

RECOVERY PLAN FOR DELHI SANDS FLOWER-LOVING FLY (*RHAPHIOMIDAS TERMINATUS ABDOMINALIS*) ([HTTPS://ECOS.FWS.GOV/DOCS/RECOVERY\\_PLAN/970914.PDF](https://ecos.fws.gov/docs/recovery_plan/970914.pdf))

**Original Approved:** September 14, 1997

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**DRAFT AMENDMENT 1**

We have identified best available information that indicates the need to amend recovery criteria for Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*) since the recovery plan was completed. In this proposed modification, we synthesize the adequacy of the existing recovery criteria, show amended recovery criteria, and the rationale supporting the proposed recovery plan modification in support of updated scientific and species information on habitat loss, isolated populations, and small effective population size. The proposed modification is shown as an appendix that supplements the recovery plan, superseding the section in PART II, where criteria for reclassification are discussed on p. 17 of the recovery plan.

**For**

**U.S. Fish and Wildlife Service**

**Region 8**

**Carlsbad, CA**

**December 2018**

Approved: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Regional Director, Pacific Southwest Region, Region 8,  
U.S. Fish and Wildlife Service

Date: XXXXXXXXXXXXXXXXXXXX

## **METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT**

Recovery criteria were updated for this addendum through internal coordination with staff and through external coordination with our partners. Work was done to update criteria for delisting and downlisting and to provide quantitative criteria. We coordinated with the partners to discuss the species' needs and information regarding recovery goals. This document will be made available for public comment to ensure the best possible scientific and practical data support the criteria described herein. This document will also undergo peer review. These coordinated efforts help to develop new quantitative criteria for the recovery plan that will better serve us as we work to recover the Delhi Sands flower-loving fly.

## **ADEQUACY OF RECOVERY CRITERIA**

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list." Legal challenges to recovery plans (see *Fund for Animals v. Babbitt*, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five delisting factors.

Recovery criteria should also address the biodiversity principles of representation, resiliency, and redundancy (Shaffer and Stein 2000, p. 307) as these concepts relate to abundance, distribution, diversity, etc. Representation involves conserving the breadth of the genetic makeup of the species to conserve its adaptive capabilities. Resiliency involves ensuring that each population is sufficiently large to withstand stochastic events. Redundancy involves ensuring a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events.

### **Recovery Criteria**

See previous version of criteria in recovery plan (USFWS 1997 p. 17; [https://ecos.fws.gov/docs/recovery\\_plan/970914.pdf](https://ecos.fws.gov/docs/recovery_plan/970914.pdf)).

### **Synthesis**

The Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*; Cazier 1985, entire) is one of more than 30 species of *Rhaphiomidas*, distributed across the southwestern United States and northern Mexico. These flies are relatively large, ranging from approximately 1.5 to 4 centimeters (0.6 to 1.6 inches). As with all species of *Rhaphiomidas*, Delhi Sands flower-loving fly (DSF) are associated with arid, sandy habitats. It is only found in the Colton Dunes of San Bernardino and Riverside Counties (Kingsley 2002, p. 94), with most occupied Delhi Sands flower-loving fly habitat located within a limited area of southwestern San Bernardino County (Figure 1; USFWS 2018). As with many species, accurate population size estimates of historical viable populations are unknown for the Delhi Sands flower-loving fly.

### Recovery Units

There are three Recovery Units (RUs) identified in the Recovery Plan (Ontario, Jurupa, and Colton; Figure 1). The intent of RUs is to identify and protect areas without which, the target species could not be recovered. The RUs identified for the Delhi Sands flower-loving fly contain current or restorable habitat for the fly and have been grouped based on geographic proximity, similarity of habitat, and potential genetic exchange. Since the writing of the Recovery Plan and the 5-year Review, land conversion within the RUs has continued to the point that individual parcels may be proximal but not contiguous, and may need to be grouped into conserved clusters in order to comprise enough suitable habitat for the fly. Within the three RUs, there are areas identified as suitable either for reintroduction or dispersal (22,663 ha; 56,002 acres; Figure 1). The available Delhi Sands soil GIS layer is generally considered incomplete or inaccurate in places, and flies have been found outside its boundaries (Ballmer 1996, p. 1; DEA 2003, p. 9; Osborne 2004, p. 17; WRCRCA 2011a, p. 3.12). The amount of land left under-developed and mapped as once having comprised Delhi Sands soils are limited (5,165 ha; 12,763 acres). Much of the identified potential restorable (under-developed; Figure 1) habitat has not been surveyed

