

Rare Butterfly Management and Conservation Planning

TASK 7:

2016 HARBISON'S DUN SKIPPER FLIGHT SEASON SURVEYS

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Executive Summary

The Harbison's dun skipper (*Euphyes vestris harbisoni*) has a very restricted distribution in southern California and northern Mexico and entomologists have expressed concern that threats will lead to the extirpation of populations. The larvae of this skipper feed only on San Diego sedge (*Carex spissa*) and are generally associated with riparian oak woodlands. Nearly all of the known information about this skipper is restricted to three papers.

Surveys for Harbison's dun skipper adults were conducted to assess year to year variation in population size. Field visits were used to document use including plants used for nectar sources, as well as obtain non-lethal genetic samples. A rapid habitat assessment was conducted at each site which included general woodland tree species composition, condition of San Diego sedge plants, and recording potential threats to the Harbison's dun skipper.

We were not able to detect Harbison's dun skipper adults at all sites, including the canyon south of San Pasqual Academy where it appears the skipper has been extirpated due to wildlife and drought. At four sites (Barrett Lake, Lake Hodges, Skye Valley Road, Sycuan Peak Ecological Reserve), the peak daily number was near or exceeded 10 individuals. At the other sites, no more than four individuals were seen on a single day. There was not a clear relationship between the 2014 and 2016 counts as some were higher, some lower, and some quite similar. In 2016, we observed adults nectaring on sacapellote (*Acourtia microcephala*) and California rose (*Rosa californica*), two plant species not previously recorded. The current list of known nectar sources includes 20 species, nearly all of which have white, purple, or pink flowers.

Habitat assessments occurred at 23 locations with recent Harbison's dun skipper observations. These surveys occurred just after the flight season (27 July – 9 August 2016). Oak species dominated the woodlands, with some sycamore and willow trees. The condition of the San Diego sedge plants ranged from nearly all very healthy (green) to all dead. Most of the plants had green leaves with brown tips, suggesting some water stress although this may be typical during the late summer and early fall. The most common threat to the Harbison's dun skipper was the presence of the goldspotted oak borer (*Agrilus auroguttatus*). In addition, more than 15 non-native plant species were detected in the riparian areas.

Introduction

The Harbison's dun skipper (*Euphyes vestris harbisoni*) is restricted to southern Orange County, extreme western Riverside County, and San Diego County (Brown and McGuire 1983, Marschalek and Deutschman 2015a), with one record from Mexico (Marschalek and Deutschman 2015a). Entomologists have expressed concern that the skipper is rare and may be negatively impacted by habitat loss and degradation (Brown 1991, Glassberg 2001). In 1989, the United States Fish and Wildlife Service (USFWS) issued a notice of review, on which Harbison's dun skipper was listed as a Category 2 species (USFWS 1989).

Prior to our initial efforts in 2013, nearly all of the known information about this skipper was restricted to descriptions in two published papers (Brown 1982, Brown and McGuire 1983). These papers identified this subspecies as morphologically different from the other subspecies and describe its biology (life history and nectaring sources) and distribution. The larvae of this skipper feed only on San Diego sedge (*Carex spissa*) and are generally associated with oak woodlands. The distribution of the skipper includes southern Orange County and San Diego County, with the skipper present in nearly all areas containing considerable numbers of the sedge. Brown and McGuire (1983) also mentioned that the skipper appears to be facing several threats related to urbanization and development. They recorded a local extirpation at Adobe Falls in San Diego due to development, pollution, and subsequent invasion of the riparian area by non-native plants.

We updated and expanded on what was known about the skipper by conducting surveys as part of a project funded by a CDFW Local Assistance Grant (Marschalek and Deutschman 2015a). Based on surveys for larvae and adults in 2013-2014, the current Harbison's dun skipper distribution includes the foothills in the northern and southern parts of San Diego County, extreme western Riverside County, and southern Orange County (Figure 1). In San Diego County, there appears to be a significant gap around the Poway area due to local extirpations likely resulting from wildfires. It is unclear whether the skipper currently occupies Silverado Canyon, its northernmost location, following the 1987 Silverado Fire. Extirpation from Silverado Canyon would represent a substantial range contraction. To the south, the Harbison's dun skipper has been documented in northern Baja California, Mexico. Skipper observations from Riverside County and Mexico are not represented in the published literature. There are a number of threats to the Harbison's dun skipper, including recent extirpations further reducing its distribution, habitat alteration/loss, wildfires, drought, grazing, and habitat degradation associated with the spread of the goldspotted oak borer (*Agrilus auroguttatus*).

