Experimental Introduction of the Ventura Marsh Milkvetch (*Astragalus pycnostachyus* var. *lanosissimus*) at Carpinteria Salt Marsh Reserve and McGrath State Beach

Prepared By:
Valerie Soza, Michael Wall and Dylan Hannon
Rancho Santa Botanic Garden
1500 N. College Avenue
Claremont, CA 91711

Submitted To:
Mary Meyer, Plant Ecologist
South Coast Region
Department of Fish and Game
4949 Viewridge Avenue
San Diego, CA 92123

Funded By:
The United States Fish and Wildlife Service
Section 6 Program
Contract No. P0050012

13 March 2003

TABLE OF CONTENTS

Executive Summary 1

Introduction 1

- Ventura Marsh Milkvetch History and Rediscovery 1
- Experimental Introduction Site Selection 3
- Carpinteria Salt Marsh Reserve General Description 4
- McGrath State Beach General Description 5

Methods 6

- Carpinteria Salt Marsh Reserve Microsite Selection 6
- McGrath State Beach Microsite Selection 9
- Ventura Marsh Milkvetch Propagation 12
- Ventura Marsh Milkvetch Site Preparation 15
- Ventura Marsh Milkvetch Installation 16
- Ventura Marsh Milkvetch Site Maintenance 17
- Ventura Marsh Milkvetch Monitoring 18

Results 19

- Ventura Marsh Milkvetch Observations 19
- Ventura Marsh Milkvetch Monitoring Data 22
- Ventura Marsh Milkvetch Experimental Sites’ Soils Analysis 24

Discussion 24

Further Recommendations 27

Acknowledgements 28

Literature Cited 29

Appendix A

Figure 1. Historic sites, rediscovery site, and experimental sites of the Ventura Marsh milkvetch
Figure 2. Potential recovery site and general experimental introduction area at Carpinteria Salt Marsh Reserve
Figure 3. Five microsites selected at Carpinteria Salt Marsh Reserve
Figure 4. Aerial photo of Carpinteria Salt Marsh Reserve experimental sites
Figure 5. Potential recovery site and general experimental introduction area at McGrath State Beach
Figure 6. Five microsites selected at McGrath State Beach
Figure 7. Aerial photo of McGrath Lake experimental sites
Figure 8. Carpinteria Salt Marsh Reserve site CSMR-3
Figure 9. Carpinteria Salt Marsh Reserve site CSMR-4
Figure 10. Carpinteria Salt Marsh Reserve site CSMR-5
Figure 11. McGrath State Beach site MSB-3
Figure 12. McGrath State Beach site MSB-5

Appendix B

Table 1. Soil analysis of Ventura Marsh milkvetch experimental introduction sites
Table 2. Ventura Marsh milkvetch experimental introduction sites in 2002
Table 3. Summary of Ventura Marsh milkvetch seed propagation results
Table 4A. Summary of Ventura Marsh milkvetch survivorship and reproduction July 2002
Table 4B. Summary of Ventura Marsh milkvetch survivorship and reproduction November 2002
Table 4C. Summary of Ventura Marsh milkvetch survivorship and recruitment February 2003
Table 5A. Summary of vegetative plants at Ventura Marsh milkvetch experimental sites, July 2002
Table 5B. Summary of reproductive plants at Ventura Marsh milkvetch experimental sites, July 2002
Table 5C. Summary of vegetative plants at Ventura Marsh milkvetch experimental sites, February 2003
Table 6A. Ventura Marsh milkvetch estimates of flower and fruit set
Table 6B. Ventura Marsh milkvetch estimates of mature fruit and seed set

EXECUTIVE SUMMARY

The Ventura Marsh milkvetch (*Astragalus pycnostachyus* var. *lanosissimus*) is a federally and state-listed endangered plant that was rediscovered in 1997 on private property in Oxnard referred to as the North Shore site. The Ventura Marsh milkvetch was historically distributed along the coast from Orange to Ventura counties. Two locations were selected, McGrath State Beach in Ventura County and Carpinteria Salt Marsh Reserve in Santa Barbara County, to establish experimental populations of the Ventura Marsh milkvetch in various microhabitats to gain a better understanding of habitat preferences of this species. Five microsites were selected at each locality along various environmental gradients within high marsh areas of the Carpinteria Salt Marsh and along various environmental gradients within the coastal dune system along the east side of McGrath Lake. A total of 155 plants was installed in April 2002 at Carpinteria Salt Marsh Reserve with 44% survivorship in February 2003. A total of 167 plants was installed in April 2002 at McGrath State Beach with 88% survivorship in February 2003. The majority of plants at McGrath State Beach were vigorous and healthy, preferring microsites in coastal dune swales or along freshwater/brackish marsh areas, and adjacent to native scrub comprised of *Euthamia occidentalis, Baccharis pilularis, Salix, Artemisia douglasiana* and *Toxicodendron diversilobum*, with low salinity soil levels. Plants at Carpinteria Salt Marsh Reserve preferred those areas at higher elevations in less saline soils, and adjacent to native shrubs at transition zones out of salt marsh areas. These preferred sites were also associated with *Artemisia douglasiana, Baccharis pilularis, Euthamia occidentalis,* and *Isocoma menziesii.* The major challenges to the Ventura Marsh milkvetch experimental populations were gopher and snail herbivory at Carpinteria Salt Marsh Reserve and aphid and sooty mold infestations at McGrath State Beach.

INTRODUCTION

Ventura Marsh Milkvetch History and Rediscovery

The Ventura Marsh milkvetch (*Astragalus pycnostachyus* var. *lanosissimus*) is a short-lived perennial herb in the legume family (Fabaceae). Adult plants typically reach up to 1 meter in height, producing annual stems each year that flower and fruit over the late spring and summer months (Hickman 1993, Wilken and Wardlaw 2001). The Ventura Marsh milkvetch was historically distributed along the coast of southern California, from Orange County north to Ventura County. In Orange County, only one historic occurrence is documented from the Bolsa Chica Salt Marsh area. In Los Angeles County, several historic occurrences are documented from the Santa Monica and Marina del Rey areas. In Ventura County, several historic occurrences are documented along the Oxnard coast at Silver Strand Beach and at the mouth of the Santa Clara River, as well as in the vicinity of the city of Ventura. Collections of the Ventura Marsh milkvetch were made mostly from the 1880s to early 1900s. More recent surveys during the 1960s and 1980s in historic localities had not revealed any remaining plants, nor sufficient suitable habitat, and all populations were presumed extirpated. The last known existing population of several plants near the mouth of the Santa Clara River, adjacent to McGrath State Beach, was reportedly destroyed in 1967 (CNDDB 2002).

The Ventura Marsh milkvetch was presumed extinct until its rediscovery in 1997. While visiting a proposed 91-acre project development site in Oxnard in June 1997, wildlife biologists Kate Symonds (U. S. Fish and Wildlife Service) and Morgan Wehtje (California Department of Fish and Game) gathered samples of an unusual milkvetch. From these specimens, Tim Thomas (U. S. Fish and Wildlife Service) identified the plant as the Ventura Marsh milkvetch. The Ventura Marsh milkvetch is currently restricted to a single population in a degraded back dune area northeast of the intersection of 5th Street and Harbor Boulevard in Oxnard, on privately-owned land. This site is referred to as the North Shore site and is located just south of the 1967 occurrence adjacent to McGrath State Beach, at approximately 8 meters (25 feet) elevation. The occupied habitat at the North Shore site was used for the disposal of oil waste products from 1955 to 1981. An aerial photograph of the site taken in 1985 shows no vegetation growing there at the time. Therefore, it is believed that the Ventura Marsh milkvetch population came in via seed with imported fill used to cap the oil disposal area, and may have come from elsewhere on the site or somewhere in the vicinity of Oxnard or Ventura (CDPR and CDFG 2001). The population is confined to an area of approximately 280 m^2 (3,000 ft^2). In 1997, the total number of plants observed was 374 with 62 reproductive individuals and 260 young seedlings. In 1998, 95 of the 192 plants were reproductive (CDFG files). In 1999, only 35 reproductive individuals were observed. In July 2000, the total number of adult plants was 39 with 22 reproductive individuals and 74 seedlings (CDPR and CDFG 2001, Wilken and Wardlaw 2001).

Habitat requirements for the Ventura Marsh milkvetch are poorly understood. Habitat information on herbarium labels is sparse but suggests an association with coastal salt marshes, meadows near seashores, and cienegas. Coastal dune systems and salt marsh habitats in southern California have been largely eliminated due to agricultural, urban, military, and industrial development (CDPR and CDFG 2001). Habitat for this species is currently reported in the California Natural Diversity Database as coastal salt marsh within reach of high tide or protected by barrier beaches, more rarely near seeps on sandy bluffs, from 1-35 meters (3-115 feet) elevation, and is largely based on habitat descriptions for its northern counterpart, northern marsh milkvetch (*A. pycnostachyus* var. *pycnostachyus*), of coastal estuarine system association or coastal bluff scrub communities (CNDDB 2002, Wilken and Wardlaw 2001).

The California Department of Fish and Game (CDFG) listed the Ventura Marsh milkvetch as an endangered species in 1999, and it was federally-listed by the U. S. Fish and Wildlife Service (USFWS) as endangered in 2001. The CDFG has developed a conservation strategy for the Ventura Marsh milkvetch to preserve and manage the existing occurrence and establish self-perpetuating populations at protected sites both within and outside its historic range (Meyer 2001). Working with Rancho Santa Ana Botanic Garden (RSABG), Santa Barbara Botanic Garden (SBBG), and the USFWS, in consultation with the California Native Plant Society (CNPS), the CDFG has implemented its strategy for the Ventura Marsh milkvetch by establishing off-site seed banks, investigating propagation protocols, investigating habitat requirements and biology of plants at the North Shore site, and initiating experimental introductions into coastal areas of Ventura and Santa Barbara counties within vicinity of its northern historical distribution. Dieter Wilken and Tricia Wardlaw of SBBG (2001) conducted an examination of ecological and life history characteristics of the Ventura Marsh milkvetch at the North Shore site, and compared habitat characteristics at the current site, historic sites, at occupied sites of the northern marsh milkvetch, and at potential introduction sites. In May 2001, CDFG awarded a contract to RSABG to establish experimental populations at two selected introduction sites in Ventura and Santa Barbara counties, and work was initiated in September 2001. Experimental populations were established in various microsites at each location to gain a better understanding of habitat preferences of the Ventura Marsh milkvetch. Once experimental populations are deemed successful, the methods and recommendations from this project will then be applied to establish additional protected populations in the southern part of the Ventura Marsh milkvetch's historic range.

Experimental Introduction Site Selection

Habitat and population characteristics of the existing Ventura Marsh milkvetch at the North Shore site and habitats of the northern marsh milkvetch along the northern California coast in San Mateo and Marin counties were examined by Wilken and Wardlaw to identify characteristics to guide selection of potential introduction sites. Five potential introduction sites for the Ventura Marsh milkvetch had been recommended by Diane Ikeda and Mary Meyer (CDFG) in 2000 and were examined by Wilken and Wardlaw for habitat suitability: Emma Wood State Beach, McGrath State Beach, Mandalay State Beach and Naval Base Ventura County (Point Mugu Naval Air Station), Ventura County, and University of California Carpinteria Salt Marsh Reserve, Santa Barbara County. Soil samples were taken from various depths at the North Shore site, from 6 different sites of the northern marsh milkvetch, and from the 5 potential recovery sites and analyzed for texture, pH, CEC, salinity, saturation, primary nutrients, secondary nutrients, and micronutrients (Wilken and Wardlaw 2001).

At the North Shore site, plants are growing on relatively level terrain, in silty loam soil, on an old oil sludge landfill. Dominant shrubs are *Baccharis pilularis* and *Baccharis salicifolia* with scattered *Rhus ovata*, an understory vegetation of primarily *Carpobrotus* with scattered *Lotus scoparius* and late spring annuals, and pockets of bare ground. Also nearby are stands of *Myoporum laetum* and *Salix lasiolepis,* native coastal dune vegetation of *Ambrosia chamissonis*, *Camissonia cheiranthifolia* and *Lotus scoparius*, and patches of *Ammophila arenaria*, *Bromus rubens*, *Centaurea*, *Cortaderia*, and *Polypogon monspeliensis.* The total vegetative cover has been estimated at 90% and bare ground cover at 40% within occupied sites (CNDDB 2002, Wilken and Wardlaw 2001).

Based on site characteristics of the North Shore site, suitable areas for introduction were determined as coastal shrublands with vegetation in one canopy, composed of native vegetation with 50-75% shrub cover and a low herbaceous cover of scattered native annuals or perennials. Additionally, the site should be in close proximity to fresh or brackish water, as evidenced by a stream channel or presence of either *Baccharis salicifolia* or *Salix*, and with the nearby presence of primarily palustrine taxa such as *Typha* and *Scirpus*. Soils from the North Shore site are fine-grained soils composed primarily of sand with some clay and silt, which enhances both saturation and percolation. Soils at potential introduction sites should be relatively compact, stable, well-drained, and sandy. In addition, potential introduction areas should be bordered by relatively broad stands of native vegetation with high species and life form diversity for supporting potential pollinator populations. Seedlings of the Ventura Marsh milkvetch have been observed germinating at the North Shore site in areas of minor depressions with higher amounts of organic debris and duff, away from established plants; or in flat areas with organic debris and duff, partly shaded by adjacent shrubs like *Baccharis pilularis* and *B. salicifolia*. Therefore, potential habitat should include open sites among shrubs, which provide shade and shelter during the dry, warm months, but which do not compete substantially for light, water, and nutrients. Plants at the North Shore site were absent from open, unvegetated microsites and from dense stands of *Carpobrotus* and *Salix.* Potential introduction sites should be free from competitive annuals or low-growing perennials (Wilken and Wardlaw 2001).

Four of the five previously recommended sites were identified as containing suitable areas for introduction: McGrath State Beach, Carpinteria Salt Marsh Reserve, Naval Base Ventura County, and Mandalay State Beach, in order of highest to lowest potential (Wilken and Wardlaw 2001). The two final sites were selected by Meyer (CDFG) for the establishment of experimental populations of the Ventura Marsh milkvetch: McGrath State Beach and Carpinteria Salt Marsh Reserve (Appendix A, Fig. 1). Permission to establish experimental populations at McGrath State Beach and Carpinteria Salt Marsh Reserve was obtained by Meyer through application to State Parks and the UC Reserve System and finalized in September 2001.

Carpinteria Salt Marsh Reserve General Description

Carpinteria Salt Marsh Reserve is administered by the University of California Natural Reserve System through UC Santa Barbara (UCSB). Access to the reserve is limited and the entire area is fenced off from public access. The Reserve covers approximately 120 acres and is part of the Carpinteria Salt Marsh (El Estero), which covers over 230 acres, located in Carpinteria Valley between the cities of Santa Barbara and Carpinteria, bordered on the south by the Pacific Ocean and on the north by the Santa Ynez Mountains in Santa Barbara County. Elevations range from approximately 2-8 meters (5-25 feet). Carpinteria Salt Marsh is situated in the northwest portion of the southern California Mediterranean climatic region, influenced by coastal winds and morning fog, with mild air temperatures and variable, largely winter rainfall (Ferren 1985). Based upon weather station data for Santa Barbara over a 74-year period from the Western Regional Climate Center (WRCC), the average maximum temperature for the month of August is 26°C (78°F), average minimum temperature for the month of January is 6°C (42°F), and average annual precipitation is 44.58 cm (17.55 in.) (WRCC website 2001).

The Carpinteria Salt Marsh Reserve is an example of a regionally large estuary occurring in a geologic structural basin that has developed as a result of faulting and folding of sedimentary rocks. Estuaries are deepwater habitats and/or wetlands that are transitional between aquatic habitats of terrestrial environments and marine habitats of oceans. Sedimentation into the basin over time from streams from the south slopes of the Santa Ynez Mountains has resulted in the formation of an alluvial fan and deltaic complex that underlies the marsh, with remnants of alluvial fan deposits present in the northeast portion of the reserve. However, the reserve is influenced more frequently by marine water than freshwater runoff and is saline to hypersaline, and has undergone periods of closure caused by the development of sand bars/spits across its mouth. Mud flats apparently remain saline or slightly hypersaline throughout the year and irregularly flooded upper marsh wetlands are characteristically hypersaline from late spring to fall. Soils are characterized as fine sandy loam on low flood plains and tidal flats, periodically flooded by tidal water; and stratified with thin layers of water-logged, saline, mineral soil and peat. The marsh consists of small series of tidal channels and emergent wetlands that occur at the mouths of Franklin and Santa Monica Creeks. The vegetation consists of areas of disturbed coastal upland habitats; unvegetated salt flats, low marsh, middle marsh, and high marsh wetlands and scrub/shrub wetlands of estuarine (intertidal) systems; and aquatic beds and emergent wetlands, scrub/shrub wetlands, and forested wetlands of palustrine (nontidal) systems (Callaway et al. 1990, Ferren 1985, Ferren et al. 1990).