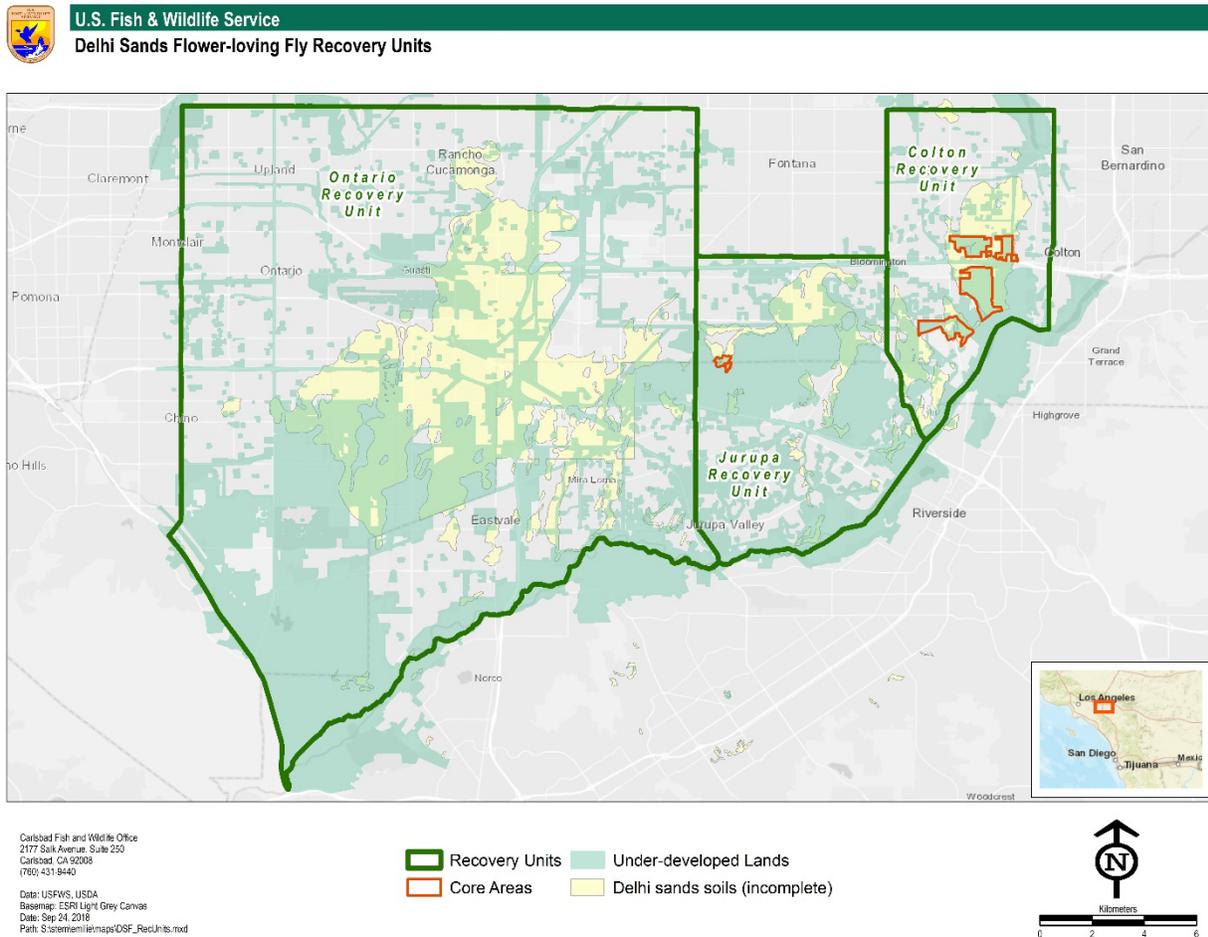


Figure 1. Delhi Sands flower-loving fly (DSF) Recovery Units in San Bernardino and Riverside counties, California, USA. Shown are known Delhi Sands soils (yellow areas), under-developed lands that maybe restored to provide DSF habitat or stepping stone corridors (green areas), and core areas identified as conservation priorities (red outlined area).

for flies, and there is more potential for identification of new sub-populations, restoration, and reintroduction than previously outlined.

The fly is presumed to be extant in each of the three Recovery Units (Ontario RU, Jurupa RU, and Colton RU; CDFG 2018). Recently, several flies have been detected in the Ontario RU near a small, conserved parcel (Powell 2018, entire). Within the Jurupa RU and Colton RU, five core areas have been identified where larger fly populations are most recently known; one in the Jurupa RU (Southridge/Teledyne Core [22 ha; 54 acres]) and four in the Colton RU (King is Coming Core [91 ha; 225 acres], Hospital Core [45 ha; 111 acres], Colton Dunes Core [174 ha; 430 acres], and Angelus Core [104 ha; 257 acres], Figure 2). These cores comprise several separate land parcels, some of which are already conserved.

