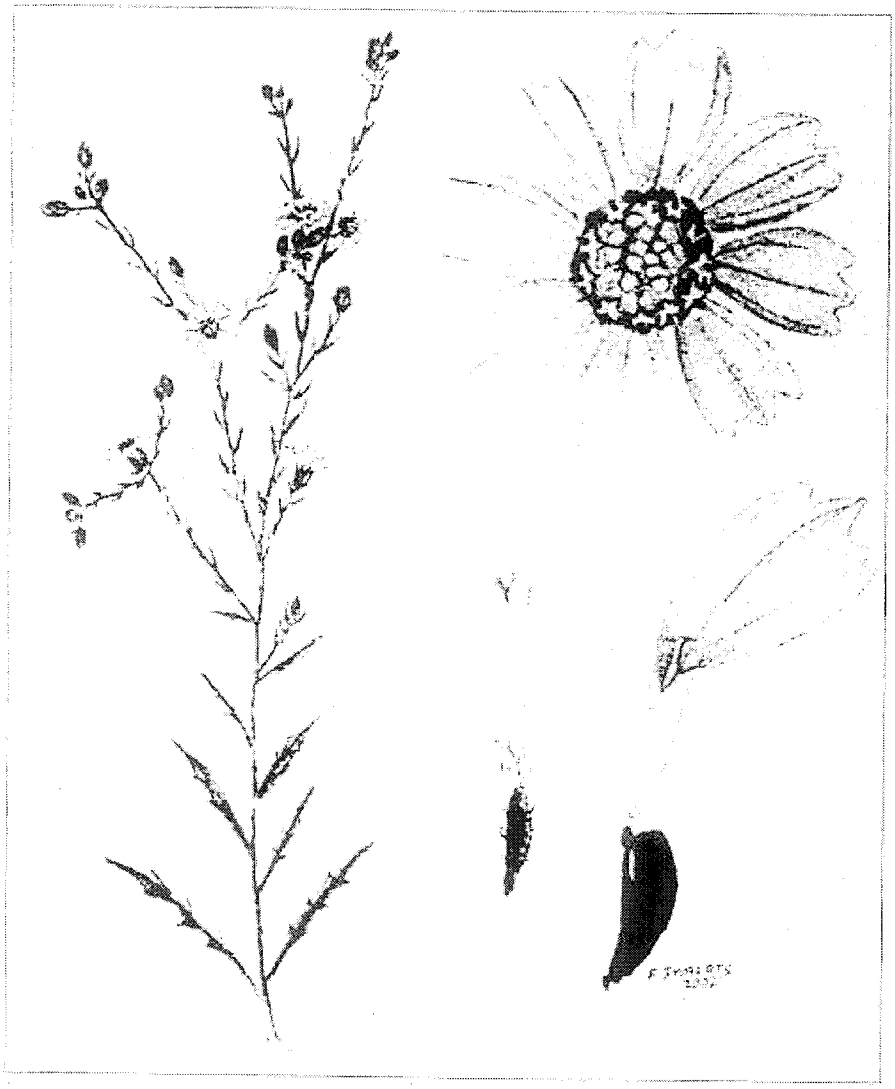
Recovery Plan for
Deinandra conjugens
(Otay tarplant)



RECOVERY PLAN

FOR

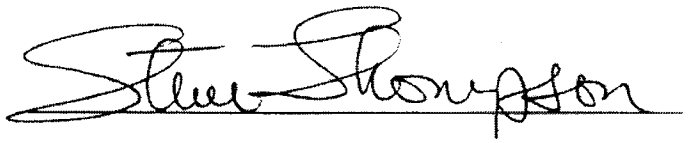
DEINANDRA CONJUGENS

(OTAY TARPLANT)

Region 1

U.S. Fish and Wildlife Service

Portland, Oregon

Approved: 

Manager, California/Nevada Operations Office

Region 1, U.S. Fish and Wildlife Service

Date: 12/07/2004

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Recovery plans delineate actions required to recover and protect federally listed plant and animal species. We (the U.S. Fish and Wildlife Service) publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and other affected and interested parties. Recovery teams serve as independent advisors to the U.S. Fish and Wildlife Service. Draft recovery plans are published for public review and submitted to scientific peer review before we adopt them. Objectives of the recovery plan will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific recovery actions and do not necessarily represent the view, official position, or approval of any individuals or agencies involved in the plan formation other than our own. They represent our official position **only** after they have been signed by the Director, Regional Director, or California/Nevada Operations Manager as **approved**. Approved recovery plans are subject to modification as directed by new findings, changes in species status, and the completion of recovery actions.

Literature Citation should read as follows:

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EXECUTIVE SUMMARY

Current Status

Deinandra conjugens (Otay tarplant) is federally listed as a threatened species. The species occurs in southwest San Diego County, California, and in northern Baja California, Mexico; its status in Mexico is unclear. Critical habitat within the United States for the species was designated on December 10, 2002. The United States portion of this species' range occurs entirely within the Multiple Species Conservation Planning (MSCP) area in California, including three associated Subarea Plans: City of San Diego, County of San Diego, and the City of Chula Vista. These Subarea Plans, if implemented, contribute to the conservation of *D. conjugens* and many other listed and non-listed species, in perpetuity, by establishing a reserve system, protecting key populations, and implementing monitoring and management plans. Additionally, other proposed and existing habitat conservation plans address *D. conjugens*. Primary threats to the species include the ongoing loss and degradation of suitable habitat, and fragmentation of remaining populations.

Habitat Requirements and Limiting Factors

Deinandra conjugens is an annual plant in the sunflower family (Asteraceae). *Deinandra conjugens* has a self-incompatible breeding system (an individual plant cannot pollinate itself, so successful reproduction requires pollination from an individual with a different genetic structure). The species' distribution is strongly correlated with clay soils, subsoils, or lenses (isolated areas of clay soil) that typically support grasslands, but may support some woody vegetation. Much of the area with clay soils and subsoils within the historical range of *D. conjugens* likely was once vegetated with native grassland, open coastal sage scrub, and maritime succulent scrub, which provided suitable habitat for the species. Urban development and agricultural activities, invasion of nonnative species, and habitat fragmentation and degradation have resulted in the loss of suitable habitat across the species' range. The species annual habit and self-incompatible breeding system potentially create additional threats from population fluctuations, reduced populations of pollinators and a decline in genetic variation. Maintenance of the genetic variability within the species, through cross-pollination, may be critical to long-term survival. The extensive fragmentation of remaining populations may exacerbate these threats by reducing connectivity between populations and potentially limiting suitable pollinators, and hence gene flow between populations.

Recovery of the species is dependent upon the conservation of sufficient habitat to sustain populations of *Deinandra conjugens* and its associated pollinators, maintenance of genetic variability within the species, and providing connections between conserved populations to ensure gene flow (through cross pollination or seed dispersal).

Recovery Priority

This species' recovery priority number is 5, per criteria published in the Federal Register (U.S. Fish and Wildlife Service 1983a, 1983b). The priority is based on designation as a species with a high degree of threat and a low potential for recovery, given our current understanding of the biology of the species and its associated threats.

Recovery Goal

The goal of this recovery plan is to recover *Deinandra conjugens* sufficiently to warrant delisting.

Recovery Objectives

1. Stabilize and protect habitat that supports known populations of *Deinandra conjugens* within areas identified for conservation under the MSCP.

2. Identify and protect extant populations of *Deinandra conjugens* and available suitable unoccupied habitat that are important to maintain genetic diversity and connectivity between established reserves.

3. Reduce and manage threats to *Deinandra conjugens*. Such threats include (but are not limited to) invasion and competition by invasive non-native weeds and factors that reduce or limit genetic diversity within areas that preserve *Deinandra conjugens* populations.

4. Conduct research necessary to refine recovery criteria.

Recovery Criteria

Deinandra conjugens may be considered for delisting when the following conditions are met:

1. Known populations (including naturally occurring seed banks) within areas identified for conservation under the MSCP are permanently protected from future development or other significant threats.

2. Permanent funding and management mechanisms that are required under the MSCP are in place and functioning.

3. Established reserves (*i.e.,* MSCP preserve lands, land protected under other habitat conservation plans, National Wildlife Refuge lands, and State preserve lands) provide sufficient suitable habitats and space to sustain the full ecological needs of *Deinandra conjugens*. We expect these needs to include: a) connectivity to maintain natural gene flow among conserved populations, and b) sufficient habitat to maintain wild populations of native *D. conjugens* pollinators.

4. Populations of *Deinandra conjugens* are stable or increasing within established reserves. As discussed by Rice (1989), seed banks typically are "more developed in annuals than in perennials" and "more extensive in forbs than in grasses." For *D. conjugens*, an annual forb, population stability will depend on the long-term maintenance of the seed banks within each reserve. The primary factors that may threaten the long-term maintenance of *D. conjugens* and its seed banks include reduced or failed pollination (*i.e.,* pollinators) and fruiting, excessive seed predation, loss of genetic variability and inbreeding, and impaired seed dispersal within and potentially among reserves.

5. Criteria 3 and 4 have been assessed through monitoring over an adequate length of time to incorporate year-to-year variability associated with known variations in climate (*e.g.,* drought, El Niño/Southern Oscillation, etc.). We anticipate a period that encompasses three drought cycles; however, this time period may change should additional scientific information on the amount of time necessary to adequately determine the population trend of *Deinandra conjugens* indicate otherwise. If the species is delisted, the monitoring period will be extended for an additional 5 years after delisting, as required by the Endangered Species Act for species that are delisted due to recovery.

6. The current status (including a threats assessment) and distribution of *Deinandra conjugens* have been determined in Mexico.

7. Depending on the results from criterion 6, dialogue should be established with Mexican governmental and nongovernmental organizations to secure protection for *Deinandra conjugens* in Mexico.

8. Research on several critical aspects of the species' biology and ecology, as detailed in the Recovery Narrative section, has been completed to adequately assess the above recovery criteria. Results should be published in readily available refereed journals. Results from this research may redirect the recovery strategy.

Actions Needed

1. Stabilize and protect habitat supporting known populations within the conserved areas under MSCP control, outside of MSCP control, and in Mexico.

2. Assess the status of all known populations to determine: population size (area and number of individuals), reproduction, distribution, threats to stability or viability, and land management objectives.

3. Conduct surveys to search for new populations and implement actions to protect populations outside of established reserves when necessary to maintain genetic diversity and/or connectivity between larger reserves.

4. Adaptively manage and monitor conserved areas.

5. Identify research needs and conduct studies on the biology and ecology of *Deinandra conjugens*.

6. Develop and implement a community outreach program.

Total Estimated Cost of Recovery

$17,385,000 over 21 years, plus additional costs that cannot be determined at this time.

Date of Recovery

Delisting could be initiated by 2025, if recovery criteria are met.

TABLE OF CONTENTS

I. INTRODUCTION 1
A. Brief Overview 1
B. Description and Taxonomy 2
C. Life History and Ecology 6
D. Distribution and Population Status 9
E. Critical Habitat 18
F. Reasons for Decline and Current Threats 19
1. Loss and Degradation of Habitat 19
2. Habitat Fragmentation/Isolation 20
3. Non-native plant interactions 21
4. Population Dynamics 21
5. Genetics 22
6. Plant/pollinator interactions and ecology 24
G. Conservation Measures 25
1. Regional Planning 26
2. San Diego National Wildlife Refuge 27
3. California Department of Fish and Game 28
H. Recovery Strategy 28
II. RECOVERY 31
A. Objectives 31
B. Recovery Criteria 31
C. Stepdown Narrative 33
1. Stepdown Outline 34
2. Recovery Narrative 37
III. IMPLEMENTATION SCHEDULE 48
A. Literature Cited 56
B. Personal Communications 60
C. *In Litt.* References 60

APPENDIX A. Summary of Threats and Recommended Recovery Actions 62

APPENDIX B. Summary of Comments 63

LIST OF FIGURES

Figure 1. Historic and current distribution of principal *Deinandra conjugens* localities, and boundaries of preserved and mitigation land under MSCP Subareas, southwestern San Diego County, California 3

Figure 2. Broad-scale distribution of clay soils known to support *Deinandra conjugens*, southwestern San Diego County, California 10

I. INTRODUCTION

A. Brief Overview

We, the U.S. Fish and Wildlife Service, listed *Deinandra conjugens* (Otay tarplant) as a federally threatened species on October 13, 1998 (U.S. Fish and Wildlife Service 1998); we designated critical habitat on December 10, 2002 (U.S. Fish and Wildlife Service 2002). *Deinandra conjugens* has a narrow ecological distribution and is endemic to southwestern San Diego County, California, and northwestern Baja California, Mexico. The species' distribution in Mexico is limited (see U.S. Fish and Wildlife Service 2002 and references therein) and its status there is uncertain. The primary reasons for the decline of *D. conjugens* are the loss, fragmentation, and degradation of its habitat by urban and agricultural developments and the introduction and spread of non-native, invasive plants (weeds).

In southwestern San Diego County, the distribution of *Deinandra conjugens* (Figure 1) occurs entirely within the planning area for the San Diego Multiple Species Conservation Program (MSCP; City of San Diego 1998). The MSCP is a regional habitat conservation planning program that provides long-term preservation for multiple species and their habitats. It also provides for the preservation of natural communities in southwestern San Diego County (see also Conservation Measures/Regional Planning, section I.G.1 below, for additional information on the MSCP). The range of *D. conjugens* is within three participating MSCP jurisdictions: City of San Diego (City of San Diego 1997); County of San Diego (County of San Diego 1997); and the City of Chula Vista* (City of Chula Vista 2003). Participating MSCP jurisdictions each prepare a Subarea Plan that establishes open space preserves to permanently protect covered

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* We worked with the City of Chula Vista to finalize their Subarea Plan. We are continuing to work with the City of Chula Vista regarding their Implementing Agreement. We anticipate the outstanding issues will be resolved soon and we expect this process will not change how *Deinandra conjugens* is addressed in the Subarea Plan. For the purposes of this recovery plan, we assume that the Chula Vista MSCP Subarea Plan will be implemented. The MSCP and its associated Subarea Plans, and especially the Chula Vista Subarea Plan, are important components in the preservation of *D. conjugens*. In the event that the Chula Vista Subarea Plan does not become effective and operational in a timely manner or if the way *D. conjugens* is addressed in the Chula Vista Subarea Plan changes, this recovery plan may need to be revised.

species, including *D. conjugens*. Preserves will be managed and monitored in perpetuity under plans that are to be developed and implemented in accordance with the Subarea Plans. However, within the boundaries of the MSCP planning area, certain populations of *D. conjugens* occur on water district or other lands that, while within the boundaries of participating jurisdictions' Subarea Plan area, are not subject to the respective plan's requirements. In some cases, these areas also have or are anticipated to have regional habitat conservation plan coverage outside of the MSCP (*e.g.*, San Diego Gas and Electric [SDG&E 1995]; Sweetwater Authority, respectively).

Although some *Deinandra conjugens* populations are not subject to the provisions of the MSCP, the majority of the extant *D. conjugens* populations are. Therefore, the MSCP is a major contributor to the recovery of *D. conjugens*. In reviewing and approving the MSCP, we concluded that the plan will not jeopardize the continued existence of *D. conjugens*. In other words, we concluded that the MSCP will not "reduce appreciably the likelihood of both the survival and recovery" of the covered species (50 CFR 402.02). We also acknowledged that the MSCP incorporates measures that will allow for the species' eventual recovery.

