

**Delhi Sands Flower-loving Fly**  
*(Rhaphiomidas terminatus abdominalis)*

**5-Year Review:**  
**Summary and Evaluation**



Photo by Gilbert Goodlett

**U. S. Fish and Wildlife Service**  
**Carlsbad Fish and Wildlife Office**  
**Carlsbad, California**

**March 2008**

**5-YEAR REVIEW**  
**Delhi Sands Flower-loving Fly**  
*(Rhaphiomidas terminatus abdominalis)*

**1. GENERAL INFORMATION**

**1.1. Reviewers**

Lead Region: Diane Elam and Jenness McBride, Region 8 (California and Nevada),  
916-414-6464

Lead Field Office: Karen A. Goebel and Eric E. Porter, Carlsbad Fish and Wildlife Office,  
760-431-9440

**1.2. Methodology used to complete the review:**

This review was compiled by Eric Porter of the Carlsbad Fish and Wildlife Office, U.S. Fish and Wildlife Service (Service), and considered available literature, office files, and discussions with researchers whose expertise included the Delhi Sands flower-loving fly, related species, or a biological field relevant to Delhi Sands flower-loving fly conservation. Many of the discussions with researchers took place during a Delhi Sands Flower-Loving Fly Workshop sponsored by the University of California at Riverside, Center for Conservation Biology, on March 30-31, 2006.

**1.3. Background:**

**1.3.1. FR Notice citation announcing initiation of this review:**

The notice announcing the initiation of this 5-year review and opening of the information request period for 60 days was published on July 7, 2005 (70 FR 39327). A notice reopening the comment period for 60 days was published on November 3, 2005 (70 FR 66842). We received information from the city officials of the cities of Rialto, Fontana, and Colton, San Bernardino County, California.

**1.3.2. Listing history**

Original Listing

FR notice: Federal Register 58 FR 49881

Date listed: September 23, 1993

Entity listed: subspecies; Delhi Sands flower-loving fly  
*(Rhaphiomidas terminatus abdominalis)*

Classification: Endangered

**1.3.3. Associated rulemakings**

No associated rulemaking has occurred for this subspecies.

#### **1.3.4. Review History**

No comprehensive status reviews have been conducted for this subspecies.

#### **1.3.5. Species' Recovery Priority Number at start of 5-year review**

6C. This priority number, as identified in the 2007 Recovery Data Call for the Carlsbad Fish and Wildlife Office, indicates a high degree of threat and a low potential for recovery for a listed subspecies that may be in conflict with construction or other development projects or other forms of economic activity (Listing and Recovery Guidelines, 48 FR 43104, September 21, 1983).

#### **1.3.6. Recovery Plan or Outline**

Name of plan: Recovery Plan For the Delhi Sands Flower-Loving Fly

Date issued: September 14, 1997

Dates of previous revisions: None

## **2. REVIEW ANALYSIS**

### **2.1. Application of the 1996 Distinct Population Segment (DPS) policy**

#### **2.1.1. Is the species under review a vertebrate?**

No. The Endangered Species Act defines species as including any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the Delhi Sands flower-loving fly is an insect (an invertebrate) and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

### **2.2. Recovery Criteria**

#### **2.2.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?**

No. Although the recovery plan defines the number of populations and abundance trends necessary within each population to consider downlisting the Delhi Sands flower-loving fly to threatened status (downlisting criterion 3 below), we have determined, since issuance of the recovery plan, that the resolution of current population data is too poor to effectively evaluate abundance trends or population distributions due to the cryptic nature and rarity of the Delhi Sands flower-loving fly. Thus, downlisting criterion 3 needs revision. The recovery plan did not establish delisting criteria.

## **2.2.2. Adequacy of recovery criteria.**

### **2.2.2.1. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?**

No. Habitat conditions have changed that preclude long-term conservation goals in the Ontario recovery unit (downlisting criterion 1 below). Thus, downlisting criterion 1 needs revision.

### **2.2.2.2. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?**

No. The recovery criteria are not explicitly threats-based, but they were developed to address the four listing factors<sup>1</sup> relevant to the subspecies: A (present or threatened destruction, modification, or curtailment of its habitat or range), B (overutilization for commercial, recreational, scientific, or educational purposes), D (inadequacy of existing regulatory mechanisms), and E (other, natural or manmade factors affecting its continued existence). However, we have now determined that downlisting criterion 3 cannot be evaluated with our current knowledge of the subspecies, and this criterion needs revision in order to adequately address listing factor E. Listing factor C (disease or predation) is not addressed in the plan, but it is not relevant to this subspecies (see section 2.3.2. Five-Factor Analysis below).

### **2.2.3. List the recovery criteria as they appear in the recovery plan and discuss how each criterion has or has not been met, citing information (for threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here):**

The recovery plan did not establish delisting criteria; however, four criteria were established to determine when the Delhi Sands flower-loving fly can be considered for reclassification to threatened status. Listing factor C, disease or predation, is not relevant to this subspecies.

#### Downlisting Criterion 1

*At least eight populations in three recovery units (RUs), i.e., Colton, Jurupa, and Ontario, are permanently protected. The population that inhabits the largest remaining block of Colton Dunes located east of Riverside Avenue, south of Interstate-10, north of*

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<sup>1</sup> A) Present or threatened destruction, modification, or curtailment of its habitat or range;  
B) Overutilization for commercial, recreational, scientific, or educational purposes;  
C) Disease or predation;  
D) Inadequacy of existing regulatory mechanisms;  
E) Other natural or manmade factors affecting its continued existence.

*the Santa Ana River, and west of the cement plant, must be protected [Slover/Pepper population]. At least four populations must be located in the Colton RU, two of them north of Interstate-10 (including the San Bernardino Hospital Reserve), and two south of Interstate-10. In the Jurupa RU, the Jurupa Hills population in the City of Fontana must be secured. The location of the remaining populations will be determined using information collected during implementation of this recovery plan. Dispersal corridors must be maintained between the populations (Figure 1).*

Downlisting criterion 1 addresses listing factor A (present or threatened destruction, modification, or curtailment of its habitat or range) and D (inadequacy of existing regulatory mechanisms) by identifying permanent protection of occupied Delhi Sands flower-loving fly habitat as a conservation priority. The recovery plan does not quantify the amount of habitat necessary to protect each of the eight populations desired for long-term conservation, rather it acknowledges that “With habitat quality varying from the location of one population and RU to another, acreage needed to sustain viable populations also varies from site to site.” Moreover, the recovery plan determined that additional data on reproduction and mortality rates, dispersal, and habitat variables were needed to determine specific habitat acreage objectives for each recovery unit, and in the absence of such data, “the highest priority will be to protect existing populations of the Delhi Sands flower-loving fly” (Service 1997). We note that insufficient data are available to adequately delineate unique biological populations, and we use the term “population” in this review to indicate physically separated locations occupied by the subspecies to be consistent with language in the recovery plan.

The Slover/Pepper population is partially protected through the establishment of the 3-hectare (ha) (7.5-acre (ac)) Colton Transmission Facility Reserve and the 61-ha (150-ac) Vulcan Materials, Inc., Colton Dunes Conservation Bank (Conservation Bank). These conserved sites are surrounded by additional undeveloped Delhi Sands flower-loving fly habitat; however, no protections are in place to prevent future impacts, and additional land will need to be protected to provide adequate protection for this population. Although the Hospital Reserve has been protected, additional habitat would need to be protected to sustain a robust population. The Jurupa Hills population has been adequately protected with conservation of 21 ha (52 ac) of Delhi Sands flower-loving fly habitat. There are no other conserved sites that are large enough and adequately managed to support a Delhi Sands flower-loving fly population (see Spatial Distribution and Habitat Conditions in section 2.3.1 for additional detail). Therefore, downlisting criterion 1 has only been partially met.

### Downlisting Criterion 2

*Each of the eight population sites and dispersal corridors are managed to maintain perpetual sand supply and sparse total native vegetative cover (no more than 20 percent) dominated by native species such as California buckwheat, California croton, and telegraph weed.*

Downlisting criterion 2 addresses listing factor A (destruction, modification or curtailment of habitat or range) through maintenance of historical habitat conditions known to support the Delhi Sands flower-loving fly. None of the Delhi Sands flower-loving fly conservation areas are currently managed to maintain perpetual sand supply. It is likely that urban and residential development have interrupted the flow of windblown sand deposits that created and maintained the Colton Dunes ecosystem. There is currently insufficient information to determine the extent or long-term importance of this impact to maintaining the dune ecosystem. While it is important to monitor shifts in dune morphology, additional data are needed to develop adequate sand management strategies.