### ***Background and Ecology***

The life history of the Delhi Sands flower-loving fly is largely unknown, but the loose, sandy soils of the Delhi Sands appear to be required for oviposition (egg-laying), which may primarily occur near *Heterotheca grandiflora* (telegraphweed; Kingsley 1996a, p. 11; Kingsley 2002, pp. 94 & 96; WRCRCA 2011b, p. 4). Larval stages develop completely underground and may remain subterranean for several years to emerge as adults in the summer. It is unknown what neonatal and larval flies eat or what subterranean conditions are required. Adults are most active during the warmest, sunniest parts of the day, and both males and females likely extract nectar from *Eriogonum fasciculatum* (California buckwheat) and other plants (Kingsley 1996b, p. 884).

Since the subspecies was first described, very little information regarding the ecology of each of the life stages of the Delhi Sands flower-loving fly has been described. It follows that what are regarded as the fly's habitat requirements are based on limited study and observation, often of similar species. Particularly unknown is the ecology of the subterranean larval life-stage, as it is presumed the larvae are completely subterranean until pupation (Rogers and Mattoni 1993, p. 27). There had been some preliminary but compelling forage investigations done suggesting that early *Rhaphiomidas* spp. larvae may be obligate myrmecophiles (live with and feed off ant host colonies; J. Wilcox and Papavero 1971, p. 47) with native ant species (Ballmer and Mattoni 1998, entire). Accordingly, stable isotope research on wild-caught sister taxa *R. trochilus* and *R. acton* suggested that the group may be all or mostly herbivorous as larvae (Longcore *et al.* 2009, p. 6). Yet, other research on *R. trochilus* demonstrated that late-instar larvae of some *Rhaphiomidas* species are predatory on the larvae of other insects such as beetles, bee flies, and wasps, and may require moist soils (Ballmer 2007, p. 7; Osborne and Ballmer 2014, pp. 3–4). Taking these results together may signify that there is ontogenetic foraging shift in the larval stages. But ultimately, it is unknown what larval flies of this subspecies forage on, how they grow, or what conditions may be required to trigger pupation. Because the larval stage constitutes an estimated 98 percent of an individual's total lifespan, sub-ground environmental variables (e.g., microclimate, distribution of food resources, etc.) are likely more important than above-ground variables (Kingsley 1996a p. 13; Longcore *et al.* 2009, p. 1). Yet, so little is known that habitat likely cannot be effectively managed.

As of the most recent 5-year review for the Delhi Sands flower-loving fly, it was still not clear if nectar feeding is essential for adult survival or reproduction (USFWS 2008, p. 8). As a consequence, adult habitat requirements are not well known. However, laboratory observation noted that an apparently moribund female immediately recovered and subsequently oviposited directly after being offered a sweet slurry (Rogers and Mattoni 1993, pp. 23–24). Additionally,

when a female of a related species (*Rhaphiomidas acton*) was dissected, only 8 of approximately 60 eggs were mature, suggesting that nectar feeding is necessary for the maturation of eggs, as in other invertebrates (Rogers and Mattoni 1993, p. 25). For males, it was posited that frequent nectar feeding may be required for prolonging activities as *Rhaphiomidas* are not known to have any other means of energy storage (e.g., fats; Rogers and Mattoni 1993, p. 25). To best manage for reproduction, conserved habitats should minimally comprise both the suspected primary adult feeding plant, *Eriogonum fasciculatum*, and the plant associated with oviposition, *Heterotheca grandiflora*.

In addition to the uncertain floral requirements, habitat size is also in question. It has been suggested that this species may do very well in small “islands” of habitat rather than larger preserves that may only have sparsely distributed useable habitat (Kingsley 1996a p. 11), and are capable of long flights between sites (M. D. Wilcox 1997, p. 6). Therefore, habitat “stepping stones” which link preserves by animal dispersal may be as effective and more practicable than continuous “habitat corridors” (Longcore and Osborne 2015, pp. 162, 178, 187). These likely help facilitate movement that could help to maintain genetic diversity among occupied areas. However, more behavioral studies involving following and observing individuals (e.g., mark-recapture) are needed to better determine adult habitat requirements and ranging patterns for effective habitat conservation.

### **Threats:**

In 1990, the Delhi Sands flower-loving fly was petitioned for listing as endangered by Dr. Greg Ballmer and was found to have substantial information indicating that listing may be warranted (90-day Finding; USFWS 1990, entire). It was listed as endangered by the USFWS September 23, 1993 (USFWS 1993, entire). In 2008, the USFWS composed a 5-year review for the species and recommended no change in status (USFWS 2008, entire). Below is a synthesis of past and current threats to the species that are the basis for its listing and protection under the Act.