McGrath State Beach General Description

McGrath State Beach is administered by the California Department of Parks and Recreation (CDPR) South Coast Region and open to public access. McGrath State Beach is situated in the general physiographic region of the Ventura Basin, which is 90 miles long and includes Santa Barbara Channel between the Channel Islands and Transverse Ranges and extends inland to Soledad Basin near the San Gabriel Fault (Ferren et al. 1990). The park covers approximately 430 acres from the mouth of the Santa Clara River to the southern edge of McGrath Lake, located in the city of Oxnard in Ventura County, bounded by Harbor Boulevard to the east and the Pacific Ocean to the west. McGrath Lake is an example of a dune pond, a lake occupying a basin formed as a result of the blocking of the mouth of a stream by sand dunes migrating along the shore (Ferren et al. 1996b,c). Elevations range from 0-6 meters (0-20 feet). The Ventura County coast is characterized by a Mediterranean climate with mild, moist winters and moderately warm, generally rainless summers, influenced by coastal morning fog and winds. Based upon weather station data for Oxnard over a 53-year period from the WRCC, the average maximum temperature for the month of August is 24°C (75°F), average minimum temperature for the month of January is 7°C (44°F), and average annual precipitation is 37.64 cm (14.82 in.) (WRCC website 2001).

The vegetation consists of areas of primarily emergent wetlands and scrub/shrub wetlands of palustrine systems with remnant patches of estuarine persistent emergent wetlands, as well as ruderal and/or introduced vegetation in artificially disturbed areas. The major plant communities within the park are riparian woodland and a small remnant of coastal salt marsh at the northern edge of the park along the southern edge of the Santa Clara estuary, southern coastal foredunes (coastal strand) along the western edge of the park, and freshwater marsh at the southern edge of the park along McGrath Lake, with a small remnant of coastal sage scrub in the eastern center of the park (Muns 1998).

Dune swale wetlands are the dominant habitat at McGrath State Beach and are topographically low areas that occur between the crests of coastal dunes. When the dune system is large enough to serve as an aquifer and support a body of fresh water, the dune swales often contain wetland habitat if the bottom of the swale intersects the water table. Dune swale wetlands are generally characterized by saline, clay soils and are seasonally saturated or flooded only by water from rain. In southern California, extensive urbanization of the coast has virtually eliminated this habitat, but areas of this type of habitat remain in portions of the Oxnard Plain within or adjacent to McGrath State Beach (Ferren et al. 1990, Ferren et al. 1996c, Gray and Bramlet 1992). In addition, coastal freshwater marsh occurs at the southern end of the park along McGrath Lake. This habitat is generally dominated by perennial, emergent monocots 4-5 m tall, often forming completely closed canopies, in seasonally or permanently flooded fresh water, low-lying areas with prolonged saturation permitting accumulation of deep, peaty soils, around margins of lakes and springs along the coast and in coastal valleys near river mouths (Ferren et al. 1990, Gray and Bramlet 1992, Holland 1986).

METHODS

One of the objectives for the establishment of experimental populations of Ventura Marsh milkvetch was to introduce populations along environmental gradients and/or in microhabitats in order to gain a better understanding of habitat preferences and tolerances for this species. At each selected site, five microsites were identified and planted within the general areas determined suitable for introduction of the Ventura Marsh milkvetch. At each site, groups of plants were planted in clusters along environmental gradients in order to compare and assess various microsites with respect to survivorship of outplanted individuals and seedling recruitment. The two recovery sites selected for the project, Carpinteria Salt Marsh Reserve (Carpinteria) and McGrath State Beach (McGrath), were visited in October 2001 by Dylan Hannon, Valerie Soza and Michael Wall (RSABG), and Mary Meyer (CDFG). Suitable areas at Carpinteria and McGrath had been identified previously by Wilken and Wardlaw (2001). In addition, Wayne Ferren, former reserve manager at Carpinteria, gave valuable suggestions for potential microsites at Carpinteria during the initial site visit for this project. For McGrath State Beach, Barbara Fosbrink (CDPR) and David Magney (CNPS) assisted in microsite selection during the planning stages of the project.

Carpinteria Salt Marsh Reserve Microsite Selection

At Carpinteria, the most suitable habitat had been previously identified at the northeastern edge of the marsh, south of the railroad tracks, and west of Santa Monica Creek, adjacent to the creek (Fig. 2). This area was comprised of mostly native vegetation with a mix of groundcover and shrub canopies, with soils comparable to

McGrath and North Shore sites, and bounded by a large expanse of salt marsh and estuarine vegetation that could support a diversity of native pollinators (Wilken and Wardlaw 2001). Approximate elevations in this area range from 6-8 meters (20-25 feet). The general habitat area lies within the transitional zone from upper delta scrub to estuarine vegetation and low salt marsh dominated by *Salicornia*, with soils comprised of silty loam overlying clay. A variety of microhabitats occur in this area, varying in levels of salinity, moisture and species composition. Upper marsh soils are typically euryhaline with seasonally fluctuating salinities, leading to a decrease in perennial cover and an increase in annual cover due to high summer salinities and low winter soil salinities due to precipitation. Grassland zones are present within the reserve and are dominated by introduced European annual grasses, such as *Bromus diandrus, B. hordeaceus,* and *Lolium multiflorum,* and often associated with the native shrub *Isocoma menziesii vernonioides*. Low marsh zones are typically dominated by *Salicornia virginica,* due to constant high levels of salinity and frequent flooding. Transition zones are dominated by *Salicornia subterminalis*, *Spergularia*, *Parapholis incurva*, and *Lasthenia glabrata coulteri,* with seasonal fluctuation of salinities and infrequent flooding during the dry season (Callaway et al. 1990). Areas at Carpinteria with deeper soils and dense stands of *Salicornia, Distichlis*, and *Bromus* were not recommended for potential introduction areas (Wilken and Wardlaw 2001). Three microhabitats were identified by Ferren within high marsh areas of estuarine intertidal emergent persistent wetlands as having a strong potential for introduction of the Ventura Marsh milkvetch: 1) small depressions amongst the *Salicornia subterminalis,* often associated with *Polypogon monspeliensis,* sparsely vegetated with low competition from other plant species, seasonally flooded, and with more clay soils; 2) slightly higher marsh areas with little flooding and low salinity, associated with dense stands of *Lolium multiflorum* amongst the *Salicornia subterminalis,* an area of potentially higher competition; and 3) edges of *Lolium multiflorum* areas, where winter annuals such as *Lasthenia glabrata coulteri* and *Parapholis incurva* co-occur, with more saline soils and less competition from *Lolium*.

Soils from nine sites at Carpinteria were sampled on October 30, 2001, before the first onset of fall rains in order to assess soil conditions after the most extreme dry season at the end of summer. Four sites identified as potential *Polypogon*-associated depressions were sampled. Two sites identified as potential *Lolium/Lasthenia* zones were sampled. One site within a dense stand of *Lolium* was sampled, and another site of dense *Lolium* at its northern boundary at the edge of delta scrub was sampled. Finally, one sample was taken within the delta scrub area at the northern part of the reserve, considered nonsaline, for comparison with the other Carpinteria sites.

Soil samples were taken from approximately the upper 15-30 cm of soil and analyzed at Fruit Growers Laboratory, Inc. in Santa Paula on November 19, 2001. Soils were analyzed for cation exchange capacity, pH, salinity, moisture, saturation, primary nutrients (nitrogen, phosphorus, and potassium), secondary nutrients (calcium, magnesium, sodium, and sulfate) and micronutrients (zinc, manganese, iron, copper, boron, and chloride) (Appendix B, Table 1). Previously, soils were sampled and analyzed from five sites at the existing North Shore population from the upper 15-30 cm of the soil mantle and taken from among Ventura Marsh milkvetch plants (Wilken and

Wardlaw 2001). Results from the North Shore samples are presented in the appendix, with a mean of 16.6 meq/100g for cation exchange capacity, 7.6 pH, 2.3 mmhos/cm salinity, 23.5% saturation, 1.0 ppm nitrogen, 6.4 ppm phosphorus, 0.9 meq/L soluble potassium, 16.8 meq/L soluble calcium, 3.2 meq/L soluble magnesium, 3.8 meq/L soluble sodium, 13.5 meq/L sulfate, 5.9 meq/L chloride and 16.6 meq/100g cation exchange capacity (Table 1). Within sites sampled at Carpinteria, attention was focused on levels of salinity and moisture. Those sites with extremely high levels of salinity (> 111 mmhos/cm) or low levels of moisture (< 8.3 %) were eliminated. Five sites suitable for capturing the various microenvironments within the salt marsh were identified: CSMR-1-5 (Sites 1-5) (Figs. 3-4). After selection of sites, the five sites were mapped on vegetation maps of Carpinteria Salt Marsh in order to classify the vegetation within each site. In addition, total vegetative cover and shrub cover was visually estimated within each microsite during each monitoring effort in April, July, and November 2002 and February 2003 after installation of Ventura Marsh milkvetch plants.

The first site (CSMR-1) is furthest west and was selected in a *Polypogon*-associated depression with a soil salinity level of 38.6 mmhos/cm and moisture level of 15.3%. Soil appeared to be a moist sandy loam at the time of sampling. Based on vegetation maps of Carpinteria Salt Marsh, CSMR-1 is located in high marsh of vegetated, irregularly flooded, estuarine intertidal emergent persistent wetland. At higher elevations, irregularly flooded estuarine emergent wetlands are typically characterized by species that occur in areas of less frequent flooding with more plant diversity (Ferren 1985). Although mapped as wetland, this area appears to lie in a transitional zone from wetland to introduced grassland. The dominant cover within the site is grasses (80%), mostly *Polypogon monspeliensis* and *Lolium multiflorum*, and surrounded by abundant stands of *Ambrosia psilostachya, Limonium californicum, Rumex crispus,* and *Salicornia subterminalis.* Other associates include *Aster subulatus, Atriplex californica, Bromus diandrus, B. hordeaceus, Distichlis spicata, Frankenia salina, Isocoma menziesii vernonioides*, *Malva cf. parviflora, Melilotus indica, Parapholis incurva, Raphanus sativa,* and *Sonchus oleraceus.* Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 85% with a shrub (*Isocoma*) cover of 45% (Table 2).

The second site (CSMR-2) is located just east of CSMR-1, also in a *Polypogon*-associated depression, with a soil salinity level of 27.3 mmhos/cm. Soil had a high soil moisture content (25.3%) at the time of sampling. Based on vegetation maps of Carpinteria Salt Marsh, CSMR-2 is located in high marsh of vegetated, irregularly flooded, estuarine intertidal emergent persistent wetland (Ferren 1985). Although mapped as wetland, this site appears to be in a transitional zone from estuarine wetland to grassland. The dominant cover within the site is grasses (80%), mostly *Polypogon monspeliensis, Bromus diandrus, B. hordeaceus* and *Distichlis spicata,* followed by *Ambrosia psilostachya* (20%), bordered by dense stands of *Salicornia subterminalis* to the southwest and *Euthamia occidentalis* to the southeast. Other associates include *Aster subulatus, Atriplex californica, Chenopodium, Frankenia salina, Heliotropium curassavicum, Limonium californicum, Malva, Melilotus indica, Raphanus sativa, Rumex crispus, Salicornia virginica* and *Sonchus oleraceus*. Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 90% with no shrub cover (Table 2).

The third site (CSMR-3) is located just south of CSMR-2, also in a *Polypogon*-associated depression, with an extremely high level of soil salinity (111 mmhos/cm) and high level of moisture (24.2 %). Soil appeared comprised of clay and relatively dry at the time of sampling. Based on vegetation maps of Carpinteria Salt Marsh, CSMR-3 is located in high marsh of vegetated, irregularly flooded, estuarine intertidal emergent persistent wetland. The dominant cover within the site is *Salicornia subterminalis* (45%) and grasses (35%), mostly *Parapholis incurva* and *Polypogon monspeliensis* with scattered *Lolium multiforum.* Other associates include *Lasthenia glabrata coulteri* and *Limonium californicum*. Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 80% with no shrub cover (Table 2).

The fourth site (CSMR-4) is located east of CSMR-3 and was selected within a dense *Lolium multiflorum* zone of lower salinity (20.4 mmhos/cm) and moderate level of moisture (15.7%). Soil was comprised of loose, sandy, relatively dry loam at the time of sampling . Based on vegetation maps of Carpinteria Salt Marsh, CSMR-4 is situated in high marsh of vegetated, irregularly flooded, estuarine intertidal emergent persistent wetland characterized by *Salicornia subterminalis, Avena, Bromus, Frankenia, Lolium,* and *Salicornia virginica.* This area lies in a grassland transition zone from salt flat at lower elevations to coastal scrub and disturbed coastal habitat at higher elevations. Grassland areas typically consist of cismontane introduced grasses on alluvial fans of Santa Monica Creek, such as *Avena fatua, Bromus hordeaceus,* and *Lolium multiflorum,* as well as *Conium maculatum, Euthamia occidentalis, Heliotropium curassavicum,* and *Isocoma menziesii vernonioides* (Ferren 1985). The dominant cover within the site is *Lolium multiflorum* (90%). Other associates include *Atriplex cf. lentiformis, Bromus diandrus, Melilotus indica, Salicornia subterminalis* and *Sonchus oleraceus.* Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 100% with no shrub cover (Table 2).

In attempting to establish populations along environmental gradients, the fifth site (CSMR-5) was selected within the delta scrub community, with a relatively low level of moisture (8.3 %) and at the low end of salinity for Carpinteria (6.15 mmhos/cm), and is the furthest north and east. Soil was considered to be nonsaline, comprised of dry sandy loam at the time of sampling. Based on vegetation maps of Carpinteria Salt Marsh, CSMR-5 is located in upland habitat, in a transition zone from disturbed coastal habitat to palustrine wetland, typically dominated largely by ruderal herbaceous species that occur on disturbed substrates, such as along roadsides, railroad banks, etc., and comprised of mostly naturalized and escaped species (Ferren 1985). The dominant cover within the site is grasses (70%), mostly *Bromus diandrus,* followed by *Ambrosia psilostachya* (30%) and *Baccharis pilularis* and *Isocoma menziesii vernonioides* (30%), and bordered to the northwest by dense stands of *Euthamia occidentalis*. Other associates include *Artemisia douglasiana, Carduus pycnocephalus, Conium maculatum, Distichlis spicata, Heliotropium curassavicum, Lolium multiflorum, Melilotus indica, Raphanus sativa, Sonchus asper,* and *Vicia sativa*. Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 75% with a shrub (*Baccharis* and *Isocoma*) cover of 30% (Table 2).

McGrath State Beach Microsite Selection

At McGrath, the most suitable habitat had been previously identified in the southern portion of the park, along the east side of McGrath Lake (Fig. 5). This area was determined to have soils similar to the North Shore site but lacking sufficient vegetative cover. However, dense stands of *Salix* along the edges of the area and the close proximity of coastal marsh taxa such as *Typha*, *Scirpus* and *Pluchea* suggested a relatively high water table at this site (Wilken and Wardlaw 2001). Approximate elevations in this area range from 2-3 meters (6-9 feet). The area east of the lake is primarily open coastal dune habitat covered with dense patches of *Carpobrotus* returning from a previous wildfire, including dune-swale wetlands, and adjacent to coastal freshwater marsh along the lake margins, with scrub of dense *Salix* thickets surrounding the area. Coastal dune areas within McGrath are characterized by *Abronia spp., Ambrosia chamissonis, Atriplex leucophylla, Calystegia soldanella, Cakile maritima, Camissonia cheiranthifolia, Carpobrotus* spp., and *Ericameria ericoides* (Muns 1998). Vegetation within dune swale wetlands can be classified as palustrine scrub, mixed-deciduous and evergreen or broadleaved-evergreen, seasonally-saturated or phreatophytic dune-swale wetlands. These dune swale wetlands in coastal dune systems generally occur on margins and in bottoms of dune swales and can be quite rich in shrubby species, with characteristic species such as *Toxicodendron diversilobum, Baccharis, Myrica, Rubus, Salix, Rhamnus,* and often dominated by phreatophytic shrubs, especially *Baccharis pilularis,* usually with emergent hydrophytes, such as *Carex praegracilis,* as a dominant understory. Phreatophytic plants are perennial plants that are very deeply rooted, deriving their water source from a more or less permanent, subsurface water supply, and thus not dependent upon annual rainfall for survival (Ferren et al. 1996a-b). Freshwater marsh areas within McGrath are characterized by *Anemopsis californica, Apium graveolens, Berula erecta, Bidens laevis, Hydrocotyle umbellata, Pluchea odorata, Potentilla anserina, Scirpus californicus, S. americanus, S. robustus, Euthamia occidentalis,* and *Typha angustifolia* (Muns 1998).