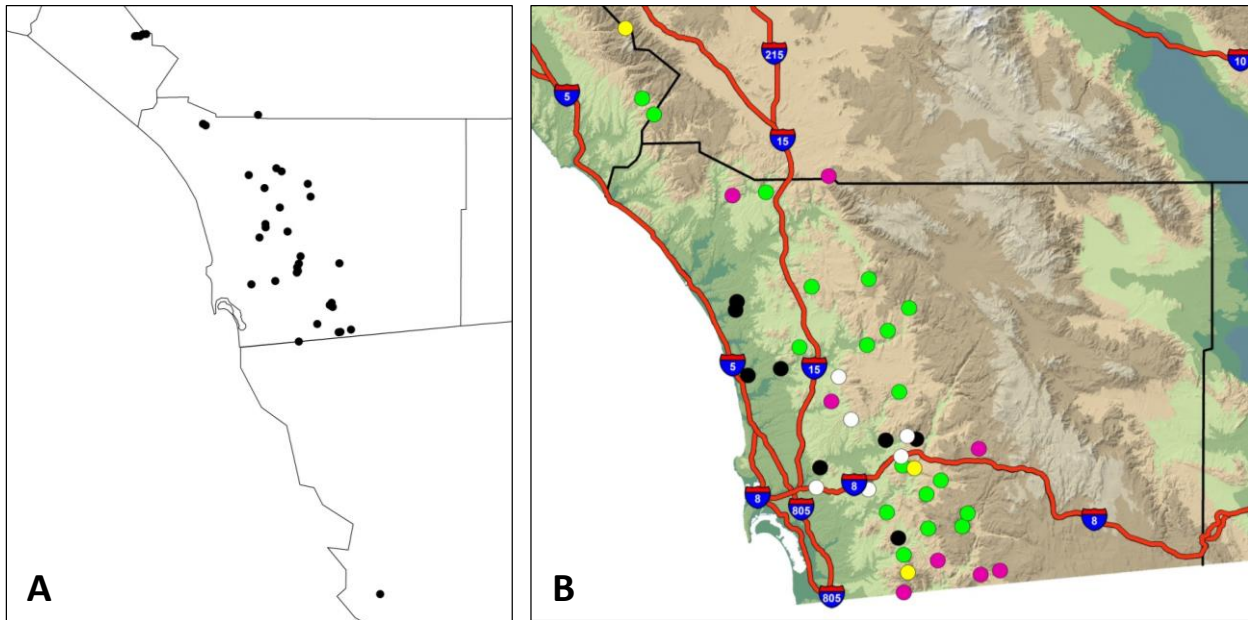


Figure 1. Harbison's dun skipper distribution in 2015. **A:** Map shows all known locations regardless of current status. **B:** Map of all known locations in the United States with current status (green = extant, yellow = probably extant but uncertainty exists, white = extirpated, purple = not surveyed). From Marschalek and Deutschman (2015a).

Additional surveys are warranted to assess annual variation in population size, quantify habitat use, further investigate threats, and collect genetic samples to describe gene-flow from which we can infer dispersal.

Methods

Adult Surveys

We conducted surveys for Harbison’s dun skipper adults at sites where we had previously detected adults. Surveys consisted of systematic searches around San Diego sedge patches conducted during periods of appropriate weather (sunny or partly sunny, 24 to 35 degrees C, and modest wind speeds). These surveys will provide an index of population size, help evaluate skipper detectability, and describe the adult flight season phenology, behavior, and nectaring sources. Non-lethal genetic samples were collected from adults in preparation for a landscape genetics project planned for the near future.

Larvae of Harbison’s dun skipper are relatively easy to find because of their distinctive hibernaculum. Unfortunately, they tend to have a more diffuse distribution and occur in terrain that is difficult to navigate (canyon bottoms with boulders, fallen trees, and abundant poison oak). Adults tend to leave the canyon bottom to search for flowers on the edge of the oak

canopy. They also tend to prefer the same small area or even a single flowering plant, facilitating the counting process.

Habitat Assessments

Habitat data was collected on woodland tree composition, condition of the San Diego sedge, surface water availability, and potential threats at all locations where we conducted surveys for adults (Table 1). The site assessments were designed to be rapid and detect large differences/changes.

Table 1. Habitat assessment variables.

Variables	Categories
Tree species	% composition of canopy, % healthy, % thin canopy, % dead, % with fire damage
San Diego sedge	Leaves green, leaves with brown tips, leaves mostly brown
Flowing or standing water	Present/absent
Threats	Grazing, dumping/trash, encampments, feral pig activity, illegal trail use, goldspotted oak borer, Kuroshio/polyphagous shot hole borer, non-native vegetation (e.g. <i>Arundo</i> , <i>Tamarix</i>)

Results

Adult Surveys

We were unable to detect Harbison’s dun skipper adults at some of the sites that were occupied in 2013-2014 (Table 2). For the 12 sites with survey data from 2014 and 2016, 5 sites had higher adult counts in 2016, 4 had higher counts in 2014, and 3 were unchanged. Surveys started on 3 May at Hollenbeck Canyon Wildlife Area and occurred weekly, if weather was appropriate. The first Harbison’s dun skipper was observed on 27 May at which time we initiated surveys at other sites. Most sites experienced peak abundances in mid-June, with some population sizes exceeding 10 individuals on a single day. Adult numbers quickly decreased and only a couple of individuals were observed during the last week of June.