Threats to the Delhi Sands flower-loving fly are summarized below as identified in either the Listing Rule (USFWS 1993), Recovery Plan (USFWS 1997), and 5-year review (USFWS 2008).

### ***Factor A: loss of habitat by ground-disturbance and development and lack of ecological knowledge***

At and around the time of listing in 1993, threats to the Delhi Sands flower-loving fly centered around habitat loss and degradation (commercial development, agricultural conversion, sand mining, invasive species, dumping of trash, dumping of manure, and off-road vehicles (USFWS 1993, entire; Kingsley 1996b p. 884). Though habitat loss is still the primary threat to the fly, the primary causes for the loss have shifted from degrading lands to a more permanent loss due to urban development. There are still various soil-disturbing activities (i.e., disking, agriculture, development, off-road vehicles, dumping) causing degradation of Delhi Sands flower-loving fly habitat as well as direct mortality of eggs, larvae, and pupae. There are several parcels currently conserved for the fly in the three RUs (CFWO 2018), but much of the remaining potential and suitable habitat is in small, fragmented parcels. Most of this habitat is not actively managed to maintain or increase Delhi Sands flower-loving fly overall 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.

***Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes***

At the time of listing and subsequently in the recovery plan, collection of the subspecies had been noted. However, in the 5-year review and through to current, no known threats exist under this factor.

***Factor C: Disease or Predation***

From the time since listing through the last 5-year review in 2008, the threat of disease or predation was not known to be applicable. However, subsequent evidence has been found to suggest that ants (e.g., invasive, nonnative Argentine ants; *Linepithema humile*) could adversely affect Delhi Sands flower-loving fly populations, either through direct attack, predation, competition for food sources, or excluding a potential interspecific host (Rogers and Mattoni 1993, p. 27; Bolger *et al.* 2000, p. 1240; Holway *et al.* 2002, pp. 186–190; Goodlett 2004 p. 10; USFWS 2008, pp. 21–22). However, neither disease nor predation are known to substantially impact the subspecies at this time.

***Factor D: Inadequacy of Existing Regulatory Mechanisms***

No Factor D threats were listed in the original recovery plan. 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.

***Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence***

Delhi Sands flower-loving fly populations were considered to be at risk at the time the subspecies was listed because of habitat fragmentation and their small population size. Small habitat fragments are subject to edge effects (i.e., degradation due to things like off-road vehicles, trash dumping, human foot traffic, etc.), effectively reducing the core habitat area. Isolation of occupied sites due to habitat loss further threatens the subspecies. Small populations are more vulnerable to natural catastrophes and stochastic demographic, genetic, and environmental events. Genetic effects may further influence population demography via inbreeding depression and genetic drift. If only small and distant sites remain, reproductive flies from disparate sites may have fewer reproduction opportunities, forcing either small populations to interbreed (causing inbreeding depression) or not to breed at all (limiting the numbers into the next generation). It neither is known how vagile adults may be, if they successfully find distant mates, or what environmental conditions are optimal for dispersal and mating. Survey efforts since the time of listing suggest that populations remain extremely small, often documenting few to no adult females at all (Mattoni *et al.* 2001, entire; Goodlett 2003, pp. 19–25; Goodlett 2004, pp. 8–9). Populations where surveys have been conducted on a regular basis are presumed extant (all within the five core conservation priority areas identified herein; Figure 2; CFWO 2018) and, though an occasional fly is found outside these areas, no new populations are known. Though some work has been done to conserve the circumscribed parcels of remaining fly habitat (e.g., Vulcan Conservation Bank), we have no information suggesting that threats to genetic diversity caused by small, isolated, or interbreeding populations have been ameliorated since the time of listing. This isolation is likely to continue, and possibly increase, in the future. Together, small

population size, isolation, and edge effects increase the risk of extirpation of the remaining Delhi Sands flower-loving fly populations, reducing representation.

Additionally, direct mortality occurs to the sub-adult life stages due to ground-disturbing activities (mostly from agricultural development activities) as outlined in factor A.

**Summary of current threats**

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, 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, which further threatens the subspecies through lack of gene flow and possible catastrophic loss due to relatively minor stochastic events.