Six sites at McGrath were originally sampled for soil from the upper 15-30 cm on October 30, 2001 and analyzed by Fruit Growers Laboratory for the same soil properties as outlined above. Soils from these six sites were comprised primarily of sand, with a thin top layer of ash in some areas that had burned. These six sites were arrayed along an east-west gradient from the lake. The two eastern-most sites were sampled along the northern edge of the open coastal dune area, bounded by a dense willow thicket to the north. Two sites were sampled in open coastal dune area with sparse vegetative cover. The two western-most sites were sampled adjacent to the eastern edge of the lake, bounded by a higher degree of vegetative cover and higher water table to the west.

Levels of salinity and other soil properties from samples taken at McGrath were comparable to those in soils sampled at the existing North Shore site and did not have as high variability as those at Carpinteria. Therefore, attention was focused on levels of moisture within sites sampled at McGrath. One of the six sites with an extremely low level of moisture (2.5%) was eliminated. The remaining five sites exhibited a range of soil properties suitable for capturing the various microenvironments within the coastal dune to dune swale to marsh transition. However, upon consultation with CDPR, the two eastern most sites of the original selected five were just outside the state park boundary and eliminated. Two new sites (MSB-4-5) were selected south of the remaining three sites (MSB-1-3), along the eastern edge of the lake (Figs. 6-7). Soil was sampled the following year from the two additional sites (MSB-4-5) on October 22, 2002 and analyzed by Fruit Growers Laboratory on November 12, 2002 (Table 1). In addition, total vegetative cover and shrub cover was visually estimated within each microsite during each monitoring effort in April, July, and November 2002 and February 2003 after installation of Ventura Marsh milkvetch plants.

The first site (MSB-1) is the furthest east and north and was selected on the rise of a sparsely vegetated, small dune, on a WSW-facing slope. Soil was dry and sandy at the time of sampling, with the lowest level of salinity (0.43 mmhos/cm) and moisture (5.8%) of the 2001 McGrath samples. The dominant cover within the site is *Ericameria ericoides* (15%). Other associates include *Ambrosia chamissonis, Bromus, Camissonia cheiranthifolia, Carpobrotus edulis, Erodium cicutarium, Hypochaeris glabra, Phacelia cf. distans* and *Plagiobothrys.* Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 25% with a shrub (*Ericameria*) cover of 15% (Table 2).

The second site (MSB-2) is located just west of MSB-1 within a relatively flat, open, sparsely vegetated area of silty sand. This site had a low level of soil salinity (0.82 mmhos/cm) and a relatively low level of moisture (7.6 %) at the time of sampling. The dominant cover within the site is grasses (65%), mostly *Bromus hordeaceus, B. rubens,* and *Vulpia myuros,* followed by *Croton californicus* (15%). Other associates include *Cakile maritima, Calandrinia ciliata, Camissonia cheiranthifolia, Camissonia* sp., *Carpobrotus edulis, Crassula connata, Erodium cicutarium, Herniaria cinerea, Heterotheca sessiliflora, Hypochaeris glabra, Lastarriaea coriacea, Lessingia filaginifolia, Lotus strigosus, Malva cf. parviflora, Medicago polymorpha, Plagiobothrys, Schismus barbatus, Senecio vulgaris, Sonchus asper*, and *Vulpia myuros*. Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 80% with no shrub cover (Table 2).

The third site (MSB-3) is located west of MSB-2, the furthest north and west, and adjacent to the scrubby area surrounding the lake margin. MSB-3 is situated within a low area of the dunes, relatively flat and sparsely vegetated. Soil was comprised of sandy loam with large amounts of ash on the surface at the time of sampling, with the highest level of soil salinity (3.22 mmhos/cm) and highest moisture level (16.6%) of the McGrath sites. The dominant cover within the site is *Ambrosia psilostachya* (20%), surrounded by dense stands of *Baccharis pilularis, Artemisia douglasiana, Carpobrotus edulis, Oenothera elata hookeri* and *Toxicodendron diversilobum.* Other associates include *Anemopsis californica, Camissonia, Conyza, Euthamia occidentalis, Oxalis, Schismus barbatus,* and *Sonchus asper.* Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 30% with a shrub (*Baccharis*) cover of 5% (Table 2).

The fourth site (MSB-4) is located south of MSB-3, adjacent to the scrubby area surrounding the lake margin. MSB-4 is relatively flat, within a low area of the dunes. Soil was dry to moist and silty to loamy with a relatively low moisture level (5.3%) at the time of sampling (possibly due to sampling at the end of a dry year in 2002), and a relatively high level of soil salinity (2.83 mmhos/cm). The dominant cover within the site is *Ambrosia psilostachya* (95%), followed by *Distichlis spicata* (20%) and *Baccharis pilularis* (15%). Other associates include *Anemopsis californica, Bromus diandrus, B. hordeaceus, B. rubens, Carex praegracilis, Carpobrotus edulis, Chenopodium, Conyza bonariensis, Frankenia salina, Medicago polymorpha,* and *Tetragonia tetragonioides.* Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 95% with a shrub (*Baccharis*) cover of 15% (Table 2).

The fifth site (MSB-5) is the furthest south site, at the southern end of the park boundary, and adjacent to the marshy/scrubby area surrounding the lake margin. Soil was dry and sandy with an extremely low level of moisture (1%) at the time of sampling (possibly due to sampling at the end of a dry year in 2002), and a moderate level of soil salinity (0.91 mmhos/cm). The dominant cover within the site is *Salix exigua* (35%) and *Baccharis pilularis* (25%), surrounded by dense stands of *Oenothera elata hookeri* and *Salix lasiolepis.* Other associates include *Ambrosia psilostachya, Anemopsis californica, Carex, Carpobrotus edulis, Equisetum laevigatum, Juncus mexicanus, Oxalis, Potentilla anserina pacifica, Scirpus acutus occidentalis,* and *Toxicodendron diversilobum.* Associated species at this site indicate a high water table or close proximity to some type of water source. Based on visual estimates of cover within the site, total vegetative cover in February 2003 was 65% with a shrub (*Baccharis* and *Salix*) cover of 60% (Table 2).

Ventura Marsh Milkvetch Propagation

One component of the conservation strategy developed by the CDFG for the Ventura Marsh milkvetch is an annual collection of 5% of the seed produced at the North Shore site for a minimum of 10 years with seed stored at RSABG and/or SBBG. This task has been completed for 1996 to 2001. Wild seed was collected along maternal lines from the existing North Shore population in 1996 (900 seeds from 24 individuals) and 1997 (1600 seeds from 38 individuals), yielding a total of approximately 2,500 seeds, packaged along maternal lines and placed in cold storage at –18°C (0°F) at RSABG. Approximately 3,750 seeds from 45 maternal lines collected from the North Shore site in 1998, and 460 seeds from 9 maternal lines in 1999 have been stored at SBBG, in addition to 2000 and 2001 collections (Meyer 2001).

In December 1998, a project was initiated by the USFWS and RSABG to increase the existing ex-situ conservation seed collection at RSABG. A maximum of 200 plants would be propagated at RSABG from wild-collected seed to provide additional seed for future horticultural trials and conservation/introduction efforts. To maximize the potential genetic diversity in this regenerated seed collection, 8 seeds from each of 26 maternal lines from the existing RSABG conservation collection, a total of 208 seeds, were pulled from the wild-collected seed for propagation, prepared, and sown. Like many species in the legume family, milkvetch seeds have hard coats that restrict water absorption and control germination. To overcome hard seed coats and maximize germination, seeds were prepared for sowing by nicking through the seed coat with a straight edge razor. Seed coats were clipped just above the cotyledons and placed onto moistened germination paper in a refrigerator at 5°C (40°F) for three days cold stratification. A total of 204 seeds were then sown into 8 cm (3 in.) pots, 8 seeds per pot, into a soil mix of 65% silica sand, 20% peat and 15% coarse perlite and covered with 5 mm of screened soil mix. After four weeks in an open screen house, 134 healthy seedlings were growing, exhibiting a 66% germination and survival rate. By July 2000, 115 plants remained, with 53 (46%) plants flowering for a total of 431 inflorescences, and 21 (18%) plants producing fruits. Seed set was extremely low and most fruits were empty or contained a high percentage of aborted or under-developed seeds, with fruits ranging in numbers of seed from 0 to 7. The health and vigor of nursery-grown plants was initially strong but gradually waned, possibly due to root stress in pots. Efforts were made to randomly hand-pollinate some of the plants which appeared to increase seed production to a small degree. Plants that were open-pollinated produced 356 seeds from 7 plants while those that were both hand and open cross-pollinated produced 1, 059 seeds from 14 plants. The RSABG nursery-grown regenerated plants produced a total of 1,415 seeds from 15 maternal lines (21 plants) in October 2000, with each maternal line contributing 9 to 301 seeds (Wall pers. comm.).

The original goal of the experimental introduction project was to establish populations supporting 75-100 adult plants and juveniles at 2 locations. In order to achieve this goal, a maximum of 400 Ventura Marsh milkvetch plants were to be propagated at RSABG with a maximum of 200 plants (5 microsites of 40 plants each) for installation at each location. Plants would be propagated from regenerated seed produced in 2000 at RSABG by nursery-grown plants from seed collected from the North Shore population. In order to maximize genetic diversity, equal numbers of seed from as many maternal lines as possible would be used. A total of 700 seeds were to be sown, determined sufficient for generating a minimum of 400 seedlings based on the previous germination rate of 66% (from wild-collected seed sown in soil at RSABG). Each microsite would receive a relatively genetically diverse population so that the various maternal lines sampled from seed collected at the North Shore population would be represented within each microsite and arrayed randomly. A total of 690 seeds from 12 maternal lines, 75 seeds from each of 6 maternal lines and 40 seeds from each of 6 maternal lines, were selected from RSABG-regenerated 2000 seed. As previously described above, seeds were prepared for sowing by clipping of the seed coat, placed on moistened germination paper, labeled according to maternal line, and cold-stratified for 3 days at 5°C (40°F) to imbibe moisture. Seeds were then sown 20-25 per 10 cm (4 in.) pot in a growing medium of 40% peat, 35% silica sand, and 25% perlite in October 2001. After two weeks, however, only 120 seedlings (17%) had germinated and another supply of seeds was needed to meet the project goal.

Another potential seed source was from RSABG nursery-grown regeneration project plants that had been transferred up to UCSB Coal Oil Point Reserve (COP) in Santa Barbara. The original mother plants that had been raised at RSABG for the seed regeneration project from 1998-2000 were transferred to COP in January 2001 and outplanted on-site. Evidently preferring unrestricted root space and the cooler coastal climate, protected from herbivory and given supplemental watering, the plants at this site had thrived, flowered abundantly and produced ample quantities of seed in 2001. This seed was collected on October 24, 2001 by Dieter Wilken and Tricia Wardlaw for storage at SBBG, with a portion available to RSABG for use in propagation for the experimental introduction project. A total of 6,240 seeds were regenerated for RSABG from 12 maternal lines (16 plants) at COP. Fruits collected at COP had an average of 3.7 seeds/fruit and an average 100-seed weight of 0.267 grams.

Germination tests on the various seed collections of the Ventura Marsh milkvetch at RSABG had to be performed to determine whether there were differing degrees of viability among the different collections before any additional seed sowing was performed to compensate for the low germination rate from the first attempt from RSABG-regenerated 2000 seed. Any seedlings that germinated from these agar tests were to be included and used in the experimental introduction project. Preliminary germination tests were conducted on three seed collections: 1) 1996 and 1997 wild-collected seed from the existing North Shore population, 2) RSABG-regenerated 2000 seed from nursery-grown plants, and 3) regenerated 2001 seed from RSABG nursery-grown plants that had been transferred to Coal Oil Point Reserve. Seeds were placed in 100% RH bath for 24 hours. Seed coats were then clipped on the dorsal side opposite the hilum/micropyle, placed on 0.5% agar and cold stratified at 5°C (40°F) for 24 hours in the dark. Agar plates were then placed in growth chambers for 11 hours light at 20°C (68°F) and 13 hours dark at 12°C (54°F) for 7-10 days. Germination tests were conducted on 100 seeds from 10 maternal lines (10 seeds each) from the 1996 and 1997 combined wild-collected seed. Of these 100 seeds tested, a total of 56% germinated, with individual maternal lines ranging from 40-90% germination. The average 100-seed weight for this collection was 0.311 grams. Germination tests were conducted on 146 seeds from 15 maternal lines (9-10 seeds each) from the RSABG-regenerated 2000 seed. Of these 146 seeds tested, 52% germinated, with individual maternal lines ranging from 0-100% germination. The average 100-seed weight for this collection was 0.142 grams. Germination tests were conducted on 110 seeds from 11 maternal lines (10 seeds each) from regenerated 2001 seed from Coal Oil Point Reserve. Of these 110 seeds tested, 67% germinated, with individual maternal lines ranging from 30-100% germination. The average 100-seed weight for this collection was 0.264 grams (Table 3). Resultant seedlings from these germination tests were transplanted individually into soil plug trays in November 2001 after cotyledons had developed and used for the experimental introduction project.

Interestingly, seeds regenerated in 2000 at RSABG and wild-collected seed from the North Shore population in 1996 and 1997 had comparable germination rates, 52% and 56% respectively. However, the average 100-seed weight of RSABG-regenerated 2000 seed (0.142 g) was less than half the weight of 1996 and 1997 wild-collected seed (0.311

g). In comparison to the 1996 and 1997 wild-collected seed, the 2001 regenerated seed from Coal Oil Point Reserve had a higher germination rate of 67%, and an average 100-seed weight closer to the wild-collected seed but not as high (0.267g vs. 0.311g). The higher germination percentage was probably due to the "freshness" of the seed, which had not been in cold storage for several years. Therefore, since seed was readily available from the 2001 regenerated seed from Coal Oil Point Reserve, this seed was utilized rather than additional RSABG-regenerated 2000 seed, which had exhibited such low seed weights.

From the 2001 regenerated seed from Coal Oil Point Reserve, 990 seeds were selected from 11 maternal lines, conservatively estimating a 50% germination rate (495 seeds). For each maternal line, 90 seeds were prepared in November 2001 with 2 different treatments: 1) 20 seeds were clipped as previously described then sown in soil, and 2) 70 seeds were treated with hot water. Two types of hot water treatment were performed on seeds before sowing: 1) full-boiling water was poured over 70 seeds in a sieve for 5-6 seconds and then placed in ½ cup cold distilled water overnight, or 2) approximately 1/3 cup of full-boiling water was added to a ceramic cup with 70 seeds and allowed to cool overnight. Only swollen, imbibed seeds were then sown into 10 cm (4 in.) pots. From trials with the Ventura Marsh milkvetch and other plant species that produce seeds with hard seed coats, it was evident that seeds produced in any given seed lot yield seeds with varying levels of hardness and thus do not respond uniformly to a single hot water treatment. Achieving acceptable germination rates required two and sometimes three exposures to hot water. Unswollen seeds from the first exposure to hot water were treated with a 2^{nd} or 3^{rd} boil and soaked for 40 hours to soften seed coats, then sown into 10 cm (4 in.) pots. Not all seeds responded favorably to the hot water treatment and only 373 (of 770) seeds from the hot water treatments and 219 (of 220) seeds from the seed coat clipping treatment were actually sown into nursery pots. Seeds were sown into 10 cm (4 in.) pots, 20-25 seeds per pot, into a soil mix of 40% peat, 35% silica sand, and 25% perlite, covered with 5 mm screened soil mix and labeled according to maternal line.

A grand total of 1,638 seeds (836 RSABG-regenerated 2000, 702 COP-regenerated 2001 seed, and 100 North Shore wild-collected seed) were sown between October and November 2001. All 10 cm (4 in.) pots were kept in a greenhouse for several days and then transferred to the RSABG Horticultural Complex screened liner house. An overall total of 480 seedlings was produced (29% of seeds sown), with a total of 373 seedlings (23%) surviving to transplanting stage and transplanted into individual 5 cm (2 in.) pots (Table 3). Transplanting into 5 cm (2 in.) pots began in December 2001, after the first 2 true leaves had emerged, and was completed in January 2002. Transplanting of seedlings from 5 cm (2 in.) pots into tree tube containers was conducted in March 2002. Tree tube containers were 25 cm (10 in.) long by 6 cm (2.5 in.) wide, 655 cu. cm (40 cu. in.) in volume, slightly tapered toward the bottom, and efficient in saving growing and transportation space. The tree tubes also had longitudinal ridges inside promoting downward root growth, preventing root girdling to facilitate in the establishment of new plantings. A total of 322 plants in tree tubes were grown up on benches under 60% shade and ready for outplanting in April 2002.

Ventura Marsh Milkvetch Site Preparation

At McGrath, large mats of iceplant (*Carpobrotus*) were present within microsites selected for planting. Iceplant is known to harbor snails and compete with native coastal dune vegetation, therefore, mechanical removal was warranted necessary before installation of plants to reduce competition and prevent invasion by pests (snails). In April 2002, iceplant and other exotics were removed mechanically by hand within approximately 3-5 meters (10-15 feet) from microsites for outplanting. Piles of iceplant were created on top of existing iceplant mats, elevated off the ground to prevent rerooting. Snail invasion and herbivory have been observed in previous studies at the North Shore site and have caused a significant amount of damage to plants in the absence of some form of snail control (Wilken and Wardlaw 2001). Therefore, additional forms of snail control would be used at both Carpinteria and McGrath after installation of plants. No dense mats of iceplant were present within microsites at Carpinteria and no site preparation was performed at this location before outplanting.