Management plans have been approved that address plant cover in only two conservation areas (Ecosystems Restoration Associates 2005; Vulcan Materials Inc. 2005), and limited vegetation management has been incorporated into the management plan for the Colton Transmission Facility Reserve (ENSR Corporation 2006). Therefore, downlisting criterion 2 has only been partially met.

### Downlisting Criterion 3

*As determined by a scientifically credible management plan, each of the eight populations must exhibit a statistically significant upward trend for at least 15 years (approximately seven fly generations) and have an estimated adult population of at least 200 individuals.*

Downlisting criterion 3 addresses listing factor E (other natural or manmade factors affecting its continued existence, such as small population size and habitat fragmentation in this instance) by ensuring that conserved populations are of sufficient size to be maintained through time. The cryptic nature and low density of Delhi Sands flower-loving fly complicate efforts to effectively monitor population abundance (Kingsley 2002). To date, it has proven difficult to conduct surveys that reliably quantify relevant population variables (*e.g.*, density and relative abundance), and no populations are regularly surveyed with sufficient effort to effectively monitor population trends. Therefore, at this time, the resolution of current population data is too poor to effectively evaluate abundance trends, and downlisting criterion 3 has not been met.

### Downlisting Criterion 4

*A program is initiated to inform the public about the Delhi Sands flower-loving fly and its habitat. This outreach effort should garner public support for conservation of the sand dune system upon which the Delhi Sands flower-loving fly depends.*

Downlisting criterion 4 addresses listing factor A (destruction, modification, or curtailment of habitat or range) by encouraging residents to avoid potentially destructive activities in Delhi Sands flower-loving fly habitat and listing factor B by discouraging excessive collection of this rare subspecies. Downlisting criterion 4 has

been partially fulfilled through education of local jurisdictions. These jurisdictions require appropriate assessments within potential Delhi Sands flower-loving fly habitat and subsequent consultation with the Service if proposed projects may impact occupied Delhi Sands flower-loving fly habitat. However, to date, efforts to discourage residents from degrading Delhi Sands flower-loving fly habitat through discing, mowing, off-highway vehicle use, and trash dumping have been largely ineffective.

Increased regulatory control of development projects in economically depressed areas supporting Delhi Sands flower-loving fly has been controversial following listing of the subspecies. No structured program has been developed to educate the public about the value of conserving Delhi Sands flower-loving fly and its habitat, although interaction with the media to clarify misinformation is common. Recent conservation partnerships with entities such as the Riverside Lands Conservancy and Vulcan Materials, Inc., have helped to inform the public and garner support for Delhi Sands flower-loving fly conservation. Overall, however, public support for conservation of the sand dune system upon which the Delhi Sands flower-loving fly depends is limited, and downlisting criterion 4 has not been met.

## **2.3. Updated Information and Current Species Status**

### **2.3.1. Biology and Habitat**

There has been one published paper (Kingsley 2002) about the general species biology and life history requirements of the Delhi Sands flower-loving fly subsequent to 1997 when the recovery plan was issued. This study provided important information about Delhi Sands flower-loving fly population dynamics, but this information does not necessitate a change in the analyses used for the recovery plan. We present the following background information on general species biology and life history topics to provide context for this 5-year review. Updated information on the spatial distribution and habitat conditions of the Delhi Sands flower-loving fly is also provided.

The Delhi Sands flower-loving fly belongs to the Dipteran (fly) family Mydidae. There are more than 30 species of *Rhaphiomidas*, distributed across the southwestern United States and northern Mexico. These flies are relatively large with size among the species ranging from approximately 1.5 to 4 centimeters (0.6 to 1.6 inches). All species of *Rhaphiomidas* are associated with arid, sandy habitats, with most species living on dune systems of inland desert valleys, rivers, deltas, and beach strands. The Delhi Sands flower-loving fly is generally found in areas containing Delhi fine sands soil type.

The life history of the Delhi Sands flower-loving fly is largely unknown. Oviposition (egg-laying) occurs within loose, sandy soils in late summer months and may primarily occur near telegraph weed (Rogers and Mattoni 1993; Kingsley 1996). Larval stages develop completely underground and emerge as adults from July through September. At the time of listing, the Delhi Sands flower-loving fly flight season was thought to be restricted to August and September, and the larval food source for the Delhi Sands

flower-loving fly was unknown. We now know that the flight period begins as early as July 1 based on several observations of adult Delhi Sands flower-loving fly in July, including a July 1, 2002, observation (AMEC Earth and Environmental, Inc. 2002). Adults are most active during the warmest, sunniest parts of the day, and both males and females extract nectar from California buckwheat and other plants (Kingsley 1996). It is not clear if nectar feeding is essential for adult survival or reproduction.

In May 2007, entomologists observed several larvae of *Rhaphiomidas trochilus*, and because *R. trochilus* is closely related to the Delhi Sands flower-loving fly, these observations are likely relevant to the understanding of Delhi Sands flower-loving fly larval biology. All larvae were found within relatively moist soil several feet (> 1 meter) below the soil surface in association with other soil-dwelling insect larvae. The observations suggest that the larvae are opportunistic subterranean predators (K. Osborne and G. Ballmer pers. comm. 2007). A captive-rearing program with the same species shows that larvae are capable of indeterminate development, molting two to three times per year for at least three years prior to pupation (K. Osborne and G. Ballmer pers. comm. 2007). Mattoni and Ballmer (1998) proposed the hypothesis that Delhi Sands flower-loving fly larvae may feed in ant nests, and the recent observations neither confirm nor dispute this hypothesis (K. Osborne and G. Ballmer pers. comm. 2007). Observational data suggest that *Rhaphiomidas* species frequently oviposit (lay eggs) within 1 to 2 meters (3 to 7 feet) of native ant nests. Some arthropods are known to mimic larval ants and receive food from adult worker ants, and other arthropods are known to feed directly on immature ants in active colonies (Hölldobler and Wilson 1990). While Mattoni and Ballmer offer a plausible explanation of Delhi Sands flower-loving fly larval feeding, no conclusive data or direct observations have been made to support the hypothesis.

We received information from one commenter that the Delhi Sands flower-loving fly may be non-native to the Riverside/San Bernardino area and may have been accidentally introduced by the early settlers. The information concluded that the Delhi Sands flower-loving fly is better suited to an area that has some water and green vegetation available during its adult life, and therefore the Delhi Sands flower-loving fly cannot be native to Delhi Sand dunes. While it is true that more information is needed to clarify the specific habitat requirements of the Delhi Sands flower-loving fly, current scientific literature identifies the Delhi Sands flower-loving fly as a subspecies endemic to the Colton Dunes Ecosystem, and related taxa are similarly restricted to arid, often dune habitat (Rogers and Mattoni 1993).

### **Spatial Distribution and Habitat Conditions**

The Delhi Sands flower-loving fly is only known from Riverside and San Bernardino counties, with most occupied Delhi Sands flower-loving fly habitat located within a limited area of southwestern San Bernardino County (Carlsbad Fish and Wildlife Office GIS database 2007). In the final rule listing the subspecies, the historical range of the Delhi Sands flower-loving fly was determined using Delhi Soils and related museum records (58 FR 49881). We received one comment questioning the use of

Delhi Soils as the only criterion for identifying the range of the subspecies in the original listing rule. To the best of our knowledge, there is no new information in the scientific literature suggesting that the range of the Delhi Sands flower-loving fly is more extensive than initially identified or that the Delhi Sands flower-loving fly occupies wind blown sandy soils in the Banning, Cabazon, Topanga, and San Joaquin Valley areas of California, as was suggested by the commenter. Following listing of the subspecies, however, we have identified additional occupied habitat for the Delhi Sands flower-loving fly, as described below.

At the time the Delhi Sands flower-loving fly was listed in 1993, the Service estimated that between 140 and 285 ha (350 and 700 ac) of known occupied Delhi Sands flower-loving fly habitat existed at five locations (58 FR 49884). We indicated that over 97 percent of the suitable habitat for the Delhi Sands flower-loving fly, primarily measured by Delhi Soils, was eliminated. This loss was primarily attributed to historical conversion of land to agricultural uses since the 1800's and more recently to development for residential, industrial, or commercial use (58 FR 49881-49882).