**Table 1. Review of past threats assessed for the Delhi Sands flower-loving fly.**

Threat	1993 Endangered Listing	1997 Recovery Plan	2008 5-year Review
Development	X	X	X
Agriculture Use	X	X	X
Grading/ plowing/ disking (fire control)	X		X
Off-road Vehicles	X		X
Dumping of Trash	X	X	X
Dumping of Manure		X	
Sand Mining		X	
Nonnative/ Invasive Species			X
Collection	X	X	
Small Population Size	X	X	X

**AMENDED RECOVERY CRITERIA**

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the Delhi Sands flower-loving fly may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from endangered to threatened. The term “endangered species” means any species (species, sub-species, or DPS) which is in danger of extinction throughout all or a significant portion of its range. The term “threatened species” means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

We provide both downlisting and delisting criteria for the Delhi Sands flower-loving fly, which will supersede those included in the final recovery plan for the Delhi Sands flower-loving fly (USFWS 1997, p. 17), as follows:

### **Downlisting Recovery Criteria**

New information may result in revision of objectives and recovery criteria. However, at this time, recovery depends on our ability to overcome current threats to the limited and degrading suitable habitat, widespread encroachment of development, low population estimates, and dearth of specific ecological information. In order to downlist the Delhi Sands flower-loving fly to threatened status, threats to the species must be reduced. This reduction will have been accomplished if the following have occurred:

#### ***Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range***

**A1:** Impacts due to ground-disturbance activities (e.g., disking, agriculture, development, off-road vehicles, dumping, etc.) are minimized or managed such that adequate baseline ecological requirements (suitable environmental conditions and food sources for all life stages) are maintained where Delhi Sands flower-loving flies occur.

**A2:** At least eight areas of suitable\* and occupied habitat (occurrences) are protected, managed and conserved across the three Recovery Units (RU; Ontario, Jurupa, and Colton). Each of the eight areas is a minimum of 20 hectares (50 acres). These areas include the lands already conserved (CFWO 2018). At least one of the areas is in the Ontario RU. At least two are within the Jurupa RU, one of which includes Southridge/Teledyne Core. At least four are within the Colton RU, one of which includes the Colton Dunes Core (Figure 2). In the Colton RU, two areas are north and two are south of the I-10 freeway. Maintained and occupied parcels within 500 meters (0.31 miles) of one another may be considered part of the same occurrence due to dispersal connectivity.

(\*Quality suitable habitat minimally consists of areas with open sands in perpetual supply and sparse, native vegetation (10–40 percent), including *Heterotheca grandiflora* [telegraphweed] and *Eriogonum fasciculatum* [California buckwheat]).

**A3:** Dispersal of Delhi Sands flower-loving flies among each occurrence is facilitated through establishment of connectivity/dispersal “habitat stepping stones” of adequate size and quality to support the fly and that link suitable and occupied habitats across the three RUs. Parcels managed as habitat stepping stone corridors are maintained within 1 kilometer (0.6 miles) of each of the occurrences and one another.

#### ***Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes***

There is some evidence that threats under this factor once occurred. However, currently there are no known threats under this factor; therefore, no criteria are necessary.

#### ***Factor C: Disease or Predation***

**C1:** Nonnative predators and/or habitat competitors (e.g., Argentine ants) are minimized or managed to the point where they can no longer be detected consistently in occupied sites so that they no longer pose a threat to the persistence of Delhi Sands flower-loving flies.

#### ***Factor D: Inadequacy of Existing Regulatory Mechanisms***

No known threats exist under this factor; therefore, no criteria are necessary.

***Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence***

**E1:** The threats associated with small population sizes (e.g., inbreeding depression, lack of mating opportunities, etc.) are addressed. There are at least three occurrences (suitable and occupied areas) comprising minimum population sizes of 200\* adults of relatively equal sex ratio and are managed and conserved in perpetuity. To ensure species representation, at least one of the occurrences is located in each of the three RUs. Monitoring has detected a statistically significant upward trend in the mean number of self-sustaining adults in each core population averaged over 15 years.

(\*If and when new demographic information is acquired, the minimum population size may be modified.)

**E2:** A program is implemented to inform the public about the Delhi Sands flower-loving fly and its habitat. This outreach effort should garner public support for the long-term conservation and management of the sand dune system upon which the Delhi Sands flower-loving fly depends.

**Delisting Recovery Criteria**

The Delhi Sands flower-loving fly will be considered for delisting when all of the above downlisting criteria are met along with the following:

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

**A4:** At least nine areas of suitable and occupied habitats (occurrences) are protected, managed, and conserved across all three Recovery Units (RU; Ontario, Jurupa, and Colton). At least one occurrence located in each of the three RUs (Ontario, Jurupa, and Colton) and comprises at least 100 ha (247 acres) of sufficient habitat quality to meet the Delhi Sands flower-loving fly's needs at every life stage. Maintained and occupied parcels within 500 meters (0.31 miles) of one another may be considered part of the same occurrence due to dispersal connectivity. Each of the nine or more occurrences will be conserved and managed in perpetuity.

