabbits, meadow voles and gophers may occur rapidly, plantings and populations of *A. pycnostachyus* var. *lanosissimus* need to be monitored regularly and preemptive, protective measures may be advisable. The main method used to control herbivory by rabbits and meadow voles is the installation of exclosures. Soza et al. (2003) used “Freegrow fine mesh plant shelters from Certified Plant Shelters” in order to protect initial transplants of *A. pycnostachyus* var. *lanosissimus* from aboveground herbivory. In subsequent years at the MSB, COPR and CSMR planting sites, short wire fences (with holes small enough to exclude targeted herbivores) have been erected in order to protect plants from herbivory. This type of exclosure is effective in minimizing damage done by rabbits and meadow voles. Meadow voles, especially, may be able to climb over cages and subsequently cause damage to milk-vetch plants (M. Meyer pers. comm. 2007). Other control measures, including a variety of commercially available and homemade repellents intended to deter rabbit herbivory, have had minimal success (M. Meyer pers. comm. 2006).

Another mammalian herbivore that has led to failed plantings of *A. pycnostachyus* var. *lanosissimus* is gophers. Gophers are indicated as the cause of failed plantings at CSMR-1 during the 2003 growing season (Soza et al. 2003). While the species of gopher responsible for this damage is not known, Botta’s pocket gopher (*Thomomys bottae*) is the most widespread and common species of gopher in California (Salmon and Gorenzel 2002).

Soza et al. (2003) used wire mesh baskets placed underground beneath transplants, prior to planting, to prevent damage by gophers. Additionally, they installed solar/battery-powered gopher repellents, which use high frequency sound to repel gophers, at sites where gopher activity was observed. Wire baskets are only effective in protecting the root systems of initial transplants and will not protect naturally-recruited milk-vetch plants. Gopher repelling devices have been proven to be unreliable and ineffective in protecting plants from herbivory by gophers (Link 2005, Salmon and Gorenzel 2002). The most effective control measures for gophers are the use

of traps and baiting with toxic baits. Both of these methods require using a probe to target areas containing underground tunnel systems, for bait or trap placement (Link 2005). Underground barriers (e.g. wire underground fences) around milk-vetch populations could be effective, but are probably impractical for use in natural areas. Methods to control gophers should be in place prior to planting in areas with observed gopher activity. Areas without observed gopher activity should be monitored frequently for signs of gopher activity.

Additionally, skunks may cause damage to milk-vetch seedlings (skunks are included in the section even though the damage attributed to them is not caused by herbivory). Skunks tilling the soil while foraging for soil-dwelling insects are implicated in the death of numerous milk-vetch seedlings at COPR and MSB-5 (M. Meyer, personal communication 2005); however, this is likely an isolated incident and probably does not need to be controlled.

Insects. Aphids feeding on *A. pycnostachyus* var. *lanosissimus* plants have been reported at NSS (Ikeda and Meyer 2000, Wilken and Wardlaw 2001). Additionally, in June and July of 2002, Soza et al. (2003) observed extensive infestations of aphids at CSMR and MSB. At the planting sites, infestations were reported to be highest within the plant shelters intended to protect plants from herbivory and to decrease water stress. While light aphid feeding is unlikely to impact healthy milk-vetch plants, heavy feeding on healthy plants and any feeding on unhealthy plants could be deleterious. Colonies of ants are also frequently associated with infestations of aphids. While feeding on plant fluids, aphids produce a sugary exudate desired by ants and in return for this food source; ants will protect aphid colonies by fending off natural predators (Flint 2000). These sugary exudates from aphids are also implicated in promoting the development of sooty mold fungus on plant stems. An additional hazard that has been attributed to aphids is the fact that aphids can vector some harmful plant diseases, including a number of plant viruses (University of California Agriculture and Natural Resources 2000).

Damage caused by aphids is probably not a severe problem if plants are healthy and the number of aphids is not extreme. Likewise, many naturally occurring predators of aphids are usually present in most areas and could provide adequate control in many situations. Where ants occur in conjunction with aphids, natural predators are likely to be less effective (Flint 2000). The main methods used to control aphids include the use of biological controls (e.g. beneficial insect predators), cultural controls (e.g. washing off aphids with water) and chemical controls.

