

**Western Riverside County  
Multiple Species Habitat Conservation Plan (MSHCP)  
Biological Monitoring Program**

**Delhi Sands Flower-loving Fly  
(*Rhaphiomidas terminatus abdominalis*) Survey Report  
2008**



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## **NOTE TO READER:**

This report is an account of survey activities undertaken by the Biological Monitoring Program for the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). The MSHCP was permitted in June 2004. The Biological Monitoring Program monitors the distribution and status of the 146 Covered Species within the Conservation Area to provide information to Permittees, land managers, the public, the California Department of Fish and Game, and the U.S. Fish and Wildlife Service. Monitoring Program activities are guided by the MSHCP species objectives for each Covered Species, the information needs identified in MSHCP Section 5.3 or elsewhere in the document, and the information needs of the Permittees.

We would like to acknowledge the land managers in the MSHCP Plan Area, who in the interest of conservation and stewardship facilitate Monitoring Program activities on the lands for which they are responsible. A list of the lands where this year's data collection activities were conducted is included in Section 7.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies.

Partnering organizations and individuals contributing data to our projects are acknowledged in the text of appropriate reports. We would especially like to acknowledge the Santa Ana Watershed Association, the Center for Natural Lands Management, and the Orange County Water District for their willingness to initiate or modify their data collection to complement our survey efforts in 2008.

While we have made every effort to accurately represent our data and results, it should be recognized that our database is still under development. Any reader who would like to make further use of the information or data provided in this report should contact the Monitoring Program to ensure that they have access to the best available or most current data. All Monitoring Program data, including original datasheets and digital datasets are stored in the Monitoring Program office in downtown Riverside, CA.

The primary authors of this report were the 2008 DSF Project Lead, Ariana Malone. If there are any questions about the information provided in this report, please contact the Monitoring Program Administrator. If you have questions about the MSHCP, please contact the Executive Director of the RCA. For further information on the MSHCP and the RCA, go to [www.wrc-rca.org](http://www.wrc-rca.org).

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## INTRODUCTION

The Delhi sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*; “DSF”) is federally listed as endangered. Within the MSHCP Conservation Area, DSF is restricted to 3 Core Areas. Species-specific objective 2 for DSF states that “within the MSHCP Conservation Area, Reserve Managers shall document successful reproduction at all 3 Core Areas ... once a year for the first five years after permit issuance and then as determined to be appropriate...” (Dudek & Associates 2003). Documentation of successful reproduction is defined as “the presence/absence of pupae cases or newly emerged (teneral) individuals”.

As of the beginning of the 2008 field season, conservation of DSF habitat had occurred at a single site (Teledyne) within the Jurupa Hills Core Area. In 2008, the Monitoring Program continued testing a protocol developed in 2005 to detect DSF at this site. The primary goal of the survey was to continue to test a protocol designed to evaluate whether the DSF species-specific objectives have been met in a given year. Because the natural history of DSF is not satisfactorily understood, and because the federal Recovery Plan for DSF requires additional data such as population densities and trends (USFWS 1997), several additional survey goals were added by the Biological Monitoring Program.

### **Survey Goals:**

- A) Document successful DSF reproduction at Core Areas.
- B) Test and refine the protocol developed in 2005 for surveying teneral and adult DSF within the Conservation Area.
- C) Gather additional data to measure adult DSF detectability during flight season and estimate the density and population size of adult DSF within Core Areas.
- D) Provide data regarding DSF resource selection and potentially important distribution covariates.

## METHODS

### **Protocol Development**

The protocol used for surveys in 2008 was the same as the protocol implemented in 2005, 2006, and 2007, which was modified from the U.S. Fish and Wildlife Service’s (USFWS) *Interim General Survey Guidelines for the Delhi Sands Flower-loving Fly dated July 1997*. We altered the original USFWS protocol to specifically address the above survey goals, rather than focusing on the USFWS’s goal of providing a credible method for determining DSF presence or absence at a given site. The main adjustments involved using line-distance sampling (Buckland et al 2001) to estimate DSF detection probability, density, and population size.

## **Personnel and Training**

All field observers studied pinned specimens of co-occurring winged invertebrate species, a DSF-specific training manual prepared by the Biological Monitoring Program, and relevant invertebrate field guides. Emphasis was placed on the ability to recognize DSF in the field using physical morphology and behavior, and on the ability to identify all co-occurring winged insects to family. Observers were also trained to identify plant species important to DSF and how to differentiate between adult and teneral DSF. All field observers passed the USFWS DSF practical exam before participating in field surveys. The following surveyors conducted DSF surveys in 2008:

- Ariana Malone, Project Lead (Regional Conservation Authority)
- Amanda Breon (Regional Conservation Authority)
- Lynn Miller (Regional Conservation Authority)
- Matt Talluto (Regional Conservation Authority)
- Rosina Gallego (Regional Conservation Authority)
- Ashley Ragsdale (Regional Conservation Authority)
- Nate Zalik, (Regional Conservation Authority)
- Jonathan Reinig (Regional Conservation Authority)
- Ana Hernandez (Regional Conservation Authority)
- Karin Cleary-Rose, Monitoring Program Coordinator (USFWS)

## **Study Site Selection**

Due to access constraints, the Monitoring Program was only able to survey 1 of 3 Core Areas designated by the MSHCP (Teledyne/Jurupa Hills) in 2008. Survey transects will be established in the other Core Areas when all or portions of them are conserved.

## **Transect Placement**

Transects were placed in the same locations as they were in 2005, 2006, and 2007. Delhi series soils were previously identified and mapped at the Teledyne site (see USFWS 1997). We installed 32 parallel transects within the mapped polygon of appropriate soils on-site (Figure 1). Transects were approximately 15 m apart, 50 to 200 m long, and oriented in a N/NE direction. Transect orientation was randomly selected prior to installation in 2005. Transects were installed by driving wooden stakes approximately every 30 to 40 m and flagging shrubs or grasses between stakes so that surveyors could easily navigate directly along the transect and accurately measure the perpendicular distance between any point on the transect and a DSF observation. The sum of all transect lengths was 4.98 km.