As a result of the listing, local jurisdictions began requiring habitat assessments and surveys within potential Delhi Sands flower-loving fly habitat, and these efforts increased our understanding of the current range of the Delhi Sands flower-loving fly. By 1997, when the recovery plan for the Delhi Sands flower-loving fly was published, we estimated that 485 ha (1,200 ac) of suitable Delhi Sands flower-loving fly habitat (both occupied and unoccupied) and several hundred acres of restorable habitat remained. The recovery plan stated that 12 known occupied sites encompassing about 180 ha (450 ac) of suitable habitat were known as of the spring of 1997 (Service 1997).

Habitat assessments and survey work have continued since the publication of the recovery plan, and the Delhi Sands flower-loving fly has been observed in areas that were previously considered unoccupied and only marginally suitable for the subspecies due to disturbances through previous land uses. Based on these more recent observations, we have expanded current acreage estimates of remaining suitable Delhi Sands flower-loving fly habitat to include moderately disturbed areas such as abandoned vineyards or grazing lands. We note that all populations discovered in these disturbed areas appear small and unlikely to persist without substantial habitat restoration and management; thus, although the area of potentially suitable habitat has expanded, no newly discovered occupied site supports a major population of the Delhi Sands flower-loving fly that was not known at the time of the listing.

We received one comment stating that only a few, isolated individuals and populations of Delhi Sands flower-loving fly have been identified and thus viable habitat is not available to support the continued survival, much less the recovery, of the subspecies. Using 2005 aerial imagery, we now estimate that approximately 1,144 ha (2,826 ac) of potential Delhi Sands flower-loving fly habitat remain (Carlsbad Fish and Wildlife Office Geographic Information Systems mapping 2006).<sup>2</sup> Of the 1,144 ha (2,826 ac) of

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<sup>2</sup> This estimate excludes portions of the Ontario recovery unit that have been extensively surveyed with no Delhi Sands flower-loving fly observations.

potential Delhi Sands flower-loving fly habitat, 365 ha (900 ac) are known to be occupied in 12 sites (Appendix A).<sup>3</sup> We define occupied sites to be sites known to be occupied at the time of listing or where Delhi Sands flower-loving fly were subsequently observed by biologists holding 10(a)(1)(A) recovery permits issued by the Service. Based on this information, we believe that sufficient suitable Delhi Sands flower-loving fly habitat remains to establish Delhi Sands flower-loving fly reserves that will support the long-term conservation of the subspecies.

Conservation efforts associated with development projects have resulted in permanent protection of the following sites within each of the three recovery units (Figure 1).

#### 1) Ontario Recovery Unit

In 2000, 4 ha (10 ac) of Delhi Sands flower-loving fly habitat near the intersection of Greystone and Milliken avenues in the City of Ontario, San Bernardino County, were acquired for conservation and an additional 1.2 ha (3 ac) of contiguous habitat was avoided but not permanently conserved. At that time, these properties were surrounded by undeveloped land with some characteristics of Delhi Sands flower-loving fly habitat, and the Service anticipated that a larger Delhi Sands flower-loving fly reserve would be created that could sustain a robust Delhi Sands flower-loving fly population. However, most of the surrounding property has subsequently been developed for commercial or industrial uses, and it is unlikely that the existing population can be sustained over the long term.

#### 2) Jurupa Recovery Unit

Approximately 21 ha (52 ac) of Delhi Sands flower-loving fly habitat have been protected for this population along the Jurupa Hills. Approximately 12 ha (30 ac) are protected under a conservation easement within Riverside County (“I-15/Galena” Biological Opinion; FWS-WRIV-774). An additional 9 ha (22 ac) will be placed under a conservation easement and managed in San Bernardino County as a result of interagency consultation between the Service and the U. S. Army Corps of Engineers (USACE) (“Fontana Business Center” Biological Opinion; FWS-SB-1788.9), in accordance with section 7 of the Endangered Species Act.

#### 3) Colton Recovery Unit

Eight sites have been permanently protected in the Colton recovery unit:

- a) The Slover/Pepper population, located east of Riverside Avenue, south of Interstate 10, north of Agua Mansa Road, and west of the cement plant (CalPortland Cement), is partially protected through the establishment of two conservation areas: the 3 ha (7.5-ac) Colton Transmission Facility Reserve at the eastern terminus of Santa Ana

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<sup>3</sup> These 12 sites are not identical to the 12 sites described in the recovery plan, as some occupied sites included in the recovery plan have been destroyed and some newly discovered sites are included herein.

Avenue in Colton and the 61 ha (150-ac) Conservation Bank. The City of Colton placed a conservation easement over the Colton Transmission Facility Reserve. Long-term protection of the Conservation Bank will be assured when all conservation credits are sold. Twenty-eight credits have been sold to date. There are approximately 65 ha (160 ac) of undeveloped Delhi Sands flower-loving fly habitat contiguous with these conservation areas.

- b) A total of 14.5 ha (36 ac) are protected within two conservation areas generally surrounding Industrial Avenue in Rialto. The 12-ha (30-ac) Angelus Block conservation area was established through the Angelus Block Habitat Conservation Plan (HCP) (FWS-SB-771); however, no conservation easement has been placed over the property to date. The 2.4-ha (6-ac) Owl Properties conservation area is approximately 0.8 kilometers (km) (0.5 mile (mi)) west of the Angelus Block conservation area west of Riverside Drive (“AMIGA MOU” Biological Opinion; FWS-SB-771). These conservation areas are interspersed within commercial and industrial facilities and approximately 16 ha (40 ac) of undeveloped Delhi Sands flower-loving fly habitat.
- c) The County of San Bernardino set aside the 4 ha (10-ac) Hospital Reserve northeast of the intersection of Valley Boulevard and Pepper Avenue in Colton. Approximately 0.6 ha (1.4 ac) of the site are used as a water detention basin and have no habitat value for the Delhi Sands flower-loving fly. An additional 0.8-ha (1.9-ac) parcel has been conserved as part of the Valley/Pepper realignment HCP (FWS-SB-4142.3). There are approximately 14 ha (35 ac) of undeveloped suitable habitat east of the Hospital Reserve.
- d) A total of 6 ha (15 ac) of Delhi Sands flower-loving fly habitat is protected within two conservation areas south of San Bernardino Avenue, west of Pepper Avenue, and east of Riverside Avenue in the cities of Colton and Rialto. Conservation easements have been placed over both the 4-ha (10-ac) Reichel HCP conservation area (FWS-SB-760) and the 2-ha (5-ac) Laing Homes HCP conservation area (FWS-SB-893). Although these conservation areas are separated by 0.8 km (0.5 mi), the intervening areas are predominately undeveloped and support the Delhi Sands flower-loving fly.
- e) A 1.8-ha (4.5-ac) area was protected for the Delhi Sands flower-loving fly northeast of the intersection of Randall and Pepper avenues in unincorporated San Bernardino County (“Randall Basin” Biological Opinion; FWS-SB-3247.5). This conservation area is separated from the nearest conservation area by 1.2 km (0.75 mi) of dense residential and commercial development.

### **Abundance**

No clear trends emerge from the demographic data that have been generated since the listing of the subspecies. Due to the cryptic nature and rarity of the Delhi Sands flower-loving fly, it is difficult to accurately estimate abundance or density for this subspecies (Kingsley 2002). Range-wide surveys have not been attempted due to lack of funding

and issues with access to privately-owned properties. Some surveys of specific locations have been conducted as discussed below.

The Hospital Preserve was sampled from 1994 through 1998 (Kingsley 2002). Because sampling was not standardized by date, transect, or number of observers, it is not possible to directly compare annual counts to one another. However, the data that were collected suggest that the Delhi Sands flower-loving fly abundance at the Hospital Preserve remained nearly constant from 1994-1998.

The largest remaining habitat block has been sampled for Delhi Sands flower-loving fly annually since 1997 (Agresearch 2006). These annual surveys consist of four to eight samples along a single transect through an approximately 89 ha (220-ac) area south of Interstate 10 in the City of Colton, San Bernardino County. The median number of individuals observed per sample was only 4.5 and varied from 0 to 25; therefore, it is not possible to identify population trends with statistical rigor. The number of individuals observed generally decreased through time such that if a trend exists, it is a decline in population size over time. The annual variation in population size may be explained by weather because the number of observations appears lower in drier years (Agresearch 2006); however, the population dynamics data are not sufficient to adequately test this hypothesis.