Soza et al. (2003) used applications of two chemicals, JMS Stylet oil and water mixed with dish soap, and the introduction of beneficial insects (green lacewing and ladybird beetles) to help control aphid infestation at MSB and CSMR. Additionally, they used granular insecticide, applied to active ant colonies, to help minimize their protection of aphid infestations. The use of insecticides that target ant species is generally ill-advised due to potential harm to non-target, native ant populations (M. Meyer pers. comm. 2006). Flint (2000) recommends the use of non-persistent insecticides (such as insecticidal soap) to help control infestations and indicates that successful aphid control is usually only possible when ant infestations are controlled as well. Additionally, since severe infestations were usually observed within plant shelters, effective control of aphids might be most successful when environmental conditions that favor heavy infestation are controlled.

Another possibly important impact to *A. pycnostachyus* var. *lanosissimus* from insects is seed predation. Impact Sciences (1998) reported finding evidence of burrowing insects and seed herbivory at the NSS in 1997 and 1998. Ikeda and Meyer (2000) reported that 25 percent of the seeds at the NSS were infested by bruchid beetles (of the family Bruchidae, the seed or bean weevils). Soza et al. (2003) observed damage to seeds by bruchid beetles at CSMR and MSB planting sites beginning in November 2002. Wilken and Wardlaw (2001) found a 30 percent decrease in the production of viable seeds from plants at the NSS. Bruchid beetles are well-known predators of a wide variety of plants, including *Astragalus* sp. (Green and Palmbald 1975), and have been implicated as a threat to at least one endangered *Astragalus* species, *A. magdalenae* var. *peirsonii* (Pierson's milk-vetch) (Federal Register 2004).

The reduction of reproductive output caused by bruchid beetles is believed to be a natural phenomenon and is probably not a limiting factor for healthy *A. pycnostachyus* var. *lanosissimus* populations, as populations of *A. pycnostachyus* var. *lanosissimus* can produce millions of viable seeds in a single growing season. Little information is available about the control of bruchid beetles in natural areas.

Disease:

Ikeda and Meyer (2000) observed a sooty mold fungus occurring on plants at NSS in 1997 that was implicated in the reduced reproductive output of affected plants. Impact Sciences (1998) reported that 27 plants at the NSS were affected by a fungus that covered the stems, seed

Pods and dried leaves. This occurrence of disease is reported to have caused the wilting and dieback of stems in affected individuals and is the likely cause of death for at least two adult plants. Soza et al. (2003) reported severe sooty mold infestations at MSB planting sites in the year following planting. Damage was most severe on plants protected by plant shelters, as a humid microclimate is known to promote disease development. The sooty mold observed at milk-vetch populations is probably directly related to infestations of aphids (Flint 2000). Additionally, cucumber mosaic virus, which is vectored by aphids, and typically causes stunted growth, a leaf mosaic pattern and other symptoms (Nahmeth 1997), has been reported at NSS and MSB (Federal Register 2002). Chlorotic spots were observed on *A. pycnostachyus* var. *lanosissimus* leaves at the MSB sites in October 2006. Recent samples from MSB sent to the California Plant Pathology Laboratory indicate these symptoms are not caused by cucumber mosaic virus, and are most likely the product of another disease, probably associated with the root system (M. Meyer, pers. comm. 2006).

Sooty mold can be adequately controlled through the management of aphid populations. Additionally, since sooty mold at the MSB and CSMR plantings was often associated with plant shelters, the removal of these structures following the establishment of plantings is likely to control damage. If the cause of other disease symptoms (attributed in the past to cucumber mosaic virus) at the MSB plantings are identified, a proper strategy for treatment can then be developed.