## **Survey Methods**

We conducted visual encounter surveys using line-distance sampling (Buckland et al 2001, 2004) along transects during appropriate weather conditions, with surveyors walking approximately 0.8 km/h. Although, as discussed below, appropriate weather conditions for DSF surveys are not comprehensively known, we conducted surveys in the

Figure 1. Delhi Sands Flower-loving Fly Observations and Transect Lines in 2008



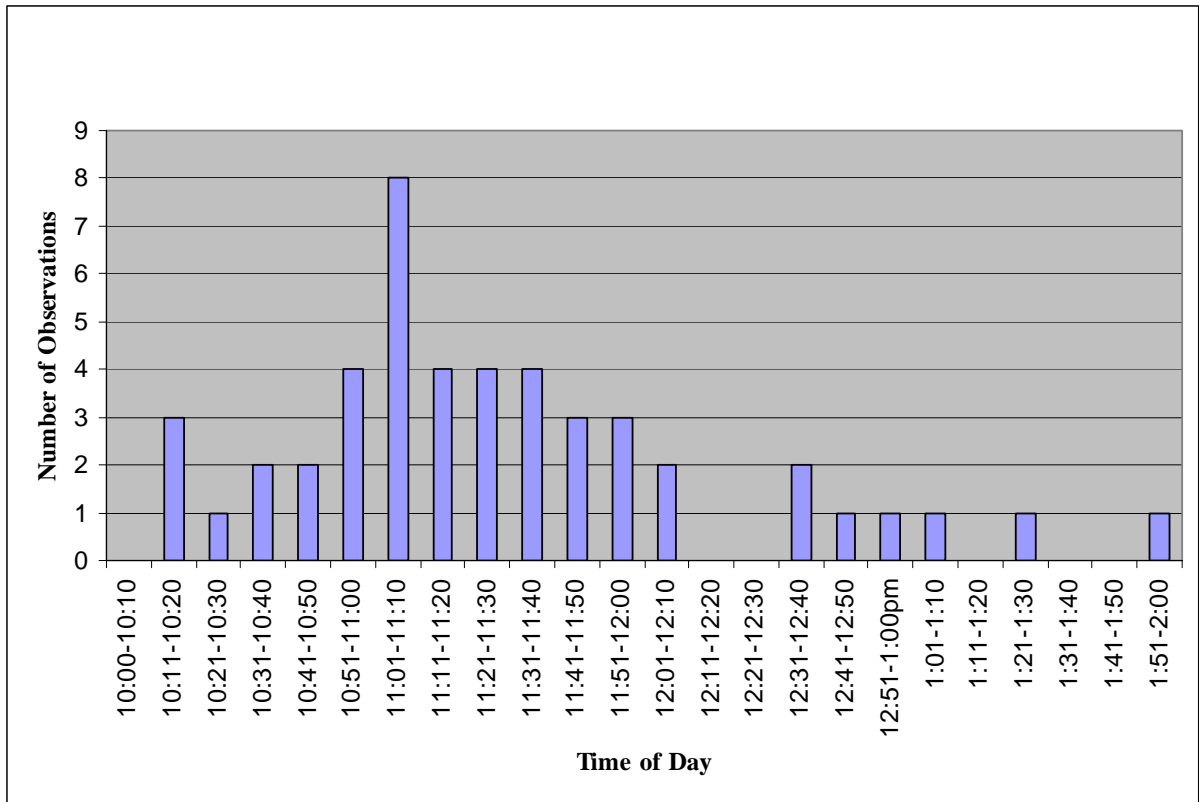
middle of the day in late summer, and not during precipitation events. Rarely, thick vegetation (e.g., *Prunus ilicifolia* or *Rhus trilobata*) prohibited surveyors from walking directly on-transect. In these situations, the impenetrable section of the transect was marked with flagging, the surveyor walked around this section, and the impenetrable section of the transect was excluded from the survey. Approximately 82 m of transect length (~1.3% of the total) was excluded in 2008.

The USFWS protocol suggests that surveys be conducted between 1000 hrs and 1400 hrs to provide some standardization of environmental conditions. However, the majority (81%) of observations made during surveys in 2007 occurred between 1000 hrs and 1200 hrs, suggesting that the morning hours may be better suited for observations of adult DSF than the early afternoon hours (Figure 2). More surveys in 2007 were conducted in the morning hours than the afternoon hours, potentially confounding the above result; however, surveyors anecdotally confirmed the suggestion that adult DSF were more easily observed in morning hours than afternoon hours at the Teledyne site. Therefore, for surveys in 2008, we adjusted the start time to 0930 and continued surveying through 1300 hrs. We performed preliminary visits at least twice weekly beginning in June to determine the start of the DSF flight season; once DSF were active, we began surveying transects. We continued conducting surveys through late summer, when DSF activity declines considerably.

We divided the approximately 6 ha site into 3 sections and walked all sections concurrently, with 1 observer in each section. Each section was walked twice daily; although rarely, because of personnel availability constraints, the site was only walked once in a day. Surveyors recorded coordinates of all DSF observed during the survey with a GPS unit. DSF incidentally detected between surveys were also recorded but were not included in detectability or density analyses.

Data collected at the start of each survey included date, observer, time, general weather description, temperature in shade at 1 m above ground, average wind speed, and cloud cover (Appendix B). Surveyors recorded the families of co-occurring winged insect species encountered as the survey progressed. Time, general weather description, temperature in shade at 1 m above ground, average wind speed, and cloud cover were also recorded 1 hour after the survey began, and hourly until the survey was complete. The same data were collected once more at the end of a survey. When DSF were encountered, we recorded the measured perpendicular distance from the original sighting location to the transect, the coordinates of the original sighting, time, sex, activity, whether or not the individual was teneral, and any other relevant notes. The 2008 survey protocol is described more completely in the *Western Riverside County MSHCP Biological Monitoring Program Protocol for Delhi Sands Flower-loving Fly Surveys, dated July 2008* (Appendix A).