The recovery strategy identified in this plan includes actions that go beyond those specified in the MSCP. These actions will enhance *Deinandra conjugens*' prospects for recovery. However, this recovery plan does not change the requirements or specified activities within the MSCP. Participating jurisdictions must continue to implement the conservation measures as specified under their respective Subarea Plans to protect *D. conjugens*; however, they are not required to implement additional measures identified in this recovery plan. Any additional measures to provide for the recovery of this species will be undertaken by us or other willing entities.

B. Description and Taxonomy

Deinandra conjugens was known as *Hemizonia conjugens* when it was originally listed as threatened (U.S. Fish and Wildlife Service 1998). Since then, studies analyzing plant and floral morphology and genetic information prompted Baldwin (1999) to revise the Madiinae (tarplants), a subtribe of the tribe Heliantheae in the Asteraceae (sunflower family), and segregate several taxa into new or different genera. As a result, *Deinandra conjugens* is now the accepted scientific name for

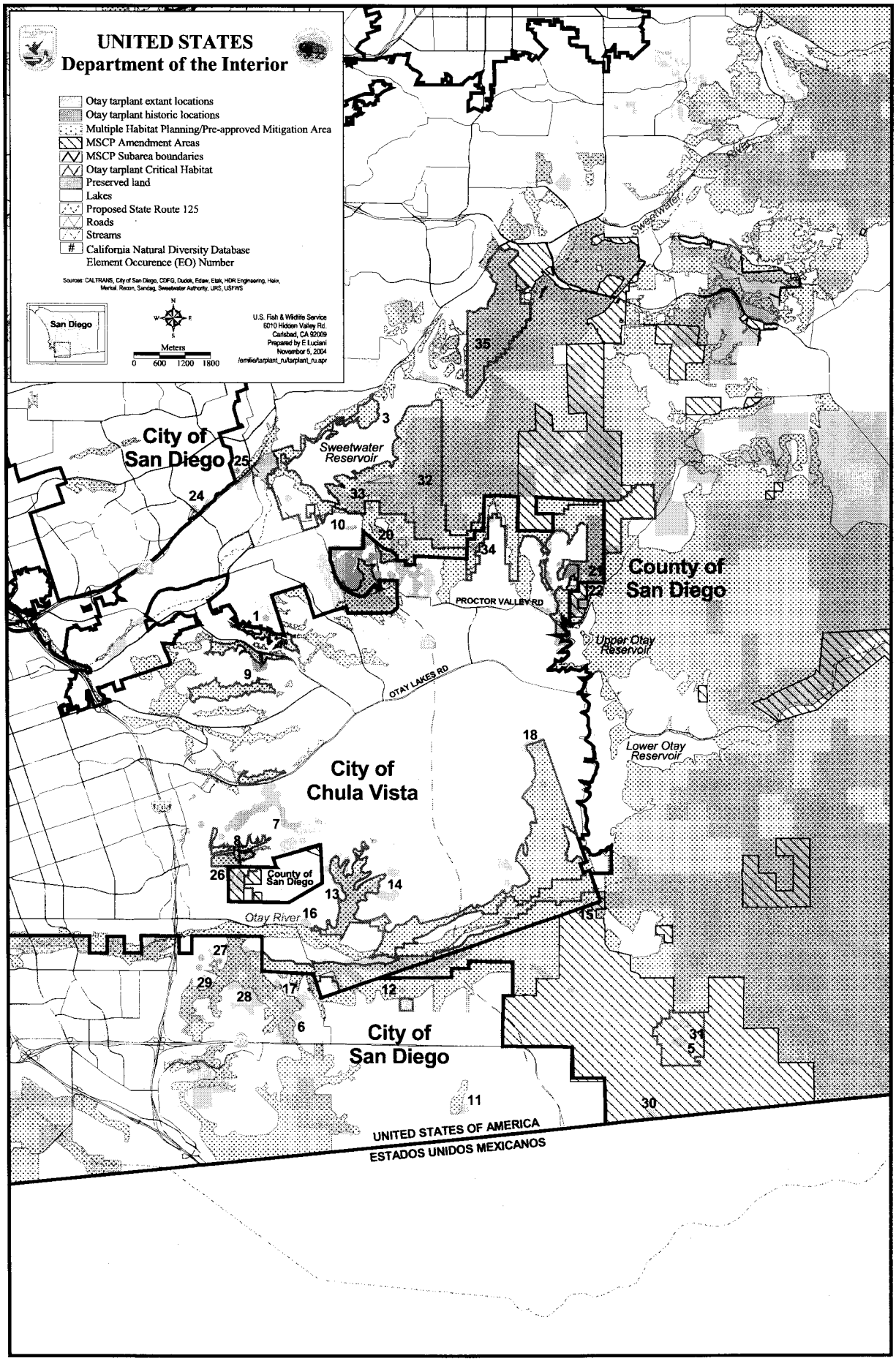

Figure 1. Historic and current locations of principal *Deinandra conjugens* localities, and boundaries of preserved and mitigation land under MSCP Subareas, southwestern San Diego County, California

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Hemizonia conjugens. This taxonomic change does not alter the geographic range, identifying characteristics, or definition of the species. We have changed the name of *Hemizonia conjugens* to *Deinandra conjugens* in the List of Threatened and Endangered Plants, 50 CFR 17.12 (h), and will refer to the species as *Deinandra conjugens* in this recovery plan.

Deinandra conjugens is a glandular, aromatic annual plant in the family Asteraceae. It was first described by David D. Keck (1958) as *Hemizonia conjugens* based on a specimen collected by L.R. Abrams in 1903 from river bottom land in the Otay Valley area of San Diego County, California. *Deinandra conjugens* has a branching stem that generally ranges from 5 to 25 centimeters (2 to 10 inches) in height with deep green or gray-green leaves covered with soft, shaggy hairs. The yellow flower heads are composed of 8 to 10 ray flowers and 13 to 21 disk flowers with hairless or sparingly downy corollas (fused petals). The phyllaries (small bracts associated with the flower heads) are ridged and have short-stalked glands and large, stalkless, flat glands near the margins. *Deinandra conjugens* occurs within the range of *D. fasciculata* [= *H. fasciculata*] (fasciculated tarplant) and *D. paniculata* [= *H. paniculata*] (San Diego tarplant). *Deinandra conjugens* can be distinguished from other members of the genus by its ridged phyllaries, black anthers (part of flower that produces pollen), and by the number of disk and ray flowers. The disk and ray flowers each produce different types of fruits (heterocarpy), which has been correlated to different germination responses (Tanowitz *et al.* 1987).

C. Life History and Ecology

Deinandra conjugens, like most other tarplants, is sporophytically self-incompatible (Keck 1959; B. Baldwin *in litt.* 2001). Within a sporophytically self-incompatible pollination system, a species typically has one self-incompatibility gene, often with many different alleles (alternative forms of a particular gene). A self-incompatible individual cannot be fertilized with its own pollen or with pollen from another plant that shares a self-incompatibility allele; an individual will only produce viable seeds when cross pollinated by an individual that does not share either allele. Sporophytic refers to the type of self-incompatibility; in this case, if the genotype of the stigma (female reproductive organ of a plant) shares an allele with the genotype of the pollen, rejection of the pollen occurs and the plant is not fertilized.

Gene flow among plant populations through pollination is important for the long-term survival of self-incompatible species (Ellstrand 1992). We anticipate gene flow among *Deinandra conjugens* occurrences is primarily achieved through pollen movement. Thus pollen movement is very important to maintaining genetic diversity between extant populations and within the species. Seed dispersal may also facilitate gene flow in contiguous habitat areas; however, we anticipate pollen movement to be a more effective agent of gene flow than seed dispersal. Some of the smaller populations of *D. conjugens* are believed to be essential to the survival and conservation of the species because they may be strategically located between larger populations, facilitating gene flow among them, and may contain unique frequencies of self-incompatibility alleles. Conservation of these populations may be very important to maintaining genetic diversity in *D. conjugens*.

Likely pollinators of *Deinandra conjugens* include, but are not limited to: bee flies (Bombylliidae), hover flies (Syrphidae), digger bees (Apidae), carpenter and cuckoo bees (Anthophoridae), leaf mason and leaf cutting bees (Megachilidae), and metallic bees (Halictidae) (Krombein *et al.* 1979; Bauder *et al.* 2002; M. Dodero, pers. comm. 2001). The following bee species have been documented visiting *Deinandra* species: *Nomia melanderi*, *Colletes angelicus*, *Nomadopsis helianthi*, *Ventralis claypolei ausralior*, *Anthidiellum notatum robertsoni*, *Heriades occidentalis*, *Anthocopa hemizoniae*, *Ashmeadiella californica californica*, *Svastra sabinensis nubila*, *Melissodes tessellata*, *M. moorei*, *M. personatella*, *M. robustior*, *M. semilupina*, *M. lupina*, *M. stearnsi*, *Anthophora urbana urbana*, and *Anthophora curta curta* (Krombein *et al.* 1979).

Deinandra conjugens fruits (achenes) are each one-seeded and have the potential to be dispersed by small to large-sized mammals and birds based on the sticky nature of the remaining flower parts that are attached to the fruits and the discontinuous distribution of other tarplants (U.S. Fish and Wildlife Service 2002, and references therein). Potential seed/fruit dispersal organisms known to occur in the region include, but are not limited to, mule deer (*Odocoileus hemionus*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), black-tailed jackrabbit (*Lepus californicus bennettii*), bobcat (*Felis rufus*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), California ground squirrel (*Spermophilus beecheyi*), and various small land birds. Additionally, in the late summer, dried *D. conjugens* plants may be blown by the wind (A. Davenport *in litt.* 2004) thereby moving seeds.

A seed bank (a reserve of viable, ungerminated seeds in a habitat; Baskin and Baskin 2001) is important for year-to-year and long-term survival of many annual or short-lived perennial species (Rice 1989; Given 1994). In general, a seed bank includes all of the seeds produced in a population from the current and previous growing seasons (generations) and is typically found in the soil, although some seeds (fruits) may occur on the soil surface, in the leaf litter or duff, or even remain on the dead parent plant (Baskin and Baskin 2001, and references therein). Because clay soils tend to crack during the dry season, the time when *Deinandra conjugens* seeds are typically released, *D. conjugens* seeds may fall into those cracks and also become mixed deeper in the soil column. Additional information is needed on *D. conjugens* seed dispersal and seed bank longevity. Nevertheless, the extent and nature of the seed bank can influence the number and location of standing *D. conjugens* plants in a population. Additional factors, including the amount and timing of rainfall, temperature, and soil conditions also influence germination. As a result, the extent and distribution of observable, standing plants may not coincide with the full extent of the seed bank.

Large annual fluctuations in the number of standing plants of *Deinandra conjugens* in a given population have been documented. Population size has ranged from 1 to more than 5,400 standing plants at a site on northwest Otay Mesa (City of San Diego 1999; California Natural Diversity Data Base 2002), from approximately 100 to 50,000 at a site in Rice Canyon (California Natural Diversity Data Base 2002), and from approximately 280,000 to 1.9 million at San Miguel Ranch South (Merkel & Associates 1999; California Natural Diversity Data Base 2002). In any given year, the observable plants in a population are only the portion of the individuals from the seed bank that germinated that year. These annual fluctuations may make it appear as though a population of annual plants "moves" spatially from year to year, when in actuality, a different portion of a population (the seed bank) germinates and flowers each year. The spatial distribution of a standing population of annual plants is generally the result of the spatial distribution of the micro-environmental conditions conducive to seed germination and growth of the plants.

The fluctuation in the number of standing *Deinandra conjugens* plants is likely associated with fluctuations in rainfall, although other factors may influence *D. conjugens* growth. Rainfall in the coastal United States/Mexico borderland area is influenced by El Niño/Southern Oscillation events, with wetter conditions in "El Niño" years and dryer conditions in "La Niña" years (Minnich *et al.* 2000). El

Niño/Southern Oscillation events occur irregularly, approximately every 2 to 7 years (National Oceanic and Atmospheric Administration 2004), with La Niña events sometimes occurring in between; however, El Niño/Southern Oscillation events are not the only source of rainfall variation. Although abundant rainfall would typically be expected to be beneficial to *D. conjugens*, it is also likely to be beneficial to non-native weeds. These weeds may out-compete *D. conjugens* or limit visitation from pollinators (Bauder *et al.* 2002). Additional research is needed to determine the effects of between-year and within-year timing of rainfall and the effects of prolonged drought on *D. conjugens* and the weeds with which it competes.

The presence of *Deinandra conjugens* is strongly correlated with clay soils, subsoils, or lenses (Figure 2) (Beauchamp 1986, S. Morey *in litt.* 1994, Bauder *et al.* 2002). Clay lenses are small areas of clay soils in a matrix of other soils. Isolated lenses may not have been mapped by broad-scale soil surveys. Soils that support *D. conjugens* typically support grasslands, but may also support some woody vegetation. Much of the area with clay soils and subsoils within the historical range of *D. conjugens* likely was once vegetated with native grassland, open coastal sage scrub, and maritime succulent scrub. Based on Geographic Information System (GIS) analysis, most current and historical *D. conjugens* occurrences are found on clay soils or lenses in one of the following soil series: Diablo, Olivenhain, Linne, Salinas, Huerhuero, Auld, Bosanko, Friant, and San Miguel-Exchequer rocky silt loams (Bauder *et al.* 2002).

Deinandra conjugens is found in vegetation communities classified as, but not limited to grasslands, open coastal sage scrub, and maritime succulent scrub, as well as the margins of some disturbed sites and cultivated fields (U.S. Fish and Wildlife Service 2002 and references therein, including: Keck 1959; Keil 1993; California Native Plant Society 2001; California Natural Diversity Data Base 2002; D. Hogan *in litt.* 1990; B. Baldwin, pers. comm. 2001; M. Dodero, pers. comm. 2001; S. McMillan, pers. comm. 2001). Plant species common to these vegetation communities include *Nassella* spp. (needlegrass), *Bloomeria crocea* (common goldenstar), *Dichelostemma pulchella* (blue dicks), *Chlorogalum* spp. (soap plant), *Bromus* spp. (brome grass), *Avena* spp. (oats), *Deinandra fasciculata* (fasciculated tarweed), *Lasthenia californica* (common goldfields), *Artemisia californica* (California sagebrush), *Eriogonum fasciculatum* (flat-top buckwheat), *Lotus scoparius* (deer weed), *Salvia* spp. (sage), *Mimulus aurantiacus* (bush monkeyflower), *Malacothamnus fasciculatum* (bushmallow),

Malosma laurina (laurel sumac), *Rhus ovata* (sugar bush), *R. integrifolia* (lemonade berry), *Lycium* spp. (boxthorn), *Euphorbia misera* (cliff spurge), *Simmondsia chinensis* (jojoba), *Opuntia* spp. (prickly pear and cholla cactuses), *Ferocactus viridescens* (coastal barrel cactus), *Ambrosia chenopodiifolia* (San Diego bur sage), and *Dudleya* spp. (live-forevers).

D. Distribution and Population Status

Throughout this document, "occurrence", "site", "patch", or "population" will represent either a site as described in the listing rule (U.S. Fish and Wildlife Service 1998) or a corresponding California Natural Diversity Database Element Occurrence code (EO-codes). The Element Occurrence code will be listed in parentheses (for example, EO 12). These terms are used in a practical sense to indicate the occurrence of one or more plants at a defined geographical location, and do not imply that the designated group of plants is necessarily a "population" in the strict biological sense of the word.