Competition:

Competition with associated vegetation is a major limiting factor at several populations of *A. pycnostachyus* var. *lanosissimus*. At the NSS, Ikeda and Meyer (2000) reported that milk-vetch seedlings are unable to grow in dense carpets of *Carpobrotus edulis* or grasses (such as *Distichlis spicata*). Likewise, competition at experimental sites is said to produce, “low vigor, weak stems, little lateral branching and low rates of flowering” (Meyer 2006a). The original sites where experimental plantings were established were quite open. Soza et al. (2003) observed the colonization of milk-vetch planting sites by exotic and native species (especially *Ambrosia psilostachya*) in the year following installation. At one site, MSB-5, increasingly dense growth of native species (especially *Salix lasiolepis*) is shading out *A. pycnostachyus* var. *lanosissimus* making the habitat at this location inhospitable. Much of the competition at these

sites is associated with the natural growth of native species in response to favorable growing conditions. High precipitation during the 2003 and 2005 growing seasons has resulted in dense growth at several of the original experimental sites to the extent that they are overgrown and no longer support good habitat for *A. pycnostachyus* var. *lanosissimus* (Meyer 2006a). Much of this vegetation is native and the increase in density is a natural process. Competition from species associated with *A. pycnostachyus* var. *lanosissimus* may be a factor limiting success at certain planting locations. Several *A. pycnostachyus* var. *lanosissimus* planting sites have historically been chosen where gaps in vegetation were caused by weed removal activities or represent severe herbivory zones (M. Meyer, pers. comm. 2006; C. Sandoval, pers. comm. 2006). The open habitat which *A. pycnostachyus* var. *lanosissimus* seems to prefer has probably been historically maintained by natural disturbances (e.g. flooding by rivers or high tides) or through the actions of herbivores (P. Baye, pers. comm. 2006).

The control of native species competing with milk-vetch plants is controversial and may need to be undertaken. High levels of precipitation over a number of years may cause sites that were once open to become more densely vegetated. A specific instance in which the control of native species may be necessary occurs when wire cages are used to protect milk-vetch plants from mammalian herbivory. The exclusion of mammalian herbivores from the areas surrounding milk-vetch plants can result in the thick growth of highly competitive native species, such as *Euthamia occidentalis*, *Oenothera elata* subsp. *hookeri* and *Ambrosia psilostachya* (M. Meyer, pers. comm. 2006). Limiting competition by native species in this situation may be required and has been undertaken at MSB planting sites. As evidenced by the current situation at the MSB-5 planting site, control of woody native species may be necessary in order for *A. pycnostachyus* var. *lanosissimus* plantings to succeed.

Most sites where *A. pycnostachyus* var. *lanosissimus* is growing occur in areas with entrenched populations of exotic weeds (especially *C. edulis*). Thick growth of *C. edulis* is believed to harbor populations of snails, which are thought to cause much of the damage attributed to herbivory (Wilken and Wardlaw 2001). Experimental planting sites that contain a dense growth of grasses (e.g. MSB-2 and some CSMR sites) have generally failed, at least partially, due to competition, especially from exotic species.

Control of vegetation at Ventura marsh milk vetch planting sites needs to be undertaken when they become invaded by exotic species, such as *C. edulis*, *Ricinus communis* and *Conium*

maculatum. Weed control is currently in use at several *A. pycnostachyus* var. *lanosissimus* planting sites, including the CSMR-5 planting site (M. Meyer, pers. comm. 2006). In addition, Soza et al. (2003) observed the growth of, and removed by hand, exotic annual species that became established in planting sites during the first season following planting. Management of exotic species competing with milk-vetch plants would be most effective if exotic species growing in areas surrounding planting sites were controlled.

Monitoring:

Monitoring of *A. pycnostachyus* var. *lanosissimus* plantings is essential to evaluate success and to decide when management activities are required. It is difficult to determine the number of years to monitor a site following planting; however, the experience with plantings of *Holocarpha macradenia* in the Santa Cruz Mountains, in which plants persisted for a number of years and then failed, seems to suggest that an indefinite period of monitoring may be required (Allen 1994). Others have reported that monitoring periods between 5 and 15 years may be adequate for some species, while decades may be required for others (Parsons and Zedler 1997, Sutter 1996). Pavlik (1996) suggests developing a set of criteria based on observations of natural populations of targeted species by which the success of reintroductions can be measured. Considering the condition of the single “natural” population of *A. pycnostachyus* var. *lanosissimus* developing such goals seems extremely difficult and is probably not feasible. At a minimum, planting sites of *A. pycnostachyus* var. *lanosissimus* should be monitored for the success of original plantings, the appearance and abundance of natural recruitment, the condition of the surrounding plant community and, ideally, the genetic variability within the new population (Sutter 1996).