At both Carpinteria and McGrath, recent gopher activity was noted during initial site visits, especially at McGrath. Solar and/or battery-powered transonic mole/gopher repellers by Weitech emit intense, high frequency sound waves, directed down a tube into rodent tunnels, which penetrate the soil and affect the mole or gopher’s nervous system, reportedly driving them away. As an experimental trial to prevent gopher disturbance to outplanted Ventura Marsh milkvetch sites, three gopher repellers were installed at McGrath in April 2002 two weeks before planting, where gopher activity appeared to pose the most problem. No gopher repellers were installed at Carpinteria initially.

In addition to site preparation, water sources for installation and maintenance of Ventura Marsh milkvetch plants had to be secured before outplanting. At McGrath, one potential water source was to pump water from the lake. In addition to soils sampled and analyzed from McGrath, a sample of water was taken from McGrath Lake to determine whether or not it would be suitable for irrigation of outplanted Ventura Marsh milkvetch at this site. One pint of water was sampled from the lake on October 9, 2001 and analyzed by Fruit Growers Laboratory on November 20, 2001. Water was analyzed for pH, electrical conductivity, sodium absorption ratio, cations (calcium, magnesium, potassium, and sodium), anions (carbonate, bicarbonate, sulfate, chloride, nitrate, and fluoride) and minor elements (boron, copper, iron, manganese, and zinc). The irrigation suitability of the water from McGrath Lake was determined to be poor. The water sample had extremely high levels of chloride (1,970 mg/L) and salinity. Salinity was determined by the electrical conductivity of the water which was reported as 7.38 mmhos/cm, significantly higher than the optimum range of 0.1 to 2.5 mmhos/cm. The sodium absorption ratio is the ratio of sodium to calcium and magnesium and was determined to be a severe problem (13.1 mg/L). In general, desired sodium absorption ratios are less than 8 mg/L in soil. The amount of sodium in the water at such high levels (1,140 mg/L) in relation to calcium and magnesium levels would result in poor soil structure and inhibit water penetration into the soil and increase compaction (Sandoval pers. comm.). McGrath Lake water was eliminated as a potential source of irrigation.

After consultation with the CDPR, permission was given to use water spigots within the McGrath State Beach Campground as a water supply for irrigation of the McGrath Ventura Marsh milkvetch plants. After consultation with the City of Carpinteria Public Works Department, permission was given to use a water spigot at the Carpinteria Salt Marsh Nature Park restroom facilities as a water supply for irrigation of the Carpinteria Ventura Marsh milkvetch plants. The water sources at McGrath State Beach Campground and Carpinteria Salt Marsh Nature Park facilities were not sampled and analyzed.

Ventura Marsh Milkvetch Installation

A total of 322 Ventura Marsh milkvetch plants, representing 19 maternal lines from the North Shore site, were installed in April 2002 at McGrath and Carpinteria. Five microsites were planted at McGrath with a total of 167 plants; and five microsites were planted at Carpinteria with a total of 155 plants. Maternal lines were evenly distributed to maximize potential genetic diversity with 31-34 plants at each experimental microsite representing at least 13 maternal lines. Each microsite was given 1-3 representatives from 13 maternal lines and remaining representatives from maternal lines with fewer than 10 nursery-grown plants were randomly distributed among microsites.

Installation of Ventura Marsh milkvetch plants at both locations was conducted by eight RSABG staff and volunteers, with assistance from Mary Meyer. At Carpinteria, planting was conducted on April 18, 2002. Sites were accessed via a dirt road that runs east along the northern boundary and fence of the reserve from the main Apple Road/Estero Way entrance. From the dirt road, plants and supplies were carried by hand to each microsite. At McGrath, planting was conducted on April 23, 2002. Sites were accessed via a foot trail from Harbor Boulevard. Plants and supplies were brought in by hand, with the assistance of a wheelbarrow and hand-pulled nursery cart. Plants were installed equidistantly, approximately 1 meter (3-4 feet) apart, radiating out from the center of each microsite. Holes were dug with posthole diggers, approximately 30 cm (1 foot) deep. To safeguard against underground herbivory, underground baskets of 2.5 cm (1 in.) mesh poultry netting, 30 cm (12 in.) long and 20 cm (8in.) in diameter, were constructed at RSABG and installed in planting holes at microsites with observed gopher activity, at CSMR-1-2, CSMR-4-5, and MSB-2-5. Plants were placed into holes, inside baskets, so that the top of the rootball was just at the soil level. Holes were backfilled with the native soil and gently hand-compacted. Freegro fine mesh plant shelters from Certified Plant Shelters in Prince Rupert, British Columbia, were installed for each plant to safeguard against herbivory aboveground, reduce evapo-transpiration in young plants, and protect plants from accidental human impact. Freegro plant shelters had 2 x 3 mm (ca. 1/8 inch) mesh openings, were 60 cm (24 in.) tall and 15 cm (6 in.) in diameter, and were fastened to a ridged rebar stake, ~2 cm (¾ in.) diameter and 1 m (39 in.) tall, by two friction grip clips at the top and bottom. Plant shelters were to remain on plants for approximately 6 months after installation, until well-established. Each plant was individually tagged with a unique identification number consisting of the seed source (COP, RSA, wild/Oxnard), maternal line number and individual number. These embossed aluminum identification tags on heavy gauge wire stakes were placed on the south side of, and approximately 13-15 cm (5-6 in.) from each plant. Due to potential human disturbance at McGrath, identification tags were placed within plant shelters at McGrath and outside plant shelters at Carpinteria. In addition, vinyl nursery identification tags were buried next to each plant just beneath the soil surface to safeguard against removal of metal tags. After installation into the ground, plants were hand-watered individually with Reliance Desert Patrol, polyethylene, 3-gallon water containers through attachable spouts. Each plant received ½ gallon (2 liters) of water in several applications to promote penetration into the soil. Plants also received water via rain the following week after installation. To provide additional protection against snail herbivory, 3 drops of Liquid Force II Deadline (Deadline) were applied around the base of each plant shelter. Deadline is a slug and snail killer with metaldehyde as the active ingredient. Metaldehyde had been used successfully at the North Shore site to control snail predation (Wilken and Wardlaw 2001).

Since the McGrath site is open to public access, four signs on T-posts were installed within the experimental introduction area. One sign was placed at the northeastern boundary of the project area at MSB-1, one sign was placed at the northwestern edge of the area at MSB-3, one sign was placed in the center of the area at MSB-4, and one sign was placed at the southern end of the project area at MSB-5. No mention of endangered species was posted on the signage. Signs were supplied by the CDPR and were standard “Area Closed For Plant Rehabilitation” or “Closed For Restoration” signs.

Ventura Marsh Milkvetch Site Maintenance

Plants were hand-watered with approximately 1.5 liters per plant (12 gallons per microsite) once a week for the first month, 3 times a month for the 2nd and 3rd months, twice a month for the 4th and 5th months, and once a month for the 6th month of October. When the fall rains began, hand-watering ceased. Plant shelters aided in catching water, moisture and rainfall and directing water down to plants.

With disturbance to microsites from installation of plants and supplemental watering, a number of exotic annual species were observed growing mostly within and immediately outside plant shelters. Weeding of only exotic species, mostly within plant shelters and immediately outside shelters, was conducted throughout the project. The most abundant colonizing native plant species, however, was *Ambrosia psilostachya,* which became very dense at several sites (especially MSB-4) and may compete with Ventura Marsh milkvetch plants.

To continue to prevent snail invasion and herbivory, 2-3 drops of Deadline were applied to the base of shelters approximately every 6 weeks. Notes were taken when dead (presumed poisoned) and live snails were observed. Upon observation, snails were crushed so as not to confuse them with new snails upon subsequent visits.

Two of the three battery-powered gopher repellers installed at McGrath had been removed by an unknown party within the first month of installation, however, no evident gopher disturbance had been observed at microsites until January 2003 (see observations below). At Carpinteria, one microsite (CSMR-1) was heavily disturbed by what appeared to be gopher activity in July 2002. Fresh mounds of dirt were observed adjacent to plant shelters and small holes were chewed through the plant shelters. In response to this activity at Carpinteria, three solar/battery powered mole & gopher repellers were installed at CSMR-1, CSMR-4, and CSMR-5 in July. No subsequent rodent damage occurred at Carpinteria after installation of gopher repellers and batteries were replaced in December 2002.

Aphid infestations and associated sooty mold also occurred at both Carpinteria and McGrath during the summer months. Aphid infestations were noticeably severe in June and July 2002 and a number of methods were employed to control infestations. Sooty mold infestations were first observed on leaves of plants in mid-July. Soapy water (1 teaspoon Palmolive dishwashing soap diluted in one quart water) was sprayed onto infested plants with a hand spray bottle, with one application in June and one application in July to control aphids. One application of JMS Stylet oil was sprayed on infested plants in July at McGrath, at sites MSB-1-3 & MSB-5. JMS Stylet oil, a mixture of mineral oil and added emulsifier, was applied at a rate of 2 tablespoons per gallon. Also in July, biological predators were released at both localities. Green lacewings (*Chrysoperla*) and convergent lady beetles (*Hippodamia convergens*) were obtained from Rincon-Vitova Insectaries, Inc. in Ventura. At each locality, 750 green lacewing larvae, 5,000 green lacewing eggs, and 1,500 adult, migratory, convergent lady beetles were distributed among the five microsites. Green lacewing larvae are general predators that feed on aphids. Adult lacewings feed on pollen and nectar from flowers. Both lady beetle larvae and adults are general predators and feed on aphids. Argentine ants will fight off lacewing larvae to protect aphids for honeydew secretions and will eat lady beetles and larvae. At the recommendation of Rincon-Vitova, Maxforce granular bait was applied at the base of plants where there were noticeable ant colonies: in July and October at MSB-2, in September and October at MSB-5, and in October at MSB-4.

Ventura Marsh Milkvetch Monitoring

The Ventura Marsh milkvetch has been reported to flower in its 2nd or 3rd year from seed (Wilken and Wardlaw 2001), and therefore we did not anticipate reproduction or seedling recruitment during the first year of the experimental introduction project. However, individuals did flower and fruit at both locations within the first year of the project and a number of seedlings were observed at the beginning of 2003. Monitoring data gathered from plants at the North Shore site have included number of inflorescences per (reproductive) shoot, number of inflorescences per plant, total number of shoots per plant, number of vegetative and flowering shoots, length of longest shoot per plant, number of flowers per inflorescence, and estimates of fruit and seed set (Wilken and Wardlaw 2001).

Individual plants at Carpinteria and McGrath have been given unique identification numbers and have been mapped and tracked at each microsite over the project period. Individuals were monitored every 3 months, from April 2002 through

February 2003, to assess vigor, establishment and survivorship and reproductive success of plants between microsites. To facilitate comparison between experimental sites and the North Shore site, monitoring data gathered for each individual includes visual estimates of general condition and mortality (good, fair, poor, dead), height (cm), number of flowering shoots, number of vegetative shoots, total number of inflorescences, and any observed threats, etc. Monitoring data for each microsite describes plant community, dominant vegetative cover, associated species and total vegetative cover, general topography and habitat characteristics (Table 2). In addition, each microsite has been photo-documented with each monitoring effort. Baseline monitoring data were collected for both locations in April 2002 after outplanting, with subsequent monitoring data collection in July and November 2002 and February 2003.

To obtain estimates of flower, fruit, and seed production at each site, one inflorescence and one infrutescence was sampled from a maximum of 5 individuals at each microsite. In July 2002, a maximum of 5 inflorescences was sampled from different individuals within each microsite and the number of flowers per inflorescence was recorded to obtain a mean number of flowers/inflorescence for each microsite. In November 2002, a maximum of 5 infrutescences was randomly collected from different individuals within each microsite and taken back to RSABG for seed cleaning and counting to obtain a mean number of mature seeds per fruit produced and weigh mature seeds for each microsite. In addition, a mean number of total fruits per infrutescence was sampled in the field and a mean number of mature fruits per infrutescence for each microsite was estimated from samples taken back to RSABG. Some microsites had fewer than five reproductive individuals, therefore, all reproductive individuals were sampled. Individuals' numbers were drawn randomly at CSMR-2, CSMR-4-5 and MSB-3-5 to obtain a sample of 5 individuals' infrutescences. Not enough fruiting individuals were present at CSMR-1, CSMR-3 and MSB-1-2 to draw random samples.

During monitoring efforts in February 2003, a number of Ventura Marsh milkvetch seedlings were unexpectedly observed at McGrath State Beach. The number of seedlings observed were counted for each microsite. In addition, the number of new shoots versus live old shoots and maximum height of new shoots versus maximum height of live old shoots per plant per microsite were recorded in February 2003.

RESULTS

Ventura Marsh Milkvetch Observations

At McGrath, Ventura Marsh milkvetch plants began developing floral buds in the middle of June (at MSB-2 and MSB-4) and flowers began opening late June at all microsites, with flowering subsiding in October and finishing by November. Plants began setting visible fruits in the middle of July at McGrath (at MSB-1) with peak fruiting in October. Most of the fruits were mature (>/= 6mm, plump, and no longer green) by November at McGrath, although some were still ripening. Plants were observed resprouting at the base as early as late October at McGrath (at MSB-3). Additional plants were observed resprouting from the base in November at McGrath at

MSB-1 (6 plants), MSB-2 (2 plants), MSB-3 (2 plants), MSB-4 (1 plant), and MSB-5 (1 plant), and through January at MSB-1-3 and MSB-5. By this time the original main shoot(s) were in various stages of senescence. No new growth at the base of the plants was observed again at MSB-4 until January 2003. Plants at McGrath retained green leaves at the tips of old shoots through February at all microsites except MSB-1, although most of the previous year's stems had senesced.

At Carpinteria, Ventura Marsh milkvetch plants began developing floral buds (at CSMR-1 and CSMR-5) and flowering (at CSMR-2 and CSMR-4) in late June. Several plants were still coming into bud at Carpinteria in late July (at CSMR-4). Plants were flowering through August and flowering had ceased by November. Fruiting had initiated by August and fruits began to mature in October with most fruits reaching maturity in November. Plants were observed resprouting from the base by November at CSMR-1 (2 plants grazed by gophers), CSMR-3 (4 plants), CSMR-4 (2 plants), and CSMR-5 (6 plants), and were resprouting at all sites by February 2003. Plants at Carpinteria retained green leaves at the tips of old shoots at CSMR-2, CSMR-4, and CSMR-5 through February. All but one plant at CSMR-3 appeared dead or had senesced by mid December and were noted as sunken down below the soil surface level, either by improper planting methods or sinking of the soil.

With regard to threats and disturbances to experimental sites, the worst aphid/sooty mold/ant infestations occurred at McGrath, with the worst infestations at site MSB-2, followed by MSB-1, MSB-4, MSB-5, then MSB-3. Ventura Marsh milkvetch plants looked better with respect to aphid infestations at Carpinteria, however, sooty mold and aphid infestations were observed at both localities through the beginning of November 2002 at most microsites. In addition, sooty mold and aphid infestations appeared to be most severe within shelters where some form of protection was provided and moist microclimates were created. The worst aphid infestation at Carpinteria was at site CSMR-5, followed by CSMR-2, CSMR-4, then CSMR-2, with no aphids observed at site CSMR-3. To prevent further infestation and once stems and foliage had begun senescing, plant shelters were removed at the beginning of December 2002.

The major pest threat to Ventura Marsh milkvetch plants at experimental sites was snail herbivory, especially at Carpinteria, at site CSMR-1. Carpinteria sites experienced the most snail activity, with damage immediately following outplanting and after the first application of Deadline in April 2002. Approximately 20 dead snails were observed at the base of shelters during one site visit in April following planting and application of Deadline at CSMR-1. At CSMR-2, approximately 5 dead snails were observed in April during the same site visit and at CSMR-3, 5-10 dead snails were observed. No snails were observed at sites CSMR-4 and CSMR-5 in April. In June, snails were observed inside plant shelters at CSMR-1 and nine plants had evident signs of snail herbivory. Several snails were observed outside plant shelters at CSMR-2 with five plants exhibiting evident signs of snail herbivory in June as well. In addition, approximately 5 snails were observed outside plant shelters at CSMR-5 in June. No signs of snail activity were observed at CSMR-3 or CSMR-4, however, Deadline was reapplied at all sites in June. Several additional live and dead snails were observed later that month at CSMR-1 and

CSMR-2. An additional 6 dead and 1 live snails at CSMR-2 and 2 dead snails at CSMR-3 were observed in July. One plant at CSMR-1 that had been grazed previously by snails had produced new growth at the base in July. Several live and dead snails were observed in October at CSMR-1. At least 15 dead snails at CSMR-1 and 6 dead and 4 live snails plus snail herbivory on 7 plants at CSMR-2 were observed in November. Another application of Deadline was made in November and December at all sites. Two additional dead snails at CSMR-1 and 4 additional dead snails at CSMR-2 were observed in December. In January, 3 dead snails at CSMR-1, 1 dead and 1 live snail at CSMR-2, 1 dead snail at CSMR-3, and 1 dead snail at CSMR-5 were observed. In February, several live and dead snails were observed at CSMR-1, CSMR-2, and CSMR-4. Another application of Deadline was made in February 2003.