We sampled vegetation on 400 2.25-m<sup>2</sup> plots and 50 100-m<sup>2</sup> at the Teledyne site in 2008 to demonstrate how the plant community and soil structure correlate with DSF



**Figure 2.** Delhi Sands Flower-loving Fly Observation Times During Surveys in 2007

presence and frequency of observation. The main focus of the 2008 vegetation sampling protocol was to characterize the site while comparing fly observations to the site as whole. Quadrats were selected using a spatially stratified random sampling design. All locations where DSF were observed as “perched” were sampled with a 2.25 m<sup>2</sup> and a 100 m<sup>2</sup> quadrat. The quadrat centers were recorded using a submeter accuracy GPS unit.

Because we are interested in the resource selection patterns of DSF, we estimated the percent cover of trees, shrubs, grasses/forbs, invasive grasses, DSF indicator plants (USFWS 1997), litter, bare ground, rock, loose sand, stabilized sand, and dead standing vegetation (Appendix C). We identified all plants to species and estimated percent cover of each species. If on-site identifications were not possible, we collected the minimum amount of plant material necessary for later identification. Finally, we recorded additional notes regarding disturbances on-site or further relevant information not collected during the standard vegetation sampling procedure. The vegetation sampling protocol we used is described more completely in the *Delhi Sands Flower-Loving Fly Vegetation Protocol, 2008* (Appendix D).

In 2006, we distributed 3 permanent photo stations across the Teledyne site to photographically monitor the spread of short-pod mustard (*Hirshfeldia incana*) and non-native grasses across the dune system. We chose these species because they appear to be stabilizing the soil. Encroaching invasive plants leading to dune stabilization may be a threat to DSF because data from previous years indicated that DSF were most abundant in areas that contain a high percentage of native vegetation and more than 60 percent open sand substrate (USFWS 1997, also see *Delhi Sands Flower-loving fly Survey Report 2006*).

In 2008 we revisited these photo stations and took digital photos in the 4 cardinal directions. Although each photo station was originally marked with a labeled wooden stake and we had location coordinates for each station, unauthorized stake removal unfortunately prevented us from relocating the exact points from 2006, and the ability to compare photos year-to-year is questionable. In the future, permanent photo station markers will be installed to allow exact relocation of photo points in subsequent years and improve the ability to compare vegetation among years.

### **Data Analysis**

We entered raw data into a Microsoft Access database and manipulated those data for entry into program DISTANCE (Thomas et al 2006) in order to estimate detection probability and density. We analyzed all 2008 data as a single group after truncating records from outside the peak DSF flight season. We excluded all data after fly observations fell to 1 sighting/day due to the likelihood that these reductions reflect the end of the peak active season for DSF. We evaluated two key functions (half normal and hazard) in combination with cosine and hermite polynomial adjustments. We assessed model fit by graphical inspection of the detection function and using a chi-squared goodness of fit test. We excluded from the model set any model demonstrating significant lack of fit, as well as any model that failed to meet the shape criterion. We selected the most descriptive model from this set using Akaike's Information Criterion, adjusted for small samples (AIC<sub>c</sub>).

We used generalized linear models (GLMs) with binomial errors and a logistic link function to model fly presence/absence in response to our vegetation and soil data (Table 1) at two spatial scales (2.25 m<sup>2</sup> and 100 m<sup>2</sup>). Because many vegetation sampling plots were near fly observations, we also tested models using the number of fly observations within 5 m (for 2.25 m<sup>2</sup> quadrats) or 20 m (for 100 m<sup>2</sup> quadrats) of the center of each quadrat as the response in a generalized linear model with Poisson errors and a log link. The Poisson distribution assumes the variance and mean are equal, an assumption that is often not met with biological data. We compared the residual deviance of each model to the residual degrees of freedom to determine if the errors were under- or overdispersed, which would indicate a departure from equality between the variance and the mean. For all GLMs, we examined the distribution of untransformed variables, and

transformed percent cover to presence/absence for variables that showed substantial zero-inflation (> 10% of observations = 0).

**Table 1.** Variables used in generalized linear models for vegetation and soil analysis. Data for trees and *Amsinkia* were originally collected as percent cover, but were transformed to presence/absence due to zero inflation.

Variable	Description
Fly presence	Presence or absence of DSF within a vegetation quadrat
Fly count	Number of flies observed within 5 m (for 2.25 m <sup>2</sup> quadrats) or 20 m (for 100 m <sup>2</sup> quadrats) of the quadrat center point
Ambrosia	Presence/absence of <i>Ambrosia</i> spp.
Amsinkia	Presence/absence of <i>Amsinkia menziesii</i>
Brassica	Percent cover of <i>Brassica</i> spp.
Grass	Percent cover of all grasses
Herbs	Percent cover of all herbaceous species
Litter	Percent ground cover of dead organic material
Loose sand	Percent ground cover of unstabilized sand
Shrubs	Percent cover of all shrubs
Stabilized Sand	Percent ground cover of stabilized sand or non-sand soil
Total Veg	Percent cover of all vegetation
Trees	Presence/absence of trees

We produced candidate models using both forward and backward stepwise procedures. Models were selected at each step based on the change leading to the largest decrease in AIC. We used these procedures to develop a candidate model set for each response; only models where  $\Delta AIC < 2$  were included in the candidate set. We averaged the models in each set (Burnham and Anderson 2002) and report the results of the averaged models here. We also used the model set to calculate an Akaike weight for each model. For each predictor, we then summed the weights for each model that included that predictor as an indicator of the degree of support for that predictor (Burnham and Anderson 2002).