The emphasis at any planting of *A. pycnostachyus* var. *lanosissimus* should be regular monitoring during the growing season. Judging from the fact that issues requiring management can develop very rapidly (Wilken and Wardlaw 2001), plantings of *A. pycnostachyus* var. *lanosissimus* should be monitored weekly during the growing season (roughly March through October). Management activities crucial to the survival of plants at (re-)introduction sites should be undertaken shortly after problems arise in order to minimize damage. Of particular importance is ensuring the survival of naturally recruited seedlings, since transplants cannot be expected to survive for more than four to five years. Individuals in charge of planting *A.*

pycnostachyus var. *lanosissimus* should ensure that monitoring and maintenance can be supplied for an indefinite period of time. Sutter (1996) emphasizes that the monitoring and management activities required by reintroduced plants should not be seen as failures. Many habitats, including that of *A. pycnostachyus* var. *lanosissimus*, exist in degraded states and the processes required by critically-imperiled species may simply no longer be intact. Persistent monitoring and management at future plantings of *A. pycnostachyus* var. *lanosissimus* will likely be major factors that separate successful establishment of new populations from failed planting attempts.

IX. Conclusion

Past experiences at experimental sites and observations of plants growing at the North Shore Site (NSS) indicate that *Astragalus pycnostachyus* var. *lanosissimus* requires a type of habitat that exist at a limited number locations in Southern California. *A. pycnostachyus* var. *lanosissimus* prefers areas that are influenced by fresh or brackish water of habitat where wetland vegetation transitions to upland vegetation. *A. pycnostachyus* var. *lanosissimus* prefers sites with relatively open vegetation architecture that is dominated by a mixture of native species characteristic of wetland and upland habitats. The short-lived nature of *A. pycnostachyus* var. *lanosissimus* makes it important to select sites where conditions (e.g. the presence of a shallow water table) ensure the survival of naturally recruited seedlings. Undesirable habitat elements at potential planting sites include areas of dense vegetation, and sites dominated by exotic species (e.g. grasses and iceplant). Sites where there is the possibility of frequent inundation by high tides and areas with high soil salinity are also undesirable. Based on these criteria there are a number of sites within and slightly beyond the historical range of *A. pycnostachyus* var. *lanosissimus* where future planting efforts are likely to be successful. These sites include the South Carpinteria Salt Marsh (SCSM) in Santa Barbara County, McGrath State Beach (MSB) in Ventura County and Bolsa Chica Ecological Reserve (BCER) in Orange County. Additionally, several large wetland areas in Southern California that are in the process of being restored may host ideal habitat for *A. pycnostachyus* var. *lanosissimus* in the future.

Future plantings of *A. pycnostachyus* var. *lanosissimus* will probably be unsuccessful without a significant commitment to management and monitoring. The two main factors that are likely to limit the success of future planting efforts are herbivory and competition from associated vegetation. Future plantings of *A. pycnostachyus* var. *lanosissimus* must be monitored indefinitely so that management activities can be undertaken when issues arise. Based on past experience, no plantings of this species can be expected to survive without significant monitoring and management (ideally on a weekly basis during the growing season).

Due to impending development activities surrounding the NSS site, the existence of *A. pycnostachyus* var. *lanosissimus* in the wild is threatened. This makes the establishment of numerous plantings within the historical range of *A. pycnostachyus* var. *lanosissimus* extremely important. Efforts should be made to ensure that future plantings are as self-sustaining as possible. The ultimate goal should be to establish numerous populations of *A. pycnostachyus*

var. *lanosissimus* within or slightly beyond its historical range that are self-sustaining and require minimal management. The findings and suggestions presented in this report are designed to help in making the goal of sustainable *A. pycnostachyus* var. *lanosissimus* populations a reality.