Deinandra conjugens has a narrow geographic and elevational range (Figure 1), which at the time of listing in 1998, was generally defined by at least 25 historic populations near Otay Mesa in southern San Diego County and 1 population near the United States border in Baja California, Mexico (California Department of Fish and Game 1994, Reiser 1996, Roberts 1997, S. Morey *in litt.* 1994). Since listing, the known range for *D. conjugens* in San Diego County, California, has been extended from the Mexican border north to the Jamacha area, a distance of about 19.5 kilometers (12 miles), and from the City of San Diego's Encanto community and Otay River Valley just west of Interstate 805 east to Rancho Jamul Ecological Reserve, a distance of about 20 kilometers (12.5 miles) (herbarium records at the San Diego Natural History Museum; California Natural Diversity Data Base 2002; U.S. Fish and Wildlife Service GIS database 2004). Further, the elevational range for *D. conjugens* appears to be between 25 and 300 meters (80 and 1,000 feet) (U.S. Fish and Wildlife Service GIS database 2004).

As mentioned above, the distribution of *Deinandra conjugens* is strongly correlated with clay soils (Figure 2). Given the distribution of these clay soils, the range of *D. conjugens* likely included much of the Otay Ranch's Otay Valley Parcel (in eastern Chula Vista), and Otay Mesa (south of the Otay River and west of Otay Mountain). However, much of these areas have been used for agriculture (Beauchamp 1986; City of San Diego 1998), which has likely caused the

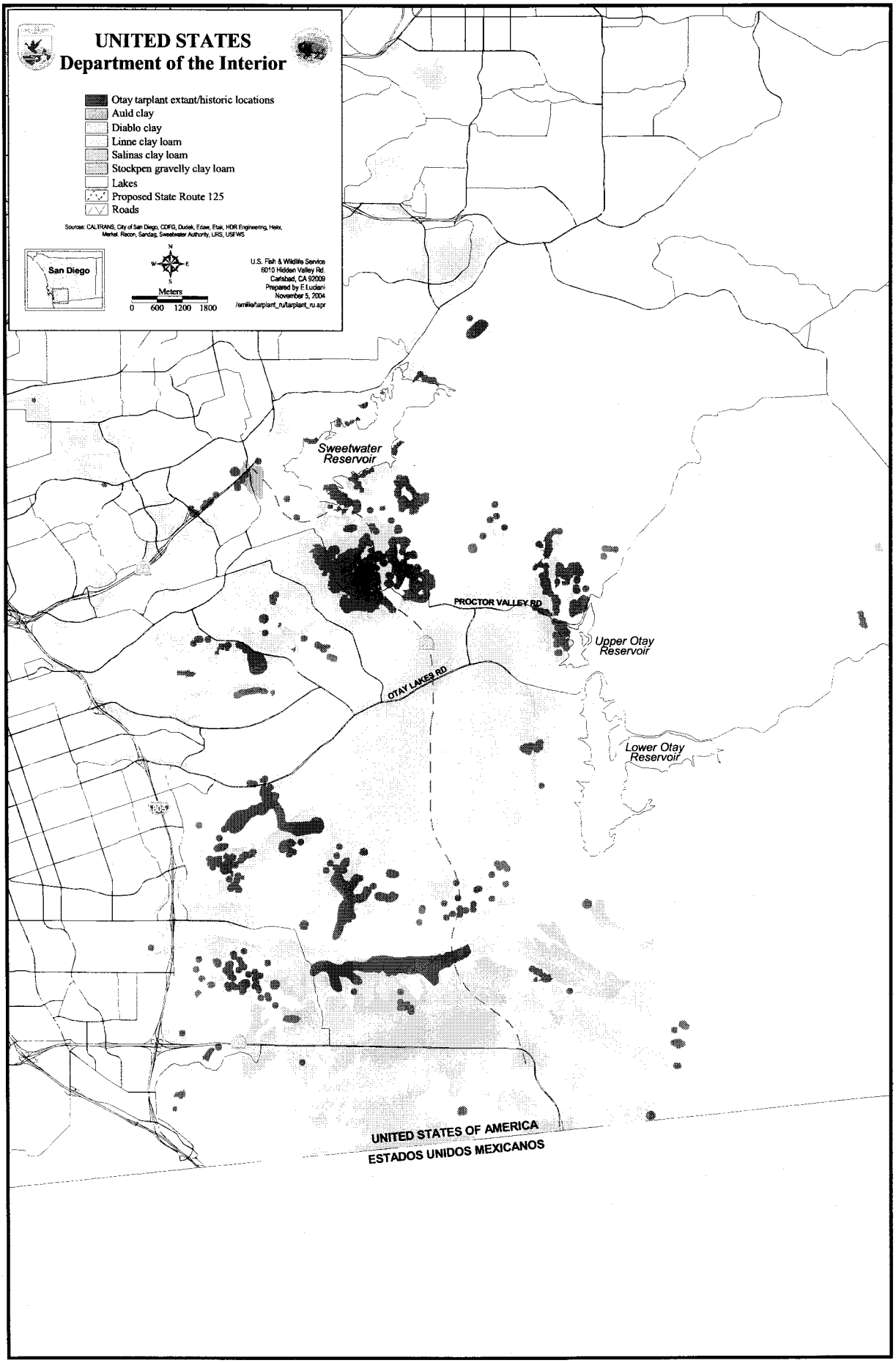

Figure 2. Broad-scale distribution of clay soils known to support *Deinandra conjugens*, southwestern San Diego County, California

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extirpation of *D. conjugens* from the heart of its former U.S. range. Currently, *D. conjugens* appears to occur as somewhat isolated occurrences around the fringes of its more continuous former range.

As discussed under Life History and Ecology (section I.C above), determining the actual size (area) or magnitude (number of individual plants) of a given *Deinandra conjugens* population is difficult due to the potentially dramatic between-year fluctuations that have been documented in extant populations of standing plants. Conditions during some years are better for growth and reproduction of *D. conjugens* in some populations (and even some portions of a population) than during other years. Because the number of standing plants in a given population can vary by orders of magnitude from one year to the next, the number of standing plants observed in a population in any one year does not necessarily indicate the potential magnitude of that population. An observation of standing plants at a given location in a given year provides a minimum number of plants that may be supported at that locale. However, additional information should be considered in the interpretation of such an observation. In particular, caution should be exercised in drawing conclusions regarding areal or numerical size of a novel *D. conjugens* population without also comparing the observations to those made at nearby known populations. Additionally, because of the similarity of appearance between *D. conjugens* and other, more abundant and potentially co-occurring (sympatric) species, care should be exercised while conducting surveys for *D. conjugens* to ensure that all observed tarplant-type plants are correctly identified to species, including within patches that appear to be homogeneous.

At the time of listing (1998), the 5 largest populations of *Deinandra conjugens* (Rancho San Miguel [EO 10 and 20], Rice Canyon [EO 9], Dennery Canyon [EO 6, 17, 27, 28, and 29], Poggi Canyon [EO 7, 8, and 26], and Proctor Valley [EO 21 and 22]) were known to support about 98 percent of all reported standing plants (City of Chula Vista 1992, S. Morey *in litt.* 1994, Brenda Stone *in litt.* 1994, San Diego Gas and Electric 1995, Roberts 1997) with each occurrence reportedly containing more than 10,000 standing plants. Portions of the two larger populations, Rancho San Miguel and Proctor Valley, have been lost to development, with the remaining areas protected through dedicated open space reserves under the MSCP, or as part of the San Diego National Wildlife Refuge. Additionally, other populations have been discovered since listing. The current status of most known extant populations (Figure 1) is described below; some

populations have not been surveyed recently and no information is available for them.

The San Diego National Wildlife Refuge (EO 32 and 35) includes scattered populations of *Deinandra conjugens*, with the larger populations occurring along the western slopes of Mother Miguel Mountain (EO 32). These populations occur in open coastal sage scrub and (native and non-native) grassland areas, including areas degraded by past agricultural activities. We are conducting surveys to better document these occurrences and have begun weed abatement activities, and a management plan is being developed.

The Sweetwater Reservoir populations (EO 3, 33) occur mostly within the Sweetwater Authority property, with a small portion of EO 33 protected by the San Diego National Wildlife Refuge. The population is estimated to be about 50,000 individuals. A historical location on the northeast side of the reservoir has been extirpated by residential development. Also, recent field data indicate that some of EO 3 may have included misidentified *Deinandra fasciculata* (P. Famolaro, pers. comm. 2004). The Sweetwater Authority has provided updated distributional information for this area. These populations (EO 3 and 33) occur on opposite sides of the reservoir and are not directly connected. Although these populations are not currently protected by any agreement, the Sweetwater Authority is aware of their locations and is actively working to minimize impacts for the portions in their control. They are also preparing a multiple species Habitat Conservation Plan that is anticipated to address *D. conjugens*. Additionally, we have initiated intensive surveys on our Refuge property. Currently, these populations are generally threatened by invasive non-native plants, impacts resulting from maintenance of access roads and firebreaks, and trail activity. The native grassland and coastal sage scrub surrounding this population are in poor condition, with most of the area converted to non-native annual grassland (S. McMillan *in litt.* 2003). Two additional populations west of Sweetwater Reservoir (EO 24 and 25) have been extirpated by development.

In 1998, an exceptionally good germination year for this species, the Rancho San Miguel/Horseshoe Bend population (EO 10 and 20) was estimated at 1.9 million plants (Merkel & Associates 1999). A portion of the population in the southern part of the Ranch has been lost to residential development and State Route 125 construction. The maintenance of utilities, habitat conversion associated with fire, and weed invasion are continuing threats to the remaining population

(S. McMillan *in litt.* 2003), which will become part of the Otay/Sweetwater Unit of the San Diego National Wildlife Refuge.

A small population (EO 34) occurs along the south side of Mother Miguel Mountain in the San Miguel Habitat Management Area, owned and managed by the Otay Water District. Although the Otay Water District initiated a Subarea Plan under the MSCP, the plan was never completed nor was a permit issued. Weed encroachment, including from the nearby Auld Goff Golf Course, has been a problem in the past (G. Hazard, pers. obs.). The future status of the Habitat Management Area is unclear.

The Proctor Valley population (EO 21 and 22) occurs south of San Miguel Mountain. Two approved developments, Rolling Hills Ranch and Eastlake Woods, have resulted in the loss of *Deinandra conjugens* habitat and plants within this complex. Additionally, Bella Lago, a project anticipated to be covered under the Chula Vista Subarea Plan, may also affect *D. conjugens* habitat and plants. However, as a result of these projects, occupied areas will be protected and managed in designated open space reserves under the County of San Diego and City of Chula Vista's Subarea Plans, and under a special *D. conjugens* reserve that was established as part of the Rolling Hills Ranch project. Some occurrences in this area occupy native grasslands and sparse coastal sage scrub habitats, however, the species is generally found in areas dominated by non-native grasses. Threats to this population include off-highway vehicle activity, grazing, trash dumping, and fragmentation of the remaining populations by urban development; however, such threats should diminish as preserves become finalized and management of the population(s) is put in place under the Subarea Plans.

The Bonita/Long Canyon population (EO 1), occurring in the canyons between Rice Canyon and Rancho San Miguel/Horseshoe Bend populations, is in good condition with an estimated 5,000 individuals (S. McMillan *in litt.* 2003). However, this figure likely underestimates the total population because additional patches have been documented (U.S. Fish and Wildlife Service GIS database) but population estimates are not currently available. This population occurs within the area covered under the City of Chula Vista's Subarea Plan. The population occurs in suitable clay soils with many native plant associates, including the endangered *Acanthomintha ilicifolia* (San Diego thornmint). Although invasion by non-native annual weeds is a serious threat at this site (S. McMillan *in litt.* 2003), the State of California has received a grant under section 6 of the

Endangered Species Act, to implement weed abatement activities, and the implementation of Chula Vista's Subarea Plan will include active management to minimize this threat. This population is surrounded with good quality coastal sage scrub (S. McMillan *in litt.* 2003).

The Rice Canyon population (EO 9) occurs within the Rancho Del Rey and Rice Canyon designated open space areas of the City of Chula Vista's Subarea Plan. Although this population is large and supports a relatively dense population it continues to decline due to edge effects from residential development. Weed invasion continues to increase every year and the populations continue to decline in area and in density. Portions of these populations are associated with native grassland and coastal sage scrub habitats; however, much of the population is surrounded by non-native annual grassland. This population is threatened by weed invasion (especially non-native annual grasses and forbs), impacts from trail access (and other edge effects from residential development), and off-road vehicle activity (S. McMillan *in litt.* 2003). The State of California has received a grant under section 6 of the Endangered Species Act to implement weed abatement activities. It is also anticipated that these impacts will be reduced through implementation of Chula Vista's Subarea Plan which requires management and monitoring of the population.

The greater Poggi Canyon population (EO 7, 8, and 26) consists of numerous scattered patches. Much of Poggi Canyon has been developed for residential purposes, which has adversely affected many of the *Deinandra conjugens* populations known from the canyon. Those that remain are within the designated open space reserve under the City of Chula Vista's Subarea Plan and will be managed and monitored under the plan. On the western portion of the County of San Diego's Otay Landfill parcel, surveys in 2000 found only a few scattered *D. conjugens* plants (Merkel and Associates *in litt.* 2000). More recently, however, surveys in 2004 found approximately 275,000 plants in this general area (S. Allen *in litt.* 2004), again illustrating the variability of this species.

The Wolf Canyon (EO 13) population occurs along the slopes and ridges of Wolf Canyon and the associated drainages. Surveys estimated a standing population of approximately 50,000 plants (S. McMillan *in litt.* 2003). Most of the lower portions of Wolf Canyon have been set aside as designated open space under the City of Chula Vista's Subarea Plan. The population in the upper portions of the canyon has been extirpated by residential development. An on-going restoration

program is also being conducted in Wolf Canyon, much of which is specifically designed for *Deinandra conjugens*. The restoration program appears to be very effective. Weeds have been controlled and restoration of a diverse assemblage of native plant species has promoted native pollinator populations (G. Hazard, pers. obs.). Despite the short-term success under intensive, active management, the long-term status is unclear.

The Dennery Canyon population (EO 6, 17, 27, 28, and 29) occurs within Dennery Canyon and the associated mesa remnants that surround the canyon. Many of the historical occurrences were destroyed when residential development began. It is possible that all of EO 29 has been extirpated. Most of the remaining populations are, or will be, included in dedicated open space as part of the City of San Diego's MSCP Preserve. The habitats continue to suffer from illegal off-road activities, although at reduced levels. Ongoing habitat restoration programs, much of which are specifically designed for *Deinandra conjugens*, are also being conducted within the area (S. McMillan, pers. comm. 2003). These programs include weed control, which has been very effective in controlling the non-native annual weed species that dominated these areas prior to restoration efforts.

The Johnson Canyon/Upper Otay Valley (EO 12, 15, and 16) occurrence is a series of populations scattered along the upper (eastern) end of Otay Valley in heavy clay soils. Most patches of *Deinandra conjugens* can be found along the southern slopes, extending up onto the mesa near the vernal pool areas along the edge of the mesa (EO 12). Scattered patches also occur along the north slopes of the valley (EO 16), with a couple of populations along the base of Rock Mountain (EO 14). Portions of these populations are adjacent to native grassland and coastal sage scrub, but much of the occurrence is associated with non-native annual grassland. Invasion by non-native annual weeds is currently the most serious threat to these populations. The native grassland and coastal sage scrub habitats surrounding these populations are in poor condition, with most of the area converted to a non-native annual grassland. Most of these populations occur within a designated mitigation area or within proposed designated open space reserves under the City of Chula Vista's, and City of San Diego's Subarea Plans and are required to be managed and monitored under the plans.