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predictor as an indicator of the degree of support for that predictor (Burnham and Anderson 2002).

## RESULTS

We surveyed transects at the Teledyne site on 38 separate days in 2008, beginning 26 June and ending 22 August. We observed adult DSF on 272 occasions during field surveys in 2008, 3 during training or transect installation, and 28 while not actively surveying for a total of 303 DSF observations (Figure 1). Evidence of successful reproduction was confirmed in 2008; we recorded teneral individuals as well as 4 sightings of individuals emerging from the pupal case (exuviae). Five pupal cases found at the site were collected and stored at the Monitoring Program office.

We walked a total of 4984 km during DSF surveys in 2008. The distance analysis using the truncated 2008 data produced a density estimate of 1.54 individuals/ha (95% CI: 0.97–2.1 individuals/ha), and a detection probability estimate of 0.32 (95% CI: 0.28–0.38). The model using the half-normal key function with a cosine adjustment had the lowest AIC; this model also met the shape criterion and showed no significant lack of fit.

We modeled the relationships between our soil and vegetation data and both DSF presence/absence and abundance using generalized linear models. The presence of *Amsinkia menziesii* was negatively associated with flies in all models, as was the % cover of *Brassica* spp., while % cover of shrub species was positively associated with DSF in all models. Percent cover of grasses, loose (unstabilized) sand, and stabilized sand were present in 3 of the 4 averaged models; grasses and loose sand were consistently positively associated with DSF and stabilized sand was consistently negatively associated with DSF. All other relationships were inconsistent among the 4 models (Table 2). Confidence intervals for the model averaged parameter estimates overlapped 0 in all cases, with the exception of presence of *A. menziesii* (in 2 of 4 models) and % cover of stabilized sand (in 1 of 4 models).

The Summed model weight, indicating the weight of support for each response variable, was high for *Amsinkia menziesii* presence for all four response variables (range 0.34–1.0); no other predictor was supported as consistently across models (Table 3). Both % herbaceous cover and % shrub cover were well-supported in models based on the 100 m<sup>2</sup> quadrats, but not for the 2.25 m<sup>2</sup> quadrats. Total vegetative cover had strong support in models with DSF presence-absence as a response (summed weights = 0.75 and 0.81), but weaker support when count data were used as the response (weights = 0.25 and 0.23; Table 3).

## DISCUSSION

In the fourth year of DSF monitoring, we recorded more DSF observations than in the previous 3 years combined and confirmed breeding at the only Core Area where

conservation has occurred (Teledyne). We also collected DSF observation covariates including vegetation sampling at 450 different points within the Teledyne site.

**Table 2.** Parameter estimates and 95% confidence intervals for vegetation and soil data models. Estimates are results from a model averaging procedure (Burnham and Anderson 2002). Bolded values have confidence intervals that do not overlap zero.

Response	Intercept	Ambrosia	Amsinkia	Brassica	Grass	Herbs
logit (Fly presence) 2.25 m <sup>2</sup> quadrats	<b>-1.08</b> (-1.6, -0.58)	3.93e <sup>-4</sup> (-1.4e <sup>-3</sup> , 2.2e <sup>-3</sup> )	<b>-0.82</b> (-1.4, -0.19)	-0.0020 (-8.3e <sup>-3</sup> , 4.4e <sup>-3</sup> )	1.75e <sup>-4</sup> (-1.1e <sup>-3</sup> , 1.5e <sup>-3</sup> )	-1.36e <sup>-4</sup> (-1.5e <sup>-3</sup> , 1.2e <sup>-3</sup> )
logit (Fly presence) 100 m <sup>2</sup> quadrats	<b>1.01</b> (0.20, 1.8)		-0.21 (-0.619, 0.294)	-0.0079 (-0.028, 0.012)		0.039 (-0.074, 0.15)
log (Fly count) 5 m radius	<b>-1.06</b> (-1.6, -0.51)	-3.95e <sup>-4</sup> (-1.8e <sup>-3</sup> , 1.0e <sup>-3</sup> )	<b>-0.59</b> (-1.05, -0.13)	-0.0063 (-0.022, 9.7e <sup>-3</sup> )	2.57e <sup>-4</sup> (-0.43e <sup>-4</sup> , 9.5e <sup>-4</sup> )	0.013 (-0.015, 0.042)
log (Fly count) 20 m radius	<b>1.23</b> (0.96, 1.5)	0.00363 (-4.1e <sup>-3</sup> , 0.011)	-0.16 (-0.39, 0.058)	-2.59e <sup>-4</sup> (-1.9e <sup>-3</sup> , 1.4e <sup>-3</sup> )	6.21e <sup>-4</sup> (-1.7e <sup>-3</sup> , 3.0e <sup>-3</sup> )	-0.013 (-0.027, 1.5e <sup>-3</sup> )