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Appendix A: Tables

Table 1: Comparison of the Two Varieties of *Astragalus pycnostachyus*

	<i>Astragalus pycnostachyus</i> var. <i>pycnostachyus</i> , northern marsh milk-vetch	<i>Astragalus pycnostachyus</i> var. <i>lanosissimus</i> , Ventura marsh milk-vetch
Peduncle Length	(3) 4-10 cm	2-4 cm
Calyx Tube Length	3.5-5 mm	3-4 mm
Calyx Tooth Shape	subulate and long	broad and shorter
Calyx Tooth Length	1.7-3 mm	1.2-1.5 mm
Fruit (pod) Length	6-9 (10) mm	8-11 mm
Number of Ovules	(2) 3-5	8-12
Sources: Barneby 1964, Hickman 1993		

**Table 2: Historical and Current Populations Natural Populations of
A. pycnostachyus var. *lanosissimus***

Location (Probable)	Element Occurrence # in CNDDDB	Last Date Seen at Location	# of Collections	Status
Ventura County				
City of Ventura	6	1911	1	Possibly Extirpated
Silver Strand Beach, near Hueneme	8	1927	1	Possibly Extirpated ("presumed extant" in CNDDDB)
Near McGrath State Beach	2	1967	1	Extirpated
City of Oxnard, North Shore Site	7	2006	1	Extant
Los Angeles County				
Santa Monica	3	1900	3	Extirpated
Ballona Wetlands	4	1902	9	Extirpated
Orange County				
Bolsa Chica Salt Marsh	1	1882	2	Possibly Extirpated
Sources: Consortium of California Herbaria 2006, CNDDDB 2006				

Table 3: Locations of Existing *A. pycnostachyus* var. *lanosissimus* Planting Sites

Experimental Planting Site Name	Abbreviation	UTME	UTMN
Coal Oil Point Reserve Lagoon	COPR Lagoon	#####	#####
Coal Oil Point Reserve Pond	COPR Pond	#####	#####
Carpenteria Salt marsh Reserve 5	CSMR-5	#####	#####
McGrath State Beach 3	MSB-3	#####	#####
McGrath State Beach 4	MSB-4	#####	#####
McGrath State Beach 5	MSB-5	#####	#####
Mandalay State Beach 1B	Mandalay-1B	#####	#####
Mandalay State Beach 1	Mandalay-1	#####	#####

NOTE: UTM (GPS) Locations removed due to the sensitivity of these locations. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