Based on habitat condition and observations, it appears that the Harbison’s dun skipper has been extirpated from the San Pasqual Academy site. At this site, a wildfire has reduced the oak canopy and there are no green San Diego sedge plants remaining.

Table 2. Comparison of Harbison’s dun skipper annual adult population sizes. Date or dates of maximum counts are provided (month represented by Roman numeral).

Location	2013 Highest Count*	2014 Maximum Count & Date*	2016 Maximum Count & Date*
Barrett Lake	6-8	4: VI-6	11: VI-6
Boden Canyon Ecological Reserve	5-6	1: V-27, VI-6	1: VI-21
Blue Sky Ecological Reserve	0	0	-
Calavera Nature Preserve	0	-	-
Camp Pendleton	-	-	0
Carlsbad Highlands Ecol. Reserve	0	-	-
Crestridge Ecological Reserve	1	0	0
Daley Ranch	1	2: VI-6	4: VI-17
El Capitan (west of reservoir)	0	-	-
Hellhole Canyon County Park	4	1: VI-6,13	1: VI-10
Hollenbeck Canyon Wildlife Area	6-10	5-6: VI-11	2: VI-9
Lake Hodges	5-6	4: V-28	15-20: VI-19
Loveland Reservoir	8	4-5: V-27 or 3-6: V-29	3: VI-14
Pamo Valley (CNF)	1-2	2-3: V-28, VI-2	0
Red Mountain	1	-	0
SDNWR- Las Montanas (South)	2	1: V-29	0
San Pasqual Academy	0-1	-	0
Skye Valley Road	2	2: VI-2	15-17: VI-14
Sycamore Canyon County Park	0	0	-
Sycuan Peak Ecological Reserve	5-6	2: V-19,27	8-12: VI-16

During surveys for Harbison’s dun skipper adults, non-lethal genetic samples were obtained from as many individuals as possible. We were able to collect a single leg from 93 individuals in 2016, more than doubling our sample size from 2013 and 2014 combined (Table 3). As would be expected, the number of samples obtained is proportional to the population sizes observed. This means that we have fewer than 10 samples for most of the sites.

In 2016, we observed adults nectaring on sacapellote (*Acourtia microcephala*) and California rose (*Rosa californica*), two plant species not previously recorded (Table 4). One individual was also observed nectaring on a short-pod mustard (*Hirschfeldia incana*) flower. The use of yellow flowers is rare but has been observed (Brown and McGuire 1983, Marschalek and Deutschman 2015a). In general, it appears the Harbison’s dun skipper is a generalist feeder but has a preference for milkweeds and thistles (Table 5, Marschalek and Deutschman 2015a).

Table 3. Number of non-lethal genetic samples obtained from Harbison’s dun skipper adults, 2013-2016.

Location	2013	2014	2016	Total
Barrett Lake	4	4	18	26
Boden Canyon Ecological Reserve	3	0	1	4
Crestridge Ecological Reserve	1	0	0	1
Daley Ranch	1	1	5	7
Elfin Forest	-	-	2	2
Hellhole County Park	5	0	1	6
Hollenbeck Canyon Wildlife Area	8	2	5	15
Hot Springs (Orange County)	-	1	-	1
Lake Hodges	9	0	24	33
Loveland Reservoir	7	11	2	20
Pamo Valley	0	2	0	2
San Diego National Wildlife Refuge	2	0	0	2
Sky Valley Road	1	1	25	27
Sycuan Peak Ecological Reserve	5	4	10	19
	46	26	93	165

Table 4. Observed nectar sources for adult Harbison's dun skippers, including those from Marschalek and Deutschman (2015a).

Common Name	Scientific Name	Flower Color
*California Buckwheat	<i>Erigonum fasciculatum</i>	White
Black Sage	<i>Salvia mellifera</i>	Purple
*Narrow-leaf Milkweed	<i>Asclepias fascicularis</i>	White
Indian Milkweed	<i>Asclepias eriocarpa</i>	White
Slender Sunflower	<i>Helianthus gracilentus</i>	Yellow
*Bull Thistle	<i>Cirsium vulgare</i>	Pink
California Thistle	<i>Cirsium occidentale</i>	Pink/Purple
Italian Thistle	<i>Carduus pycnocephalus</i>	Pink
Fleabane Daisy	<i>Erigeron foliosus</i>	Purple
Coastal Bushmallow	<i>Malacothamnus fasciculatus</i>	Purple
Salt Heliotrope	<i>Heliotropium curassavicum</i>	White
*Hedge Nettle	<i>Stachys rigida</i>	Purple
*Sacapellote	<i>Acourtia microcephala</i>	Purple
*California Rose	<i>Rosa californica</i>	Pink/White
California Loosestrife	<i>Lythrum californicum</i>	Pink
Golden Yarrow	<i>Eriophyllum confertiflorum</i>	Yellow
*Short-pod Mustard	<i>Hirschfeldia incana</i>	Yellow
Black Mustard	<i>Brassica nigra</i>	Yellow
*Morning Glory	<i>Calystegia macrostegia</i>	White
*Watercress	<i>Nasturtium officinale</i>	White

*observed in 2016

Table 5. Observed nectar sources for adult Harbison's dun skippers in 2016.