Response	Litter	Loose Sand	Shrubs	Stabilized Sand	Total Veg	Trees
logit (Fly presence) 2.25 m <sup>2</sup> quadrats	3.60e <sup>-5</sup> (-4.5e <sup>-4</sup> , 5.2e <sup>-4</sup> )	6.64e <sup>-4</sup> (-8.8e <sup>-4</sup> , 2.2e <sup>-3</sup> )	7.17e <sup>-4</sup> (-1.5e <sup>-3</sup> , 2.9e <sup>-3</sup> )	-0.0014 (-4.3e <sup>-3</sup> , 1.6e <sup>-3</sup> )	-0.012 (-0.026, 2.7e <sup>-3</sup> )	-0.041 (-0.20, 0.12)
logit (Fly presence) 100 m <sup>2</sup> quadrats			0.082 (-0.025, 0.19)		-0.067 (-0.16, 0.027)	0.30 (-0.34, 0.94)
log (Fly count) 5 m radius	0.0018 (-1.8e <sup>-3</sup> , 5.4e <sup>-3</sup> )	0.0014 (-1.6e <sup>-3</sup> , 4.4e <sup>-3</sup> )	0.015 (-0.015, 0.045)	<b>-0.0067</b> (-0.013, -2.0e <sup>-4</sup> )	-0.015 (-0.044, 0.015)	-0.066 (-0.24, 0.11)
log (Fly count) 20 m radius	6.69e <sup>-5</sup> (-2.6e <sup>-4</sup> , 4.0e <sup>-4</sup> )	2.32e <sup>-4</sup> (-3.4e <sup>-4</sup> , 8.0e <sup>-4</sup> )	0.0054 (-2.7e <sup>-3</sup> , 0.013)	-2.42e <sup>-5</sup> (-1.7e <sup>-4</sup> , 1.3e <sup>-4</sup> )	0.0016 (-2.3e <sup>-3</sup> , 5.6e <sup>-3</sup> )	-0.011 (-0.043, 0.022)

**Table 3.** Summed model weights for each predictor in each of 4 averaged models.

Response	Ambrosia	Amsinkia	Brassica	Grass	Herbs
Fly presence 2.25 m <sup>2</sup> quadrats	0.058	1.000	0.071	0.054	0.053
Fly presence 100 m <sup>2</sup> quadrats	0.000	0.337	0.073	0.000	0.743
Fly count 5 m radius	0.065	1.000	0.222	0.062	0.251
Fly count 20 m radius	0.271	0.692	0.030	0.057	0.925
Litter	Loose Sand	Shrubs	Stabilized Sand	Total Veg	Trees
0.053	0.156	0.071	0.223	0.810	0.112
0.000	0.000	0.817	0.000	0.749	0.356
0.245	0.243	0.261	0.810	0.247	0.149
0.060	0.100	0.576	0.030	0.234	0.102

We observed a large and statistically significant increase in the density of DSF between 2007 (density = 0.42 individuals/ha) and 2008 (density = 1.54 individuals/ha). Although the sample size in 2007 was small ( $n = 47$  individuals), the precision of the estimate was relatively high (95% CI 0.33-0.53 individuals/ha), thus it is unlikely that this difference is solely due to imprecision from small sample sizes. Systematic bias in our density estimates could contribute to a difference between years, although this is likely to affect both the 2007 and 2008 estimates similarly, as the same sampling methods were employed during both years. Considering the large increase in the number of observations between years ( $n_{2007} = 47$ ,  $n_{2008} = 272$ ), it is likely that the increase in density estimates reflects an actual increase in both density and abundance of DSF at Teledyne.

Although we were able to obtain a density estimate with our distance-sampling model, this estimate should not be interpreted as indicative of absolute DSF abundance at the site. Distance sampling produces a “snapshot” density, reflecting the density of the organism at a particular instant in time. DSF density appears to be relatively low at Teledyne at any given time, despite the increasing population size implied by the consistent increase in the number of observations at the site each year ( $n_{2005} = 6$ ,  $n_{2006} = 8$ ,  $n_{2007} = 47$ ,  $n_{2008} = 272$ ). The low density estimated by our model suggests that DSF at this site spend a large proportion of the sampling season unavailable for observation. Possible causes for this low availability include an open population, with many DSF spending a

large proportion of their time offsite, a short aboveground life cycle, and a high proportion of inactivity. The open population scenario would contribute to unavailability of some individuals; however, it is unlikely that this effect is large, given the small size of the organism (and associated improbability of many long-distance movements over a short time period) and the scarcity of adjacent appropriate habitat. The contribution of the other 2 scenarios to the low observable density of DSF is unknown; too little information on DSF life history exists to estimate either the length of the active life cycle or the diurnal activity cycle of the organism. Additional ecological and life history information such as microhabitat resource use, lifespan as an adult, and typical adult emergence patterns could help us to understand the availability of DSF to be observed during a survey, design more appropriate sampling schemes, and direct data analysis. However, even if the ecological information necessary to correctly interpret DSF density estimates are not available, the visual encounter surveys along pre-established transects help standardize the survey method through the season and among observers, and ensures that the surveyed sites are thoroughly covered. This sampling design coupled with vegetation sampling of areas where flies are observed perching versus areas where flies are not observed perching yield the best information we can hope for about the species' use of the site.

We found few consistent patterns when modeling vegetation and soil associations with DSF presence or abundance. Most effect sizes were small, and confidence intervals for nearly all parameter estimates overlapped 0 (Table 2). Although we analyzed data at two scales, we found no strong associations using the large scale data; all confidence intervals at this scale included 0. This could be due to an unimportance of vegetation and soil parameters for DSF at larger scales; however, this seems unlikely, given that DSF are highly mobile and can easily cover a 100 m<sup>2</sup> area in a short time. Another possibility is that DSF track different habitat factors at large scales than at small scales, and that we failed to identify and measure the important factors at large scales. A final possibility is that a combination of high variance inherent in our data collection methods (particularly visual cover estimates) and low sample size resulted in imprecise estimates and low statistical power. Although it is impossible to conclusively distinguish between these explanations, our vegetation data collection was based on anecdotal reports or DSF preferences, and thus it would seem likely that we would find at least some vegetation associations given enough statistical power.

The presence of *Amsinkia menziesii* was negatively associated with DSF in all models tested, and the effect was strongly nonzero for both models at the smaller spatial scale (Table 2). *A. menziesii* cover was not correlated with cover of any other species for which we collected data. For a quadrat with mean values for all other variables included in the models, the presence of *A. menziesii* decreased the probability of observing a fly within the quadrat from 0.21 to 0.11, and decreased the predicted number of flies within 5 m of the quadrat from 0.23 to 0.13. More investigation will be necessary to determine if

DSF truly avoid *A. menziesii*, or if this association is simply the result of increased difficulty of observing DSF perched in this species leading to a reduction in the number of observations when *A. menziesii* is present.