At McGrath, only 3 dead snails were observed during one site visit immediately following outplanting and application of Deadline in April. One small snail was observed at MSB-2 and MSB-3 at the end of July. One dead snail at MSB-3 and one snail plus herbivory at MSB-5 were observed in November. One dead snail at MSB-3 and one dead snail at MSB-5 were observed at the beginning of December. Several dead and live snails were observed in February 2003 at MSB-4 and MSB-5. Another application of Deadline was made in March 2003.

With regard to gopher activity and damage at sites, the only significant damage took place at Carpinteria site CSMR-1 in July with 17 plant shelters chewed through and 12 plants grazed. Some digging was noted at the beginning of November at CSMR-4 at several plants but no significant damage had occurred. Recently, a large amount of new gopher activity as evidenced by fresh mounds of dirt was observed at McGrath in January 2003 within the vicinity of MSB-2 and MSB-3 and in February 2003 within the vicinity of MSB-2 and MSB-4.

Fruit herbivory on Ventura Marsh milkvetch plants by bruchid beetles (weevils) was observed at both Carpinteria and McGrath, especially at the beginning of November during monitoring data collection. Live beetles and holes in fruit walls were observed on fruits of at least 1 plant at CSMR-2 and CSMR-3, in 3 plants at CSMR-4, and in 2 plants at CSMR-5. Live beetles and holes in fruit walls were observed on fruits in 3 plants at MSB-1, in 4 plants at MSB-2, in 1 plant at MSB-3, in 1 plant at MSB-4, and in 3 plants at MSB-5.

Due to public access at McGrath State Beach sites, signage was erected at experimental sites to safeguard against human disturbance, however, the only human disturbance noted at McGrath was removal of two gopher repellers in April, removal of one plant at site MSB-5 in June, and evidence of paintball activity was noted in August.

One final observation of potential disturbances at experimental sites for the Ventura Marsh milkvetch was made at Carpinteria in November 2002 when high tide had risen up close to several microsites, but no salt water reached the plants. In December 2002, the northwest portion of site CSMR-2 was covered in standing water 4-5 cm (1.5-2 in.) deep and the ground was very spongy from what appeared to be tidal water. In addition, at CSMR-3, the soil was saturated with water collecting in the basins of plants 1-5 cm (0.5-2 in.) deep. The other sites at Carpinteria were not flooded by high tides.

Ventura Marsh Milkvetch Monitoring Data

A summary of survivorship and reproduction in July and November 2002 and survivorship and seedling recruitment in February 2003 at Carpinteria and McGrath, at all microsites, is presented in tabular data (Table 4A-C). During peak flowering in July, 41% of the surviving plants at Carpinteria (53/129) were flowering. In November, 54% of the surviving plants (53/99) were either fruiting or had flowered. At Carpinteria, 68 (44%) of the 155 plants installed in April had survived as of February 2003. No Ventura Marsh milkvetch seedlings were observed at Carpinteria during the project period. During peak flowering in July, 50% of the surviving plants at McGrath (83/165) were flowering. In November, 53% of the surviving plants (81/154) were either fruiting or had flowered. At McGrath, 147 (88%) of the 167 plants installed in April had survived as of February 2003. A total of 46 Ventura Marsh milkvetch seedlings was observed at McGrath in February. An unpaired t-test was performed on percent survivorship and mortality and reproduction for the two locations using StatView statistical software. The only significant difference between the two general locations was survivorship and mortality in February ($t = 2.717$, $P = 0.0264$). McGrath had significantly higher survivorship and lower mortality than Carpinteria.

A total of 87 of the 155 plants installed at Carpinteria was recorded as dead in February 2003. Approximately five dead plants at Carpinteria were observed as early as June: 3 at CSMR-1, 1 at CSMR-3 and 1 at CSMR-5. However by July, 14 plants were observed dead at CSMR-1, mostly due to snail and gopher herbivory and by November, a total of 26 plants was recorded dead at this site. At CSMR-2, no dead plants were observed until November with 3 plants recorded as dead. By February, 18 plants were recorded dead at CSMR-2, with noted herbivory, snail damage, and/or hypersaturation of the soil. At CSMR-3, 3 plants were observed dead by July, 15 were recorded dead in November, and 30 were recorded dead in February with noted hypersaturation of the soil. By the end of April, 4-5 plants at CSMR-4 were observed with dead leaves, although the stems were still green at the time, and may have begun dying back due to improper planting. In May, CSMR-4 exhibited the most mortality at that time with a total of 8 dead plants by June. By February, 9 plants were recorded as dead at CSMR-4. At CSMR-5, 1 plant was observed dead by July and 4 were recorded as dead in November and February.

A total of 20 of the 167 plants installed at McGrath was recorded as dead in February 2003 with only 2 plants previously recorded as dead in July 2002. At MSB-1, no dead plants were observed until November with 1 plant recorded dead and February with 2 plants recorded dead . At MSB-2, no dead plants were observed until November with 8 plants recorded dead and February with 7 plants recorded dead. At MSB-3, no plants had died or senesced as of November. By February, only 1 plant was observed dead at MSB-3. At MSB-4, 1 plant was observed dead by July, 3 were recorded dead in November, and 6 were recorded dead in February. At MSB-5, only 1 plant had been recorded dead in July when it was found missing from its plant shelter, and presumably removed by somebody. By February, 4 plants were observed dead at MSB-5.

A summary of the monitoring data for each microsite is presented in tabular form for the month of July when plants were considered at their prime. For vegetative plants, the mean number of shoots per plant, height, and growth since installation are summarized for each microsite (Table 5A). For reproductive plants, the mean number of shoots per plant, number of flowering shoots per plant, height, growth since installation, number of inflorescences per plant, and number of inflorescences per reproductive shoot are summarized for each microsite (Table 5B). Surviving plants in February 2003 were observed in a vegetative state with new shoots emerging at the base of plants and with some shoots from the previous year still alive and green with new growth. For surviving plants in February, the mean number of new shoots per plant and mean number of live old shoots per plant are summarized for each microsite (Table 5C). Of the 66 vegetative plants at Carpinteria in July, mean number of shoots per plant was 1.8, mean height was 38.2 cm, and mean growth was 13.5 cm. Of the 82 vegetative plants at McGrath in July, mean number of shoots per plant was 1.9, mean height was 44.3 cm, and mean growth was 16.4 cm. Of the 53 reproductive plants at Carpinteria in July, mean number of shoots per plant was 1.9, mean number of flowering shoots per plant was 1.1, mean height was 58.6 cm, mean growth was 31.7 cm, mean number of inflorescences per plant was 8.1, and mean number of inflorescences per reproductive shoot was 6.6. Of the 83 reproductive plants at McGrath in July, mean number of shoots per plant was 1.6, mean number of flowering shoots per plant was 1.0, mean height was 65.8 cm, mean growth was 37.3 cm, mean number of inflorescences per plant was 6.3, and mean number of inflorescences per reproductive shoot was 6.0. Of the 68 surviving plants at Carpinteria in February, mean number of new shoots per plant was 6.9 and mean number of live old shoots per plant was 0.6. Of the 147 surviving plants at McGrath in February, mean number of new shoots per plant was 10.1 and mean number of live old shoots per plant was 0.5. Because mean height of plants for each location was significantly different ($t = 3.260$, $P = 0.0012$) at time of installation in April - based on an unpaired t-test performed for mean heights at Carpinteria (25.8 cm) and McGrath (28.3 cm) with StatView - growth from installation height was examined instead between the two locations. An unpaired t-test was performed for all monitoring data presented above for the two locations. A significant difference between Carpinteria and McGrath was found for mean number of shoots in reproductive plants ($t = 2.278$, $P = 0.0243$) and growth in reproductive plants ($t = 2.339$, $P = 0.0208$). McGrath had significantly less shoots in reproductive plants and more growth in reproductive plants than Carpinteria.

At Carpinteria, the mean number of flowers per inflorescence was 31.7, mean total fruits per infrutescence was 20.8, mean mature fruits per infrutescence was 8.9, mean mature seeds per fruit was 3.9, and mean 100-seed weight was 0.310 grams (Table 6A-B). At McGrath, the mean number of flowers per inflorescence was 30.1, mean total fruits per infrutescence was 20.3, mean mature fruits per infrutescence was 13.7, mean mature seeds per fruit was 4.2, and mean 100-seed weight was 0.298 grams. Due to the unequal sample sizes between microsites at each locality, a nonparametric test, the Mann-Whitney U test, was performed on flower, fruit, and seed estimates presented above for the two locations with StatView. The only significant difference between Carpinteria and McGrath was the mean number of mature fruits per infrutescence ($z = -2.298$, $P =$

0.0216). McGrath had significantly more mature fruits per infrutescence than Carpinteria.

With respect to reproductive ability at the North Shore site in Oxnard, the average reproductive plant had 26.2 inflorescences, 3.2 inflorescences per shoot, and 36.8 flowers per inflorescence. Flowers produced 7-9 ovules per ovary with a mean of 7.4. Some open-pollinated flowers produced as many as 6-7 seeds, with a mean number of 2.8 seeds/fruit (including full and empty fruit). Flowers not open-pollinated (with bagged inflorescences) had a mean of 2 seeds/fruit (Wilken and Wardlaw 2001).

Ventura Marsh Milkvetch Experimental Sites' Soils Analysis

Means for soil characteristics from samples taken previously by Wilken and Wardlaw at the North Shore Site were summarized above. Soil samples for Carpinteria and McGrath are summarized below with respect to means for saturation, salinity, moisture, pH, nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulfate, chloride, cation exchange capacity (CEC), zinc, manganese, iron, copper, and boron (Table 1). At Carpinteria, mean saturation was 36.6%, salinity 40.7 mmhos/cm, moisture 17.8%, pH 7.8, nitrogen 12.1 ppm, phosphorus 10.0 ppm, potassium 5.9 meq/L, calcium 29.2 meq/L, magnesium 53.4 meq/L, sodium 226.6 meq/L, sulfate 40.4 meq/L, chloride 271 meq/L, CEC 26.1 meq/100g, zinc 2.6 ppm, manganese 9.3 ppm, iron 36.7 ppm, copper 0.9 ppm, and boron 1.7 ppm. At McGrath, mean saturation was 29.9%, salinity 1.6 mmhos/cm, moisture 7.3%, pH 6.8, nitrogen 6.6 ppm, phosphorus 27.4 ppm, potassium 0.7 meq/L, calcium 6.1 meq/L, magnesium 6.1 meq/L, sodium 5.51 meq/L, sulfate 4.4 meq/L, chloride 6.1 meq/L, CEC 12.7 meq/100g, zinc 1.8 ppm, manganese 10.9 ppm, iron 85.7 ppm, copper 0.6 ppm, and boron 0.6 ppm. Mean soil data was available for all three sites (Carpinteria, McGrath, and North Shore) for all soil properties except moisture, zinc, manganese, iron, copper, and boron. For soil properties from all three locations, an analysis of variance (ANOVA) was performed using StatView, with a significance level of 5%. A significant difference was found between all three locations with regard to saturation ($P = 0.002$), salinity ($P = 0.0359$), pH ($P = 0.0002$), potassium ($P = 0.0157$), calcium ($P = 0.0092$), magnesium ($P = 0.0500$), sodium ($P = 0.0291$), sulfate ($P = 0.0313$), and chloride ($P = 0.0350$). Carpinteria and McGrath were significantly different with respect to saturation, salinity, pH, potassium, calcium, magnesium, sodium, sulfate, and chloride. Carpinteria had significantly higher saturation, salinity, pH, potassium, calcium, magnesium, sodium, sulfate, and chloride levels than McGrath. Carpinteria and North Shore were significantly different with respect to saturation, salinity, potassium, magnesium, sodium, sulfate, and chloride. Carpinteria had significantly higher saturation, salinity, potassium, magnesium, sodium, sulfate, and chloride levels than North Shore. North Shore and McGrath were significantly different with respect to only saturation and pH. North Shore had significantly lower saturation and higher pH levels than McGrath. An unpaired t-test was performed for remaining soil properties with data from just Carpinteria and McGrath: moisture, zinc, manganese, iron, copper, and boron. The only significant difference between Carpinteria and McGrath was with respect to moisture ($P = 0.0325$). Carpinteria had significantly higher moisture levels than McGrath.

DISCUSSION

We are able to look at statistical differences in site characteristics easily between the two locations of Carpinteria and McGrath because of a sample size of 5 at each location. However, looking at differences between microsites at each location is more difficult due to a sample size of 1. Between the two locations, the majority of vigorous and healthy plants were observed at McGrath, while comparatively fewer plants at Carpinteria exhibited similar robustness. In February 2003, 88% of the plants installed at McGrath had survived, while only 44% of the plants installed at Carpinteria had survived. In addition, by July 2002, plants at McGrath had grown an average of 37.3 cm, whereas plants at Carpinteria had grown 31.7 cm.

In general, the probability of flowering and fruiting is approximately 50% after 18 months following germination of Ventura Marsh milkvetch plants (observed in 1 to 2-year old plants) and 100% in 3-year old plants. At RSABG, 2000 seed regeneration project plants, approximately 18 months old, were 63/116 (54%) vegetative and 53/116 (46%) reproductive (Wilken and Wardlaw 2001). In July, 41% of the surviving plants at Carpinteria and 50% of the surviving plants at McGrath were reproductive. This reproduction rate was unexpected in 8-month old plants and comparable to previous observations on older, more established plants.

Mean data from the two experimental sites at Carpinteria and McGrath will be examined and compared to data previously gathered at the North Shore population by Wilken and Wardlaw (2001). Reproductive plants at both Carpinteria and McGrath had a higher mean number of inflorescences per shoot (6.6 and 6.0 respectively) than at North Shore (3.2), but a much lower mean total of inflorescences per plant (8.1 and 6.3 respectively) than at North Shore (26.2). This is most likely due to the young age of plants at the experimental sites; younger plants have fewer shoots than more established individuals.

In vegetative plants at the North Shore site, the mean number of shoots per plant was 4.8, in contrast to reproductive plants with a mean of 6.6 shoots per plant. The mean length of the longest shoots of vegetative plants was 11.3 cm, in contrast to reproductive plants with a mean length of longest shoots of 46.2 cm (Wilken and Wardlaw 2001). In vegetative plants at Carpinteria, the mean number of shoots per plant was 1.8, in contrast to reproductive plants with a mean of 1.9 shoots per plant. Vegetative plants had a mean height of 38.2 cm, in contrast to reproductive plants with a mean height of 58.6 cm in July. In vegetative plants at McGrath, the mean number of shoots per plant was 1.9, in contrast to reproductive plants with a mean of 1.6 shoots per plant. Vegetative plants had a mean height of 44.3 cm, in contrast to reproductive plants with a mean height of 65.8 cm. Both Carpinteria and McGrath exhibited many fewer shoots per plant than those at the North Shore site, most likely due to the age of the plants, but had longer vegetative shoots than at the North Shore site.

Plants at the North Shore site had been previously observed to be dormant in January 2000, with leaves developing in February through April and seedling recruitment beginning in February, with most recruitment from March to May. Flowers were observed budding in mid-June, opening in late June, with peak flowering in mid-July with some open flowers until early September. Fruit were observed beginning in mid-July with maturation beginning in August and completed in September, with pods remaining on plants until January. Plants began to senesce in late September, however, some plants retained a few green leaves up until the following January or began to produce vegetative shoots, first observed in February (Wilken and Wardlaw 2001). At both McGrath and Carpinteria, flowers were observed budding in mid- to late June as well, with flowering through October. Fruiting began in July as well, however, maturation of fruits at both sites appeared to be later (November) than at North Shore (September). In addition, plants at experimental sites appeared to begin developing new shoots at the base earlier (October-November) than at North Shore (February). Plants at both experimental sites have also retained green leaves at the tips of the shoots through at least February. In addition, seedling recruitment was similarly first observed in February at McGrath, with no seedling recruitment to date at Carpinteria.

Significant damage to fruit (50%) and seeds (30%) by weevils was documented at the North Shore site. Weevil damage to fruit and seeds was also observed at Carpinteria and McGrath the first year.

The mean 100-seed weight for 1996 and 1997 wild-collected seed from the North Shore site was reported as 0.311 grams. The mean 100-seed weight for 2002 collected seed from Carpinteria and McGrath was 0.310 and 0.298 grams respectively. These seed weights are comparable to that of wild-collected seed from the North Shore site and demonstrate the development of healthy, mature seeds at the experimental introduction sites, in comparison to nursery regenerated seed at RSABG with a reported 100-seed weight of 0.142 grams and a low germination rate.