The Salt Creek population (EO 18) occurs at the northern end of Salt Creek. Most of the population occurs within an area that has been proposed as designated open space under the City of Chula Vista's Subarea Plan; however, a residential

development is located immediately upstream of this occurrence. The population occurs in a ruderal (disturbed, weedy) area in heavy clay soils, and is threatened by continued maintenance of access roads to aqueduct lines, sewer lines, and other utilities. The indirect effects of urban development will be minimized through management and monitoring required under the Subarea Plan.

Several populations near the Mexican border (EO 11 and 30) are likely still extant, but they have not been surveyed recently and we have no specific information about current population status. Nearby, at the base of the western foothills of Otay Mountain, recent surveys (especially 2001) have reconfirmed and expanded the distribution of the populations at the base of what some refer to as "Big Murphy Hill" (EO 5 and 31; RECON Environmental *in litt.* 2004). Additionally, surveys south of the proposed State Route 905 corridor in 2003 found more than 1.3 million standing *Deinandra conjugens* plants on the southwest edge of the Otay Mesa (west of Moody Canyon) and an additional 16,000-plus plants in Spring Canyon (Caltrans 2004). The former population (southwest Otay Mesa edge) is located in the City of San Diego's MSCP Multiple Habitat Planning Area, which is expected to provide protection against development. Another population on the western edge of Otay Mesa has been partially preserved within the City of San Diego's MSCP Multiple Habitat Planning Area (RECON Environmental 1998, City of San Diego *in litt.* 2001). The other Otay Mesa/border-area populations are not preserved and have the potential to be impacted by development. Also, in general, all of the greater Otay Mesa populations have been impacted by off-highway vehicle activity, potentially including U.S. Border Patrol activities. These populations will likely continue to be impacted by off-highway vehicle activity over the near term.

Since listing, surveys have detected several new locations of *Deinandra conjugens* away from other previously known occurrences. These include some sites generally within the previously known range (*e.g.*, Johnson Canyon [Helix *in litt.* 2001], southwestern Otay Mesa, described above) and three (in two general locations) that extend the species' range. These latter three populations are discussed in greater detail below.

Two new, previously unknown populations were documented in the City of San Diego's Skyline-Paradise Hills community (Paradise Hills Community Park) and Encanto community (Valencia Hills "neighborhood"). Both populations are within designated open space under the City of San Diego's Subarea Plan. These

populations were found while conducting rare plant surveys for the City of San Diego in 2001 (S. McMillan *in litt.* 2003) and slightly extend the known range for *Deinandra conjugens* to the northwest. The populations are in good-quality native grassland and non-native annual grassland surrounded by coastal sage scrub. Although these populations are protected as designated open space, adjacent residential development may have indirect impacts on these populations. These impacts should be minimized in the future as part of the City's adjacency criteria in their Subarea Plan.

A new population was also recently discovered on a large clay lens in the middle of the California Department of Fish and Game's Rancho Jamul Ecological Reserve. This population was found while conducting rare plant surveys for the Department of Fish and Game (McMillan Biological Consulting 2002); surveys in 2003 estimated the population at 2,000 plants (S. McMillan *in litt.* 2003). To date, this population is the easternmost known population of *Deinandra conjugens* and is isolated from the other populations to the west. Although only one population was found, it may be likely that additional populations of *D. conjugens* occur on Rancho Jamul Ecological Reserve. Invasive non-native weeds are the most serious threat to the population now that grazing has been eliminated from the property. Additionally, *D. conjugens* should be watched for in the surrounding areas.

E. Critical Habitat

On December 10, 2002, we published the final rule designating critical habitat for *Deinandra conjugens* (U.S. Fish and Wildlife Service 2002; see Figure 1 in this plan). This rule became effective on January 9, 2003. Critical habitat is defined as specific areas that provide the physical and biological features (primary constituent elements) essential to the conservation of the species and which may require special management considerations or protection. The primary constituent elements for *D. conjugens* consist of:

1. Soils with a high clay content (generally greater than 25 percent), or clay intrusions or lenses, that are associated with grasslands (native, non-native, and mixed), open coastal sage scrub, maritime succulent scrub communities or disturbed habitat between 25 and 300 meters (80 and 1,000 feet) elevation; and

2. Plant communities associated with *Deinandra conjugens* that include, but are not limited to, grasslands (native, non-native, and mixed), open coastal sage scrub, and maritime succulent scrub between 25 and 300 meters (80 and 1,000 feet) elevation in southwestern San Diego County, California and adjacent northwestern Estado de Baja California, Mexico. These plant communities contain areas that provide nesting, foraging, and dispersal sites for pollen and seed dispersal agents of *D. conjugens*. These openings may have soil inclusions that contain a significantly higher concentration of sandy soils than the adjacent clay soils.

F. Reasons for Decline and Current Threats

Species are determined to be threatened or endangered under the Endangered Species Act of 1973, as amended, based on one or more of five listing factors. The five listing factors are: (1) The present or threatened destruction, modification, or curtailment of habitat or range; (2) Overutilization for commercial, recreational, scientific, or educational purposes; (3) Disease or predation; (4) Inadequacy of existing regulatory mechanisms; and (5) Other natural and manmade factors affecting the species' continued existence.

Deinandra conjugens was listed as a threatened species on October 13, 1998 (U.S. Fish and Wildlife Service 1998). Since its listing, information relating to the distribution of the species, as well as information pertaining to threats to its continued existence, has become more refined. However, the basic factors identified in the listing rule as responsible for the species' decline still apply to some extent. Therefore, the following discussion briefly restates and offers an expanded discussion of some of the threats to the species based on current information.

1. Loss and Degradation of Habitat

As discussed in the final rule, the primary cause of the decline of *Deinandra conjugens* was the loss and degradation of occupied and suitable habitat, primarily due to urban development and agriculture, resulting in the fragmentation and isolation of remaining populations. These factors remain a threat to the long-term recovery of the species.

At the time the species was listed in 1998, we estimated that about 11,930 hectares (30,310 acres) of land with clay soils or clay subsoils were within the

general range of *Deinandra conjugens* in San Diego County, California (U.S. Fish and Wildlife Service 1998). Also at that time, about 4,200 hectares (10,600 acres) (about 37 percent) of this area had been urbanized and about 4,155 hectares (10,555 acres) (about 37 percent) had been heavily cultivated and grazed. Additional areas have been lost to urbanization since this time. New information from herbarium records at the San Diego Natural History Museum indicates that the historical range of *D. conjugens* extended farther to the north and northwest; however, most of the habitat in this area has been lost to development. Much of the cultivated and grazed land within this range could be restored to support *D. conjugens* (M. Dodero, pers. comm. 2001, and S. McMillan, pers. comm. 2001, in U.S. Fish and Wildlife Service 2002), although most of these lands are available for development under the San Diego MSCP.

Several populations of *Deinandra conjugens* are subject to impacts from off-road vehicle activity, even within conserved open space and within the San Diego National Wildlife Refuge. Although implementation of the MSCP requires that these effects be alleviated, this activity continues to threaten some populations. We anticipate this threat will diminish as the Subarea Plans under the MSCP are fully implemented.

2. Habitat Fragmentation/Isolation

Habitat loss and degradation often result in the fragmentation of remaining habitat patches and the isolation of habitat from the surrounding biological community. The result is disruption or impairment of processes within the biological community upon which *Deinandra conjugens* depends. Remnant patches of native vegetation become habitat islands and are subject to changes in their physical environment and microclimate that can disrupt or curtail their ability to function as suitable habitat. The effects of these changes may be modified by the size, shape and location of the remnant habitat in relation to the surrounding landscape. Fragmentation and isolation of native habitat can affect abiotic factors such as temperature, wind, erosion, and soil nutrients and cycling. For example, fragmentation can lead to changes in temperature; smaller remnants and edges of larger patches may experience higher air temperatures resulting from increased radiation. Higher temperatures may change nutrient cycling and soil microorganisms, and lower soil moisture. Such changes may affect germination and reproduction, and alter the plant community composition (Saunders *et al.* 1991).

Several interacting factors are likely to affect the biotic (plant and animal) communities of fragmented habitats. Time since isolation, distance to other remnants, connectivity with the remaining intact landscape, and size and shape of fragments will all affect the species composition of fragmented habitats and the rate of species loss. Recently isolated patches will likely have more species than can be sustained in the long-term, and both plant and animal species will be lost over time (Soulé *et al.* 1988, Saunders *et al.* 1991, Bolger *et al.* 1997), while invading species are likely to gain a foothold. Therefore the presence of a species at the time a patch is isolated does not indicate that the species will continue to persist in that patch into the future. As remaining populations of *Deinandra conjugens* are further fragmented by surrounding urban development, the remaining patches of habitat will be more susceptible to changes that affect vegetation and animal communities. Changes in the diversity, distribution, and abundance of plants and animals could adversely affect *D. conjugens* directly or indirectly through changes in habitat suitability, disruption of plant/pollinator relationships, changes in seed dispersal, and demographic changes in extant populations.

3. Non-native plant interactions

Extant populations of *Deinandra conjugens* often occur in areas dominated by persistent weeds. Anecdotal field observations indicate that *D. conjugens* does not compete well in areas of dense invasive weeds (A. Davenport, pers. comm. 2003; S. McMillan, pers. comm. 2003). Invasive weeds and the associated buildup of thatch can have significant impacts on local populations of *D. conjugens* (M. Dodero, pers. comm. 2004). Greenhouse experiments with *D. conjugens* have documented significant reductions in plant biomass, plant height, extent of branching on individual plants, and flower production in plants grown in high densities of invasive weeds (Bauder *et al.* 2002). These factors can reduce successful reproduction and seed set. The adverse effects of invasive weeds on *D. conjugens* may be greatest in years of abundant rainfall, resulting in depressed populations of *D. conjugens* when conditions would otherwise be most favorable for population growth (Bauder *et al.* 2002).

4. Population Dynamics

As discussed under Life History and Ecology (section 1.C above), *Deinandra conjugens* is an obligate out-crosser (*i.e.*, is self-incompatible); individual plants

exhibiting this trait will not set viable seed when pollinated by pollen from the same plant, and pollination between full siblings will result in significantly reduced fecundity and successful reproduction (*e.g.*, DeMauro 1993). Consequently, cross pollination between unrelated individuals and annual seed set are essential for long-term population survival and recovery. Limited seed dispersal or cross pollination can result in populations with localized clusters of related individuals. Such situations in *D. conjugens* may significantly reduce compatible pollinations, resulting in lowered annual reproduction.

The number of standing plants and reproductive success fluctuates yearly depending upon environmental conditions including rainfall (amount and timing), temperature, and soil conditions. Insufficient rain can significantly reduce or even preclude germination, or result in lowered seed set, while adequate or above average rainfall can result in large robust plants and high seed production; however, this relationship may be complicated by invasive weeds (Bauder *et al.* 2002). As discussed under Life History and Ecology (section I.C above) repeated surveys of the same populations demonstrate the wide population fluctuations inherent in this species. The spatial distribution of a standing population of annual plants is generally the result of the spatial distribution of the micro-environmental conditions conducive to seed germination and growth of the plants, which may vary from year to year. Smaller populations in years of reduced rainfall can also result in lowered opportunities for compatible pollinations between individuals.

A significant decline in a local population, coupled with other environmental and demographic factors and the extensive habitat/population fragmentation and isolation, could result in the complete extirpation of *Deinandra conjugens* from a reserve. It is unlikely that a locally extirpated and isolated population can be naturally recolonized from nearby sites through seed dispersal, especially if the sites are separated by urban development. The lack of connectivity between many extant populations of *D. conjugens* renders these populations susceptible to deterministic or stochastic extirpations (Gilpin and Soulé 1986, Lande 1988, Frankham and Ralls 1998), and increases the risk of species extinction.

5. Genetics

Genetic variation is positively correlated with population size and/or species range, and is inextricably linked to population viability and long-term species

survival. Large populations occupying contiguous habitat, or ones that cover a large range, generally have higher levels of genetic diversity, while smaller populations, or species occurring within restricted ranges or on islands, have lower levels of genetic variation (Frankham *et al.* 2002). A reduction in population size, or permanent fragmentation of formerly contiguous populations can result in reduced genetic diversity.

Both theoretical and empirical evidence indicates that smaller populations (those also possessing lower genetic variation) tend to have higher mortality rates and reduced fecundity, which leads to demographic fluctuations (*e.g.*, slower population growth, reduced pollination success and lowered recruitment) (Lande 1988, Les *et al.* 1991, DeMauro 1993, Heywood 1993, Lacy 1997, Frankham *et al.* 2002). At the extreme, very small populations suffer from inbreeding depression and the adverse effects of genetic drift (the accumulation of deleterious mutations or fixation of alleles that reduce fitness) (Barrett and Kohn 1991, Les *et al.* 1991). In plant species exhibiting sporophytic self-incompatibility, the level of genetic diversity at the S locus can have significant implications for long-term survival. Because successful reproduction can only occur between plants with different genotypes at the S locus, a minimum number of S alleles are necessary to sustain a population. A reduction in population size, due to demographic or environmental stochasticity or long-term fragmentation of populations, could reduce the pool of S alleles, thereby reducing successful cross-pollination and reproduction (Les *et al.* 1991, DeMauro 1993). Maintenance of S allele diversity within and among populations of *Deinandra conjugens* will increase the probability of cross pollination and successful reproduction.

The impacts of population fragmentation on genetic diversity depend upon the resulting population size, structure, and connectedness of the remaining patches. Larger populations and populations with sufficient cross pollination or seed dispersal between patches are more likely to sustain the level of genetic diversity and suffer little adverse effect from fragmentation in the short or mid term. Complete population isolation, with no cross pollination or seed dispersal between remaining patches (*e.g.*, population islands), will likely result in the greatest reduction in genetic diversity, and will occur at a faster rate in the short or mid-term (Frankham *et al.* 2002).

The current reserve design for *Deinandra conjugens* includes many fragmented populations surrounded by urban development. The level of genetic diversity

across the range of the species, including diversity at the S locus, in *D. conjugens* is unknown; however, initial studies of two populations indicate that diversity is high (Bauder and Truesdale 2000). Maintenance of the genetic diversity and gene flow (through cross pollination and/or seed dispersal) between fragmented populations could be critical to long-term survival and recovery. Nevertheless, we anticipate that the remaining populations may lose varying (but currently unknown) levels of genetic diversity without active management. Completely isolated populations may experience adverse effects from increased genetic drift and inbreeding depression (lowered population growth, reduced fitness, and higher susceptibility to environmental catastrophes; Frankham *et al.* 2002). These effects can be accelerated in populations that experience repeated and dramatic fluctuations in population size (Hard 1995, Lande 1999), which has been observed in *D. conjugens* (see Population Dynamics, section I.F.4 above).

6. Plant/pollinator interactions and ecology

Due to the self-incompatible trait inherent in *Deinandra conjugens*, successful cross pollination between unrelated individuals is essential to the long-term survival of populations of the species. The impacts of fluctuating population size and increased population fragmentation and isolation can be further complicated through changes in plant/pollinator interactions. Habitat fragmentation and degradation can be deleterious to both native pollinators and to the plants that depend upon pollination service. Increased fragmentation and/or decreased patch (population) size can lead to a reduction in frequency of pollinator visits and pollinator diversity, and decrease seed set (Jennersten 1988). If the distance between habitat patches is greater than the foraging range of pollinators, or if pollinators ignore small plant populations or small habitat patches, reduction in pollination service may result. Individual plant size, patch (population) size, and/or plant density of the target species can also contribute to pollination limitation; isolated plants or patches may receive fewer pollinator visits and/or reduced deliverance of pollen from conspecifics versus foreign pollen (Kearns *et al.* 1998 and references therein). Non-native plant densities may also affect plant/pollinator interaction. Bauder *et al.* (2002) noted much lower visitation to *D. conjugens* by potential pollinators in an area dominated by non-native vegetation, as opposed to a patch growing in proximity to native scrub vegetation. Further, non-native vegetation may reduce the floral display of *D. conjugens*, thereby reducing their attractiveness to potential pollinators, and likely reducing seed set.