Service biologists initiated a study in 2004 designed to improve Delhi Sands flower-loving fly survey protocol recommendations. This study required the effort of 3 biologists working 6 days a week during the peak of the flight season, and the data were only marginally adequate to estimate abundance, density, and detection probability (Service 2004 unpublished data). This effort indicated that measurement of population demographic trends will likely require substantial effort unless new techniques prove effective.

## **Taxonomy**

The common name, Delhi Sands flower-loving fly, is no longer appropriate for the subspecies and should be changed to Delhi Sands giant flower-loving fly. The common name for the genus *Rhaphiomidas* is the “giant flower-loving flies,” and the common name for the family Apioceridae is “flower-loving fly.” At the time of listing, the Delhi Sands flower-loving fly was considered a member of the family Apioceridae; therefore, the common name Delhi Sands flower-loving fly was appropriate though not as specific as Delhi Sands giant flower-loving fly. However, recent taxonomic work has shown that the genus *Rhaphiomidas* belongs in the family Mydidae (Cazier 1985), which has no standard common name. Therefore, the common name should be changed to Delhi Sands giant flower-loving fly, which indicates that the subspecies is within the genus *Rhaphiomidas*.

At the time of listing, the Delhi Sands flower-loving fly was thought to be the only remaining subspecies of *Rhaphiomidas terminatus*. However, the nominate subspecies,

*Rhaphiomidas terminatus terminatus* (El Segundo giant flower-loving fly), was recently rediscovered and likely remains extant (George and Mattoni 2006).

### **2.3.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)**

#### **2.3.2.1. Factor A, Present or threatened destruction, modification or curtailment of its habitat or range:**

##### Habitat Loss

Habitat loss was identified as a major threat to the Delhi Sands flower-loving fly at the time of its listing in 1993 (58 FR 49881). While we have identified additional lands occupied by Delhi Sands flower-loving fly (see Spatial Distribution and Habitat Conditions section above), urban development has rapidly progressed within the range of the Delhi Sands flower-loving fly since the listing of the subspecies. Occupied sites have become increasingly isolated by surrounding development. According to land use data from the State of California's Department of Conservation, Division of Land Resource Protection Farmland Mapping and Monitoring Program, the area of urban or built-up land within Delhi Soils increased from 53 to 64 percent (6,276 to 7,576 ha (15,509 to 18,721 ac)) from 1998 to 2004 (Carlsbad Fish and Wildlife Service GIS database 2006). Of the remaining open space land, most has been impacted to some degree by current or historical agricultural practices.

In addition, all remaining Delhi Sands flower-loving fly habitat has high development value due to its location within a highly urbanized landscape. Due to the listing of the Delhi Sands flower-loving fly, most local jurisdictions require habitat assessment and, if necessary, Delhi Sands flower-loving fly presence/absence surveys prior to issuing grading permits for development projects. Thus, the uncontrolled destruction of known occupied Delhi Sands flower-loving fly habitat, as a result of development projects, is greatly diminished. Delhi Sands flower-loving flies are cryptic (Kingsley 2002), however, and even with the established two-year protocol survey, it is doubtful that all occupied sites are being identified. Moreover, because most Delhi Sands flower-loving fly habitat is in private ownership and no regulations are in place to address loss of unoccupied Delhi Sands flower-loving fly habitat, the permanent loss of potential and restorable Delhi Sands flower-loving fly habitat important to recovery often proceeds.

##### Habitat Degradation

Habitat degradation of occupied sites was also identified as a major threat to the Delhi Sands flower-loving fly at the time of its listing. The primary habitat degrading activity identified in the final rule was soil disturbance resulting from grading, plowing, disking to remove vegetation for fire control, and off-road

vehicle use (58 FR 49884). Illegal dumping of automobiles and other trash was also known to degrade Delhi Sands flower-loving fly habitat (58 FR 49884-49885). These activities continue today despite the listed status of the subspecies (Service personnel, personal observation).

In particular, undeveloped land that is out of agricultural production is frequently disturbed by weed abatement (*e.g.*, discing) or off-highway vehicle use (Service personnel, personal observation). Discing may result in direct mortality to Delhi Sands flower-loving fly eggs, larvae, and/or pupae, and this practice expedites the establishment of non-native vegetation and thereby reduces habitat quality. In addition, the sandy soils associated with Delhi Sands flower-loving fly are popular with off-road vehicle users. Most known occupied sites have some degree of off-road vehicle use, which may also cause direct mortality to Delhi Sands flower-loving flies and expedite establishment of nonnative vegetation.

Illegal dumping remains a problem in spite of efforts by local jurisdictions to prevent it (Service personnel, personal observation). Dumping of trash directly eliminates potential sites for Delhi Sands flower-loving fly oviposition. Dumping of waste construction and landscaping material may alter the characteristics of the soil by mixing with the native sandy soils. Areas with mixed soils are unlikely to support robust Delhi Sands flower-loving fly populations.

#### Habitat Conservation

We received information during the public response period stating that 254.07 ha (627.63 ac) of habitat have been set aside for the Delhi Sands flower-loving fly. Our records indicate that this is an overstatement. Our records show that only approximately 66 ha (162 ac) of habitat have been acquired for Delhi Sands flower-loving fly conservation (see below). In addition to this acreage, the 61 ha (150-ac) Conservation Bank was established in 2005 by Vulcan Materials, Incorporated. The Conservation Bank will provide long-term protection and management of Delhi Sands flower-loving fly-occupied habitat upon sale of its conservation credits (“Colton Dunes Habitat Enhancement and Management” Biological Opinion; FWS-SB-3849.1). The Conservation Bank is within the largest remaining block of occupied Delhi Sands flower-loving fly habitat, and protection of this habitat is key to maintaining the Delhi Sands flower-loving fly in this important conservation area.

Of the existing 66 ha (162 ac) now in conservation, only the Jurupa Hills conservation area, at 21 ha (52 ac), likely includes sufficient habitat to support a local Delhi Sands flower-loving fly population over the long-term. Virtually all conserved sites occur in small, isolated habitat patches surrounded by unprotected land (Carlsbad Fish and Wildlife Service internal database). Populations located on small, isolated habitat patches such as these are

commonly considered highly vulnerable to extirpation (Meffe and Carroll 1997). Thus, most of the existing Delhi Sands flower-loving fly conservation sites are likely too small and fragmented to sustain Delhi Sands flower-loving fly populations through time. Additional lands will need to be acquired to ensure long-term conservation of Delhi Sands flower-loving flies at the existing protected sites (Service 1997).

In addition, while protected from development, most of the existing conservation areas remain susceptible to invasion by nonnative grasses, off-road vehicle use, and other disturbances. We estimate that only 25 of 66 ha (62 of the 162 ac) of Delhi Sands flower-loving fly conservation lands are actively managed to maintain or improve Delhi Sands flower-loving fly habitat quality. Most conservation areas do not have monitoring programs to track Delhi Sands flower-loving fly occupancy or habitat quality. However, the Conservation Bank has initiated a habitat restoration and management program that will ensure that habitat quality within that 61-ha (150-ac) area will be maintained or improved through time.

#### **Summary of Factor A Analysis:**

Listing of the Delhi Sands flower-loving fly has increased regulatory control over the destruction of Delhi Sands flower-loving fly occupied habitat. However, with at least 90 percent loss of historical Delhi Soils, potential and suitable Delhi Sands flower-loving fly habitat available for conservation and restoration is extremely limited. The loss of some occupied habitat may still be occurring due to the cryptic nature of the Delhi Sands flower-loving fly. Loss of unoccupied and potential or restorable habitat by urban development continues to threaten Delhi Sands flower-loving fly recovery. Various soil-disturbing activities causing degradation of Delhi Sands flower-loving fly habitat at the time of the listing are still problematic, even though several local jurisdictions are attempting to control these activities. Only 10 percent<sup>4</sup> of the remaining potential and suitable habitat for Delhi Sands flower-loving flies, in mostly small, fragmented parcels, has some type of protected status, and most of this habitat is not actively managed to maintain or increase Delhi Sands flower-loving fly abundance. Thus, while some progress has been made at reducing these threats, loss and degradation of habitat remain the primary threats to Delhi Sands flower-loving fly survival and recovery.