Common Name	Frequency	Flower Color
California Buckwheat	2	White
Narrow-leaf Milkweed	11	White
Bull Thistle	3	Pink
Hedge Nettle	1	Purple
Sacapellote	2	Purple
California Rose	3	Pink/White
Short-pod Mustard	1	Yellow
Morning Glory	3	White
Watercress	4	White

Habitat Assessments

We assessed the habitat at 23 locations with recent Harbison’s dun skipper observations just after the flight season (27 July – 9 August 2016). Oak species dominated the woodlands, with lesser amounts of sycamore and willow trees (Table 6). The condition of the San Diego sedge plants ranged from nearly all very healthy (green) to all dead. Most of the plants had green leaves with brown tips, suggesting some water stress although this may be typical during the late summer and early fall. The most common potential threat was the presence of the goldspotted oak borer. Evidence of this beetle was observed at 8 of the 23 sites (35%) and it is close to 5 other sites (an additional 22%). At least 15 non-native plant species were detected in the riparian area. The full habitat assessment data matrix can be found in Appendix B.

Table 6. Composition of woodlands occupied by Harbison’s dun skippers.

Tree Species	% Composition
Oaks	71.6
Sycamores	13.0
Willows	12.0
Other species	3.4

One site had no trees and is excluded from this table.

Discussion

The number of Harbison’s dun skippers observed in 2016 was variable, ranging from a single individual to as many as 15 individuals detected at a site on a single day. The 2016 populations were also variable compared to 2014. Some sites increased in numbers while others experienced a decline. While the number of skippers seems to be generally associated with the condition of the habitat (more skippers in habitats with more green vegetation), our understanding of what drives habitat quality requires additional work. Annual precipitation (amount and frequency), temperatures (average and extremes), topography, tree canopy characteristics, and interactions between these variables are likely key drivers. A better understanding of habitat quality will allow for the prioritization of conservation and management actions.

By capturing and marking adults to obtain a genetic sample, we learned important information regarding population sizes. Even at the larger populations, more than four individuals were rarely observed at any single instance. However, there were a number of times when adults would continually appear in an area after each adult was captured, marked, and released. This suggests that they use a relatively larger area than what would be expected if they were strictly

territorial. It also means that the local population is larger than what can be seen at any one time. This may not be surprising but the clustered distribution of the skipper may give the appearance that all of the individuals are truly at that one location.

In addition to not fully understanding the factors that determine annual population sizes, we are just starting to understand the variability of the flight season phenology across San Diego County. This is particularly important for determining the appropriate time to conduct adult surveys.

Hollenbeck Canyon Wildlife Area was selected as a reference site to detect first emergence because the site is easy to access and the adult population size was relatively large in 2013. In addition, the Jamul area tends to experience warmer temperatures in the early part of the year which has resulted in earlier emergence of other butterflies (Hermes copper, Marschalek and Deutschman 2015b). Based on current information, at least two reference sites should be monitored due to the variability of temperatures and precipitation observed over the last four years. Hellhole Canyon and Barrett Lake are two sites that should be considered as it appears the Barrett Lake population will be more consistent in terms of size, and Hellhole Canyon's microclimate tends to be very hot.

The Harbison's dun skipper is found in woodlands that are predominately oak dominated but can include other tree species such as sycamores and willows. Non-native plants are frequently found in the riparian areas and some, like *Arundo*, are likely to represent a much more serious threat than others. The goldspotted oak borer is relatively common in the same woodlands occupied by the skipper. Observations during drought conditions suggest that the shade provided by a tree canopy is required for the San Diego sedge to survive dry conditions (Marschalek and Deutschman 2015a). This is also supported by observations at the canyon south of San Pasqual Academy following a fire. The oak trees are recovering slowly and have few small branches and leaves. In 2016, this area was very dry and all the sedge plants appear to have died (no green leaves). Canopy thinning or oak tree mortality due to the goldspotted oak borer may lead to similar degraded conditions.

It appears that frequent drought and the increasing range of the goldspotted oak borer are two serious threats to the quality of the skipper's habitat. Habitat fragmentation is already resulting in further isolation of what were relatively disjunct populations (Brown and McGuire 1983). The San Pasqual Academy site has been extirpated due to dry conditions that were not able to support the San Diego sedge. Habitats at other sites, such as at Otay Mountain and Hollenbeck Canyon Wildlife Area (1 of 3 woodlands), are becoming extremely dry and most or all of the sedge is dying or drought-stressed. The synergy between these two threats (and wildfire, which is also related) could be particularly problematic for the long-term persistence of the skipper.