While these effects may be offset by honeybees (including Africanized bees), which can successfully pollinate patches in disturbed habitats, they may also contribute to a reduction in native pollinator species. Additionally, honeybees may be less successful pollinators than native species and may compete with native pollinators for resources, although additional studies on the interactions of native and non-native pollinators are necessary (Kearns *et al.* 1998 and references therein).

Maintenance of ecological functions through habitat and pollinator management should be an important consideration in the long-term conservation of *Deinandra conjugens*. Some native pollinators may not find suitable nest conditions within the clay soils that sustain populations of *D. conjugens*. Further, insect populations relying on nectar as a food resource generally require a suite of flowers available throughout the year. Consequently, maintenance of the surrounding native vegetation/habitats must be considered in recovery of *D. conjugens*. Additionally, not all insects that visit *D. conjugens* flowers may provide pollen transfer among individual plants. More research is needed regarding the specific pollinators of *D. conjugens* and their biology/ecology.

G. Conservation Measures

Section 7(a)(1) of the Endangered Species Act requires Federal agencies to carry out "programs for the conservation of endangered species and threatened species". Also, section 7(a)(2) requires Federal agencies to consult with us if any action they fund, authorize, or carry out may affect listed species. This consultation process promotes interagency cooperation in finding ways to avoid or minimize adverse effects to listed species and ensures that Federal actions do not jeopardize the continued existence of listed species.

As described in the Critical Habitat section (section I.E above), critical habitat has been designated for *Deinandra conjugens*. Section 7(a)(2) of the Endangered Species Act also requires Federal agencies, including us, to ensure that actions they fund, authorize, or carry out, do not destroy or adversely modify critical habitat. Individuals, organizations, states, local governments, and other non-Federal entities are affected by the designation of critical habitat only if their actions occur on Federal lands, require a Federal permit, license or other authorization, or involve Federal funding.

Sections 9 and 10 of the Endangered Species Act and the corresponding implementing regulations found at 50 CFR 17.71 and 17.72, set forth a series of prohibitions (section 9) and exceptions (section 10; see below) that apply to all threatened plant species not covered by a special rule. No special rule has been published for *Deinandra conjugens*. These prohibitions, in part, make the following activities illegal for any person subject to the jurisdiction of the United States: import or export; transport in interstate or foreign commerce in the course of a commercial activity; sell or offer for sale this species in interstate or foreign commerce; remove and reduce to possession this species from areas under Federal jurisdiction; and maliciously damage or destroy this species on any other area in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law. The term "plant" means any member of the plant kingdom, including seeds, roots and other parts. Because *D. conjugens* is a threatened plant species, seeds from cultivated specimens are exempt from these prohibitions provided that a statement of "cultivated origin" appears on their containers. Certain exceptions apply to agents of the U.S. Fish and Wildlife Service and State conservation agencies.

Section 10(a)(1)(B) of the Endangered Species Act authorizes us to issue to non-Federal entities a permit for the take of endangered and threatened animal species incidental to otherwise lawful activities. An incidental take permit must be supported by a "habitat conservation plan" that identifies conservation measures that minimize and mitigate the impacts of take of covered animal species to the maximum extent practicable and that we believe necessary to reduce project related effects to the extent that they do not appreciably reduce the likelihood of the survival and recovery of the species in the wild. Where a habitat conservation plan includes adequate conservation measures for listed plant species, we will also include such species on the incidental take permit in recognition of those conservation benefits even though take of listed plant species is not prohibited under section 9 of the Endangered Species Act. Under the MSCP, each participating jurisdiction's Subarea Plan constitutes a habitat conservation plan. *Deinandra conjugens* is a species covered under the plans and therefore receives conservation benefit under the MSCP (see below).

1. Regional Planning

The San Diego Multiple Species Conservation Program (MSCP) was initiated by local jurisdictions including the City of San Diego, County of San Diego, other

cities, and private interests, and is being integrated as a component of California's Natural Community Conservation Plan Act. Implementation of the MSCP will extend protection to many natural habitat communities in San Diego County. *Deinandra conjugens* is a covered species under the San Diego MSCP.

The MSCP encompasses approximately 236,000 hectares (582,000 acres) of southwestern San Diego County, and involves multiple jurisdictions. Approximately 69,600 hectares (172,000 acres) are targeted to be conserved within the planning area. Goals of the MSCP include: conserving listed and sensitive species, conserving biodiversity in the MSCP Plan Area, and achieving certainty in the land development process. Each take authorization holder will prepare a framework management plan to provide general direction for all preserve management issues. We, and the California Department of Fish and Game, approved the overall MSCP and the City of San Diego's Subarea Plan in July 1997. The County of San Diego's Subarea Plan was approved in 1998. The City of Chula Vista's Subarea Plan is complete; however, we are still working with the City of Chula Vista to finalize their permit. The preservation, management and monitoring of reserves will occur in perpetuity. Some areas within the MSCP boundary are designated as "amendment areas" and are not covered under the MSCP. In amendment areas, development and conservation areas will be determined by future negotiations between landowners, local jurisdictions, and the wildlife agencies. Any activities within these amendment areas that may affect *Deinandra conjugens* will need to be addressed in the future.

Additionally, other non-MSCP habitat conservation plans address *Deinandra conjugens*. The San Diego Gas and Electric Subregional Plan (SDG&E 1995) covers this species. Additionally, the Sweetwater Authority and Otay Water District are each preparing habitat conservation plans that we anticipate will address *D. conjugens*.

2. San Diego National Wildlife Refuge

Habitat conservation efforts include protection of *Deinandra conjugens* populations on the San Diego National Wildlife Refuge (formerly known as the Otay-Sweetwater Unit of the San Diego National Wildlife Refuge). The San Diego National Wildlife Refuge was established in 1996, with the acquisition of 745 hectares (1,840 acres) at Rancho San Diego in San Diego County. The Refuge Planning Area encompasses 18,605 hectares (45,974 acres) within

southwest San Diego County, with 3,665 hectares (8,063 acres) currently managed by the Refuge, and 2,129 hectares (5,262 acres) managed by the California Department of Fish and Game. Funding for acquisition from the Land and Water Conservation Fund had remained steady at about $2 million per year until 2003; future funding is uncertain. We conducted *D. conjugens* surveys on the Refuge in 2001 and 2003. Surveyed locations were primarily in the vicinity of San Miguel Mountain.

3. California Department of Fish and Game

The California Fish and Game Commission listed *Deinandra conjugens* as endangered in November 1979, under the California Endangered Species Act. The State of California has also passed the Natural Community Conservation Planning Act of 1991, as amended (California Fish and Game Code, Section 2800 to 2835), which was designed to protect California's flora and fauna at the regional/ecosystem level while allowing continued development. Under the California Environmental Quality Act, an analysis of direct, indirect, and cumulative project impacts to biological resources, including *D. conjugens*, is required. The California Environmental Quality Act sometimes requires development and implementation of mitigation plans for projects that result in loss of habitat. The California Department of Fish and Game has protected populations of *D. conjugens* under the Natural Community Conservation Program and through land acquisition.

H. Recovery Strategy

The distribution of *Deinandra conjugens* in southwestern San Diego County (Figure 1) occurs entirely within the planning area for the San Diego MSCP. Therefore, as discussed previously in the Brief Overview and Conservation Measures sections (I.A and I.G above), the MSCP is an important preservation and management tool in the conservation of *D. conjugens*. Again, as mentioned previously, this recovery plan includes actions that, in some instances, go beyond those specified in the MSCP. However, this recovery plan does not change the requirements or specified activities within the MSCP. Participating jurisdictions must continue to implement the conservation measures to protect *D. conjugens* as specified under their respective Subarea Plans. Likewise, this recovery plan does not obligate participating jurisdictions to implement any measures identified in this recovery plan that are not addressed within their respective Subarea Plans.

The participating jurisdictions may, on a voluntary basis, implement any additional measures to recover *D. conjugens* as outlined in this plan. These additional measures may also be implemented by us or other willing entities to provide for the recovery of this species.

The long-term survival and conservation of *Deinandra conjugens* is dependent upon a number of factors, including:

- Protecting and managing extant populations, especially those within MSCP Preserve areas.

- Maintaining natural ecological conditions within protected areas. These conditions include, but are not limited to, areas of appropriate soils that are sufficiently weed-free to allow germination of *Deinandra conjugens* and that have an adequate suite of effective pollinators and seed dispersal agents to allow gene flow within and among populations.

- Identification and protection of any populations outside of MSCP jurisdiction that provide connectivity between conserved populations.

- Preserving and maintaining areas with suitable micro-habitat characteristics that could be recolonized and allow a population to survive a catastrophic event.

Given that *Deinandra conjugens* is an obligate outcrosser (self-incompatible), and population/habitat fragmentation may significantly limit gene flow between remaining populations, our strategy must also address the importance of maintaining and conserving the genetic diversity currently exhibited in the species (including genetic variability of currently unprotected populations). This task may include conserving genetic diversity through seed storage (sometimes referred to as "seed banking", not to be confused with the *soil* seed bank) from all available populations across the extant range of the species. High levels of genetic diversity, or heterozygosity, and continued, adequate exchange of genes between populations (through cross pollination) are important to maintain adaptability to changing environmental conditions, and thereby ensure the long-term persistence of the species (Lynch *et al.* 1995, Lande 1999). The small, fragmented distribution of this species, coupled with its breeding system (*i.e.*, self-incompatibility and annual habit), makes it especially vulnerable to natural and anthropogenic effects including disturbance from human and agricultural

activities; spread of non-native species; and nearby use of herbicides, pesticides, and other contaminants (U.S. Fish and Wildlife Service 1998; B. Baldwin, pers. comm. 2001; S. McMillan, pers. comm. 2001).

To ensure long-term viability of *Deinandra conjugens* populations, population monitoring and intensive habitat management will likely be required. Survival and recovery will depend upon the implementation of a scientifically valid monitoring program to ensure that each conserved population allows for natural shifts in population size and distribution and maintains adequate numbers to survive extinction risks from environmental, demographic and genetic variation. Monitoring must also ensure that populations demonstrate stable or positive growth rates as measured by recruitment and fecundity over a period that spans a minimum of three drought cycles. Ensuring successful reproduction and establishment of seed banks within reserves will allow populations to persist through demographic and environmental fluctuations. Management plans must be developed and implemented across the reserve network to insure that non-native vegetation, which can create unsuitable growing conditions for *D. conjugens* and competition for resources, is controlled within established reserves using techniques that are not harmful to the persistence of *D. conjugens* populations.

Finally, a research program should be developed and implemented to better understand the biology and ecology of *Deinandra conjugens*, as well as the biology and ecology of its primary pollinators. Broad research topics include: identifying the genetic variation in *D. conjugens* and its geographic distribution; determining the level of outcrossing needed to sustain fragmented/isolated populations of *D. conjugens*; identifying the primary pollinators and assessing habitat requirements, dispersal distances and population trends necessary to ensure their viability; and developing propagation techniques for *D. conjugens* and relocation/reintroduction methods.

II. RECOVERY

A. Objectives

The goal of this recovery plan is to recover *Deinandra conjugens* sufficiently to warrant delisting. The recovery objectives are:

1. Stabilize and protect habitat that supports known populations of *Deinandra conjugens* within areas identified for conservation under the MSCP.

2. Identify and protect extant populations of *Deinandra conjugens* and available suitable unoccupied habitat that are important to maintain genetic diversity and connectivity between established reserves.

3. Reduce and manage threats to *Deinandra conjugens*. Such threats include (but are not limited to) invasion and competition by invasive non-native weeds, and factors that reduce or limit genetic diversity within areas that preserve *D. conjugens* populations.

4. Conduct research necessary to refine recovery criteria.

B. Recovery Criteria

Deinandra conjugens may be considered for delisting when:

1. Known populations (including naturally occurring seed banks) within areas identified for conservation under the MSCP are permanently protected from future development or other significant threats.

2. Permanent funding and management mechanisms that are required under the MSCP are in place and functioning.

3. Established reserves (*i.e.,* MSCP preserve lands, land protected under other habitat conservation plans, National Wildlife Refuge lands, and State preserve lands) provide sufficient suitable habitats and space to sustain the full ecological needs of *Deinandra conjugens*. We expect these needs to include: a) connectivity to maintain natural gene flow among conserved populations, and b) sufficient habitat to maintain wild populations of native *D. conjugens* pollinators.

4. Populations of *Deinandra conjugens* are stable or increasing within established reserves. As discussed by Rice (1989), seed banks typically are "more developed in annuals than in perennials" and "more extensive in forbs than in grasses." For *D. conjugens*, an annual forb, population stability will depend on the long-term maintenance of the seed banks within each reserve. The primary factors that may threaten the long-term maintenance of *D. conjugens* and its seed banks include reduced or failed pollination (*i.e.,* pollinators) and fruiting, excessive seed predation, loss of genetic variability and inbreeding, and impaired seed dispersal within and potentially among reserves.

5. Criteria 3 and 4 have been assessed through monitoring over an adequate length of time to incorporate year-to-year variability associated with known variations in climate (*e.g.,* drought, El Niño/Southern Oscillation, etc.). We anticipate a period that encompasses three drought cycles; however, this time period may change should additional scientific information on the amount of time necessary to adequately determine the population trend of *Deinandra conjugens* indicate otherwise. If the species is delisted, the monitoring period will be extended for an additional 5 years after delisting, as required by the Endangered Species Act for species that are delisted due to recovery.

6. The current status (including a threats assessment) and distribution of *Deinandra conjugens* have been determined in Mexico.

7. Depending on the results from criterion 6, dialogue should be established with Mexican governmental and nongovernmental organizations to secure protection for *Deinandra conjugens* in Mexico.

8. Research on several critical aspects of the species' biology and ecology, as detailed in the Recovery Narrative (section II.C.2 below), has been completed to adequately assess the above recovery criteria. Results should be published in readily available refereed journals. Results from this research may redirect the recovery strategy.

    a. The maximum period for which a downward trend in population size/recruitment in *Deinandra conjugens* can be sustained without significantly increasing the risk of demographic/genetic extirpation or a genetic bottleneck.

b. The spatial scale at which an occurrence of *Deinandra conjugens* is sufficiently independent from other occurrences to be considered a separate population for the purposes of monitoring.

c. The amount of suitable and occupied habitat necessary to sustain a viable population of *Deinandra conjugens* within an established reserve.

d. The number of populations of *Deinandra conjugens* and area of suitable and occupied habitat that must be maintained to conserve the species in perpetuity.

e. The minimum number of S alleles that must be maintained within a population of *Deinandra conjugens* to sustain cross pollination and successful reproduction, and avoid genetic drift and/or inbreeding depression.

f. The habitat/ecological needs of *Deinandra conjugens* pollinators and the amount of suitable/occupied habitat necessary to sustain a population(s) within a reserve.

g. The level of cross pollination that must occur among populations of *Deinandra conjugens* to maintain genetic diversity across the range of the species.

h. The maximum dispersal/movement distance of *Deinandra conjugens* pollinators, beyond which cross pollination between populations (occurrences) is precluded.