We also observed a negative association between stabilized sand and the number of DSF observed in the vicinity of small quadrats. When *A. menziesii* was absent, expected DSF count ranged from 0.28 on completely unstabilized dunes (0% stabilized, 100% unstable sand) to 0.13 when 100% of the surface soil was stabilized sand. In the presence of *A. menziesii*, expected counts ranged from 0.13 on unstabilized dunes to 0.07 on stable sand. DSF have been anecdotally observed preferring unstabilized dune habitat (USFWS 1997); our observations seem to confirm this.

### **Recommendations for Future Surveys**

We will continue to use our existing survey methods (visual encounter surveys along established transects with vegetation sampling) to document DSF reproduction at Teledyne, as required by the species objective, at least for the next field season. In accordance with the DSF species objective, both the survey frequency and sampling design should be reviewed 5 years after permit issuance (i.e., June 2009).

The established photo stations will help document the spread of non-native weedy species on the site. Management actions to address the spread of weeds and the stabilization of the dunes should be considered. When conservation is accomplished within the other 2 Core Areas, we will focus on documenting reproduction in those locations.

If density estimates for DSF are to be interpreted in context, and if these figures will be used for comparison across sites (assuming other sites are conserved), additional studies focusing on seasonal and diurnal behavior patterns and life history will be necessary. More intensive monitoring efforts may be needed to provide the necessary information to evaluate the detection probability, density, and population size of this species. For example, attaching transmitters to newly emerged individual DSF would allow us to track lifespan and daily microhabitat use. As an alternative, observers could follow DSF individuals and record data about their location and activities, although this method would not provide information regarding lifespan. Individually marking DSF with unique identification tags for a mark/recapture analysis may also be feasible given the apparent small population size, but this approach would be time consuming and would require capturing and handling a potentially delicate federally-listed endangered species.

Use of transmitters and individually marking flies are beyond the scope of what is needed to meet current species objectives, and while these activities would yield important life history information about the fly, management actions to control weeds and address the stabilization of the dune system would probably be more beneficial to the

species and MSHCP management needs. If transmitters or a mark-recapture program are pursued, they should be pursued with funding from outside the MSHCP.

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## **Appendix A: Western Riverside County MSHCP Biological Monitoring Program Protocol for Delhi Sands Flower-loving Fly Surveys June 2008**

This protocol was modified from the U.S. Fish and Wildlife Service's (USFWS) Interim General Survey Guidelines for the Delhi Sands Flower-loving Fly (*Rhaphiomidas terminatus abdominalis*, DSF) dated December 1996. Protocol adjustments were made to specifically address the survey goals below, rather than focusing on the USFWS's goal of providing a credible method for determining DSF presence-absence at a given site. The main adjustments include using a line-distance sampling methodology to estimate DSF density and detectability and less emphasis on mapping habitats on-site.

### **GOALS:**

**A)** Document successful reproduction of DSF within Core Areas, as measured by the presence/absence of newly emerged (teneral) individuals.

**B)** Gather data regarding DSF density, detectability, resource selection, and important distribution covariates (including co-occurring insect families).

To achieve the above goals, visual encounter surveys along pre-established transects will be conducted annually in Core Areas accessible to the Monitoring Program. Data resulting from these surveys will be used to verify reproduction within Core Areas and analyzed to provide insight into the ecology of DSF as described in Goal B. Although they are to be recorded if detected, focused surveys for pupae cases (exuviae) will not be conducted using this protocol.

### **TIMING:**

Surveys for adult DSF will be conducted annually for approximately twelve weeks during the flight season, generally from July through September. The beginning and end of the survey season will be established by biologists from the Monitoring Program. Annual surveys at a given location will not begin until adult DSF have been observed at that location in the year of the survey.

### **SURVEY LOCATIONS:**

Surveys will be conducted annually in Core Areas accessible to the Monitoring Program. Accessible lands will be identified by the Lead Field Coordinator prior to surveys.

In 2008, we will survey only the Jurupa Hills Core Area, as the Core Areas in the northwestern corner of the Plan Area (Mira Loma), and in the Agua Mansa Industrial Center area are currently inaccessible to the Monitoring Program.

### **METHODS:**

## I. Transect Setup

Survey transects will be established in suitable habitat within accessible Core Areas. Suitable habitat was previously defined by the presence of Delhi series soils described by a GIS layer. Pilot surveys in 2005 indicated that 32 parallel transects spaced approximately 15 m apart, and ranging from approximately 50 to 200 m long provided adequate coverage of the suitable habitat within the Jurupa Hills Core Area (see Delhi Sands Flower-loving Fly (*Rhaphiomidas terminatus abdominalis*) Survey Report 2005). Transects will be marked with wooden stakes approximately every 30 – 40 m and flagging on shrubs or grasses between stakes so that surveyors can easily navigate between stakes and accurately measure the perpendicular distance between any point on the transect and any DSF observation.

During transect establishment, impenetrable vegetation stands (*e.g.*, *Prunus ilicifolia* or *Rhus trilobata*) that prohibit surveyors from walking directly on-transect will be marked with flagging on both sides of the stand. Surveyors will walk around these sections, and the impenetrable section of the transect will be excluded from the transect and subsequent analyses.

## II. Surveying for Adult Delhi Sands Flower-loving Fly

Before surveys begin, surveyors must demonstrate the ability to identify DSF and co-occurring insect families by passing the USFWS Delhi Sands flower-loving fly practical exam, and locating and identifying insects in the field with the Lead Field Coordinator. Refer to the Field Training Manual for instructions.