Soils at McGrath and North Shore sites were most similar to each other, only differing significantly in pH and saturation, than either were to Carpinteria. Carpinteria sites tended to have higher saturation, salinity, potassium, calcium, magnesium, sodium, sulfate, and chloride. At Carpinteria, *Parapholis incurva* is tolerant of salinity and often indicative of highly saline soils. The only sites where this species was present at Carpinteria were CSMR-1 and CSMR-3, which were the two sites with the highest salinity in soil samples, 38.60 mmhos/cm and 111 mmhos/cm respectively (Table 1-2). These two sites exhibited the lowest percentage of reproducing individuals at Carpinteria in July, 20% and 13% respectively, and the highest mortality in February, 84% and 97% respectively. Although most of the mortality at CSMR-1 can be attributed to snail and gopher herbivory and damage, in the absence of these factors, plants at this site might have done well. Another possibility as to why there was a higher mortality rate in February at CSMR-3 and at CSMR-2 (58%) could be due to the hypersaturation of soil at these two sites. A third possibility as to why there was a higher mortality rate at CSMR-3 and at CSMR-4 (29%) could be due to the absence of shrub cover at these two sites (Figs. 8-9). The remaining site CSMR-5 was associated with native shrub cover and at the highest elevation at Carpinteria (Fig. 10). *Euthamia occidentalis* generally occurs at the edge of non-tidal areas and was associated with CSMR-5, with the lowest soil salinity level of 6.15 mmhos/cm. This site had the highest survivorship at Carpinteria in February (87%); a higher amount of growth in reproductive individuals in July (34.3 cm); and a higher number of inflorescences per reproductive shoot (6.5).

At McGrath, the sites exhibiting the highest percentage of reproducing individuals in July was MSB-5 (79%), followed by MSB-4 (63%). The greatest amount of growth in reproductive individuals in July was observed at MSB-5 with 51.6 cm. The largest number of inflorescences per reproductive shoot was observed at MSB-3 with 8.8. The sites with the highest survivorship at McGrath in February were MSB-3 (97%) and MSB-1 (94%), followed by MSB-5 (88%), MSB-4 (82%), and MSB-2 (79%). MSB-3, MSB-5, and MSB-4 are adjacent to scrubby areas of native vegetation associated with the margin of the lake and fresh/brackish marshy areas. These sites are often associated with dune swale wetlands and characteristic species include *Anemopsis californica*, *Baccharis pilularis,* and *Toxicodendron diversilobum.*

FURTHER RECOMMENDATIONS

It is recommended that the experimental populations at Carpinteria and McGrath be monitored for at least five years after outplanting and monitoring data continue to be collected to better assess the success of the experimental populations in meeting the long term recovery goal of the CDFG. In addition, as recommended by Wilken and Wardlaw (2001), future monitoring efforts should also include data collection on seedling recruitment, which began as early as February 2003.

Based on overall survivorship and growth at both sites, it appears that areas at McGrath may be more suitable for establishment of populations of the Ventura Marsh milkvetch, especially sites similar to MSB-3-5 (Figs. 11-12). These sites are adjacent to native shrubs like *Baccharis pilularis* and other vegetation, and within the vicinity of freshwater/brackish marsh areas or in dune swales. Freshwater marsh areas appear to be preferential over coastal salt marsh areas for the Ventura Marsh milkvetch. At Carpinteria, only those areas at higher elevations at the edges of salt marshes that are less frequently flooded by tidal water (lower salinities) and adjacent to scrubby areas with *Isocoma*, *Euthamia*, and *Baccharis* may be suited for populations of the Ventura Marsh milkvetch, as exhibited at CSMR-5. Areas in high salt marsh that are dominated by *Salicornia subterminalis* or *Salicornia virginica* should be avoided, as well as coastal dune areas that are sparsely vegetated, at higher elevations, and comprised of mostly sand. Coastal dune systems similar to McGrath should be given priority for the establishment of additional populations of the Ventura Marsh milkvetch, especially within the southern portion of its historic range.

For future maintenance or introduction of experimental populations, fresh collected seed from plants growing in coastal habitats should be used to propagate additional plants. Precautionary measures should be taken to prevent aphid infestations, snail herbivory, and gopher damage. Soapy water may be used for aphid infestations, but should be applied before watering to prevent damage to leaves, or soapy water must be very dilute. Aphids and sooty mold were observed mostly occurring in the lower half of plants at McGrath, within protection by plant shelters. These shelters may have aided in persistence of aphid and sooty mold infestations. Therefore, future introduction efforts should involve the removal of plant shelters before summer (June). Ideally in the future, plants should be installed in the fall, when they may not need as much supplemental watering, but this needs to be further investigated. In addition, plant shelters will be able to be removed after 6 months and be absent by summer months. The recent presence of gopher activity at McGrath State Beach may warrant efforts to install gopher repellers at these sites, but in such a way to avoid removal of repellers by unknown parties with public access to sites. Application of Deadline or some other form of metaldehyde will need to continue at both locations to prevent severe snail invasions and herbivory, especially at Carpinteria. Deadline application should occur every 6 weeks throughout the entire year. Another precautionary measure to prevent snail invasion is the location of experimental sites far from roads or thoroughfares that facilitate the importation of exotic snails. In addition, serious thought should be given to the control of *Ambrosia psilostachya* in some of the microsites exhibiting a dense cover this past year.

ACKNOWLEDGEMENTS

We would like to thank Mary Meyer at California Department of Fish and Game; Andrew Brooks, Wayne Ferren and the University of California Natural Reserve System, for assistance at UCSB Carpinteria Salt Marsh Reserve; Barbara Fosbrink and California Department of Parks and Recreation, Channel Coast District, for assistance at McGrath Sate Beach; Dieter Wilken and Tricia Wardlaw at Santa Barbara Botanic Garden for assistance in seed collection at Coal Oil Point and suggestions during development of site specific planting plans; Cristina Sandoval at UCSB Coal Oil Point Natural Reserve; Brian Roberts at Certified Plant Shelters; Scott Wright at N. J. Products, Inc.; RSABG volunteers Andreas Hessing, Bill Hogshead, Leland Lubinsky, and John MacDonald for assistance in installation of plants; RSABG staff Monica Acosta, Genevieve Arnold, Valentin Arvizu, Susan Caplow, Tsuping Chen, Marisa Colon, Michael Denslow, Naomi Fraga, LeRoy Gross, Susan Jett, Amber Maurice, Smita Sanbui and Samantha Tessel for assistance in installation, maintenance, and monitoring of plants; Mark Porter at RSABG for assistance in statistical analysis; and Steve Boyd at RSABG for all his suggestions and support.

LITERATURE CITED

California Department of Parks and Recreation (CDPR) and the California Department of Fish and Game (CDFG). Memorandum of Understanding between the California Department of Parks and Recreation and the California Department of Fish and Game for the Conservation of Ventura Marsh Milkvetch (*Astragalus pycnostachyus* var. *lanosissimus*). Signed August 17, 2001. 6 pp.

California Natural Diversity Database (CNDDB). 2002. California Department of Fish and Game, Sacramento, CA.

Callaway, Ragan M., Scott Jones, Wayne R. Ferren, Jr. and Anuja Parikh. 1990. Ecology of a mediterranean-climate estuarine wetland at Carpinteria, California: plant distributions and soil salinity in the upper marsh. Can. J. Bot. Vol. 68, 1139-1146.

Ferren, Wayne R., Jr. 1985. Carpinteria Salt Marsh: Environment, History, and Botanical Resources of a Southern California Estuary. The Herbarium, Department of Biological Sciences, University of California, Santa Barbara, Publication Number 4. 300 pp.

Ferren, Wayne R., Jr., Mark H. Capelli, Anuja Parikh, David L. Magney, Ken Clark, and J. Robert Haller. 1990. Botanical Resources at Emma Wood State Beach and the Ventura River Estuary, California: Inventory and Management. Report to the State of California, Department of Parks and Recreation. Environmental Research Team, The Herbarium, Department of Biological Sciences, University of California, Santa Barbara, Environmental Report No. 15. 310 pp.

Ferren, Wayne R., Jr., Peggy L. Fiedler, Robert A. Leidy, Kevin D. Lafferty, and Leal A. K. Mertes. 1996a. Wetlands of California, Part II: Classification and description of wetlands of the central and southern California coast and coastal watersheds. Madrono 43(1): 125-182.

Ferren, Wayne R., Jr., Peggy L. Fiedler, Robert A. Leidy, Kevin D. Lafferty, and Leal A. K. Mertes. 1996b. Wetlands of California, Part III: Key to and catalogue of wetlands of the central and southern California coast and coastal watersheds. Madrono 43(1): 183-233.

Ferren, Wayne R., Jr., Peggy L. Fiedler, and Robert A. Leidy. Revised 1996c. Wetlands of the central and southern California coast and coastal watersheds: A methodology for their classification and description. Prepared for United States Environmental Protection Agency, Region IX, San Francisco, CA. http://ucjeps.berkeley.edu/wetlands/, visited 23 January 2003

Gray, John and David Bramlet. 1992. Habitat Classification System Natural Resources Geographic Information System (GIS) Project. Prepared for County of Orange, Environmental Management Agency, Santa Ana, California Planning. 46 pp.

Hickman, James, C., ed. 1993. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, California. 1400 pp.

Holland, Robert F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. State of California, The Resources Agency, Department of Fish and Game, Sacramento, CA. 156 pp.

Meyer, Mary. 2001. Conservation Strategy for Ventura Marsh Milkvetch (*Astragalus pycnostachyus* var. *ramosissimus*). California Department of Fish and Game, South Coast Region-Habitat Conservation Planning. 9 pp.

Muns, Bob. 1998. A Check List, McGrath State Beach Flora, Ventura County, California. Bob Muns, 10604 E. Live Oak Ave., Arcardia, CA. 16 pp.

Sandoval, Ricardo. 2001. Fruit Growers Laboratory, Inc., Santa Paula, CA. personal communication on 30 November 2001.

Wilken, Dieter and Tricia Wardlaw. 2001. Ecological and Life History Characteristics of Ventura Marsh Milkvetch (*Astragalus pycnostachyus* var. *lanosissimus*) and their Implications for Recovery. Prepared for Mary Meyer, South Coast Region, Department of Fish and Game, San Diego, California. 55 pp.

WRCC website, http://www.wrcc.dri.edu/. Visited Nov 26, 2001. Oxnard, CA (046569), Period of Record Monthly Climate Summary, Period of Record: 07/1/1948 to 12/31/200 (www.wrcc.dri.edu/cgi-bin/cliRECtM.pl?caoxna); and Santa Barbara, CA (047902), Period of Record Monthly Climate Summary, Period of Record: 12/1/1927 to 12/31/2000 (http://www.wrcc.dri.edu/cgi-bin/cliRECtM.pl?casbar).

APPENDIX A

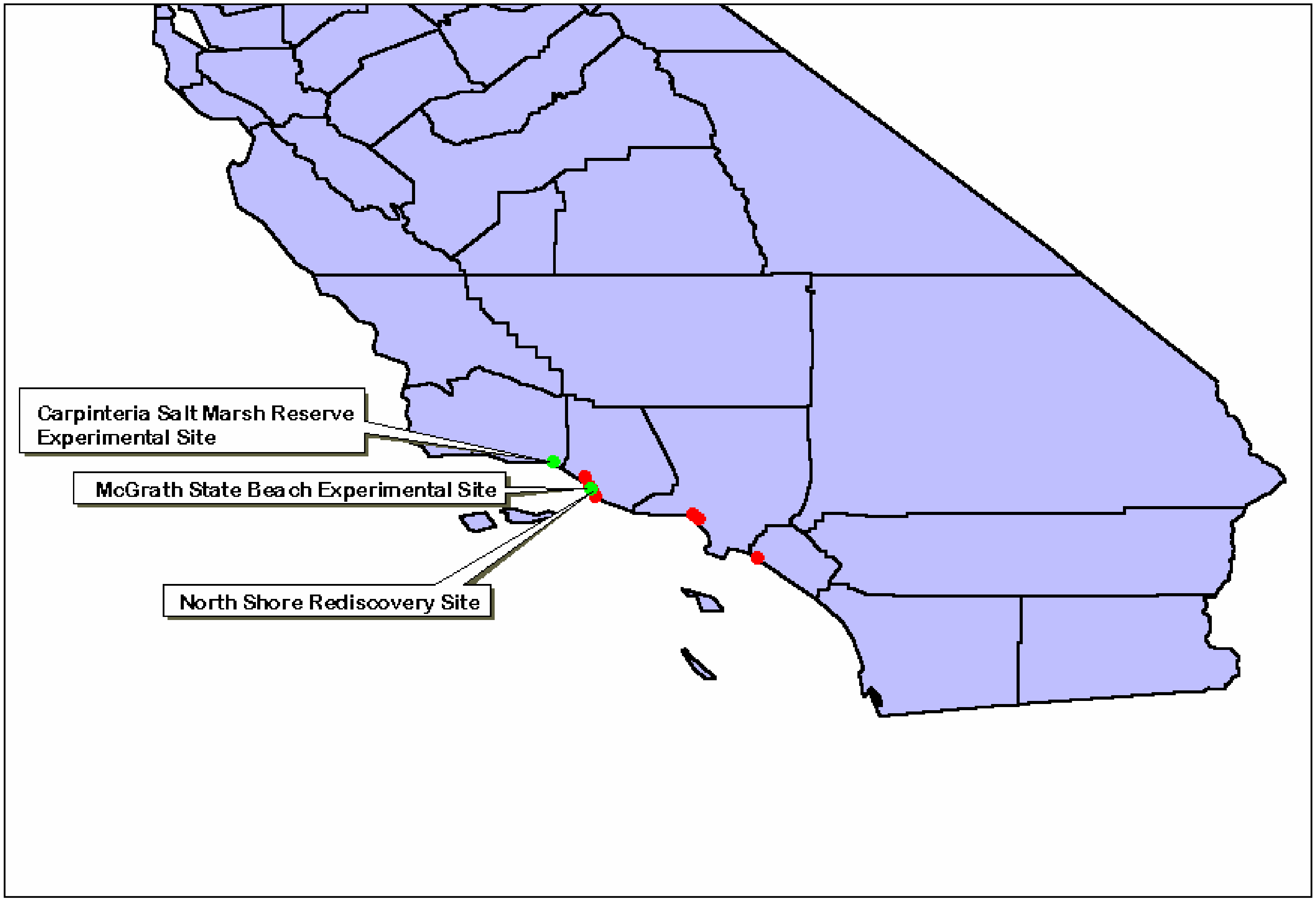

Figure 1. Historic sites and rediscovery site of the Ventura Marsh milkvetch highlighted in red along the southern California coast from Ventura to Orange County. Experimental sites at Carpinteria Salt Marsh Reserve, Santa Barbara County, and McGrath State Beach, Ventura County, highlighted in green.

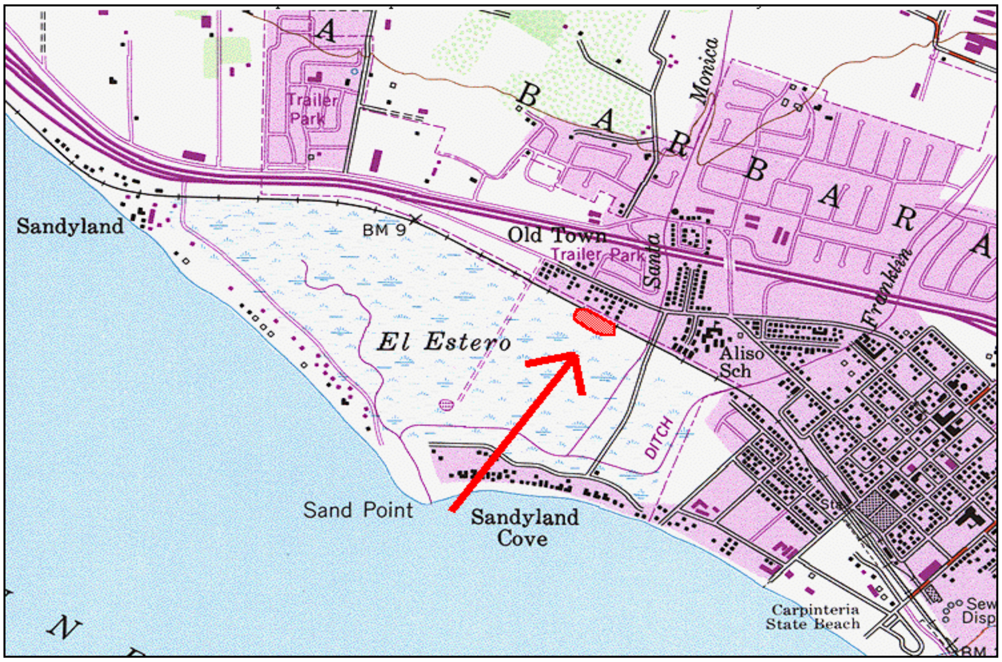

Figure 2. Potential recovery site and general experimental introduction area at Carpinteria Salt Marsh Reserve, Santa Barbara County, for the Ventura Marsh milkvetch.