C. Recovery Program

Given that the entire U.S. range of *Deinandra conjugens* occurs within the boundaries of the MSCP, it is anticipated that many of the recovery actions identified below will be addressed through implementation of the Subarea Plans for the County of San Diego, City of San Diego, and City of Chula Vista. If a specific action is not required under the MSCP and its associated Subarea Plans, the action will be addressed by us or another willing entity. Other entities with section 10(a)(1)(B) permits and associated habitat conservation plans that address *Deinandra conjugens* are also required to enact only the conditions of their permits and are not required to address additional measures. Jurisdictions and

agencies anticipated to contribute to implementation of each action are identified in the Implementation Schedule below. Each recovery action addresses threats to the species and contributes to fulfillment of recovery criteria needed for delisting, as summarized in the Appendix.

1. Stepdown Outline

The following recovery "actions" are described further in the Recovery Narrative below (section II.C.2; see also Implementation Schedule):

1. Protect *Deinandra conjugens* habitat.

    1.1. Protect *Deinandra conjugens* habitat within areas identified for preservation under the respective County of San Diego, City of San Diego, and City of Chula Vista MSCP Subarea Plans.

    1.2. Protect habitat supporting known populations of *Deinandra conjugens* outside of MSCP participating jurisdictional control.

2. Evaluate the status of all known populations of *Deinandra conjugens*.

3. Conduct surveys to search for new populations of *Deinandra conjugens* and implement actions to protect populations outside of established (or proposed) reserves when necessary to maintain genetic diversity and/or connectivity between larger reserves.

4. Adaptively manage and monitor areas conserved for *Deinandra conjugens*.

    4.1. Develop and implement appropriate techniques to control invasive weeds within suitable *Deinandra conjugens* habitat.

    4.2. Develop and implement appropriate management plans for areas conserved for *Deinandra conjugens*.

4.3. Develop and implement a *Deinandra conjugens* monitoring plan for conserved areas.

5. Identify research needs and conduct studies on the biology and ecology of *Deinandra conjugens*.

5.1. Conduct research to determine the population dynamics of conserved populations of *Deinandra conjugens*.

5.2. Conduct research to determine ecological requirements of *Deinandra conjugens*.

5.3. Assess and plan for conservation of genetic variability within *Deinandra conjugens.*

5.3.1. Conduct a baseline census of current genetic structure of populations and genetic diversity of *Deinandra conjugens*.

5.3.2. Determine the level of variability at the "S locus" within and among populations of *Deinandra conjugens*, and identify isolated populations that may need genetic augmentation.

5.3.3. Identify appropriate management techniques to provide genetic exchange and/or genetic augmentation among *Deinandra conjugens* populations.

5.4. Based on research and monitoring of population dynamics in *Deinandra conjugens* and the extent of genetic variability within the species, determine the number of populations, the spatial distribution, and the amount of suitable and occupied habitat necessary to recover the species.

5.5. Study *Deinandra conjugens* pollinators and their management needs.

5.5.1. Conduct research to identify the primary and secondary pollinators of *Deinandra conjugens*.

5.5.2. Identify the habitat requirements of *Deinandra conjugens* pollinators and assess population status in conserved areas.

5.5.3. Determine what distances pollinators can travel and how fragmentation affects pollinators' ability to contribute to long distance pollen transfer between populations of *Deinandra conjugens*.

5.6. Continue to develop techniques to germinate and propagate *Deinandra conjugens*.

5.7. Develop seed storage techniques for *Deinandra conjugens* and collect seeds from all available sources.

6. Develop and implement a community outreach program.

6.1. Develop and implement outreach plans to conserve *Deinandra conjugens*.

6.2. Continue to develop informational outreach materials regarding the conservation of *Deinandra conjugens* and its associated habitat, and the greater ecosystem needs (including the interplay of other species) within preserved lands.

7. Enter into dialogue with Mexican governmental and nongovernmental organizations to secure protection for *Deinandra conjugens* in Mexico.

2. *Recovery Narrative*

The following actions are needed to recover *Deinandra conjugens*.

1. Protect *Deinandra conjugens* habitat.

1.1. Protect *Deinandra conjugens* habitat within areas identified for preservation under the respective County of San Diego, City of San Diego, and City of Chula Vista MSCP Subarea Plans.

The entire United States range of *Deinandra conjugens* is within the Multiple Species Conservation Program boundary. Further, the range of *D. conjugens* is within geographical limits of three participating jurisdictions: the County of San Diego, the City of San Diego, and the City of Chula Vista. However, not all of the areas within with the limits of those jurisdictions are under their control; other public and quasi-public entities (*e.g.*, utilities, water districts, etc.) control certain areas within those jurisdictions. Nevertheless, the three participating MSCP jurisdictions listed above control the vast majority of *D. conjugens* habitat. Therefore, the MSCP, as enacted through the respective Subarea Plans, makes a very important contribution to the recovery of this species.

The Subarea Plans identify boundaries for reserves and pre-approved mitigation areas. Future urban or agricultural development within these reserve boundaries should avoid suitable and occupied *Deinandra conjugens* habitat. Habitat for this species is to be conserved by land acquisition (fee title or permanent biological conservation easement), donation, and exactions. Certain lands within San Miguel Ranch that support *D. conjugens* are being conveyed to and acquired by us as part of the San Diego National Wildlife Refuge.

Areas conserved for *Deinandra conjugens* should allow opportunities for plant populations to disperse to areas of suitable, unoccupied habitat, and should include sufficient area to provide for the ecological needs of *D. conjugens* pollinators. Conserved habitats should provide buffers against the adverse effects of

adjacent development, such as altered soil moisture and enhanced weed establishment.

1.2. Protect habitat supporting known populations of *Deinandra conjugens* outside of MSCP participating jurisdictional control.

Areas outside of MSCP participating jurisdictions' control (see 1.1 above) may contribute to genetic diversity populations and provide connectivity among populations

2. Evaluate the status of all known populations of *Deinandra conjugens*.

The purpose of this action is to assemble all available information necessary to make informed decisions regarding actions necessary to stabilize and manage protected populations and identify those populations outside of established conservation areas (including in Mexico) that may require protection to ensure survival and recovery of the species. Population size (area and number of individuals), reproduction, distribution, threats to stability or viability, and land management objectives should be determined for all sites. Populations should be ranked according to status and level of threat. A single methodology (comparable among sites) should be developed to conduct population assessments and implemented across all reserves.

3. Conduct surveys to search for new populations of *Deinandra conjugens* and implement actions to protect populations outside of established (or proposed) reserves when necessary to maintain genetic diversity and/or connectivity between larger reserves.

Deinandra conjugens is an annual plant whose distribution and abundance can change dramatically from year to year. Populations outside of MSCP control, including in Mexico, may be important for maintaining genetic diversity and/or connectivity among established reserves. Surveys for *D. conjugens* should continue within areas of suitable habitat. New populations should be assessed according to action 2, and management plans adjusted to protect new populations. Specific methods should be developed and implemented to ensure that surveyors accurately

distinguish *D. conjugens* from the sympatric *D. fasciculata*. We should ensure that surveys for this species are conducted using a standardized and comparable monitoring methodology within conserved areas.

4. Adaptively manage and monitor areas conserved for *Deinandra conjugens*.

Public and private lands conserved for *Deinandra conjugens* should be adaptively managed to reduce and minimize threats and maximize their potential to recover this species.

4.1. Develop and implement appropriate techniques to control invasive weeds within suitable *Deinandra conjugens* habitat.

Greenhouse studies have demonstrated that *Deinandra conjugens* experiences reduced growth and seed set and produces fewer inflorescences in the presence of dense stands of invasive weeds (Bauder *et al.* 2002). Surveys conducted in 2003 indicate that most populations of *D. conjugens* are threatened by invasive weeds (S. McMillan *in litt.* 2003). Appropriate techniques should be developed and implemented to control invasive weeds within suitable *D. conjugens* habitat, while avoiding adverse impacts to the species or its habitat.

4.2. Develop and implement appropriate management plans for areas conserved for *Deinandra conjugens*.

Management plans that address the biological and ecological needs of *Deinandra conjugens* should be developed and implemented for areas conserved for *D. conjugens*. Based on the information gathered under action 2 and supplemented through ongoing research identified under action 5, threshold levels should be established to indicate when appropriate actions should be implemented or when specific changes in management practices are required. Actions should be implemented with relative priority according to the population ranking conducted in action 3. If new

threats are identified, or other new information becomes available, then management plans should be revised.

At a minimum, management plans should include: a) specific methods for the control and removal of invasive weeds and thatch; b) actions necessary to maintain populations of native *Deinandra conjugens* pollinators including providing sufficient nectar resources; and c) actions necessary to control unauthorized use of off-highway vehicles. Management activities should be evaluated periodically and adjusted to maximize the potential for the conservation and recovery of *D. conjugens*. Results of new biological research should be considered in adaptive management plans. Management plans should be consistent and comparable among reserves and among management entities. The MSCP includes measures for developing management plans.

4.3. Develop and implement a *Deinandra conjugens* monitoring plan for conserved areas.

A standardized and coordinated monitoring program should be established and implemented across all reserves to ensure that data collection is consistent and comparable across the range of the species. The program should develop specific methods for tracking population dynamics in *Deinandra conjugens* and their pollinators, and to monitor the genetic variability within *D. conjugens*. The monitoring program should also determine whether the existing reserves provide the necessary ecological requirements for recovery of *D. conjugens*. For the purposes of assessing whether *D. conjugens* is sufficiently viable to warrant delisting, the monitoring program should be implemented for a minimum period encompassing at least three drought cycles. If the species is delisted, this monitoring period will be extended by an additional 5 years of post-delisting monitoring, as required by the Endangered Species Act for species delisted due to recovery.

Monitoring components should include (but are not limited to): abundance, distribution, recruitment, and seed production in *Deinandra conjugens*; genetic variability within and among

populations of *D. conjugens*; pollinator abundance and population dynamics (the plan should be refined as additional knowledge of specific *D. conjugens* pollinators becomes available), invasion by non-native weeds, and the extent of impact from existing and potential threats. The monitoring program should specify the appropriate timing and frequency for implementing each component that reflects environmental conditions (*e.g.*, rainfall) and will enable identification of population trends and characteristics. The monitoring program must be approved by us and the California Department of Fish and Game prior to adoption.

Monitoring results should be provided to us and the California Department of Fish and Game to be incorporated into the annual review of the Subarea Plans, adaptive management, and recovery program. The MSCP includes measures for monitoring covered species.

5. Identify research needs and conduct studies on the biology and ecology of *Deinandra conjugens*.

Research is needed to identify limiting ecological and genetic factors for *Deinandra conjugens* and determine methods for controlled propagation & reintroduction.

5.1. Conduct research to determine the population dynamics of conserved populations of *Deinandra conjugens*.

Research is needed to better understand the population dynamics of *Deinandra conjugens*. Important questions that should be answered to evaluate recovery criteria include: What is the extent of suitable and occupied habitat necessary within a reserve to sustain a viable independent population of *D. conjugens* in the context of natural fluctuations? What constitutes an independent population for the purposes of monitoring? What is the number of populations and area of habitat that must be maintained to conserve the species in perpetuity? What is the maximum period for which a downward trend in population size/recruitment can be sustained

without significantly increasing the risk of demographic or genetic extirpation or a genetic bottleneck (founder event)?

5.2. Conduct research to determine ecological requirements of *Deinandra conjugens.*

Ecological studies should also address: the influence of disturbance on the species' habitat, various life history stages, and population dynamics; effective fire management requirements; techniques for maintaining habitat openings; soil characteristics (pH, texture, hydrology, slope, etc.) of the species' habitat; fine scale mapping of soil distribution (limited pockets of clay soils); seed bank characteristics; seed dispersal mechanisms; and the impact of herbivory.

5.3. Assess and plan for conservation of genetic variability within *Deinandra conjugens.*

5.3.1. Conduct a baseline census of current genetic structure of populations and genetic diversity of *Deinandra conjugens.*

Preliminary results indicate that *Deinandra conjugens* may have a high level of genetic diversity (Bauder and Truesdale 2000). All known populations should be examined to expand on this preliminary information and assist in identifying populations with unique genetic diversity.

Collection and analysis of plant tissue will be needed to determine genetic lineages within and among populations. Understanding genetic lineages among *Deinandra conjugens* populations may be important for determining the feasibility of long distance crosses, and to increase genetic diversity within populations, if necessary. Determination of the genetic variability within and among populations can provide an accurate estimate of effective population size and recovery potential. Maintenance of the

genetic diversity in *D. conjugens* should enhance long-term viability and adaptability to changing environmental conditions.

5.3.2. Determine the level of variability at the "S locus" within and among populations of *Deinandra conjugens*, and identify isolated populations that may need genetic augmentation.

An assessment of genetic variability at the S locus would further clarify self-pollination limitations and identify small, isolated populations which may become extirpated due to limited genetic diversity. These studies could identify the degree to which inbreeding depression in small populations is a problem and how much genetic variation is needed for viable restoration. Populations that are genetically similar may require augmentation to increase the genotypic diversity and potentially restore reproductive ability. Research should be able to identify the minimum number of S alleles necessary to sustain an independent population.

5.3.3. Identify appropriate management techniques to provide genetic exchange and/or genetic augmentation among *Deinandra conjugens* populations.

The maintenance or augmentation of genetic variability between/within populations may be accomplished by a variety of techniques including the distribution of seeds among populations, establishment of seedlings from nursery stock, and/or collection and transfer of pollen. Appropriate techniques should be developed and evaluated.

5.4. Based on research and monitoring of population dynamics in *Deinandra conjugens* and the extent of genetic variability within the species, determine the number of populations, the spatial

distribution, and the amount of suitable and occupied habitat necessary to recover the species.

5.5. Study *Deinandra conjugens* pollinators and their management needs.

A variety of native and non-native insects has been observed visiting *Deinandra conjugens* flowers. However, flower visitation does not necessarily indicate that the particular insect species is an effective pollinator of *D. conjugens*. Research is needed on the biology and ecology of important pollinators and an assessment should be made to determine if pollinator species have been, or may be, extirpated from conserved areas. Specific methods to manage for *D. conjugens* pollinators should be developed and incorporated into *D. conjugens* management plans.

5.5.1. Conduct research to identify the primary and secondary pollinators of *Deinandra conjugens*.

5.5.2. Identify the habitat requirements of *Deinandra conjugens* pollinators and assess population status in conserved areas.

Research on the habitat requirements to maintain viable populations of primary and secondary pollinators will be important for the long-term survival of *Deinandra conjugens*. Pollinators may require different soils and vegetation types for nest sites and adequate food resources. The size and distribution of pollinator populations should also be evaluated. Management actions within conserved areas may need to be developed to ensure that adequate habitat needs for pollinators are being provided.

5.5.3. Determine what distances pollinators can travel and how fragmentation affects pollinators' ability to contribute to long distance pollen transfer between populations of *Deinandra conjugens*.

5.6. Continue to develop techniques to germinate and propagate *Deinandra conjugens*.

Restoration of habitat and reintroduction of *Deinandra conjugens* may be necessary for recovery. These techniques for artificial enhancement, repatriation, and/or introduction reduce the risk of local extirpation from random disturbance and natural events and to maintain genetic diversity. Stored seed and seed from nursery propagated plants can provide material for potential enhancement of existing populations and/or introducing plants to new sites. Plants can be reintroduced to areas of historical occurrences if the site is currently unoccupied. Experimental introductions of this plant into appropriate habitats should be monitored to determine the validity of this technique for recovery of this species. Additionally, care in using the proper genetic stock should be used with any reintroductions.