After the survey season begins, each transect will be surveyed twice per weekday for a minimum of twelve weeks during the flight season, or until the Lead Field Coordinator has determined that a sufficient amount of data has been collected. Surveys will be conducted on established transects between 0930 and 1430 hours. Weather conditions should be clear skies and winds less than 5 mph. If wind speeds are sustained at greater than 5 mph, surveyors will delay beginning the survey until they decrease or cancel the survey if winds do not decrease. Infrequent gusts over 5 mph are acceptable. Surveys should not be conducted under extremely cloudy, overcast, or rainy conditions since DSF has not been observed under these conditions (USFWS 1997).

### Survey Equipment:

- |                    |  |
|--------------------|--|
| -Handheld GPS unit | -Clipboard with data sheets and pen      |
| -Thermometer       | -Measuring tape                          |
| -Anemometer        | -Binoculars (if desired)                 |
| -Camera            | -Insect Identification Aids (if desired) |

Data collected at the start of a survey include: date, observer, time, general weather condition, temperature in shade at 1 m above ground, average wind speed, and cloud cover category (see Delhi Sands Flower-loving Fly Survey Datasheet). Time, general weather condition, temperature in shade at 1 m above ground, average wind speed, and cloud cover are also recorded hourly beginning 1 hour after the survey begins, and at the end of the survey.

Surveying consists of walking previously established parallel transects looking for DSF either flying or perched on vegetation. **Move carefully to avoid trampling DSF adults, larvae or otherwise harming the habitat onsite.** Although, as discussed below, DSF are likely to flush out of the way of a moving observer it is imperative to avoid harming individuals because this Endangered Species is so rare. Walk slowly and stop occasionally to look around – surveyors standing still are more likely to see an insect already in flight.

**While walking a transect, always remain as close to the centerline of the transect as possible.** The statistics used to analyze the data collected assume that close to 100% of the DSF that are directly on-transect are observed. DSF **should** take flight if an observer approaches them and a vigilant observer should notice a DSF take flight in front of them nearly 100% of the time. DSF further off-transect will be observed with a decreasing probability as the distance from an observer on transect to the fly increases and this bias is accounted for in the statistical analysis.

Data collected when a DSF is encountered include: the perpendicular distance from the transect to the **original sighting location** (accurate to the inch, data will be converted to metric measurements later), the coordinates of the original sighting, time, sex, activity, whether or not the individual was teneral, and any other relevant notes. Teneral individuals are “covered with golden pelage and have emerald green eyes and no rigid wing venation” (Kingsley 1996). If recording a DSF as teneral, take a digital photo when possible. Otherwise, take photos if time permits or you want to document the location of the fly. Binoculars are not required for surveying, but can aid in identifying behavior and age class of observed individuals.

When approaching a perched DSF for identification purposes, move slowly and keep the movement of your hands, arms, legs, and body to a minimum. If the fly is first seen in flight, follow from 1 – 2 m away until it lands, or you have seen enough to confirm that it is a DSF. Do not make sudden movements. If the fly is circling, stand still and wait for it to land – if it perceives your movement, it is less likely to stop. After the individual has been confirmed or disconfirmed as a DSF, and necessary data have been taken, return to the transect departure point, and continue with the survey.

Surveyors should also record the families of co-occurring winged insect species encountered as the survey progresses. Counts of co-occurring families are optional. If an

insect is observed that you know is **not DSF**, do not spend time attempting to identify the family if it isn't immediately apparent.

Also take waypoints and/or photographs of any other MSHCP Covered Species encountered. Record photographs and waypoints of Covered Species on an Incidental Species Sighting Form if the necessary data can not be stored by naming the marked waypoints appropriately (see Incidental Observation Instructions and Instructions for Taking and Storing Digital Photos).

### **III. Recording Data**

There should be two Delhi Sands Flower-loving Fly datasheet per surveyor for each day of survey activities at each locality surveyed. If there are no observations of DSF on a particular day, that should be noted on the datasheet.

The locations of all adult DSF **incidentally observed** should be recorded with a GPS unit, whether they are observed before, during, or after a survey. DSF observations made during a survey but while walking around an excluded section of a transect are considered incidental and these points are not entered on the survey datasheet. If additional info beyond the date, time, observer, species code, and location coordinates are desired (*e.g.*, substrate, number of individuals, sex, etc.) fill out an Incidental Species Sighting Form. If two or more DSF individuals are observed in the same small area (~10 m diameter circle) these can be recorded with the same waypoint, taken near the center of the cluster. Record the number of DSF observed on the Incidental Species Sighting Form. DSF observations made on-transect during a survey do not need to be marked with a GPS, simply record the coordinates on the survey form, as described above. Data will be recorded in the NAD83 datum; all survey areas are in Zone 11S.

### **IV. Vegetation Sampling**

The DSF is associated with Delhi series soils, which are fine and sandy. Within this rare environment, three plant species are typically present in occupied DSF habitat: *Eriogonum fasciculatum*, *Heterotheca grandiflora*, and *Croton californica* (U.S. Fish and Wildlife Service 1997). Because we are interested in furthering our understanding of the resource selection patterns of DSF we will conduct vegetation Relevés (CNPS 2002) at DSF survey observation locations and at randomly selected locations without DSF observations. See the 2008 Delhi Sands Flower-Loving Fly Vegetation Sampling Protocol for methods.