#### **2.3.2.2. Factor B, Overutilization for commercial, recreational, scientific, or educational purposes:**

The final rule for listing of the Delhi Sands flower-loving fly noted that *Rhaphiomidas* species are prized among insect collectors because of their unusual size, coloration, and rarity. Given what was known at the time about the distribution of the Delhi Sands flower-loving fly (*i.e.*, five small, isolated,

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<sup>4</sup> This estimate includes the entire acreage of the Conservation Bank, although not all conservation credits are sold.

extant populations), there was some concern that a dedicated collector or collectors could readily eliminate remaining populations (58 FR 49885).

Likewise, the recovery plan also discussed this threat, noting that specimens of the Delhi Sands flower-loving fly had been sold by a commercial dealer and presenting the concern that handling and/or marking even a few individuals or collecting a few females could result in significant impacts to the survival of the subspecies (Service 1997). We are unaware of any substantial impact to the Delhi Sands flower-loving fly from collectors since the subspecies was listed. In addition, as a result of the listing, research activities on the Delhi Sands flower-loving fly are controlled and monitored by the Service through the issuance of section 10(a)(1)(A) recovery permits.

#### **2.3.2.3. Factor C, Disease or predation:**

At the time of listing, the threat of disease or predation was not known to be applicable. Neither disease nor predation is known to substantially impact the subspecies at this time.

#### **2.3.2.4. Factor D, Inadequacy of existing regulatory mechanisms:**

##### **State Protections**

California Endangered Species Act. The Delhi Sands flower-loving fly is not listed under the California Endangered Species Act, which does not protect insects. Thus, the only State laws providing any potential protection to the Delhi Sands flower-loving fly are the California Environmental Quality Act (CEQA) and the Natural Communities Conservation Planning (NCCP) Act.

California Environmental Quality Act (CEQA). The CEQA is the principal statute mandating environmental assessment of projects in California. The purpose of CEQA is to evaluate whether a proposed project may have an adverse effect on the environment and, if so, if that effect can be reduced or eliminated by pursuing an alternative course of action or through mitigation. CEQA applies to projects proposed to be undertaken or requiring approval by State and local public agencies (<http://www.ca.gov/state/portal>).

If significant effects are identified through the CEQA process, the lead agency has the option to require mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). Because the Colton Dunes Ecosystem is recognized in California as a unique and declining resource with several endemic species, projects in San Bernardino and Riverside counties in the Colton Dunes Ecosystem area that are mandated to comply with CEQA may provide some consideration of impacts to the Delhi Sands flower-loving fly and its habitat.

However, any protection afforded rare or sensitive species or their habitats, through CEQA, are at the discretion of the lead agency involved.

Natural Community Conservation Planning (NCCP). The NCCP program is a cooperative effort involving the State of California and numerous private and public partners to protect habitats and species. A NCCP identifies and provides for the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. The program began in 1991 under the State's NCCP Act (California Fish and Game Code 2800-2835). The primary objective of the NCCP program is to conserve natural communities at the ecosystem scale while accommodating compatible land use (<http://www.dfg.ca.gov/NCCP/>). Regional NCCPs may provide protection to federally listed species, such as the Delhi Sands flower-loving fly, by conserving native habitats upon which the species depend. To date, the Western Riverside County Multiple Species Habitat Conservation Plan/NCCP is the only NCCP that includes coverage for the Delhi Sands flower-loving fly. This HCP/NCCP will be described in the following section. In addition, a plan was considered for portions of San Bernardino County at one time, an effort which has since been abandoned (see Endangered Species Act section below).

## **Federal Protections**

National Environmental Policy Act (NEPA). The NEPA may provide some protection for the Delhi Sands flower-loving fly for projects with a Federal nexus (undertaken, funded, or authorized by Federal agencies). NEPA requires that the planning process for Federal actions be documented to ensure that effects on the environment are considered. The NEPA process is intended to help public officials make better decisions based on an understanding of the environmental consequences of their actions and to take actions to protect, restore, and enhance the environment (40 CFR 1500.1). Carrying out the NEPA process ensures that agency decision makers have information about the environmental effects of Federal actions and information on a range of alternatives that will accomplish the project purpose and need.

For environmental impacts that are significant, the Federal agency must identify means to mitigate these impacts (40 CFR 1502.16). For projects undertaken, funded, or authorized by Federal agencies, NEPA would at least require that any significant adverse impacts to the human environment, including impacts to the natural and physical environment (40 CFR 1508.14), be considered. Again, because the Colton Dunes Ecosystem is recognized in California as a unique and declining resource with several endemic species, projects in San Bernardino and Riverside counties in the Colton Dunes Ecosystem area that are mandated to comply with NEPA may

provide some consideration of impacts to the Delhi Sands flower-loving fly and its habitat.

Clean Water Act. Under Section 404 of the Clean Water Act (CWA), USACE regulates the discharge of fill material into “Waters of the United States,” including wetlands (33 USC 1344). Most projects under USACE jurisdiction are not likely to affect the arid, dune community recognized as Delhi Sands flower-loving fly habitat. There have been a few instances, however, where the Delhi Sands flower-loving fly and its habitat were affected by an interrelated USACE action, thus invoking interagency section 7 consultation requirements under the Endangered Species Act. Because the primary purpose of the CWA is the protection of U. S. waters and the Delhi Sands flower-loving fly’s primary habitat is an upland community, the CWA provides little direct protection for the Delhi Sands flower-loving fly or its habitat.

Endangered Species Act (Act). The Act (1973, as amended; 16 USC 1531 *et seq.*) is the primary Federal law providing protection for the Delhi Sands flower-loving fly. Beyond the actual listing of the subspecies, these protections are afforded particularly through sections 7, 9, and 10 of the Act. Section 7 of the Act requires Federal agencies to insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or adversely modify their critical habitat. Section 7 also encourages Federal agencies to use their authorities to carry out programs for the conservation of listed species. Section 9 of the Act includes prohibitions against possessing, selling, importing, exporting, and taking listed species. Section 10 of the Act provides a process whereby private landowners can gain an exemption to the section 9 take prohibitions through a section 10(a)(1)(B) permit and Habitat Conservation Plan (HCP), provided such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

At the time of the listing in 1993, discussions were initiated for two habitat conservation planning (HCP) efforts to address the Delhi Sands flower-loving fly and other listed species issues in Riverside and San Bernardino counties for the purpose of securing section 10(a)(1)(B) permits: 1) a regional multi-species HCP involving the County of San Bernardino and several local jurisdictions and 2) the Agua Mansa Industrial Growth Association (AMIGA) Habitat Conservation Plan. It was not until 1995-1996, however, that Memoranda of Understanding to further develop these HCPs were signed (USFWS *et. al.* 1996a, 1996b).

In 1996, San Bernardino County and approximately 15 local jurisdictions signed an MOU with the Service and the California Department of Fish and Game to develop a Multiple Species HCP/NCCP (San Bernardino County Valley-wide MSHCP) to address approximately 80 species, including the

Delhi Sands flower-loving fly, on over 202,344 ha (500,000 ac) throughout the southwestern portions of the county (Service 1996a). Subsequent to the initiation of this effort, the County of San Bernardino and five cities (Ontario, Colton, Rialto, Rancho Cucamonga, and Fontana) entered into discussions with the Service to develop a subregional plan to address the Colton Dunes Ecosystem ahead of the multi-species effort. Discussion continued through 2001, but no consensus between the cities, the County, and the Service could be reached on an adequate conservation strategy for the Delhi Sands flower-loving fly that met the needs of all of the jurisdictions. Both the subregional planning effort and the larger multi-species effort have been abandoned.

In 1996, the Service signed an MOU with AMIGA, which included the cities of Colton and Rialto and the counties of Riverside and San Bernardino, to address potential Delhi Sands flower-loving fly impacts within the Agua Mansa Enterprise Zone (AMEZ). By entering into the MOU, AMIGA agreed to prepare a regional HCP for the AMEZ that would have preserved the best remaining Delhi Sands flower-loving fly habitat and allowed for future industrial/economic growth consistent with the conservation of the Delhi Sands flower-loving fly (“AMIGA MOU” Biological Opinion; 1-6-97-F-12). Side agreements associated with the MOU authorized development of three projects ahead of the HCP. After the MOU was signed and the three developments were authorized, members of the AMIGA lost interest in the HCP. The County indicated that the preserve design contemplated was economically infeasible, and the HCP was never developed.