5.7. Develop seed storage techniques for *Deinandra conjugens* and collect seeds from all available sources.

Seed storage is a prudent strategy for maintaining listed plants such as *Deinandra conjugens* that exist as a narrowly distributed endemic species where only a small portion of its native habitat is extant. This strategy helps to guard against chance catastrophic disturbance, which often occurs in source populations of these types of species. Guidelines for seed collection are available from the Center for Plant Conservation. Seeds from non-contiguous populations should be segregated and stored separately from each other to prevent mixing. Seeds from both ray and disc flowers should be stored in the seed storage facility. Seeds should be collected from as many different populations as possible, to ensure that the widest array of genetic diversity is captured in the seed storage facility. Priority should be placed on collecting seeds from extant populations outside of designated reserves, which may be lost in the near future.

Seeds should be stored in at least two appropriate seed storage facilities. Rancho Santa Ana Botanic Garden is a local facility. An agreement that ensures long term storage of adequately represented populations of *Deinandra conjugens* should be developed with Rancho Santa Ana Botanic Garden.

6. Develop and implement a community outreach program.

6.1. Develop and implement outreach plans to conserve *Deinandra conjugens*.

Outreach is an important component of implementing all recovery plans. An outreach plan should be developed to enhance the public's understanding of issues related to conservation and recovery of *Deinandra conjugens* and its associated habitat. Participation from both public and private entities should be encouraged for the establishment of conservation plans for this species. The MSCP includes measures to increase awareness of covered species.

6.2. Continue to develop informational outreach materials regarding the conservation of *Deinandra conjugens* and its associated habitat, and the greater ecosystem needs (including the interplay of other species) within preserved lands.

Agencies such as City of San Diego, City of Chula Vista, County of San Diego, and San Diego National Wildlife Refuge should develop outreach material (perhaps including exhibits) to inform the public on the value of regional planning, rare biota, ecosystem functions (*e.g.*, role of pollinators, plant-soil interactions, etc.), and compatible recreational use of the conserved areas.

7. Enter into dialogue with Mexican governmental and nongovernmental organizations to secure protection for *Deinandra conjugens* in Mexico.

If surveys indicate a significant population or populations of *Deinandra conjugens* exists in Baja California, Mexico, then those populations should

be preserved. Efforts should be directed toward establishing a dialogue among United States and Mexican organizations, both governmental and nongovernmental, to establish and implement measures to permanently preserve *D. conjugens* in Mexico.

III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows lists the actions and estimated costs for the recovery program for *Deinandra conjugens*. It is a guide for meeting the recovery goals outlined in this plan. Because several recovery actions are dependent on drought cycles and because drought cycles in the region are variable but are somewhat linked to El Niño/La Niña cycles (see Life History and Ecology, section I.C above), we assume a 21-year period until recovery. The actual drought cycles are likely to vary. Additionally, information gathered under the research recommended in this recovery plan may further alter the actual schedule.

Parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. When more than one party has been identified the proposed lead party is indicated by an asterisk (*). In some cases, there may be more than one lead party when each party oversees a specific geographical location or has joint responsibilities. The listing of a party in the Implementation Schedule neither requires, nor implies a requirement, that the identified party has agreed to implement the action(s) or to secure funding for implementing the action(s). However, parties willing to participate may benefit by being able to show in their own budgets that their funding request is for a recovery action identified in an approved recovery plan and is therefore considered a necessary action for the overall coordinated effort to recover *D. conjugens*. Also, section 7(a)(1)of the Endangered Species Act directs all Federal agencies to utilize their authorities in furtherance of the purposes of the Endangered Species Act by carrying out programs for the conservation of threatened and endangered species.

Priority Numbers

Recovery Actions are assigned Priority Numbers as follows:

Priority 1 — Actions that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2 — Actions that must be taken to prevent a significant decline in the species' population and/or habitat quality, or some significant negative impact short of extinction.

Priority 3 — All other actions necessary to provide for full recovery of the species.

The Priority 1 category is subdivided into three priority tiers (1a, 1b, 1c) to identify the relative priority of these actions. Tiers 1b and 1c represent actions that are prerequisites to or are needed to support actions in Tier 1a.

Key to Acronyms used in the Implementation Schedule

BLM	Bureau of Land Management
BP	Border Patrol
Caltrans	California Department of Transportation
CCV	City of Chula Vista
CDF	California Department of Forestry
CDFG	California Department of Fish and Game
CDPR	California Department of Parks and Recreation
CSD	City of San Diego
NGO	Nongovernmental Organizations
SDC	San Diego County
SDNHM	San Diego Natural History Museum
USFWS	U.S. Fish and Wildlife Service
*	Indicates responsible lead entity or entities

IMPLEMENTATION SCHEDULE FOR *DEINANDRA CONJUGENS* (OTAY TARPLANT) RECOVERY PLAN												
Priority Number	**Action Number**	**Action Description**	**Estimated Action Duration (Years)**	**Primary Responsible Parties**	**Cost ($1,000s)**						**Comments**
					Total Cost	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**	
1a	1.1	Protect *Deinandra conjugens* habitat within areas identified for preservation under the respective County of San Diego, City of San Diego, and City of Chula Vista MSCP Subarea Plans.	Ongoing	USFWS, CSD*, SDC*, CCV*, CDFG	TBD	TBD	TBD	TBD	TBD	TBD	Costs will reflect MSCP planning for multiple species.
1a	5.7	Develop seed storage techniques for *Deinandra conjugens* and collect seeds from all available sources.	4	USFWS*, CSD, SDC, CCV, CDFG	100	20	20	20	10		Repeat collections periodically to ensure fresh supply and diversity
1b	5.4	Based on research and monitoring of population dynamics in *Deinandra conjugens* and the extent of genetic variability within the species, determine the number of populations, the spatial distribution, and the amount of suitable and occupied habitat necessary to recover the species.	2	USFWS*, CDFG	TBD	TBD	TBD	TBD	TBD	TBD	Costs and specific timing dependent on research results
1c	5.3.1	Conduct a baseline census of current genetic structure of populations and genetic diversity of *Deinandra conjugens*.	Continuous	USFWS*, CDFG	200	50	30	0	0	0	After FY 06, $30K to re-evaluate every 5 years

IMPLEMENTATION SCHEDULE FOR *DEINANDRA CONJUGENS* (OTAY TARPLANT) RECOVERY PLAN											
Priority Number	**Action Number**	**Action Description**	**Estimated Action Duration (Years)**	**Primary Responsible Parties**	**Cost ($1,000s)**						**Comments**
					Total Cost	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**	
1c	5.3.2	Determine the level of variability at the "S locus" within and among populations of *Deinandra conjugens*, and identify isolated populations that may need genetic augmentation.	Continuous	USFWS*, CDFG	210	50	50	25	25		After FY 08, $20K to re-evaluate every 5 years
Priority 1 Actions subtotal					**510**	**120**	**100**	**45**	**35**	**0**	
2	1.2	Protect habitat supporting known populations of *Deinandra conjugens* outside of MSCP participating jurisdictional control.	Ongoing	USFWS*, CDFG*	TBD	TBD	TBD	TBD	TBD	TBD	Includes working with non-MSCP entities to develop multi-species HCPs that address *D. conjugens*.
2	2	Evaluate the status of all known populations of *Deinandra conjugens*.	Continuous	USFWS*, CSD*, SDC*, CCV*, CDFG*	310	50	20	20	20	20	Every other year after 2009
2	3	Conduct surveys to search for new populations of *Deinandra conjugens* and implement actions to protect populations outside of established (or proposed) reserves when necessary to maintain genetic diversity and/or connectivity between larger reserves.	5	USFWS*, CDFG*, CSD, SDC, CCV.	125	25	25	25	25	25	

IMPLEMENTATION SCHEDULE FOR *DEINANDRA CONJUGENS* (OTAY TARPLANT) RECOVERY PLAN											
Priority Number	**Action Number**	**Action Description**	**Estimated Action Duration (Years)**	**Primary Responsible Parties**	**Cost ($1,000s)**						**Comments**
					Total Cost	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**	
2	4.1	Develop and implement appropriate techniques to control invasive weeds within suitable *Deinandra conjugens* habitat.	Ongoing	USFWS*, CSD*, SDC*, CCV*, CDFG*	15,000	3,000	3,000	3,000	3,000	3,000	Assume 1,000 acres. Intensive mgmt = $15K/ac for 5 yr program. Initiate program on 200 ac/yr (1/5th) over 5 yrs. Multi-species benefit. Long-term mgmt, in part, through MSCP.
2	4.2	Develop and implement appropriate management plans for areas conserved for *Deinandra conjugens*.	Ongoing	USFWS*, CSD*, SDC*, CCV*, CDFG*	230	25	25	0	20	0	For outside MSCP-managed areas; MSCP will develop & implement own plans. $20K every other year after plan development.

IMPLEMENTATION SCHEDULE FOR *DEINANDRA CONJUGENS* (OTAY TARPLANT) RECOVERY PLAN											
Priority Number	**Action Number**	**Action Description**	**Estimated Action Duration (Years)**	**Primary Responsible Parties**	**Cost ($1,000s)**						**Comments**
					Total Cost	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**	
2	4.3	Develop and implement a *Deinandra conjugens* monitoring plan for conserved areas.	Ongoing	USFWS*, CSD*, SDC*, CCV*, CDFG	230	25	25		20		For outside MSCP-managed areas; MSCP will develop & implement own plans. $20K every other year after plan development.
2	5.5.1	Conduct research to identify the primary and secondary pollinators of *Deinandra conjugens*.	4	USFWS*, CDFG	60		30	10	10	10	Timing and duration may vary with yearly weather.
2	5.5.2	Identify the habitat requirements of *Deinandra conjugens* pollinators and assess population status in conserved areas.	Continuous	USFWS*, CDFG	175	0	0	20	20	15	Start FY 07; Every other year after 2009
Priority 2 Actions subtotal					**16,130**	**3,125**	**3,125**	**3,075**	**3,115**	**3,070**	
3	5.1	Conduct research to determine the population dynamics of conserved populations of *Deinandra conjugens*.	Continuous	USFWS*, CSD, SDC, CCV, CDFG*	280	30	30	20	20	20	Every other year after 2009. Timing and duration may vary with yearly weather.

IMPLEMENTATION SCHEDULE FOR *DEINANDRA CONJUGENS* (OTAY TARPLANT) RECOVERY PLAN											
Priority Number	**Action Number**	**Action Description**	**Estimated Action Duration (Years)**	**Primary Responsible Parties**	**Cost ($1,000s)**						**Comments**
					Total Cost	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**	
3	5.2	Conduct research to determine ecological requirements of *Deinandra conjugens*.	10	USFWS*, CSD, SDC, CCV, CDFG*	160	50	50	20	20	20	Timing and duration may vary with yearly weather.
3	5.3.3	Identify appropriate management techniques to provide genetic exchange and/or genetic augmentation among *Deinandra conjugens* populations.	Continuous	USFWS*, CDFG	80	10	10	10	10	10	$10K every 5 years after 2009
3	5.5.3	Determine what distances pollinators can travel and how fragmentation affects pollinators' ability to contribute to long distance pollen transfer between populations of *Deinandra conjugens*.	4	USFWS*, CSD, SDC, CCV, CDFG	80			20	20		2 additional years to complete research. Timing and duration may vary with yearly weather.
3	5.6	Continue to develop techniques to germinate and propagate *Deinandra conjugens*.	2	USFWS*, CSD, SDC, CCV, CDFG	20		10	10			
3	6.1	Develop and implement outreach plans to conserve *Deinandra conjugens*.	Continuous	USFWS, CSD*, SDC*, CCV*, CDFG	62	0	5	3	3	3	$3K annually after 2009; augments MSCP outreach efforts.

IMPLEMENTATION SCHEDULE FOR *DEINANDRA CONJUGENS* (OTAY TARPLANT) RECOVERY PLAN											
Priority Number	**Action Number**	**Action Description**	**Estimated Action Duration (Years)**	**Primary Responsible Parties**	**Cost ($1,000s)**						**Comments**
					Total Cost	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**	
3	6.2	Continue to develop informational outreach materials regarding the conservation of *Deinandra conjugens* and its associated habitat, and the greater ecosystem needs (including the interplay of other species) within preserved lands.	Continuous	USFWS*, CSD*, SDC*, CCV*, CDFG*	63	3	3	3	3	3	$3K annually after 2009; augments MSCP outreach efforts.
3	7	Enter into dialogue with Mexican governmental and nongovernmental organizations to secure protection for *Deinandra conjugens* in Mexico.	Ongoing	USFWS*, CDFG, NGO	TBD	TBD	TBD	TBD			
Priority 3 Actions subtotal					**745**	**93**	**108**	**86**	**76**	**56**	
Total Estimated Cost of *Deinandra conjugens* Recovery: $17,385,000.00 + additional costs that cannot be estimated at this time											

IV. REFERENCES

A. Literature Cited

Baldwin, B. G. 1999. New combinations and new genera in the North American tarweeds (Compositae - Madiinae). Novon 9(4):462-471.

Barrett, S. C. H., and J. R. Kohn. 1991. Genetics and evolutionary consequences of small population size in plants: Implications for conservation. Pages 1-30 in: D. A. Falk and K. E. Holsinger (Eds.). Genetics and conservation of rare plants. Oxford University Press, New York.

Baskin, C. B., and J. M. Baskin. 2001. Seeds, ecology, biogeography, and evolution of dormancy and germination. Academic Press, San Diego. 666 pp.

Bauder, E. T., and D. Truesdale. 2000. A comparison of *Hemizonia conjugens* (Otay tarplant) with two closely related tarplant species using enzyme electrophoresis and soil textural analysis. Prepared for California Department of Fish and Game, Region 5, Natural Community Conservation Planning Program, San Diego, California. Contract # FG 7186 ES, February 2000.

Bauder, E. T., J. Snapp-Cook, and J. Sakrison. 2002. Ecology and management of *Deinandra conjugens* (D. D. Keck) B. G. Baldwin (Otay tarplant); Final Report. Prepared for California Department of Fish and Game, Region 5, Natural Community Conservation Planning Program, San Diego, California. Contract # FG 8058 HP, February 2002.

Beauchamp, R. M. 1986. A flora of San Diego County, California. Sweetwater River Press, National City, California.

Bolger, D. T., A. C. Alberts, R. M. Sauvajot, P. Potenza, C. McCalvin, D. Tran, S. Mazzoni, and M. E. Soulé. 1997. Response of rodents to habitat fragmentation in coastal southern California. Ecological Applications 7(2):552-563.

California Department of Fish and Game. 1994. California Endangered Species Act Biological Opinion, California Department of Transportation widen State Route 54, San Diego County. California Department of Fish and Game, Sacramento, California.

California Department of Transportation. 2004. State Route 905 extension, San Diego County, California: Biological Assessment [11-SD-905 KP-9.2 – 19.3 (PM 5.7 – 12.0); EA 093160; FWS-SDG-2296].

California Native Plant Society. 2001. Inventory of Rare and Endangered Plants of California (sixth edition). Rare Plant Scientific Advisory Committee, D. P. Tobor, Convening Editor. California Native Plant Society, Sacramento, California. x + 388 pp.

California Natural Diversity Data Base. 2002. *Hemizonia conjugens*. Unpublished Report, California Natural Diversity Data Base, Natural Heritage Division, California Department of Fish and Game, Sacramento, California.

City of Chula Vista. 1992. Rancho San Miguel General Development Plan; Volume 2: Technical Appendices for Final Environmental Impact Report EIR-90-02; State Clearinghouse Number 90010155. September 1992.

City of Chula Vista. 2003. City of Chula Vista MSCP Subarea Plan.

City of San Diego. 1997. Multiple Species Conservation Program: City of San Diego MSCP Subarea Plan.

City of San Diego. 1998. Final Multiple Species Conservation Program: MSCP Plan.