Conclusions

Additional work is required to develop a better understanding of the fundamental biology and status of the Harbison's dun skipper. Describing the phenological shifts of the adult flight season among sites is important for developing monitoring protocols. Effective monitoring protocols are critical for assessing the status of populations, as this information can be used to trigger management actions as well as to evaluate the success of management. Monitoring should continue at most of the sites as we have just started to describe the year to year variation in adult population sizes. The impact on habitat from the recent drought has been variable across sites. The condition of vegetation at several skipper populations is on a trajectory that could lead to extirpations in the near future (as observed at San Pasqual). Drought is clearly a threat to this riparian woodland skipper as the larval food plant requires relatively higher soil moisture. The goldspotted oak borer is likely another threat, although we are not aware of any oak borer induced extirpations. The beetle has recently invaded several Harbison's dun skipper woodlands and the beetle's impacts should be documented.

Acknowledgements

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Appendix A: 2016 adult Harbison's dun skipper observations

Date	Site	Latitude	Longitude
27-May-16	Hollenbeck Canyon Wildlife Area	32.695287	-116.811960
2-Jun-16	Hollenbeck Canyon Wildlife Area	32.695501	-116.811116
4-Jun-16	Loveland Reservoir	32.796428	-116.760830
4-Jun-16	Loveland Reservoir	32.796428	-116.760830
6-Jun-16	Barrett Lake	32.696603	-116.703190
6-Jun-16	Barrett Lake	32.696609	-116.703199
6-Jun-16	Barrett Lake	32.696682	-116.703300
6-Jun-16	Barrett Lake	32.696683	-116.703300
6-Jun-16	Barrett Lake	32.696742	-116.703420
6-Jun-16	Barrett Lake	32.696744	-116.703572
6-Jun-16	Barrett Lake	32.696750	-116.703410
6-Jun-16	Barrett Lake	32.696817	-116.703587
6-Jun-16	Barrett Lake	32.713435	-116.702607
6-Jun-16	Barrett Lake	32.713435	-116.702606
6-Jun-16	Barrett Lake	32.713446	-116.702633
9-Jun-16	Hollenbeck Canyon Wildlife Area	32.694472	-116.793185
9-Jun-16	Hollenbeck Canyon Wildlife Area	32.694560	-116.793713
10-Jun-16	Hellhole Canyon	33.226653	-116.933728
14-Jun-16	Barrett Lake	32.696675	-116.703287
14-Jun-16	Barrett Lake	32.696734	-116.703314
14-Jun-16	Barrett Lake	32.696745	-116.703225
14-Jun-16	Barrett Lake	32.696745	-116.703225
14-Jun-16	Barrett Lake	32.712430	-116.702292
14-Jun-16	Loveland Reservoir	32.796522	-116.760851
14-Jun-16	Loveland Reservoir	32.796547	-116.760894
14-Jun-16	Loveland Reservoir	32.796559	-116.760894
14-Jun-16	Skye Valley	32.726071	-116.693838
14-Jun-16	Skye Valley	32.726084	-116.693805
14-Jun-16	Skye Valley	32.726123	-116.693588
14-Jun-16	Skye Valley	32.726123	-116.693588
14-Jun-16	Skye Valley	32.726123	-116.693588
14-Jun-16	Skye Valley	32.726815	-116.694235
14-Jun-16	Skye Valley	32.726833	-116.694310
14-Jun-16	Skye Valley	32.726838	-116.694336
14-Jun-16	Skye Valley	32.726839	-116.694274
14-Jun-16	Skye Valley	32.726840	-116.694245
14-Jun-16	Skye Valley	32.726850	-116.694292
14-Jun-16	Skye Valley	32.726855	-116.694283
14-Jun-16	Skye Valley	32.726954	-116.694340
14-Jun-16	Skye Valley	32.727136	-116.694424