Table 4: Status Summary of Experimental Plantings

Site Name	Abbreviation	Date Planted	Number Planted	Current Status of Site
Carpinteria Salt Marsh Reserve 1	CSMR-1	April 2002	31	No plants observed as of August 2003
Carpinteria Salt Marsh Reserve 2	CSMR-2	April 2002	31	No plants observed as of August 2004
Carpinteria Salt Marsh Reserve 3	CSMR-3	April 2002	31	No plants observed as of August 2003
Carpinteria Salt Marsh Reserve 4	CSMR-4	April 2002	31	No plants observed as of August 2004
Carpinteria Salt Marsh Reserve 5 Supplemental plantings W and E of CSMR 5	CSMR-5	April 2002 April 2004	31 40	Adults, juveniles and seedlings present as of October 2006 with natural recruitment occurring
McGrath State Beach 1	MSB-1	April 2002	33	No plants observed as of August 2004
Mcgrath State Beach 2	MSB-2	April 2002	33	No plants observed as of August 2004
McGrath State Beach 3	MSB-3	April 2002	34	Adults, juveniles and seedlings present as of October 2006 with natural recruitment occurring
McGrath State Beach 4	MSB-4	April 2002	33	Adults, juveniles and seedlings present as of October 2006 with natural recruitment occurring
McGrath State Beach 5	MSB-5	April 2002	34	Adults and some younger plants present but site is in a state of decline as of October 2006
Mandalay State Beach 1	Mandalay-1	February 2003	20	One adult present as of October 2006, little natural recruitment
Mandalay State Beach 1A (supplemental)	Mandalay-1A	April 2004	10	Same as location Mandalay-1
Mandalay State Beach 1B (supplemental)	Mandalay-1B	April 2004	15	Adults and juveniles present as of October 2006, low seedling survival
Mandalay State Beach 1C (supplemental)	Mandalay-1C	April 2004	10	No plants observed as of Summer 2005
Mandalay State Beach 2	Mandalay-2	February 2003	19	No plants observed as of the end of Summer 2005
Mandalay State Beach 3	Mandalay-3	February 2003	15	No plants observed as of the end of Summer 2005
Coal Oil Point Reserve Pond Original	COPR Pond- Original	January 2003	8	None of these original plants observed as of October 2006
Coal Oil Point Reserve Pond A	COPR Pond-A	May 2004	10	Three juveniles present as of October 2006
Coal Oil Point Reserve Pond B	COPR Pond-B	May 2004	5	One adult present in the vicinity as of October 2006
Coal Oil Point Reserve Pond C	COPR Pond-C	May 2004	8	No plants observed as of Summer 2005
Coal Oil Point Reserve Pond D	COPR Pond-D	May 2004	17	No plants observed as of Summer 2005
Coal Oil Point Reserve Lagoon COPR Lagoon Supplemental Planting	COPR Lagoon	January 2003 April 2004	5 54	Adults, juveniles and seedlings present as of October 2006
Coal Oil Point Reserve Jaumea	COPR Jaumea	April 2004	6	No plants observed as of Summer 2005
Ormond Beach	Ormond	March 2004	40	No plants observed as of Summer 2005

Sources: Personal Observations 2006, Meyer 2006a, Meyer 2006b, Meyer 2006c, Meyer 2006d, Meyer 2003, Meyer 2005, Soza et. al. 2003

Table 5: Soil Salinity and Moisture Measured at CSMR and MSB Planting Sites

Site	Abbreviation	Salinity (mmhos/cm)	Moisture (percent)
Carpinteria Salt Marsh Reserve 1	CSMR-1	38.6	15.3
Carpinteria Salt Marsh Reserve 2	CSMR-2	27.3	25.3
Carpinteria Salt Marsh Reserve 3	CSMR-3	111	24.2
Carpinteria Salt Marsh Reserve 4	CSMR-4	20.4	15.7
Carpinteria Salt Marsh Reserve 5	CSMR-5	6.5	8.3
McGrath State Beach 1	MSB-1	0.43	5.8
McGrath State Beach 2	MSB-2	0.82	7.6
McGrath State Beach 3	MSB-3	3.22	16.6
McGrath State Beach 4	MSB-4	3.22	5.3
McGrath State Beach 5	MSB-5	0.91	1
Source: Soza et al. 2003			

Table 6: Contact Information for Sites Visited

NOTE: Table removed to protect the privacy of these individuals. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

Appendix B: Maps

NOTE: Map 1 removed due to the sensitivity of these locations. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