Large-scale regional planning efforts to address listed species issues, including the Delhi Sands flower-loving fly, have been more successful in Riverside County. On June 22, 2004, the Service issued a section 10(a)(1)(B) permit for the Western Riverside County Habitat Conservation Plan (MSHCP). The MSHCP, which is also an NCCP under State law, includes a conservation program for the Delhi Sands flower-loving fly that places occupied habitat in conservation to offset impacts to known occupied areas proposed for development (Dudek and Associates 2003).

We received information during the public response period stating that 101 ha (250 ac) of Delhi Sands flower-loving fly habitat will be set aside for conservation as a result of the Western Riverside County MSHCP. This is not consistent with the requirements of the plan, which are as follows. The permittees have committed to conserving 20 ha (50 ac) of Delhi Sands flower-loving fly occupied habitat to offset impacts near Agua Mansa Boulevard in unincorporated Riverside County. Where Delhi Sands flower-loving flies are observed outside of the Agua Mansa Boulevard area, Delhi Sands flower-loving fly habitat will be conserved onsite or impacts will be offset at a 3:1 conservation ratio (Dudek and Associates 2003).

While plans to develop comprehensive habitat conservation plans in San Bernardino County have made little progress since the listing of the Delhi Sands flower-loving fly, the Service has been successful working with local jurisdictions and private landowners to address Delhi Sands flower-loving fly issues through individual HCPs. Between 1995 and 2007, we have issued 11 section 10(a)(1)(B) incidental take permits for HCPs covering the Delhi Sands flower-loving fly. An additional four HCPs are in progress, including individual HCPs for the City of Rialto and the City of Colton, San Bernardino County (Carlsbad Fish and Wildlife Service internal database).

The Service has also addressed some, though fewer, projects through section 7 consultations with the USACE (“Fontana Business Center” Biological Opinion; FWS-SB-1788.9), the Federal Highways Administration (“Interstate 10 Interchange Projects” Biological Opinion; FWS-SB-4339.5), and the Department of Housing and Urban Development (“North Colton Public Development” Biological Opinion; FWS-SB-3467.4). Each of the projects authorized through the Endangered Species Act section 7 or 10 processes included conservation for the Delhi Sands flower-loving fly.

#### **Summary of Factor D Analysis:**

While both CEQA and NEPA may provide some discretionary conservation benefit to the Delhi Sands flower-loving fly, the Act is the primary regulatory mechanism mandating Delhi Sands flower-loving fly conservation and ensuring that the Delhi Sands flower-loving fly is addressed during planning efforts to develop remnant areas of the Colton Dunes Ecosystem. Section 10 of the Act is the primary Federal process for addressing both the economic development needs of southwestern San Bernardino County and the conservation needs of the subspecies.

#### **2.3.2.5. Factor E, Other natural or manmade factors affecting its continued existence:**

As described in the final rule for listing of the Delhi Sands flower-loving fly, this subspecies is threatened by small population size and severe habitat fragmentation (58 FR 49881). These factors combine to make the Delhi Sands flower-loving fly vulnerable to local extirpation as described below.

As noted above, it is difficult to determine population sizes for the Delhi Sands flower-loving fly because of their cryptic nature. We do know, however, that the number of individuals observed at known occupied sites is extremely low in comparison with population sizes of related species with similar ecological and life history strategies (Rogers and Mattoni 1993). While surveys in the best remaining sites may yield more than five observations per day (Tierra Madre Consulting 1998; EnviroPlus Consulting 2003, 2004; Agresearch 2006), surveys

in most occupied sites report fewer than five observations during an entire flight period (14 or more survey days). These observations support Rogers and Mattoni's (1993) assertion that no more than a few hundred individuals existed in 1989. It is possible that even fewer Delhi Sands flower-loving flies exist today than in 1989 due to continued habitat loss and fragmentation. Recent observations, Rogers and Mattoni's (1993) assertion, and the continued habitat loss and fragmentation, all suggest that population sizes of the Delhi Sands flower-loving fly are likely to be very small.

It is commonly accepted in conservation biology that small populations have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Soulé 1987; Shaffer 1981, 1987; Meffe and Carroll 1997; Primack 1998). Because it is likely that Delhi Sands flower-loving fly populations are small, it is reasonable to consider the remaining Delhi Sands flower-loving fly populations at risk due to these effects of small population size.

Another factor commonly understood to make populations vulnerable to stochastic events is isolation. Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (i.e., colonization is less likely as isolation increases) (Wilcox and Murphy 1985; Meffe and Carroll 1997). Urbanization and land conversion have fragmented the historical range of the Delhi Sands flower-loving fly such that remaining blocks of occupied habitat likely now function more independently of each other (i.e., are more isolated) where they were formerly connected. This increased isolation is likely to increase the susceptibility of Delhi Sands flower-loving fly populations to extirpation. In addition, continued increases in the degree of isolation of remnant Delhi Sands flower-loving fly populations due to loss of habitat to land development in the future will very likely further increase the probability that these populations will be lost (i.e., extirpated).

In addition to isolation, populations in fragmented habitat are increasingly affected by their surroundings (i.e., "edge effects" such as physical effects differing at the boundaries of a patch and the interior of a patch) (Noss and Cooperrider 1994). One effect of concern for the Delhi Sands flower-loving fly is increased vulnerability to introduced predators and competitors. For example, Argentine ants (*Linepithema humile*) are invading native California ecosystems. These non-native ants may have adverse direct or indirect effects on Delhi Sands flower-loving fly populations. Argentine ants are known to exclude native ant species upon invasion (Holway *et al.* 2002), and they are known to reduce Dipteran (fly) species richness and abundance in urban

southern California habitat fragments (Bolger *et al.* 2000). Argentine ants could adversely affect Delhi Sands flower-loving fly individuals directly by preying on larva and teneral (newly emerged) adults, by affecting the ecosystem prey base or seed plants, or by disrupting key ecosystem functions typically carried out by native ants. Invasion of these ants is expected with development and associated irrigation adjacent to areas occupied by the Delhi Sands flower-loving fly and can have cascading effects through the ecosystem.

Edge effects also facilitate the introduction of invasive, alien weeds (Alberts *et al.* 1993). Introduced invasive weeds can degrade Delhi Sands flower-loving fly habitat by out-competing and supplanting native vegetation, altering the amount of soil moisture or otherwise alter the soil substrate (D'Antonio and Vistousek 1992). Native plants cannot compete with drought-tolerant annual grasses in many parts of the Colton Dunes Ecosystem once these grasses are established. The diversity and abundance of arthropods have been found to be significantly reduced in coastal dune areas containing nonnative plants versus native vegetation (Nagano *et al.* 1981; Nagano and Hogue 1982; Slobodchikoff and Doyen 1977). Similar effects are expected within the Colton Dunes Ecosystem.

#### **Summary of Factor E Analysis:**

Delhi Sands flower-loving fly populations were considered to be at risk at the time the subspecies was listed because of their small size and habitat fragmentation. We have no information suggesting that these threats have been ameliorated since the time of listing. Monitoring efforts since the time of listing, though limited, do not suggest population increases, and it is reasonable to believe that Delhi Sands flower-loving fly populations are likely to be very small. In addition, past habitat fragmentation has left the remaining Delhi Sands flower-loving fly populations isolated from one another. This isolation is likely to continue, and possibly increase, in the future. The habitat fragmentation also increases the vulnerability of the occupied sites to edge effects. Together, small population size, isolation, and edge effects increase the risk of extirpation of the remaining Delhi Sands flower-loving fly populations.

#### **2.4. Synthesis**

The final rule listing the Delhi Sands flower-loving fly identified habitat loss and degradation as major threats (58 FR 49884). Some progress has been made at reducing these threats as a result of the listing, and a small percentage (about 10 percent) of the very limited remaining Delhi Sands flower-loving fly habitat has been conserved, though most of this habitat is not yet actively managed.

While significant efforts have been made to conserve occupied Delhi Sands flower-loving fly habitat, only the Jurupa Hills conservation area is likely of sufficient size and quality to potentially sustain a stable population through time. We anticipate that the Conservation

Bank will be effectively managed to protect a relatively large block of Delhi Sands flower-loving fly habitat once all of the conservation credits are sold, but additional lands surrounding the Conservation Bank are still needed to ensure the long term conservation of the largest remaining block of Delhi Sands flower-loving fly habitat. Other conserved areas are likely too small and isolated to provide adequate protection to existing populations without protection of additional surrounding lands and adequate land management.