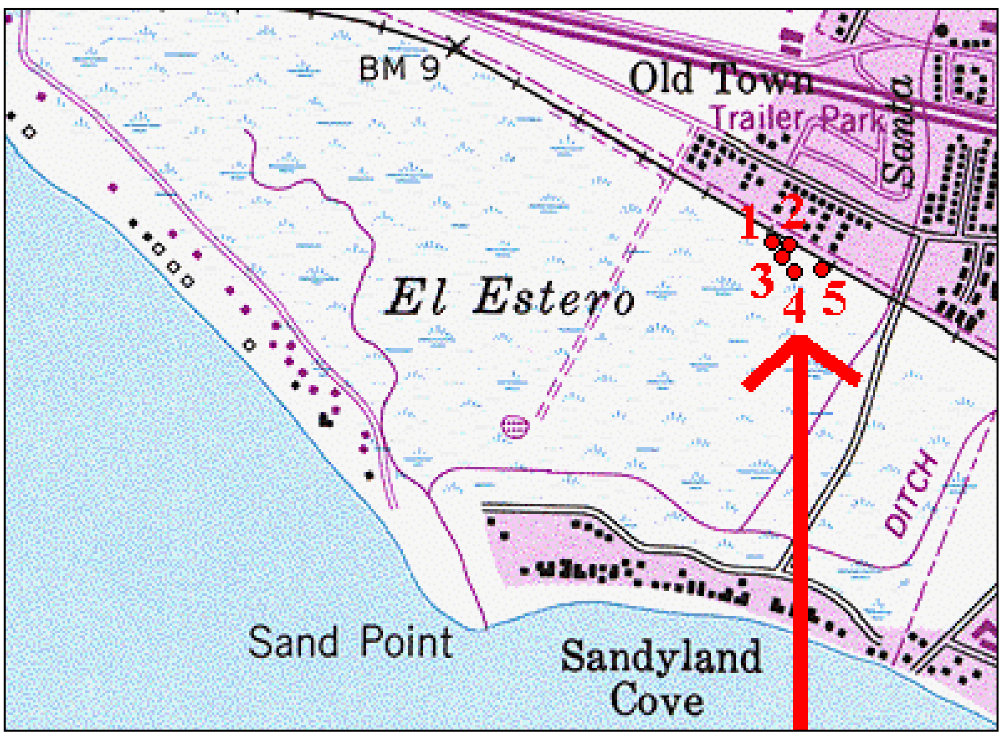

Figure 3. Five microsites selected at Carpinteria Salt Marsh Reserve for establishment of experimental populations of the Ventura Marsh milkvetch, CSMR-1-5.

Figure 4. Aerial photo of Carpinteria Salt Marsh Reserve looking NNE at Ventura Marsh milkvetch experimental sites, CSMR-1-5. (Aerial photo taken by Kenneth Adelman in 2002 for the California Coastal Records Project.)

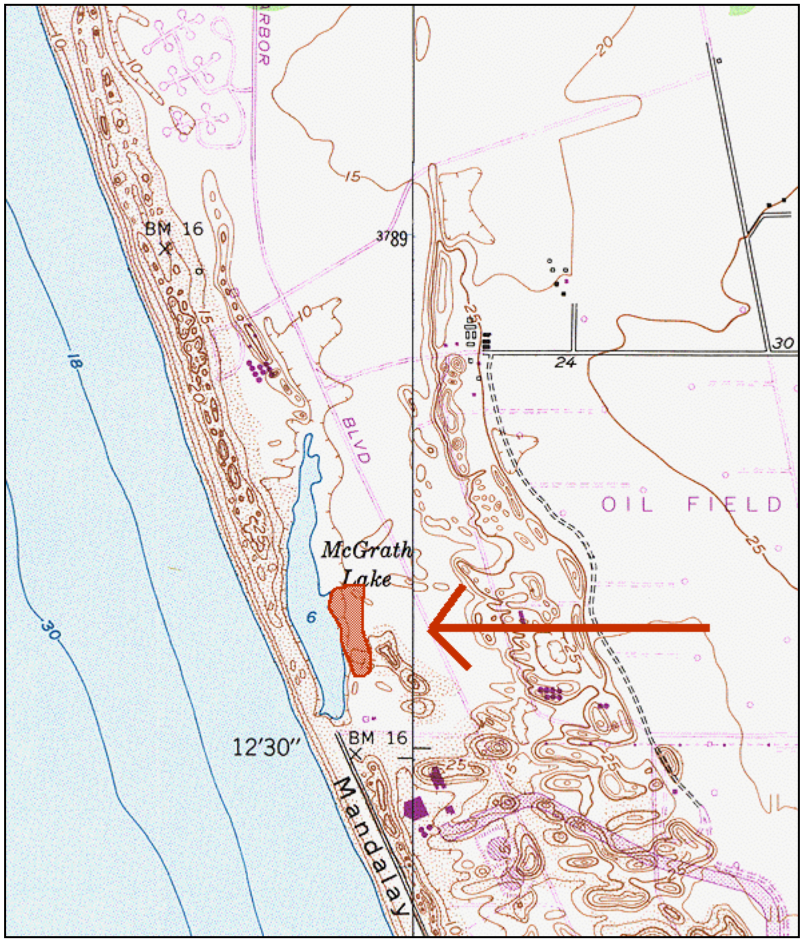

Figure 5. Potential recovery site and general experimental introduction area at McGrath State Beach, Ventura County, for the Ventura Marsh milkvetch.

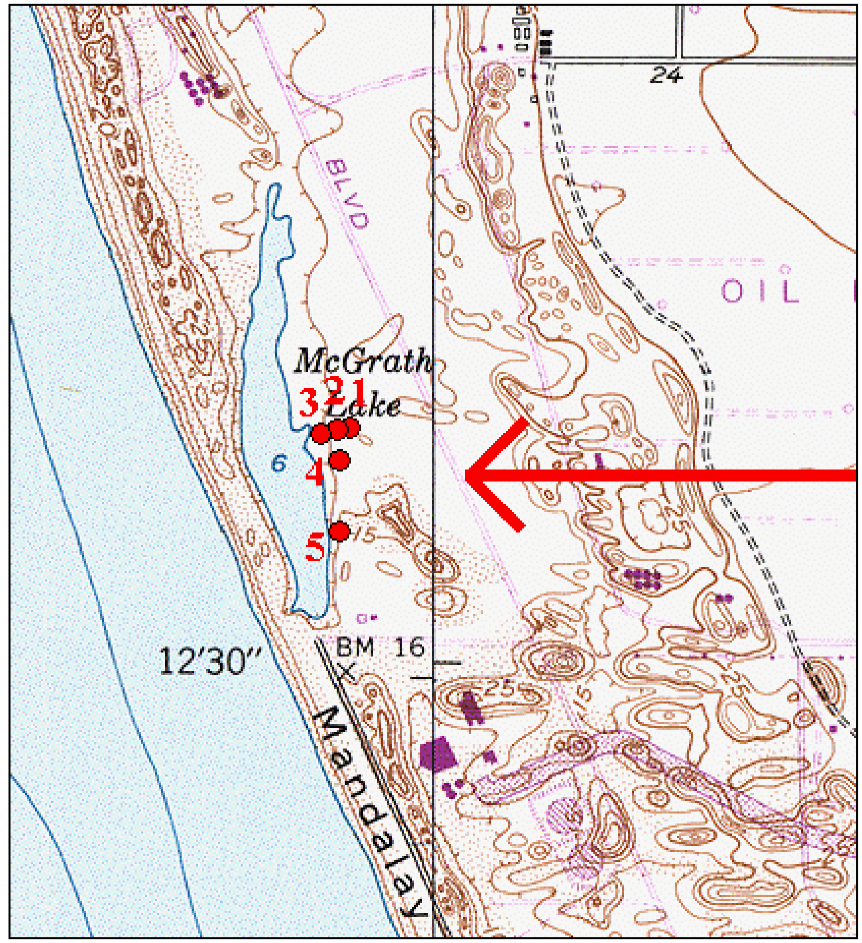

Figure 6. Five microsites selected at McGrath State Beach for establishment of experimental populations of the Ventura Marsh milkvetch, MSB-1-5.

Figure 7. Aerial photo of McGrath Lake looking east at Ventura Marsh milkvetch experimental sites, MSB-1-5. (Aerial photo taken by Kenneth Adelman in 2002 for the California Coastal Records Project.)

Figure 8. Carpinteria Salt Marsh Reserve Site CSMR-3 in July 2002.

Figure 9. Carpinteria Salt Marsh Reserve Site CSMR-4 after installation of Ventura Marsh milkvetch plants in April 2002.

Figure 10. Carpinteria Salt Marsh Reserve Site CSMR-5 in July 2002.

Figure 11. McGrath State Beach Site MSB-3 after installation of Ventura Marsh milkvetch plants in April 2002, looking SSE.

Figure 12. McGrath State Beach Site MSB-5 in July 2002.

APPENDIX B

TABLE 1. SOIL ANALYSIS OF VENTURA MARSH MILKVETCH EXPERIMENTAL INTRODUCTION SITES AT CARPINTERIA SALT MARSH RESERVE AND MCGRATH STATE BEACH AND AT EXISTING NORTH SHORE POPULATION FROM SAMPLES TAKEN FROM THE UPPER 15-30 CM OF THE SOIL

Site	Saturation[1] (%)	Salinity (mmhos/cm)	Moisture[2] (% Satn)	pH	Nitrogen (PPM)	Phosphorus (PPM)	Soluble Potassium (meq/L)	Soluble Calcium (meq/L)	Soluble Magnesium (meq/L)	Soluble Sodium (meq/L)	Sulfate (meq/L)	Chloride (meq/L)	CEC (Cation Exchg Capacity - meq/100g)	Zinc (PPM)	Manganese (PPM)	Iron (PPM)	Copper (PPM)	Boron (PPM)
Optimum Range	**20 - 60**	**0.5 - 2.0**	**10 - 25**	**5.8 - 8.2**	**10 - 70**	**12 - 60**	**0.25 - 1.0**	**2.0 - 50**	**1.5 - 60**	**0 - 25**	**0.6 - 20**	**0.1 - 4.0**	**10 - 35**	**0.7 - 50**	**1.4 - 50**	**8.0 - 100**	**0.2 - 15**	**0.3 - 2.1**
CSMR																		
1	33.2	38.60	15.3	7.9	14.1	12.0	4.90	25.0	44.0	231.00	60.0	262.00	26.00	2.9	9.1	39.4	0.8	1.70
2	40.2	27.30	25.3	8.3	15.1	11.0	3.90	14.0	29.0	167.00	34.0	189.00	34.30	3.4	7.0	51.7	1.3	2.70
3	41.0	111.00	24.2	7.9	3.7	8.0	14.00	49.0	150.0	607.00	84.0	742.00	39.20	2.7	15.5	46.8	1.5	3.00
4	34.1	20.40	15.7	7.6	21.6	9.0	4.10	28.0	29.0	103.00	10.0	157.00	14.20	2.4	5.7	20.7	0.4	0.70
5	34.4	6.15	8.3	7.3	6.2	10.0	2.70	29.9	15.0	24.90	13.9	5.02	16.60	1.6	9.4	24.7	0.5	0.60
Mean	**36.6**	**40.69**	**17.8**	**7.8**	**12.1**	**10.0**	**5.92**	**29.2**	**53.4**	**226.58**	**40.4**	**271.00**	**26.06**	**2.6**	**9.3**	**36.7**	**0.9**	**1.74**
Std. Err.	1.7	18.35	3.1	0.2	3.2	0.7	2.05	5.7	24.6	101.05	14.1	124.98	4.85	0.3	1.7	6.1	0.2	0.50
MSB																		
1	30.5	0.43	5.8	6.8	2.0	7.0	0.24	3.7	0.8	0.75	0.5	1.11	3.64	1.3	6.9	12.0	0.2	0.08
2	24.8	0.82	7.6	6.5	2.3	7.0	0.23	3.2	1.2	3.20	1.1	4.81	4.47	1.7	13.7	29.9	0.7	0.10
3	29.2	3.22	16.6	6.9	3.4	37.0	0.92	11.3	13.7	11.30	10.6	14.80	19.60	2.5	13.1	127.0	0.7	1.26
4	36.3	2.83	5.3	6.8	22.0	64.0	1.29	8.8	12.0	9.80	8.0	8.50	27.90	2.5	16.7	233.0	1.0	1.50
5	28.8	0.91	1.0	7.2	3.4	22.0	0.85	3.4	2.9	2.52	1.8	1.44	7.96	1.0	4.2	26.8	0.4	0.28
Mean	**29.9**	**1.64**	**7.3**	**6.8**	**6.6**	**27.4**	**0.71**	**6.1**	**6.1**	**5.51**	**4.4**	**6.13**	**12.71**	**1.8**	**10.9**	**85.7**	**0.6**	**0.64**
Std. Err.	1.9	0.57	2.6	0.1	3.9	10.7	0.21	1.7	2.8	2.11	2.1	2.55	4.75	0.3	2.3	42.1	0.1	0.31
NS																		
11	21.2	1.70		7.5	0.9	6.0	0.70	13.1	2.0	2.60	11.2	1.50	12.40					
12	24.4	3.20		7.6	0.9	7.0	0.70	31.9	5.7	3.20	30.0	4.20	18.20					
13	24.9	0.70		7.7	1.3	7.0	0.30	5.3	0.7	0.50	1.3	0.70	16.30					
14	25.1	4.10		7.6	0.9	6.0	2.20	22.1	4.9	10.20	14.9	20.40	19.40					
15	22.1	1.80		7.7	0.9	6.0	0.70	11.5	2.8	2.70	10.3	2.70	16.50					
Mean	**23.5**	**2.30**		**7.6**	**1.0**	**6.4**	**0.92**	**16.8**	**3.2**	**3.84**	**13.5**	**5.90**	**16.56**					
Std. Err.	0.8	0.60		0.0	0.1	0.2	0.33	4.6	0.9	1.66	4.7	3.67	1.19					

CSMR-1-5 & MSB-1-3 samples collected and analyzed October 2001
MSB-4 & MSB-5 samples collected and analyzed October 2002
NS-11-15 samples collected and analyzed in 2000 by Wilken and Wardlaw

[1]Saturation is the amount of water required to saturate 100 grams of soil. This value is approximately twice the field capacity of the soil. Soil saturation % serves as an approximation of soil texture and nutrient retention potential, in addition to its water holding capacity.

[2]Soil Moisture is a measurement of the amount of moisture present in a soil sample when received at the laboratory. The ample soil moisture % is in a range of +/- 20% of 1/2 saturation.

TABLE 2. VENTURA MARSH MILKVETCH EXPERIMENTAL INTRODUCTION SITES IN 2002.