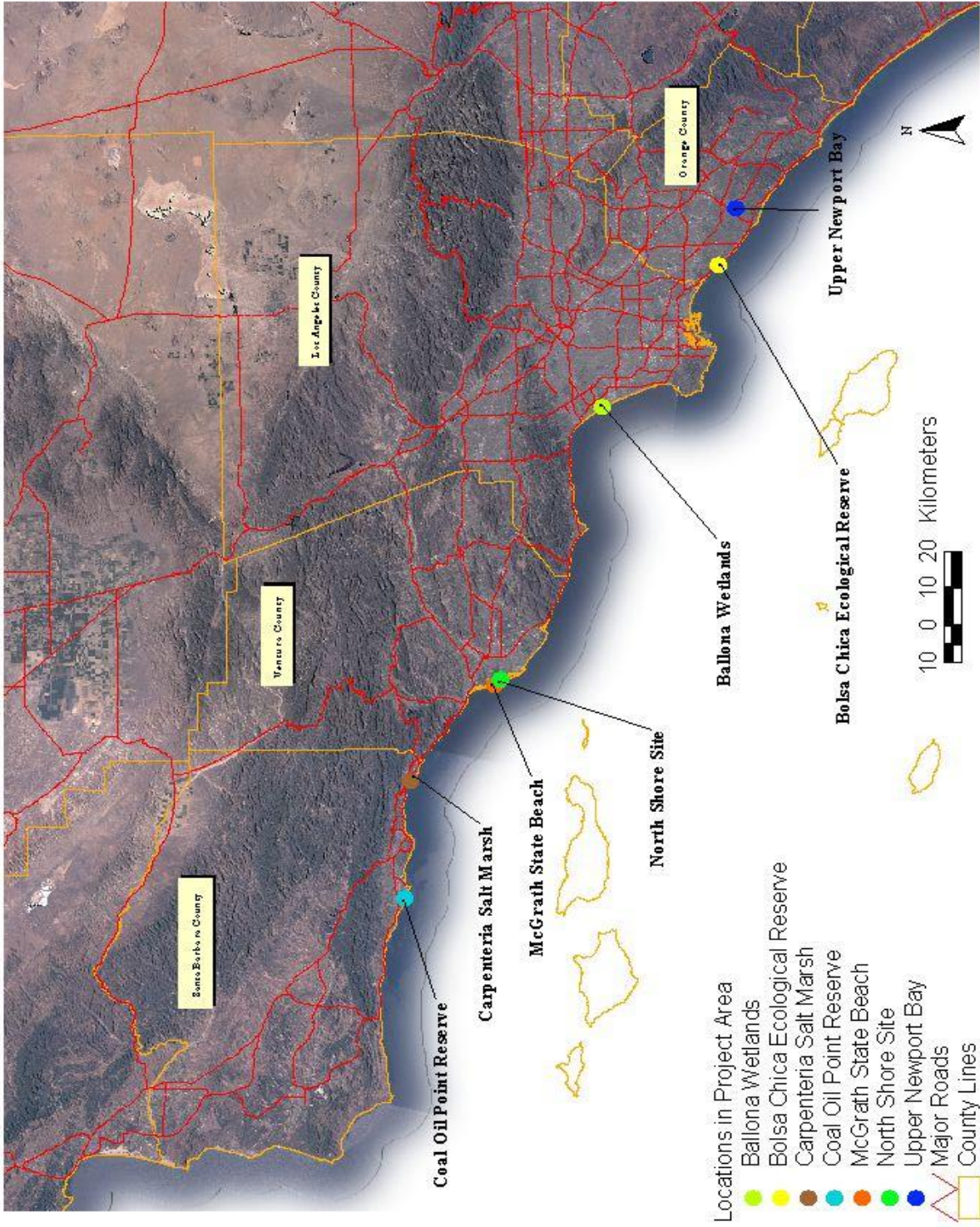
NOTE: Map 2 removed due to the sensitivity of these locations. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

NOTE: Map 3 removed due to the sensitivity of these locations. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

NOTE: Map 4 removed due to the sensitivity of these locations. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

NOTE: Map 5 removed due to the sensitivity of these locations. For more information please contact Nick Jensen (njensen@cnps.org, (916) 324-5143).

Map 6: Selected Locations in the Ventura Marsh Milkvetch Project Area



Appendix C: Figures



Figure 1: Flowers of *A. pycnostachyus* var. *lanosissimus*



Figure 2: *A. pycnostachyus* var. *lanosissimus* fruits



Figure 3: Overview of milk-vetch plants at CSMR-5



Figure 4: Juvenile milk-vetch plant



Figure 5: Habitat at CSMR-5 (milk-vetch plants are depicted by the arrow)



Figure 6: *A. pycnostachyus* var. *lanosissimus* plants growing at MSB-3



Figure 7: Habitat at a potential planting site at South Carpinteria Salt Marsh (SCSM)



Figure 8: Habitat at a potential planting site at MSB



Figure 9: Potential planting site at Bolsa Chica Ecological Reserve (iceplant will be removed)



Figure 10: Site where NSS developers will install a planting of *A. pycnostachyus* var. *lanosissimus* at Ballona Wetlands Ecological Reserve