**A5:** Connectivity between the protected occurrences are maintained through habitat stepping stones (as defined above in A3) linking at least nine occurrences across all three RUs, all of which are conserved in perpetuity.

***Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes***

There is some evidence that threats under this factor once occurred. However, at the time of writing this document, there are no known threats under this factor; therefore, no criteria are necessary.

***Factor C: Disease or Predation***

No further threats under this factor are known, therefore, no further criteria are necessary.

***Factor D: Inadequacy of Existing Regulatory Mechanisms***

No known threats exist under this factor; therefore, no criteria are necessary.

***Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence***

**E3:** A rangewide monitoring program has detected a statistically significant upward trend in the mean number of self-sustaining adults in each core population averaged over 20 years. There are at least nine occurrences with minimum population sizes of 200\* adults of relatively equal sex ratios, two of which occur in each RU, to provide sufficient redundancy and resiliency and sustain genetic diversity (representation).

(\*If and when new demographic information is acquired, the minimum population size may be modified to address effective population size needed to sustain species stability.)

All classification decisions consider the following five factors: (1) is there a present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) is the species subject to overutilization for commercial, recreational scientific or educational purposes; (3) is disease or predation a factor; (4) are there inadequate existing regulatory mechanisms in place outside the ESA (taking into account the efforts by states and other organizations to protect the species or habitat); and (5) are other natural or manmade factors affecting its continued existence. When delisting or downlisting a species, we first propose the action in the *Federal Register* and seek public comment and peer review. Our final decision is announced in the *Federal Register*.

**RATIONALE FOR AMENDED RECOVERY CRITERIA**

The amended criteria provide more updated benchmarks that clearly link and address current threats. The criteria ensure that the underlying causes of decline are addressed and mitigated providing a valid path to recovery.

Factor A threats are addressed to ensure habitat degradation from past threats (e.g., agricultural development) and more current threats (e.g., urbanization, overly dense vegetative communities, small and distant habitat patches, etc.) are properly ameliorated. Maintaining adequate adult and larval habitats are critical for redundancy and resiliency of the subspecies. The percentage and type of appropriate vegetation within the conserved habitat (10–40 percent buckwheat and telegraphweed) is based on the limited knowledge that the flies minimally require this habitat type for successful reproduction and larval survival. However, so little is known regarding possible species associations or subterranean ecology, studies should be conducted to determine how larvae survive until they are vagile and what subsurface environmental conditions are required so that it can be appropriately restored and managed. Having nine occurrences (suitable and occupied areas) across the three Recovery Units (RUs) helps provide redundancy and representation to protect the fly from catastrophic events and provide adaptive capacity. The addition of habitat corridors (“stepping stones”) helps to minimize potential land use impacts while allowing for possible dispersal events. The stepping stone habitats should be no more distant than 1 km because this is the maximum distance that few flies have been found near a known self-sustaining population (i.e., may be dispersing from a nearby population). Managing potential threats is necessary for maintaining or restoring suitable habitat, and is needed to attain stable population numbers. Each of the nine occupied areas comprise at least 20 ha with adequate buffer because this is the minimum sized plot known which is also suspected to be self-sustaining. Maintaining adequate larval habitat is critical for the resiliency and redundancy of the species and is important for the long-term success of recovery. No known work has been done to

understand the carrying capacity or fly requirements in natural systems. Considering that development pressures will continue to reduce the fly's habitat, more information is needed from natural systems to ensure habitat is appropriately identified and conserved.

Factor C threats are addressed to ensure predation is sufficiently controlled to minimally affect the persistence of fly eggs, larvae, and pupae. It is unknown how intense or widespread this threat may be.

Factor E threats associated with a relatively sedentary species and small population sizes (limited access to mates, low genetic diversity, inbreeding depression, susceptibility to catastrophic loss during stochastic events, etc.) are addressed through minimum population numbers, population management (breeding program or reintroductions), and implementation of education programs.

Minimum population sizes need to be large enough to withstand stochastic events. To ensure the species is resilient enough to overcome those potential negative impacts, a minimum number of 200 adult flies in each of the nine occurrences must be attained before delisting can be considered (USFWS 1997, p. 17). No rangewide population estimates are known to have been conducted, but by comparison, other *Rhaphiomidas* species studied exceed densities of 1,200 adults per hectare (500/acre; USFWS 1997, p. 1).

Achieving these recovery criteria will ensure that we recover the species by confirming threats are ameliorated and that the population has rebounded to resilient levels.

#### **ADDITIONAL AND AMENDED RECOVERY ACTIONS**

1. Seek funding for acquisition of habitat from willing sellers in areas with suitable habitat to help meet recovery criteria (**Priority 1**).