## Appendix B: Delhi Sands Flower-loving Fly Survey Sheet

Date \_\_\_\_\_ **Delhi Sands Flower-loving Fly**

**Teledyne** \_\_\_\_\_ Data Entered/Data Proofed

Observers \_\_\_\_\_ Section \_\_\_\_\_

Time	Temp °C	Avg Wind*	Weather**	Cloud Cover***
Start : _____				
Hour 1: _____				
Hour 2: _____				
Hour 3: _____				
Hour 4: _____				
End : _____				

Activities/Behaviors
<b>Perched:</b> indicate substrate
<b>Interspecific Interaction:</b> describe interaction
<b>Intraspecific Interaction:</b> describe interaction
<b>Nectaring:</b> record plant species, or take sample
<b>Oviposition:</b> describe site, record soil temp!!!
<b>Cruising</b>
<b>Mating</b>

\* mph

\*\* general description

\*\*\* 0, 1-20, 21-40, 41-60, 61-80, 81-100

**Age Code**

**1:** fuzz entirely covers dorsal thorax = teneral (note wing margin wear)

**2:** fuzz partially covers body or no fuzz seen

Transect #	Distance	UTM East	UTM North	Time	♀ or ♂	Activity	Age Code	Notes

Appendix C: DSF Vegetation Sampling Datasheet

Observers: \_\_\_\_\_ Date: \_\_\_\_\_

Plot ID: \_\_\_\_\_ Plot Size (circle one): 100 m<sup>2</sup> 2.25 m<sup>2</sup>

Vegetation		
	Species	% cover
<b>Trees</b>		
	species 1	
	species 2	
	species 3	
<b>Shrub</b>		
	species 1	
	species 2	
	species 3	
	<i>Eriogonum fasciculatum</i>	
	<i>Croton californicus</i>	
<b>Forb/Grass</b>		
	species 1	
	species 2	
	species 3	
	<i>Heterotheca grandiflora</i>	
	<i>Ambrosia acanthicarpa</i>	
	<i>Stephanomeria</i> sp.	
	<i>Brassica</i> and <i>Sisymbrium</i>	
	non-native grass	
<b>Total vegetation cover:</b>		

Ground codes	
Surface substrate	% cover
<b>Litter</b>	
<b>Rock</b>	
<b>Basal stem</b>	
<b>Bare ground- stabilized sand</b>	
<b>Bare ground- loose sand</b>	
<b>Bare ground- hardpan</b>	
<b>Bare ground- other (describe):</b>	
<b>All ground codes</b>	<b>100%</b>

Notes: Disturbance, Site Characteristics, etc.

## Appendix D: Delhi Sands Flower-Loving Fly Vegetation Sampling Protocol 2008

The objective of this vegetation protocol is to determine what aspects of the plant community and soil structure correlate with DSF presence and frequency of observation. Vegetation sampling for DSF surveys will focus on characterizing the study site and comparing areas where flies have been observed to the site as a whole. We will monitor plant species diversity, vegetation structure, community composition, and surface soil structure at multiple spatial scales as potential predictors of DSF presence or frequency of observation.

To characterize the study site, we will place 400 2.25 m<sup>2</sup> and 50 100 m<sup>2</sup> quadrats throughout the study site using a spatially stratified random sampling design. To characterize sites where DSF have been observed, we will center a 2.25 m<sup>2</sup> and a 100 m<sup>2</sup> quadrat at each location where a perched DSF was recorded during surveys. Within each quadrat, we will record percent cover of the tree, shrub, and herbaceous layers, as well as percent cover of individual shrub species that are strongly dominant within individual quadrats or are hypothesized to be important to DSF (*Eriogonum fasciculatum* and *Croton californicus*). We will also record percent cover of herbaceous species or functional groups, including *Heterotheca grandiflora*, *Ambrosia acanthicarpa*, *Stephanomeria* sp., non-native grasses, and non-native mustards (*Brassica* and *Sisymbrium*).

Data will be analyzed using logistic regression to develop models predicting the probability of occurrence of DSF in relation to vegetation and soil. The location of quadrat centers will be recorded using a submeter accuracy GPS unit to facilitate the use of spatially explicit models.

Instructions for field crew:

1. Locate the center of the quadrat using the Trimble GPS.
2. Record the location of the plot center by logging a new point feature on the GPS. Record at least 5-6 data points for each quadrat (the GPS will beep each time it records a point). Enter the plot number in the notes on the GPS unit.
3. Record the plot number and plot size on the top of the datasheet. For plots named using a 3 digit number, use a single datasheet and only collect data from a small

- plot. For plots named with a 4 digit number, use two datasheets and record data for a large plot and a small plot.
4. For small quadrats, center a frame around the plot center to mark the quadrat boundary.
  5. For large quadrats, center the small frame around the quadrat center, as above. Extend a measuring tape (oriented north-south) to mark the diagonal of the large plot. The center of the plot should be at 7.05 m, with the entire length of the diagonal measuring 14.1 m. Mark the plot corners with flags.
  6. Enter the name of the surveyor(s) and the date of the survey and circle the plot size.
  7. Estimate and enter the percent cover of the tree layer. List up to 3 dominant species present in this layer and list the percent cover of each.
  8. Enter the percent cover of the entire shrub layer and the individual cover of the 3 most dominant shrub species. Also enter the percent cover of *Eriogonum fasciculatum* and *Croton californicus*, if they are not included as dominant species.
  9. Estimate and enter the percent cover for all herbaceous plants combined, as well as the percent cover of the 3 most dominant species or groups. Next enter the percent cover of *Heterotheca grandiflora*, *Ambrosia acanthicarpa*, *Stephanomeria* sp., non-native grasses (taken as a group), and non-native mustards (*Brassica* and *Sisymbrium*) if they are not already included as dominant species.
  10. Estimate total vegetative cover.
  11. Under the heading Ground codes, record the percent cover for all of components of the surface substrates. These will include basal stem (should generally be between 1 and 5%), litter, rock (> 2 cm), and 4 different categories of bare ground. *Stabilized sand* refers to sand whose movement is arrested or whose form is protected from further wind action by growth of vegetation or cementation of sand. *Loose sand* is that on which erosion and deposition can still occur. *Hardpan* is any bare ground that is substantially compacted and is not composed of sand. There is an 'Other' category for any bare ground that does not fit into these three categories. Include next to 'Other' a description of the soil. All of the ground codes together should add up to 100%.
  12. In the final section, include any noteworthy remarks about the site, specifically anything relating to the disturbance or deterioration of the site.