Appendix A: 2016 adult Harbison's dun skipper observations

Date	Site	Latitude	Longitude
14-Jun-16	Skye Valley	32.727492	-116.694363
14-Jun-16	Skye Valley	32.728338	-116.693959
14-Jun-16	Sycuan Peak	32.765520	-116.795744
15-Jun-16	Hollenbeck Canyon Wildlife Area	32.695361	-116.812656
15-Jun-16	Hollenbeck Canyon Wildlife Area	32.703444	-116.816820
16-Jun-16	Sycuan Peak	32.765459	-116.795750
16-Jun-16	Sycuan Peak	32.765459	-116.795748
16-Jun-16	Sycuan Peak	32.765461	-116.795744
16-Jun-16	Sycuan Peak	32.765462	-116.795744
16-Jun-16	Sycuan Peak	32.765467	-116.795733
16-Jun-16	Sycuan Peak	32.765468	-116.795738
16-Jun-16	Sycuan Peak	32.765474	-116.795782
16-Jun-16	Sycuan Peak	32.765476	-116.795713
16-Jun-16	Sycuan Peak	32.765830	-116.795746
16-Jun-16	Sycuan Peak	32.765857	-116.795736
17-Jun-16	Daley Ranch	33.207429	-117.085190
17-Jun-16	Daley Ranch	33.207429	-117.085190
17-Jun-16	Daley Ranch	33.207429	-117.085190
17-Jun-16	Daley Ranch	33.207429	-117.085190
17-Jun-16	Lake Hodges	33.082515	-117.114640
17-Jun-16	Lake Hodges	33.082607	-117.114602
17-Jun-16	Lake Hodges	33.082619	-117.114589
17-Jun-16	Lake Hodges	33.082842	-117.114060
17-Jun-16	Lake Hodges	33.082916	-117.113997
19-Jun-16	Lake Hodges	33.082490	-117.114630
19-Jun-16	Lake Hodges	33.082492	-117.114601
19-Jun-16	Lake Hodges	33.082492	-117.114601
19-Jun-16	Lake Hodges	33.082496	-117.114603
19-Jun-16	Lake Hodges	33.082503	-117.114597
19-Jun-16	Lake Hodges	33.082506	-117.114533
19-Jun-16	Lake Hodges	33.082512	-117.114595
19-Jun-16	Lake Hodges	33.082517	-117.114641
19-Jun-16	Lake Hodges	33.082517	-117.114642
19-Jun-16	Lake Hodges	33.082523	-117.114674
19-Jun-16	Lake Hodges	33.082532	-117.114662
19-Jun-16	Lake Hodges	33.082834	-117.113962
19-Jun-16	Lake Hodges	33.082834	-117.113960
19-Jun-16	Lake Hodges	33.082839	-117.113966
19-Jun-16	Lake Hodges	33.082846	-117.113965
19-Jun-16	Lake Hodges	33.083171	-117.113644

Appendix A: 2016 adult Harbison's dun skipper observations

Date	Site	Latitude	Longitude
19-Jun-16	Lake Hodges	33.083194	-117.113616
19-Jun-16	Lake Hodges	33.083319	-117.113568
19-Jun-16	Lake Hodges	33.083327	-117.113562
20-Jun-16	Barrett Lake	32.696654	-116.703314
20-Jun-16	Barrett Lake	32.696742	-116.703221
20-Jun-16	Skye Valley	32.726812	-116.694207
20-Jun-16	Skye Valley	32.726814	-116.694257
20-Jun-16	Skye Valley	32.726847	-116.694253
20-Jun-16	Skye Valley	32.726931	-116.694378
21-Jun-16	Boden Canyon	33.112820	-116.896866
23-Jun-16	Daley Ranch	33.207485	-117.085229
23-Jun-16	Lake Hodges	33.082463	-117.114706
23-Jun-16	Lake Hodges	33.082463	-117.114706
23-Jun-16	Lake Hodges	33.082463	-117.114706
23-Jun-16	Lake Hodges	33.082492	-117.114668
23-Jun-16	Lake Hodges	33.082493	-117.114587
23-Jun-16	Lake Hodges	33.082507	-117.114573
23-Jun-16	Lake Hodges	33.083057	-117.114183
23-Jun-16	Sycuan Peak	32.765429	-116.795691
23-Jun-16	Sycuan Peak	32.765429	-116.795690
23-Jun-16	Sycuan Peak	32.765449	-116.795721
24-Jun-16	Barrett Lake	32.713379	-116.702545
24-Jun-16	Hollenbeck Canyon Wildlife Area	32.726874	-116.694236
24-Jun-16	Skye Valley	32.702742	-116.817515
24-Jun-16	Skye Valley	32.726781	-116.694234
24-Jun-16	Skye Valley	32.726852	-116.694285
27-Jun-16	Lake Hodges	33.082531	-117.114665
27-Jun-16	Lake Hodges	33.082531	-117.114665
27-Jun-16	Lake Hodges	33.082531	-117.114665
27-Jun-16	Lake Hodges	33.082882	-117.113890
28-Jun-16	Barrett Lake	32.713062	-116.702548
28-Jun-16	Barrett Lake	32.713062	-116.702548
28-Jun-16	Skye Valley	32.726809	-116.694194
28-Jun-16	Skye Valley	32.726816	-116.694203
28-Jun-16	Skye Valley	32.726817	-116.694226
28-Jun-16	Skye Valley	32.726828	-116.694212
28-Jun-16	Skye Valley	32.726831	-116.694249
28-Jun-16	Skye Valley	32.726848	-116.694257
28-Jun-16	Skye Valley	32.726861	-116.694229
29-Jun-16	Lake Hodges	33.082490	-117.114684