Despite the progress that has been made to protect lands occupied by the Delhi Sands flower-loving fly, habitat destruction in association with residential and commercial development continues to be the primary threat to the subspecies. Secondary threats include habitat degradation from weed abatement activities for fire control, trash dumping, and off-road vehicle use, small population size, and isolation due to habitat fragmentation. Isolation due to habitat fragmentation is likely to increase in the future as a consequence of continued habitat loss. Because habitat destruction and the other secondary threats have not been ameliorated, our analysis indicates that the Delhi Sands flower-loving fly continues to meet the definition of endangered (in danger of extinction throughout all or a significant portion of its range). For these reasons, we conclude that the Delhi Sands flower-loving fly continues to meet the Act's definition of endangered, and we recommend no status change at this time.

### 3. RESULTS

#### 3.1. Recommended Classification

- Downlist to Threatened
- Uplist to Endangered
- Delist (Indicate reasons for delisting per 50 CFR 424.11):
  - Extinction
  - Recovery
  - Original data for classification in error
- No change is needed

**2.3. New Recovery Priority Number:** 6C (no change)

### 4. RECOMMENDATIONS FOR FUTURE ACTIONS

- **Protection of Additional Delhi Sands flower-loving fly Habitat**

Additional habitat should be conserved to ensure protection of populations large enough to remain viable in the long term. Most existing conservation parcels are unlikely to support viable populations without additional surrounding habitat.

- **Management of Occupied Delhi Sands flower-loving fly Habitat**

Restoration and management are necessary in Delhi Sands flower-loving fly conservation areas to improve or maintain habitat quality. Additional research is needed to identify the most effective and efficient techniques to establish or maintain important Delhi Sands flower-loving fly habitat characteristics. Delhi Sands flower-loving flies are most commonly observed in sandy areas with sparse cover of native shrubs, and the goal of habitat restoration and management should be to establish and maintain this condition until more specific habitat requirements are determined.

- **Monitor Existing Populations**

Systematic monitoring of the Delhi Sands flower-loving fly throughout known and potentially occupied sites is necessary to track the recovery of the subspecies. Because Delhi Sands flower-loving flies are scarce and difficult to observe, it is difficult to estimate population distribution, abundance, or density. Systematic sampling efforts would provide the basic data to estimate occupancy and relative abundance through time.

- **Research Objectives Related to Delhi Sands flower-loving fly Biology**

The lack of definitive information regarding many aspects of Delhi Sands flower-loving fly biology limits the effectiveness of restoration and management within Delhi Sands flower-loving fly conservation areas. Information related to oviposition (egg-laying), larval biology, and adult dispersal could potentially improve efficiency of restoration and management.

- **Revise Recovery Plan**

Several years of presence/absence survey data, combined with known changes in land use throughout historical Delhi Sands flower-loving fly habitat, provide information that can be used to generate more precise recovery strategies. Some locations that were previously considered valuable conservation areas should no longer be considered viable targets for conservation, which increases the importance of conserving lands that provide known long-term conservation value for the Delhi Sands flower-loving fly.

In general, the research goals in the existing recovery plan are reasonable; however, the habitat conservation goals should be refined to provide more specific guidance and to ensure that the goals can be realistically achieved. Specifically, criteria related to population abundance or density trends need to be revised to provide realistically achievable standards that can be measured with accepted sampling techniques and analyses. It is important that all criteria are measurable and threats-based.

## 5. REFERENCES

- Agresearch, Inc. 2006. Habitat enhancement and monitoring report across the Delhi Sands flower-loving fly conservation parcel west of Pepper and south of Slover, City of Colton, San Bernardino County, California for January 1, 2005 to December 31, 2005.
- Alberts, A. C, A. D. Richman, D. Tran, R. Sauvajot, C. McCalvin. and D. T. Bolger. 1993. Effects of habitat fragmentation on populations of native and exotic plants in southern California coastal scrub. Pages 103-110 in J. E. Keely, editor, Interface between ecology and land development in California. Southern California Academy of Science, Los Angeles, California, USA.
- AMEC Earth & Environmental, Inc. 2002. Delhi Sands flower-loving fly, Emergency pipeline repair and burial project, City of Colton, 2002. Submitted to USFWS February 4, 2003.
- Bolger, D. T., A. V. Suarez, K. R. Crooks, S. A. Morrison, and T. J. Case. 2000. Arthropods in urban habitat fragments in southern California: area, age, and edge effects. *Ecological Applications* 10:1230-1248.
- Cazier, M. A. 1985. A revision of the North American flies belonging to the genus *Rhaphiomidas* (Diptera: Apioceridae). *Bulletin American Museum Natural History* 182:181-263.
- D'Antonio, C. M. and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. *Annual Review of Ecology and Systematics*: 23:63-87.
- Dudek and Associates. 2003. Final Western Riverside County Multiple Species Habitat Conservation Plan dated June 17, 2003. Prepared for County of Riverside Transportation and Land Management Agency.
- Ecosystems Restoration Associates. 2005. Delhi Sands flower-loving fly habitat management plan, Jurupa Hills, Riverside County. Prepared for the County of Riverside Transportation and Land Management Agency.
- ENSR Corporation. 2006. 2005 Annual Report of management activities associated with the habitat conservation plan for the Colton Transmission Line and Substation Project.
- EnviroPlus Consulting. 2003. Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*) 2003 focused adult survey on Pepper Avenue 12-acre site, San Bernardino County, California. Submitted to USFWS October 24, 2003.
- EnviroPlus Consulting. 2004. Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*) 2004 focused adult survey on the 160 acre Vulcan Materials Site. Submitted to USFWS October 9, 2004.

- George, J. N. and R. A. Mattoni. 2006. *Rhaphiomidas terminatus terminatus* Cazier, 1985 (Diptera: Mydidae): notes on the rediscovery and conservation biology of a presumed extinct species. *The Pan-Pacific Entomologist* 82:30-35.
- Hölldober, B. and E. O. Wilson. 1990. The ants. Belknap Press, Harvard University Press, Cambridge, Massachusetts, USA.
- Holway, D. A., L. Lach, A. V. Suarez, N. D. Tsutsui, and T. J. Case. 2002. The causes and consequences of ant invasions. *Annual Review of Ecology and Systematics* 33:181-233.
- Kingsley, K. J. 1996. Behavior of the Delhi Sands flower-loving fly (Diptera, Mydidae), a little-known endangered species. *Annals of the Entomological Society of America* 89:883-891.
- Kingsley, K. J. 2002. Population dynamics, resource use, and conservation needs of the Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis* Cazier) (Diptera: Mydidae), an endangered species. *Journal of Insect Conservation* 6:93-101.
- Mattoni, R. A. and G. Ballmer. 1998. A fly spec. *Fly Times* 20
- Meffe, G. K. and C. R. Carroll. 1997. Principles of Conservation Biology. Sinauer Associates, Sunderland, Massachusetts.
- Nagano, C., C. Hogue, R. Snelling, and J. Donahue. 1981. The insects and related terrestrial arthropods of Ballona. Pp. E1-E89 *in* R. Schreiber (ed.). The biota of the Ballona region, Los Angeles County. Supp. I, Marina del Rey/Ballona Local Coastal Plan. Los Angeles County Natural History Museum Foundation, Los Angeles, California.
- Nagano, C. and J. Hogue. 1982. The insects and terrestrial arthropods of Point Mugu Naval Air Station. Report to the Point Mugu Naval Air Station, California.
- Noss, R. F., and Cooperrider. 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, Covelo, California.
- Primack, R. B. 1998. Essentials of Conservation Biology. Sinauer Associates, Sunderland, Massachusetts.
- Rogers, R. and M. Mattoni. 1993. Observations on the natural history and conservation biology of the giant flower-loving flies, *Rhaphiomidas* (Diptera: Apiceridae). *Dipterological Research* 4(1-2):21-34.
- Shaffer, M. L. 1981. Minimum population sizes for species conservation. *Bioscience* 31:131-134.
- Shaffer, M. L. 1987. Minimum viable populations: coping with uncertainty. Pp69-86 *in* M.E. Soulé, Viable Populations for Conservation, Cambridge University Press.