City of San Diego. 1999. Public Notice of Draft Re-circulated Environmental Impact Report for Hidden Trails Community Plan. City of San Diego Development Services, Land Development Review Division, San Diego, California.

County of San Diego. 1997. Multiple Species Conservation Program: County of San Diego MSCP Subarea Plan.

DeMauro, M. M. 1993. Relationship of breeding system to rarity in the lakeside daisy (*Hymenosyx acaulis* var. *glabra*). Conservation Biology 67:542-550.

Ellstrand, N. C. 1992. Gene flow by pollen: implications for plant conservation genetics. Oikos 63:77-86.

Frankham, R., and K. Ralls. 1998. Inbreeding leads to extinction. Nature 241:441-442.

Frankham, R., J. D. Ballou, and D. A. Briscoe. 2002. Introduction to conservation genetics. Cambridge University Press. New York, NY. 617 pp.

Gilpin, M. E., and M. E. Soulé. 1986. Minimum viable populations: the process of species extinctions. Pages 13-34 *in*: M. E. Soulé (ed.). Conservation Biology: The science of scarcity and diversity. Sinauer Associates, Sunderland, Massachusetts.

Given, D. R. 1994. Principles and practice of plant conservation. Timber Press. Portland, OR. 292 pp.

Hard, J. J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17:304-326.

Heywood, J. S. 1993. Biparental inbreeding depression in the self-incompatible annual plant *Gaillardia pulchella* (Asteraceae). American Journal of Botany 80:545-550.

Jennersten, O. 1988. Pollination in *Dianthus deltoides* (Caryophyllaceae): effects of habitat fragmentation on visitation and seed set. Conservation Biology 4:359-366.

Kearns, C. A., D. W. Inouye, and N. M. Waser. 1998. Endangered mutualisms: The conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics 29:83-112.

Keck, D. D. 1958. Taxonomic notes on the California flora. Aliso 4(1):101-114.

Keck, D.D. 1959. *Hemizonia*. Pages 1117-1124 *in*: P. A. Munz. A California flora. University of California Press, Berkeley.

Keil, D. J. 1993. Asteraceae (Compositae) Sunflower Family. Page 282 *in*: Hickman, J. C. (Ed.). The Jepson Manual: Higher Plants of California. University of California Press, Berkeley.

Krombein, K. V., P. D. Hurd, Jr., D. Smith, and B. D. Burks. 1979. Catalog of Hymenoptera in America North of Mexico. Smithsonian Institution Press, Washington, D.C. 2,735 pp.

Lacy, R. C. 1997. Importance of genetic variation to the viability of mammalian populations. Journal of Mammalogy 78(2):320-335.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

Lande, R. 1999. Extinction risks from anthropogenic, ecological, and genetic factors. Pp. 1-22 *In*: L. F. Landweber and A. P. Dobson (Eds.). Genetics and the Extinction of Species. Princeton University Press.

Les, D. H., J. A. Reinarts, and E. J. Esselman. 1991. Genetic consequences of rarity in *Aster furcatus* (Asteraceae), a threatened, self-incompatible plant. Evolution 45:1641-1650.

Lynch, M., J. Conrey and R. Burger. 1995. Mutation accumulation and the extinction of small populations. American Naturalist 146:489-518.

McMillan Biological Consulting. 2002. 2001 rare plant survey report for Jamul Ranch. Unpublished Report. June 2002. La Mesa, California.

Merkel & Associates, Inc. 1999. San Miguel Ranch South Parcel Otay Tarplant (*Hemizonia conjugens*). Preliminary Survey Report Submitted to P&D Consultants, Inc., San Diego, California. Unpublished Report. May 20, 1999.

Minnich, R. A., E. F. Viscaìno, and R. J. Dessani. 2000. The El Niño/Southern Oscillation and precipitation variability in Baja California, Mexico. Atmósfera 13:1-20.

National Oceanic and Atmospheric Administration. 2004. Frequently asked questions about El Niño and La Niña. Available online at: <http://www.pmel.noaa.gov/tao/elnino/faq.html#lanina>. Accessed November 10, 2004.

RECON Environmental. 1998. Biological technical report for the Beyer Hills project. Unpublished report (Recon #3046B). August 24, 1998.

Reiser, C. H. 1996. Rare plants of San Diego. Aquafir Press, San Diego, California.

Rice, K. J. 1989. Impacts of seed banks on grassland community structure and population dynamics. Pages 211-230 *In*: M. A. Leck, V. T. Parker, and R. L. Simpson (Eds.). Ecology of soil seed banks. Academic Press, Inc. San Diego, California.

Roberts, F. M., Jr. 1997. The Status of *Hemizonia conjugens* (Otay tarplant); An analysis of existing California Natural Diversity Database Records and other Sources. Unpublished Report. U.S. Fish and Wildlife Service, Carlsbad Field Office, Carlsbad, California.

San Diego Gas and Electric. 1995. San Diego Gas and Electric Company subregional Natural Community Conservation Plan. San Diego Gas and Electric, San Diego, California.

Saunders, D. A., R. J. Hobbs, C. R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. Conservation Biology 5(1):18-32.

Soulé, M. E., D. T. Bolger, A. C. Alberts, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitat islands. Conservation Biology 2(1):75-92.

Tanowitz, B. D., P. F. Salopek, and B. E. Mahall. 1987. Differential germination of ray and disc achenes in *Hemizonia increscens* (Asteraceae). American Journal of Botany 74(3):303-312.

U.S. Fish and Wildlife Service. 1983a. Endangered and threatened species: Listing and recovery priority guidelines. Federal Register 48:43098-43105. September 21, 1983.

U.S. Fish and Wildlife Service. 1983b. Endangered and threatened species: Listing and recovery priority guidelines correction. Federal Register 48:51982. November 15, 1983.

U.S. Fish and Wildlife Service. 1998. Endangered and threatened wildlife and plants: determination of endangered or threatened status for four plants from southwestern California and Baja California, Mexico. Federal Register 63(197):54938-54956. October 13, 1998.

U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants designation of critical habitat for *Deinandra conjugens* (Otay tarplant). Federal Register 67(237):76030-76053. December 10, 2002.

B. Personal Communications

Baldwin, Bruce. 2001. Jepson Herbarium, University of California, Berkeley. Berkeley, California.

Davenport, Arthur. 2003. Davenport Biological Services.

Dodero, Mark. 2001, 2004. RECON Environmental, Inc. San Diego, California.

Famolaro, Pete. 2004. Sweetwater Authority. Chula Vista, California.

Friar, Elizabeth. 2001. Claremont Graduate University, Claremont, California.

McMillan, Scott. 2001, 2003. McMillan Biological Consulting, La Mesa, California.

C. *In Litt.* References

Allen, S. M. 2004. Letter report to Mr. Chuck Cleeves, HDR Engineering: Results of a focused survey for Otay tarplant (*Hemizonia* [*sic*] *conjugens*) on the Otay Water District (OWD) proposed 450-1 recycled water reservoir & pump station project. August 9, 2004. *In* Draft Environmental Impact Report: Otay Water District recycled water pipeline, reservoir, and pump station project. September 2004. AMEC Earth & Environmental.

Baldwin, Bruce. 2001. Curator, Jepson Herbarium; Associate Professor, University of California at Berkeley. Letter to Jim Bartel, U.S. Fish and Wildlife Service, Region 1, dated March 6, 2001.

City of San Diego. 2001. City of San Diego MHPA Boundary Adjustment Meeting; agenda and subsequent e-mails.

Davenport, Arthur. 2004. Letter to Jim Bartel, U.S. Fish and Wildlife Service, dated February 20, 2004.

Helix Environmental Planning. 2001. Johnson Canyon Otay tarplant populations (PBH-02). Undated, but received (as new information) by the U.S. Fish and Wildlife Service on July 13, 2001.

Hogan, David. 1990. *Hemizonia conjugens* petition. Petition to list *Hemizonia conjugens* as endangered. Submitted by the San Diego Biodiversity Project.

McMillan, Scott. 2003. Consultant, McMillan Biological Consulting. Current Known Status of Element Occurences (EO's) for *Deinandra conjugens* (Otay tarplant). Unpublished data prepared for U.S. Fish and Wildlife Service, Carlsbad, California.

Merkel and Associates. 2000. Letter report from Keith Merkel, Merkel and Associates, to Kim Marsden, California Department of Fish and Game, and Gjon Hazard, U.S. Fish and Wildlife Service: Chula Vista Sports Park proposed minor amendment area. December 28, 2000.

Morey, Sandy. 1994. Coordinator of Endangered Plant Program, California Department of Fish and Game. Summary of the Otay tarplant Recovery Workshop held on September 23, 1994, dated November 17, 1994.

RECON Environmental. 2004. Letter report to Mr. Chris Otahal, U.S. Fish and Wildlife Service: Otay tarplant focused survey results for the Otay Mesa Generating Company (RECON #3496-1B). September 24, 2004.

Stone, Brenda. 1994. *Hemizonia conjugens* field report for spring 1994. Unpublished report prepared for California Department of Transportation, San Diego, California.

APPENDIX A. Summary of Threats and Recommended Recovery Actions

Listing Factor	Threat	Still a Threat?	Recovery Action Number	Recovery Criteria
A	Habitat loss due to agriculture and urbanization	yes	1, 2, 3	1, 2
A	Habitat fragmentation	yes	1, 2, 5.3.3, 5.4, 5.5.2, 5.5.3	1, 2
A	Off-highway vehicle use	yes	1, 4.2, 6.1, 6.2	5
A	Trampling	yes	1, 4.2, 6.1	5
A,E	Competition from non-native plant species.	yes	4.1, 4.2, 4.3, 5.2	2, 5
B	Overcollection	Possible; not currently known to be a threat.		
C	Disease or Predation	Possible; not currently known to be a threat.		
D	Need for full enforcement of State (CEQA, CESA) and local laws	yes	Beyond scope of recovery plan.	N/A
D	Inadequacy of protective regulatory mechanisms in Mexico	yes	Beyond scope of recovery plan.	N/A
E	Inbreeding depression and infertility due to self-incompatible breeding system and genetic homogeneity	yes	5.3.1, 5.3.2, 5.3.3, 5.4, 5.6, 5.7	3, 4, 5, 6, 9,10
E	Loss of pollinators	yes	4.2, 4.3, 5.2, 5.5.1, 5.5.2, 5.5.3, 6.2	2, 5, 8
E	Susceptibility to extirpation from random environmental fluctuations due to small population size	yes	4.3, 5.1, 5.2, 5.4, 5.6, 5.7, 6.1, 6.2	2, 3, 4, 6, 7

Listing Factors:

A. The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

B. Overutilization for Commercial, Recreational, Scientific, Educational Purposes

C. Disease or Predation

D. The Inadequacy of Existing Regulatory Mechanisms

E. Other Natural or Manmade Factors Affecting Its Continued Existence

APPENDIX B. Summary of Comments.

On December 18, 2003, we released the Draft Recovery Plan for *Deinandra conjugens* (Otay Tarplant) for public comment. We solicited comments on the Draft Recovery Plan from the public from December 18, 2003, to March 2, 2004. We also requested peer review from three independent specialists with expertise with *D. conjugens* and closely related species. Additionally, we requested the State of California (Department of Fish and Game) to provide comments. During the comment period, we received letters from two members of the public, two independent experts, and from the State. All comment letters are kept on file at the Carlsbad Fish and Wildlife Office.

We reviewed all of the comments that were received during the comment period. Comments ranged from recommending specific changes and providing new information to larger issues related to the Multiple Species Conservation Program and species recovery. We have tried to incorporate all applicable comments into the recovery plan.

Summary of Significant Comments and Service Responses

Comment: We received several comments critical of the Multiple Species Conservation Program (MSCP) and its role in tarplant recovery.

Response: The MSCP is a program in which participating jurisdictions receive coverage for incidental take of listed wildlife species. Take is prohibited under section 9(a)(1)(B) of the Endangered Species Act of 1973, as amended. Coverage is received through a permit issued under section 10(a)(1)(B) of the Act. However, take prohibitions of the Act do not apply to listed plants, although Section 9 of the Act does prohibit certain acts, including the removal or destruction of listed plants in violation of State law. Although take of listed plants is not prohibited under the Act, plant species covered by the MSCP's associated Subarea Plans are identified on the respective permits in recognition of the conservation measures and benefits that will be provided to them under the MSCP.

Nevertheless, we must analyze the impacts of issuing the permit on any listed species that may be affected by the action to ensure that issuing the permit is not likely to jeopardize the species' continued existence. We have done this for *Deinandra conjugens* for each of the three MSCP Subarea Plans that address this species: City of San Diego (U.S. Fish and Wildlife Service 1997); County of San Diego (U.S. Fish and Wildlife Service 1998), and City of Chula Vista (U.S. Fish and Wildlife Service 2003a). We do not agree with

the comments asserting that the MSCP will appreciably reduce the likelihood of both the survival and recovery of the species. We concluded that urban development that has resulted and is anticipated to result from the MSCP will not jeopardize *D. conjugens*.

Although each Subarea Plan's approach is slightly different, in general, the MSCP includes measures to avoid and minimize impacts to *Deinandra conjugens*. In addition to considering *D. conjugens* in the MSCP's preserve design (U.S. Fish and Wildlife Service and California Department of Fish and Game 1996), this species further benefits by being specially earmarked as a Narrow Endemic species. Through the MSCP, species identified as Narrow Endemics receive additional avoidance and minimization measures. Further, we anticipate that monitoring and management of the MSCP Preserve will mitigate impacts to *D. conjugens*.

Because the United States range of *Deinandra conjugens* is within the planning area for three participating jurisdictions' Subarea Plans, this species' preservation is strongly linked to the implementation of the MSCP. This recovery plan acknowledges and relies upon benefits *D. conjugens* receives under the MSCP.

Comment: One comment was critical of the timing of the recovery plan; that it should have been completed sooner.

Response: Although section 4(f)(1) of the Endangered Species Act requires the development and implementation of recovery plans, it does not provide a deadline for when recovery plans need to be developed, which is in contrast to other Endangered Species Act-related actions that we conduct (*e.g.*, formal consultations under section 7). We must prioritize our workload. The Fish and Wildlife Service entered into a settlement agreement in *California Native Plant Society v. Babbitt* to develop a final recovery plan for *Deinandra conjugens* by the end of 2004.

References

California Native Plant Society; Southwest Center for Biological Diversity versus Bruce Babbitt, Secretary of the Interior; Jamie Rappaport Clark, Director, U.S. Fish and Wildlife Service. 2000. Stipulated settlement agreement and order. United States District Court, Southern District of California. Case No. 99CV1454L (LAB). December 21, 2000.

U.S. Fish and Wildlife Service. 1997. Biological and conference opinions on issuance of an Incidental Take Permit to the City of San Diego pursuant to the Multiple Species Conservation Program (1-6-97-FW-47). June 6, 1997.

U.S. Fish and Wildlife Service. 1998. Biological and conference opinions on issuance of an Incidental Take Permit to the County of San Diego under the Multiple Species Conservation Program for their Subarea Plan (1-6-98-FW-03). March 12, 1998.

U.S. Fish and Wildlife Service. 2003a. Biological and conference opinions on issuance of an Incidental Take Permit to the City of Chula Vista pursuant to the Multiple Species Conservation Program, San Diego County, California (1-6-03-FW-882.1)

U.S. Fish and Wildlife Service. 2003b. Notice of Availability: Draft recovery plan for *Deinandra conjugens* (Otay tarplant). Federal Register 68(243):70526-70527. December 18, 2003.

U.S. Fish and Wildlife Service and California Department of Fish and Game. 1996. MSCP 1995 and 1996 species evaluations. Unpublished report. September 1996.