Appendix B: Habitat assessment data matrix

Site	Date	Latitude	Longitude	Oaks					Sycamores					Willows				
				% composition	% healthy	% thin canopy	% dead	% fire damage	% composition	% healthy	% thin canopy	% dead	% fire damage	% composition	% healthy	% thin canopy	% dead	% fire damage
Barrett Lake	1-Aug-16	32.713197	-116.702284	80	10	50	40	0	20	100	0	0	0	0	0	0	0	0
Barrett Lake	1-Aug-16	32.696975	-116.704016	70	20	70	10	0	20	100	0	0	5	10	95	2	2	0
Boden Canyon	8-Aug-16	33.107782	-116.894202	70	55	45	0	70	15	95	0	5	0	15	80	20	0	0
Boden Canyon	8-Aug-16	33.11428	-116.893779	99	70	30	1	25	1	100	0	0	0	0	0	0	0	0
Canada de San Vicente	8-Aug-16	32.98655	-116.863408	38	90	10	0	0	2	100	0	0	0	60	80	20	0	0
Crestridge	1-Aug-16	32.833718	-116.857530	80	75	20	5	90	15	90	10	0	20	5	100	0	0	0
Crestridge	1-Aug-16	32.828825	-116.858335	95	97	0	3	80	3	100	0	0	0	2	100	0	0	0
Daley Ranch	3-Aug-16	33.207584	-117.085058	70	50	50	0	0	20	85	10	0	5	10	95	5	0	0
Daley Ranch	3-Aug-16	33.207237	-117.081729	95	20	60	20	0	0	0	0	0	0	5	100	0	0	0
Elfin Forest	3-Aug-16	33.063878	-117.171897	20	90	10	0	0	10	100	0	0	0	40	90	10	0	0
Hollenbeck Canyon Wildlife Area	27-Jun-16	32.695256	-116.811423	80	80	20	0	10	10	80	20	0	0	10	100	0	0	0
Hollenbeck Canyon Wildlife Area	27-Jun-16	32.703180	-116.817280	90	75	20	5	80	5	99	0	1	0	5	99	0	1	0
Hollenbeck Canyon Wildlife Area	27-Jul-16	32.694483	-116.793406	80	60	38	2	90	12	50	50	0	0	8	100	0	0	0
Lake Hodges	29-Jul-16	33.082879	-117.114126	98	95	3	2	5	1.5	100	0	0	0	0.5	100	0	0	0
Las Montanas	9-Aug-16	32.729285	-116.897522	15	100	0	0	0	30	100	0	0	0	35	100	0	0	0
Loveland	5-Aug-16	32.796917	-116.761078	65	70	30	0	60	25	100	0	0	0	10	80	20	0	0
Otay Mountain	9-Aug-16	32.638843	-116.854403	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pamo Valley	8-Aug-16	33.101796	-116.857978	85	5	94	1	95	15	100	0	0	5	0	0	0	0	0
Pamo Valley	8-Aug-16	33.157767	-116.840751	55	60	40	0	80	10	80	15	5	10	15	100	0	0	0
Red Mountain	3-Aug-16	33.407583	-117.199124	40	40	55	5	50	20	95	0	5	0	40	95	0	5	0
San Pasqual Academy	8-Aug-16	33.085662	-116.946162	95	75	20	5	100	5	90	0	10	10	0	0	0	0	0
Skye Valley	1-Aug-16	32.727802	-116.694091	75	97	0	3	0	20	100	0	0	0	5	0	100	0	0
Sycoun Peak	9-Aug-16	32.766058	-116.796393	80	70	30	0	100	5	100	0	0	0	10	0	0	0	0

Site	Cottonwood					Eucalyptus					Ornamental				
	% composition	% healthy	% thin canopy	% dead	% fire damage	% composition	% healthy	% thin canopy	% dead	% fire damage	% composition	% healthy	% thin canopy	% dead	% fire damage
Barrett Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barrett Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boden Canyon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boden Canyon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada de San Vicente	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crestridge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crestridge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daley Ranch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daley Ranch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elfin Forest	0	0	0	0	0	15	0	100	0	0	15	100	0	0	0
Hollenbeck Canyon Wildlife Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hollenbeck Canyon Wildlife Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hollenbeck Canyon Wildlife Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake Hodges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Las Montanas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loveland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Otay Mountain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pamo Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pamo Valley	15	90	10	0	20	0	0	0	0	0	0	0	0	0	0
Red Mountain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Pasqual Academy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skye Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sycaun Peak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site	Royal Empress Tree					Ash				
	% composition	% healthy	% thin canopy	% dead	% fire damage	% composition	% healthy	% thin canopy	% dead	% fire damage
Barrett Lake	0	0	0	0	0	0	0	0	0	0
Barrett Lake	0	0	0	0	0	0	0	0	0	0
Boden Canyon	0	0	0	0	0	0	0	0	0	0
Boden Canyon	0	0	0	0	0	0	0	0	0	0
Canada de San Vicente	0	0	0	0	0	0	0	0	0	0
Crestridge	0	0	0	0	0	0	0	0	0	0
Crestridge	0	0	0	0	0	0	0	0	0	0
Daley Ranch	0	0	0	0	0	0	0	0	0	0
Daley Ranch	0	0	0	0	0	0	0	0	0	0
Elfin Forest	0	0	0	0	0	0	0	0	0	0
Hollenbeck Canyon Wildlife Area	0	0	0	0	0	0	0	0	0	0
Hollenbeck Canyon Wildlife Area	0	0	0	0	0	0	0	0	0	0
Hollenbeck Canyon Wildlife Area	0	0	0	0	0	0	0	0	0	0
Lake Hodges	0	0	0	0	0	0	0	0	0	0
Las Montanas	0	0	0	0	0	20	100	0	0	0
Loveland	0	0	0	0	0	0	0	0	0	0
Otay Mountain	0	0	0	0	0	0	0	0	0	0
Pamo Valley	0	0	0	0	0	0	0	0	0	0
Pamo Valley	0	0	0	0	0	0	0	0	0	0
Red Mountain	0	0	0	0	0	0	0	0	0	0
San Pasqual Academy	0	0	0	0	0	0	0	0	0	0
Skye Valley	0	0	0	0	0	0	0	0	0	0
Sycaun Peak	5	100	0	0	0	0	0	0	0	0