- Slobodchikoff, C. and J. Doyen. 1977. Effects of *Ammophila arenaria* on sand dune arthropod communities. *Ecology* 1171-1175.
- Soulé, M. E. ed. 1987. *Viable Populations for Conservation*. Cambridge University Press, Cambridge, United Kingdom. 189 pp.
- Tierra Madre Consulting. 1998. Southern California Edison Properties: focused surveys for the Delhi Sands flower-loving fly. Tierra Madre Consulting (TMC Job 98-129).
- U. S. Fish and Wildlife Service. 1996a. Memorandum of Understanding by and between the U. S. Fish and Wildlife Service, the California Department of Fish and Game, the County of San Bernardino, the Fifteen Affected Cities in Southwestern San Bernardino County and Additional Undersigned Participating Agencies for the Purpose of Developing and Implementing a Habitat Conservation Plan to Conserve Wildlife and Plant Species of Concern in the San Bernardino Valley.
- U. S. Fish and Wildlife Service. 1996b. Memorandum of Understanding by and between the U. S. Fish and Wildlife Service and Agua Mansa Industrial Growth Association.
- U. S. Fish and Wildlife Service. 1997. Delhi Sands Flower-loving Fly (*Rhaphiomidas terminatus abdominalis*) Recovery Plan.
- Vulcan Materials, Inc. 2005. Habitat Enhancement and Management Plan for the Colton Dunes Habitat Preserve, San Bernardino County, California.
- Wilcox, B. A. and D. D. Murphy. 1985. Conservation strategies: the effects of fragmentation on extinction. *The American Naturalist* 125:879-887.

#### Delhi Sands flower-loving fly Workshop Participants

The following people participated in a workshop designed to compile the current state of knowledge concerning Delhi Sands flower-loving fly biology and provide direction for future research efforts. The workshop was conducted on March 30-31, 2006 at the University of California at Riverside and sponsored by the Center for Conservation Biology.

Anderson, Alison. Carlsbad Fish and Wildlife Office, United States Fish and Wildlife Service, Carlsbad, California

Allen, Edie. Department of Botany and Plant Sciences, University of California at Riverside, Riverside California

Ballmer, Greg. Department of Entomology, University of California at Riverside, Riverside, California

Bornyasz, Margaret. M. J. Klinefelter GIS and Environmental Consulting, Temecula, California

George, Jeremiah. Department of Entomology, University of California at Riverside, Riverside, California

Holway, David. Section of Ecology, Behavior and Evolution, Division of Biological Sciences, University of California at San Diego, La Jolla, California

Irwin, Michael. Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, Urbana, Illinois

Kingsley, Kenneth. SWCA, Inc., Tucson, Arizona

Linton, Michael. Vulcan Materials Company, Western Division, Los Angeles, California.

Minnich, Richard. Department of Earth Sciences, University of California at Riverside, Riverside, California

Porter, Eric. Carlsbad Fish and Wildlife Office, United States Fish and Wildlife Service, Carlsbad, California

Schlinger, Evert. Department of Entomological Sciences, University of California at Berkeley, Berkeley, California

Schroeder, Mari. ECorp Consulting, Inc., Redlands, California

Sprague, Doug. Vulcan Materials Company, Western Division, Los Angeles, California

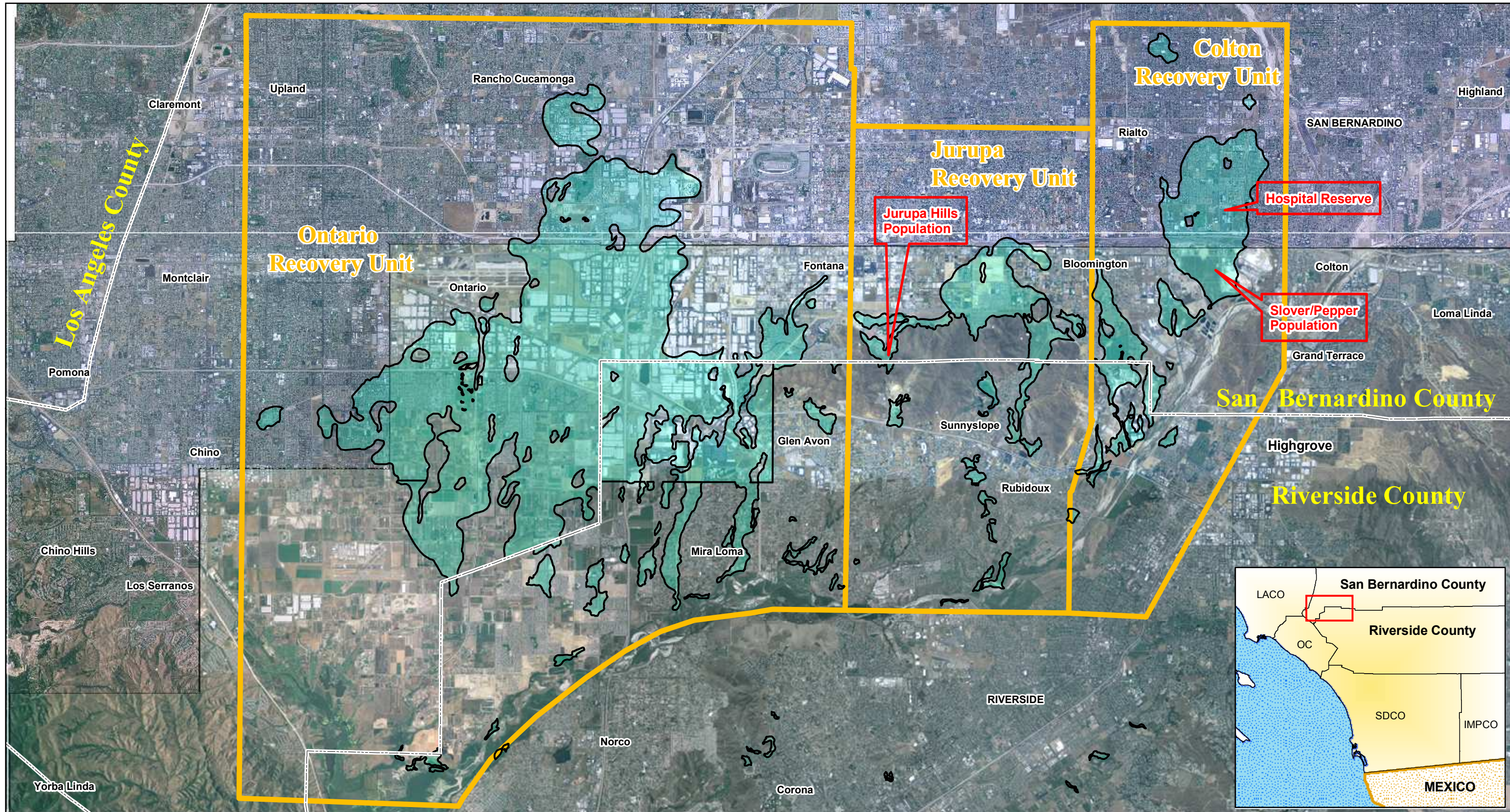
Williams, Kathy. Department of Biology, San Diego State University, San Diego, California

#### Personal Communications

We obtained valuable information about Delhi Sands flower-loving fly through personal communication with the following people that have an expert knowledge about the subspecies or its habitat:

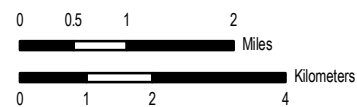
Greg Ballmer, Department of Entomology, University of California at Riverside

Ken Osborne, Osborne Biological Consulting



PRODUCED BY GIS SERVICES  
CARLSBAD FIELD OFFICE  
GIS CONTACT: EDWIN TURNER  
BIOLOGICAL CONTACT: ERIC PORTER

MAP DATE: 03/27/08  
DATA SOURCE: CNDDDB, FWS  
IMAGE SOURCE: NAIP 2005  
S:\stem\edstemplsbcoldfly\dfly\_5yearreview\_base.mxd



**Legend**

- Delhi Sands flower-loving fly Soils
- Delhi Sands flower-loving fly Recover Unit boundaries
- County Line

**U.S. FISH AND WILDLIFE SERVICE  
5-YEAR REVIEW OF DELHI SANDS FLOWER-LOVING FLY**

**Current Classification:** Endangered

**Recommendation resulting from the 5-Year Review:**


- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

**Appropriate Listing/Reclassification Priority Number, if applicable:** 6C

**Review Conducted By:** Karen A. Goebel and Eric E. Porter


**FIELD OFFICE APPROVAL:**

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 3-27-08

**REGIONAL OFFICE APPROVAL:**

Lead Regional Director, Fish and Wildlife Service

Approve  Date 3/31/08