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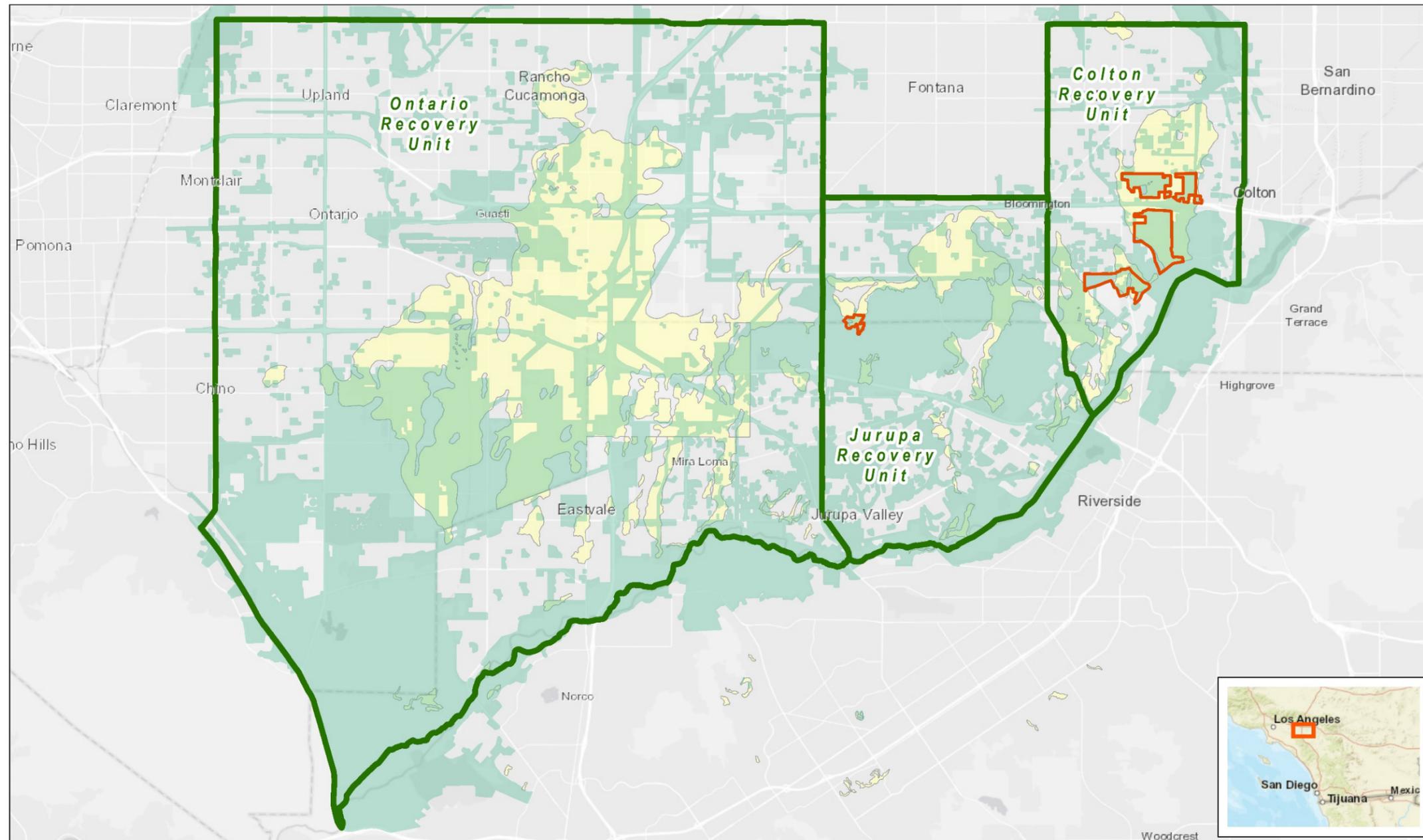
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**U.S. Fish & Wildlife Service**  
**Delhi Sands Flower-loving Fly Recovery Units**



Carlsbad Fish and Wildlife Office  
 2177 Salk Avenue, Suite 250  
 Carlsbad, CA 92008  
 (760) 431-9440

Data: USFWS, USDA  
 Basemap: ESRI Light Grey Canvas  
 Date: Sep 24, 2018  
 Path: S:\stem\emilii\maps\DSF\_RecUnits.mxd

- Recovery Units
- Core Areas
- Under-developed Lands
- Delhi sands soils (incomplete)