Site	<i>Carex spissa</i>			Water	
	% all green	% brown tips	% mostly brown	Flowing Water	Standing Water
Barrett Lake	20	80	0	N	N
Barrett Lake	93	5	2	N	N
Boden Canyon	5	95	0	N	N
Boden Canyon	20	80	0	N	Y
Canada de San Vicente	0	100	0	N	N
Crestridge	90	10	0	N	N
Crestridge	0	50	50	N	N
Daley Ranch	0	100	0	N	N
Daley Ranch	0	70	30	N	N
Elfin Forest	20	80	0	Y	N
Hollenbeck Canyon Wildlife Area	70	20	10	N	N
Hollenbeck Canyon Wildlife Area	0	10	90	N	N
Hollenbeck Canyon Wildlife Area	35	55	10	N	Y
Lake Hodges	5	88	7	N	Y
Las Montanas	0	100	0	N	N
Loveland	5	90	5	N	N
Otay Mountain	0	30	70	N	N
Pamo Valley	0	60	40	N	N
Pamo Valley	20	80	0	N	N
Red Mountain	0	60	40	N	Y
San Pasqual Academy	0	0	100	N	N
Skye Valley	20	80	0	N	Y
Sycaun Peak	0	80	20	N	Y

Site	Threats								Non-native Vegetation													
	Grazing	Dumping/ Trash	Encampments	Feral Pig Activity	Illegal Trails	GSOB	KSHB/PSHB	<i>Arundo donax</i>	Tamarisk	Pampas Grass	Smilo Grass	Thistle	Tree Tobacco	Mustard	Fennel	Palm Trees	Castor Bean	Fountaingrass	Ice Plant	Horehound	Tocolote	Umbrella Sedge
Barrett Lake	N	Y	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N
Barrett Lake	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Boden Canyon	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N
Boden Canyon	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	Y	N	N
Canada de San Vicente	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Crestridge	N	N	N	N	N	C	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N
Crestridge	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Daley Ranch	N	N	N	N	N	C	N	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	Y
Daley Ranch	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Elfin Forest	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	Y	Y	N	N	N	N	N	Y
Hollenbeck Canyon Wildlife Area	N	N	N	N	N	C	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Hollenbeck Canyon Wildlife Area	N	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N
Hollenbeck Canyon Wildlife Area	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lake Hodges	N	Y	N	N	Y	Y	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	Y
Las Montanas	N	Y	N	N	N	C	N	Y	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N
Loveland	N	Y	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N
Otay Mountain	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
Pamo Valley	N	C	N	N	N	C	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N
Pamo Valley	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N
Red Mountain	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	Y
San Pasqual Academy	N	N	N	N	Y	N	N	N	N	N	Y	N	Y	N	N	N	N	N	N	Y	Y	N
Skye Valley	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N
Sycaun Peak	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Habitat Assessment Legend

Tree Species

% Composition: Across all tree species; adds up to 100%.

% Healthy, % Thin Canopy, % Dead: Within a tree species; adds up to 100%.

% Fire Damage: Within a tree species; same tree could be included in other categories.

San Diego Sedge

Carex spissa: % of plants that have leaves that are all green, green with brown tips, or all brown; adds up to 100%.

Threats

GSOB: goldspotted oak borer

KSHB/PSHB: Kuroshio shot hole borer/polyphagous shot hole borer (*Euwallacea* sp.)

Tamarisk: *Tamarix* sp.

Pampas Grass: *Cortaderia* sp.

Smilo grass: *Stipa miliacea*

Thistle: several genera possible

Tree Tobacco: *Nicotiana glauca*

Mustard: *Brassica nigra* or *Hirschfeldia incana*

Fennel: *Foeniculum vulgare*

Palm Trees: several genera possible

Castor Bean: *Ricinus communis*

Fountaingrass: *Pennisetum setaceum*

Ice Plant: several general possible

Horehound: *Marrubium vulgare*

Tocolote: *Centaurea melitensis*

Umbrella Sedge: *Cyperus involucratus*