Site #	Latitude (N)	Longitude (W)	Size	Aspect	Slope	Description	Plant Community	Soil	Associated Species	Dominant Veg cover	Total Shrub Cover	Total Veg Cover
CSMR-1	34º 24' 06.3"	119º 31' 48.9"	7.2 x 7m	0	0	Mixed Polypogon and Lolium depression west of goldenrod	Estuarine emergent wetland - high marsh	Moist sandy loam	Isocoma menziesii var. vernonioides, Polypogon monspeliensis, Aster subulatus, Atriplex californica Lolium multiflorum, Malva cf. parviflora, Melilotus indica, Salicornia subterminalis, Limonium californicum, Rumex crispus, Ambrosia psilostachya, Parapholis incurva, Frankenia salina, Distichlis spicata, Bromus hordeaceus, Bromus diandrus, Raphanus sativus, Sonchus oleraceus.	Grasses (80%)	Isocoma (45%)	85%
CSMR-2	34º 24' 06.0"	119º 31' 48.6"	8 x 7m	0	0	Polypogon depression	Estuarine emergent wetland - high marsh	Higher moisture content	Chenopodium, Heliotropium curassavicum, Distichlis spicata, Rumex crispus, Aster subulatus, Polypogon monspeliensis, Limonium californicum, Salicornia subterminalis, Atriplex californica, Ambrosia psilostachya, Bromus hordeaceus, Raphanus sativus, Frankenia salina, Euthamia occidentalis, Lolium multiflorum, Bromus diandrus Sonchus oleraceus, Melilotus indica, Malva cf. parviflora, Salicornia virginica (rare at edge).	Grasses (80%) and Ambrosia (20%)	0%	90%
CSMR-3	34º 24' 05.3"	119º 31' 48.6"	8 x 8m	0	0	Polypogon depression	Estuarine emergent wetland - high marsh	Dry clay soil	Polypogon, Salicornia subterminalis, Lasthenia glabrata coulteri, Limonium californicum, Lolium multiflorum, Parapholis incurva.	Salicornia (45%) and grasses (35%)	0%	80%
CSMR-4	34º 24' 04.7"	119º 31' 48.0"	7.5 x 6.5 m	0	0	Lolium Zone	Estuarine emergent wetland - high marsh, grassland transition zone	Dry loose sandy loam, not saline	Lolium multiflorum, Salicornia subterminalis, Bromus diandrus, Melilotus indica, Sonchus oleraceus, Atriplex cf. lentiformis.	Lolium (90%)	0%	100%
CSMR-5	34º 24' 04.5"	119º 31' 46.3"	10.6 x 6 m	0	0	Delta scrub	Palustrine wetland transition - disturbed coastal habitat	Dry sandy loam, not saline	Baccharis pilularis, Artemisia douglasiana, Ambrosia psilostachya, Lolium multiflorum, Isocoma menziesii var. vernonioides, Carduus pycnocephalus, Bromus diandrus, Euthamia occidentalis, Conium maculatum, Sonchus asper, Heliotropium curassavicum, Distichlis spicata, Vici sativa, Melilotus indica.	Grasses (70%) and Ambrosia (30%)	Baccharis and Isocoma (30%); Euthamia at northwestern edge	75%
MSB-1	34º 12' 45.6"	119º 15' 06.6"	7.5 x 7.5 m	250º	6º	Coastal sand dune rise/swell	Sparsely vegetated w/ Ericameria	Open dry sandy soil	Ericameria ericoides, Camissonia cheiranthifolia, Carpobrotus edulis, Ambrosia chamissonis, Phaceli cf. distans, Erodium cicutarium, Hypochaeris glabra, Plagiobothrys, and Bromus.	Ericameria (15%)	Ericameria (15%)	25%

Site #	Latitude (N)	Longitude (W)	Size	Aspect	Slope	Description	Plant Community	Soil	Associated Species	Dominant Veg cover	Total Shrub Cover	Total Veg Cover
MSB-2	34º 12' 45.6"	119º 15' 07.6"	6.5 x 9 m	244º	1º	Open flat on coastal sand dunes	Sparsely vegetated w/ introduced annual grassland	Open silty sand	Croton californicus, Carpobrotus edulis, Bromus hordeaceus, B. rubens, Lessingia filaginifolia, Heterotheca sessiliflora, Hypochaeris glabra, Cakile maritima, Camissonia cheiranthifolia, Camissonia (intermedia/micrantha), Schismus barbatus, Vulpia myuros, Plagiobothrys, Erodium cicutarium, Herniaria cinerea, Lastarriaea coriacea, Crassula connata, Lotus strigosus, cf. Medicago polymorpha, Senecio vulgaris. Malva cf. parviflora, Sonchus asper, and Calandrinia ciliata.	Grasses (65%) and Croton (15%)	0%	80%
MSB-3	34º 12' 45.4"	119º 15' 08.8"	8 x 6 m	0	0	Coastal dune (swale)	Baccharis, Artemisia, and Salix scrub	Open ashy soil previously burned	Ambrosia psilostachya, Artemisia douglasiana, Carpobrotus edulis, Anemopsis californica, Baccharis pilularis, Conyza, Camissonia, Oenothera elata hookeri, Oxalis, Sonchus asper, Euthamia occidentalis, Schismus barbatus, and Toxicodendron diversilobum (at edge).	Ambrosia (20%)	Baccharis (5%)	30%
MSB-4	34º 12' 43.6"	119º 15' 07.5"	7 x 10 m	0	0	Low area of coastal dunes (swale)	Semi-salt marsh w/ Baccharis	Moist to dry, more (silty) loamy	Carex cf. praegracilis, Ambrosia psilostachya, Baccharis pilularis, Chenopodium, Distichlis spicata, Bromus hordeaceus, Bromus rubens, Frankenia salina, Anemopsis californica, Tetragonia tetragonioides, Conyza bonariensis, Bromus diandrus, Carpobrotus edulis, Medicago/Melilotus.	Ambrosia (95%), Distichlis (20%) and Baccharis (15%)	Baccharis (15%)	95%
MSB-5	34º 12' 38.5"	119º 15' 07.5"	9 x 7 m	214º	0	Adjacent to marshy area	Salix & Baccharis scrub/marshy area	Dry and sandy	Salix exigua, Salix lasiolepis, Baccharis pilularis, Anemopsis californica, Potentilla anserina ssp. pacifica, Juncus mexicanus, Oenothera elata hookeri, Oxalis, Ambrosia psilostachya, Carex, Carpobrotus, Toxicodendron diversilobum, Equisetum laevigatum, Scirpus acutus occidentalis.	Salix exigua (35%) and Baccharis (25%)	Baccharis and Salix (60%)	65%

TABLE 3. SUMMARY OF VENTURA MARSH MILKVETCH SEED PROPAGATION RESULTS FROM VARIOUS SEED SOURCES IN 2001

Seed Source	Year of Collection	Mean 100-Seed Weight (g)	Seed Treatment	% Imbibition	Quantity seed sown	% Germination	Surviving seedlings to 2" pots	% Survival
North Shore	1996 & 1997	0.311	CL-Agar	100	100	56	12	12
Coal Oil Point-regenerated	2001	0.267	CL-Agar	100	110	67	61	55
RSABG-regenerated	2000	0.142	CL-Agar	100	146	52	21	14
Coal Oil Point-regenerated	2001	0.267	CL-Soil	100	219	71	136	62
Coal Oil Point-regenerated	2001	0.267	HW-Soil	46	373	29	90	24
RSABG-regenerated	2000	0.142	CL-Soil	100	690	17	53	8
Totals					**1638**		**373**	**23**

CL = clipping of seed coat
HW = hot water treatment

TABLE 4A. SUMMARY OF VENTURA MARSH MILKVETCH SURVIVORSHIP AND REPRODUCTION AT EXPERIMENTAL INTRODUCTION SITES IN 2002

SITE	NO. PLANTS INSTALLED APR 2002	LIVE PLANTS JUL 2002	DEAD PLANTS JUL 2002	% SURVIVAL JUL 2002	% MORTALITY JUL 2002	FLOWERING PLANTS JUL 2002	% FLOWERING JUL 2002
CSMR-1	31	17	14	55%	45%	2	12%
CSMR-2	31	31	0	100%	0%	17	55%
CSMR-3	31	28	3	90%	10%	1	4%
CSMR-4	31	23	8	74%	26%	15	65%
CSMR-5	31	30	1	97%	3%	18	60%
CSMR TOTAL	**155**	**129**	**26**	**83%**	**17%**	**53**	**41%**
MSB-1	33	33	0	100%	0%	12	36%
MSB-2	33	33	0	100%	0%	15	45%
MSB-3	34	34	0	100%	0%	11	32%
MSB-4	33	32	1	97%	3%	22	69%
MSB-5	34	33	1	97%	3%	23	70%
MSB TOTAL	**167**	**165**	**2**	**99%**	**1%**	**83**	**50%**
GRAND TOTAL	**322**	**294**	**28**	**91%**	**9%**	**136**	**46%**

TABLE 4B. SUMMARY OF VENTURA MARSH MILKVETCH SURVIVORSHIP AND REPRODUCTION AT EXPERIMENTAL INTRODUCTION SITES IN 2002

SITE	NO. PLANTS INSTALLED APR 2002	LIVE PLANTS NOV 2002	DEAD PLANTS NOV 2002	% SURVIVAL NOV 2002	% MORTALITY NOV 2002	REPRODUCTIVE PLANTS NOV 2002	% REPRODUCTIVE NOV 2002
CSMR-1	31	5	26	16%	84%	1	20%
CSMR-2	31	28	3	90%	10%	19	68%
CSMR-3	31	16	15	52%	48%	2	13%
CSMR-4	31	23	8	74%	26%	11	48%
CSMR-5	31	27	4	87%	13%	20	74%
CSMR TOTAL	**155**	**99**	**56**	**64%**	**36%**	**53**	**54%**
MSB-1	33	32	1	97%	3%	8	25%
MSB-2	33	25	8	76%	24%	11	44%
MSB-3	34	34	0	100%	0%	17	50%
MSB-4	33	30	3	91%	9%	19	63%
MSB-5	34	33	1	97%	3%	26	79%
MSB TOTAL	**167**	**154**	**13**	**92%**	**8%**	**81**	**53%**
GRAND TOTAL	**322**	**253**	**69**	**79%**	**21%**	**134**	**53%**

TABLE 4C. SUMMARY OF VENTURA MARSH MILKVETCH SURVIVORSHIP AND RECRUITMENT AT EXPERIMENTAL INTRODUCTION SITES IN 2003

SITE	NO. PLANTS INSTALLED APR 2002	LIVE PLANTS FEB 2003	DEAD PLANTS FEB 2003	% SURVIVAL FEB 2003	% MORTALITY FEB 2003	NO. SEEDLINGS FEB 2003
CSMR-1	31	5	26	16%	84%	0
CSMR-2	31	13	18	42%	58%	0
CSMR-3	31	1	30	3%	97%	0
CSMR-4	31	22	9	71%	29%	0
CSMR-5	31	27	4	87%	13%	0
CSMR TOTAL	**155**	**68**	**87**	**44%**	**56%**	**0**
MSB-1	33	31	2	94%	6%	0
MSB-2	33	26	7	79%	21%	0
MSB-3	34	33	1	97%	3%	12
MSB-4	33	27	6	82%	18%	32
MSB-5	34	30	4	88%	12%	2
MSB TOTAL	**167**	**147**	**20**	**88%**	**12%**	**46**
GRAND TOTAL	**322**	**215**	**107**	**67%**	**33%**	**46**

TABLE 5A. SUMMARY OF VEGETATIVE PLANTS AT VENTURA MARSH MILKVETCH EXPERIMENTAL SITES
JULY 2002

SITE	VEGETATIVE PLANTS	MEAN NUMBER OF SHOOTS/ PLANT	STD. ERR.	MEAN HEIGHT (CM)	STD. ERR.	MEAN GROWTH (CM)	STD. ERR.
CSMR-1	5	2.0	0.3	39.4	4.7	12.4	2.8
CSMR-2	14	1.6	0.2	41.4	3.0	17.2	2.1
CSMR-3	27	1.7	0.1	35.3	1.5	9.0	1.6
CSMR-4	8	2.5	0.3	40.0	3.7	17.6	4.4
CSMR-5	12	1.7	0.3	39.3	3.5	17.0	3.4
CSMR TOTAL	**66**	**1.8**	**0.1**	**38.2**	**1.2**	**13.5**	**1.2**
MSB-1	21	1.9	0.2	42.9	2.3	13.2	1.8
MSB-2	18	2.0	0.2	44.4	2.3	17.1	2.0
MSB-3	23	1.7	0.1	40.2	2.8	14.9	2.5
MSB-4	10	1.8	0.2	43.6	2.9	16.9	2.7
MSB-5	10	1.7	0.2	57.2	3.7	24.4	3.6
MSB TOTAL	**82**	**1.9**	**0.1**	**44.3**	**1.3**	**16.4**	**1.1**

TABLE 5B. SUMMARY OF REPRODUCTIVE PLANTS AT VENTURA MARSH MILKVETCH EXPERIMENTAL SITES JULY 2002

SITE	REPRODUCTIVE PLANTS	MEAN NUMBER OF SHOOTS/ PLANT	STD. ERR.	MEAN NUMBER OF FLOWERING SHOOTS/ PLANT	STD. ERR.	MEAN HEIGHT (CM)	STD. ERR.	MEAN GROWTH (CM)	STD. ERR.	MEAN NO. INFLS/ PLANT	STD. ERR.	MEAN NO. INFLS/ SHOOT	STD. ERR.
CSMR-1	2	1.5	0.5	1.0	0.0	44.0	13.0	18.0	8.0	1.0	0.0	1.0	0.0
CSMR-2	17	1.8	0.2	1.2	0.1	65.9	2.8	36.9	3.0	13.4	4.6	9.7	2.7
CSMR-3	1	1.0		1.0		48.0		25.0		4.0		4.0	
CSMR-4	15	1.9	0.2	1.1	0.1	49.1	2.2	24.9	1.9	4.3	0.5	4.0	0.5
CSMR-5	18	2.0	0.2	1.1	0.1	61.7	2.2	34.3	1.5	7.3	1.1	6.5	0.9
CSMR TOTAL	**53**	**1.9**	**0.1**	**1.1**	**0.0**	**58.6**	**1.7**	**31.7**	**1.4**	**8.1**	**1.6**	**6.6**	**1.0**
MSB-1	12	1.3	0.2	1.0	0.0	55.8	3.8	25.8	1.8	2.9	0.6	2.9	0.6
MSB-2	15	1.9	0.2	1.1	0.1	61.7	1.9	33.0	1.8	5.7	0.8	5.0	0.5
MSB-3	11	1.5	0.2	1.1	0.1	58.9	3.7	34.7	2.6	9.4	1.5	8.8	1.5
MSB-4	22	1.5	0.1	1.0	0.0	61.8	2.5	32.8	3.2	7.0	0.9	7.0	0.9
MSB-5	23	1.6	0.1	1.0	0.0	80.7	3.6	51.6	3.3	6.3	0.8	6.0	0.8
MSB TOTAL	**83**	**1.6**	**0.1**	**1.0**	**0.0**	**65.8**	**1.8**	**37.3**	**1.7**	**6.3**	**0.5**	**6.0**	**0.4**

TABLE 5C. SUMMARY OF VEGETATIVE PLANTS AT VENTURA MARSH MILKVETCH EXPERIMENTAL SITES FEBRUARY 2003

SITE	VEGETATIVE PLANTS	MEAN NUMBER OF NEW SHOOTS/ PLANT	STD. ERR.	MEAN NUMBER OF LIVE OLD SHOOTS/ PLANT	STD. ERR.
CSMR-1	5	4.6	1.3	0.0	0.0
CSMR-2	13	4.4	1.2	0.9	0.2
CSMR-3	1	1.0		0.0	
CSMR-4	22	8.2	0.7	1.0	0.2
CSMR-5	27	16.1	1.7	1.3	0.2
CSMR TOTAL	**68**	**6.9**	**2.6**	**0.6**	**0.3**
MSB-1	31	7.1	0.5	0.0	0.0
MSB-2	26	6.7	0.5	0.2	0.1
MSB-3	33	9.7	0.7	1.2	0.2
MSB-4	27	15.8	1.7	0.3	0.1
MSB-5	30	11.1	1.3	0.8	0.1
MSB TOTAL	**147**	**10.1**	**1.6**	**0.5**	**0.2**

TABLE 6A. VENTURA MARSH MILKVETCH ESTIMATES OF FLOWER AND FRUIT SET AT 2002 EXPERIMENTAL SITES

SITE	SAMPLE SIZE	MEAN FLS/INFL (JUL 2002)	STD. ERR.	SAMPLE SIZE	MEAN TOTAL FRS/INFL (NOV 2002)	STD. ERR.
CSMR-1	n=1	19.0		n=1	23.0	
CSMR-2	n=5	35.4	2.9	n=5	25.6	3.3
CSMR-3	n=1	26.0		n=1	6.0	
CSMR-4	n=5	31.8	3.3	n=5	20.4	3.0
CSMR-5	n=5	31.6	4.9	n=5	19.0	1.6
CSMR TOTAL	**n=17**	**31.7**	**2.0**	**n=17**	**20.8**	**1.7**
MSB-1	n=1	13.0		n=2	16.0	4.0
MSB-2	n=5	27.2	3.3	n=2	10.0	3.0
MSB-3	n=5	37.0	2.6	n=5	24.2	2.2
MSB-4	n=5	27.2	4.9	n=5	22.8	2.3
MSB-5	n=5	32.6	6.0	n=5	19.8	1.6
MSB TOTAL	**n=21**	**30.1**	**2.3**	**n=19**	**20.3**	**1.4**

TABLE 6B. VENTURA MARSH MILKVETCH ESTIMATES OF MATURE FRUIT AND SEED SET AT 2002 EXPERIMENTAL SITES

SITE	SAMPLE SIZE	MEAN MATURE FRS/INFL (NOV 2002)	STD. ERR.	MEAN MATURE SEEDS/ FRUIT (NOV 2002)	STD. ERR.	MEAN 100-SEED WEIGHT (G)	STD. ERR.
CSMR-1	n=1	10.0		2.8		0.307	
CSMR-2	n=5	10.4	2.4	3.5	0.5	0.326	0.010
CSMR-3	n=1	3.0		5.7		0.300	0.015
CSMR-4	n=5	7.4	2.7	4.1	0.4	0.290	0.009
CSMR-5	n=5	9.8	2.5	4.0	0.4	0.315	
CSMR TOTAL	**n=17**	**8.9**	**1.3**	**3.9**	**0.3**	**0.310**	**0.006**
MSB-1	n=3	15.3	4.8	4.5	0.3	0.286	0.006
MSB-2	n=1	11.0		5.0		0.282	
MSB-3	n=5	13.0	3.1	4.4	0.8	0.314	0.014
MSB-4	n=5	17.6	4.2	3.9	0.7	0.303	0.007
MSB-5	n=5	10.0	2.8	4.1	0.6	0.287	0.019
MSB TOTAL	**n=19**	**13.7**	**1.7**	**4.2**	**0.3**	**0.298**	**0.007**