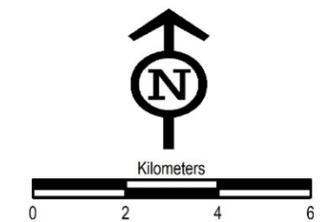
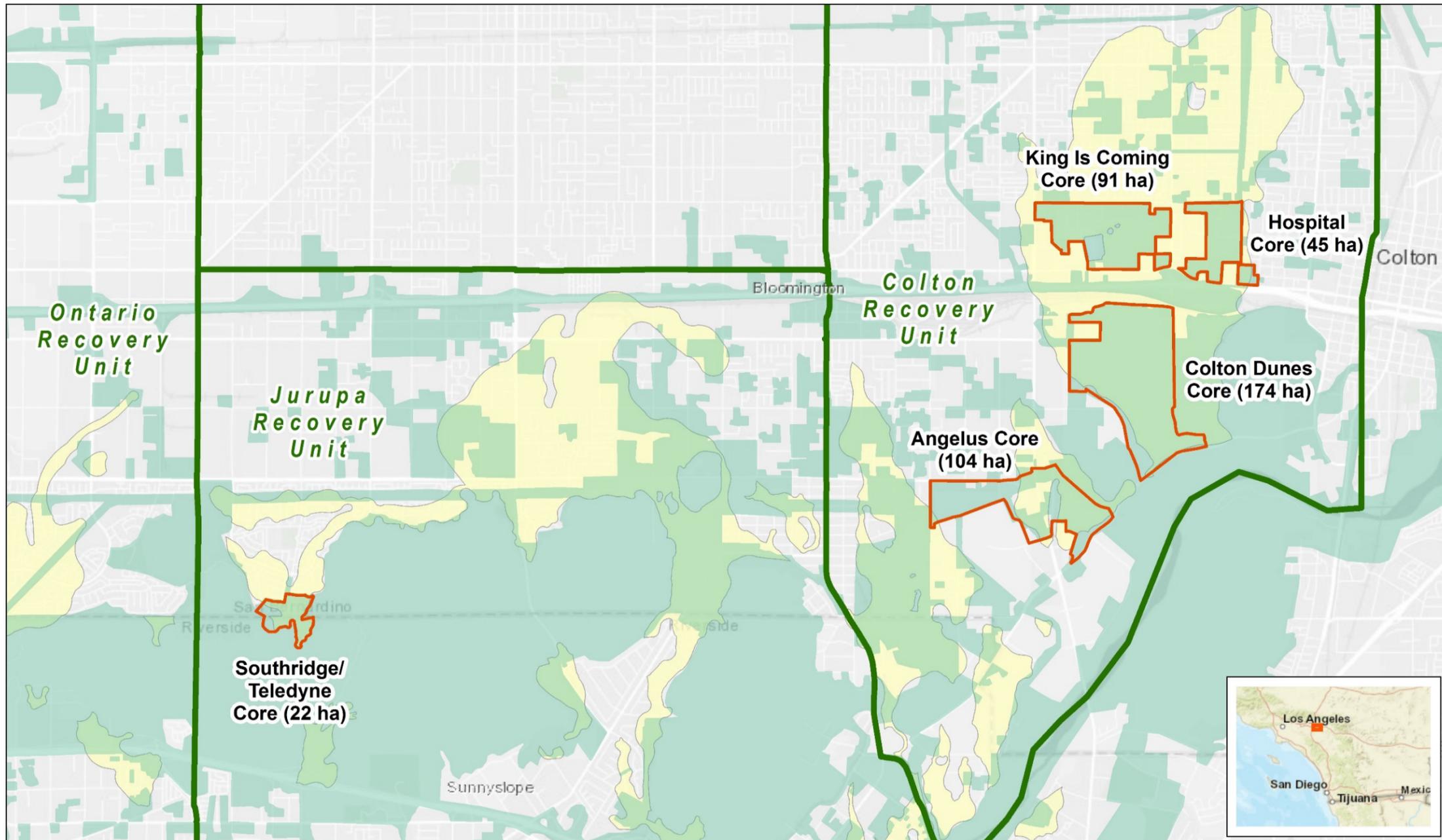


Figure 1. Delhi Sands flower-loving fly (DSF) Recovery Units in San Bernardino and Riverside Counties, California, USA. Shown are known Delhi Sands soils (yellow areas), under-developed lands that may be restored to provide DSF habitat or stepping stone corridors (green areas), and core areas identified as conservation priorities (red outlined area).



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Data: USFWS, USDA  
 Basemap: ESRI Light Grey Canvas  
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- Recovery Units
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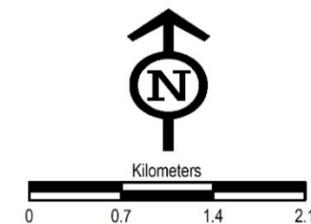


Figure 2. Core areas identified as priority conservation areas for the Delhi Sands flower-loving fly.