

Hermes Copper Butterfly Surveys and Translocation Efforts

Task 8: 2022 Harbison's Dun Skipper Adult Surveys
SANDAG Contract #: 5005783



Abigail Lyons

and

Daniel Marschalek, PhD (PI)
Department of Biological & Clinical Sciences
University of Central Missouri



29 November 2022

Table of Contents

Table of Contents.....	2
Figures.....	3
Tables.....	3
Executive Summary.....	4
Introduction.....	5
Methods.....	6
Results.....	7
Discussion.....	12
Conclusions.....	14
Acknowledgements.....	14
Literature Cited.....	15
Appendix A: 2022 adult Harbison’s dun skipper observations.....	17

Figures

Figure 1. Harbison's dun skipper distribution in 2022.	8
Figure 2. Valley Fire which occurred in September 2020.	13
Figure 3. Map of the Barrett Lake area that includes two Barrett Lake subsites.	13

Tables

Table 1. Comparison of Harbison's dun skipper annual adult population sizes.	9
Table 2. Site totals for 2022 surveys.	10
Table 3. Proportion of male and female adult skippers captured and recaptured at each site.	10
Table 4. Adult Harbison's dun skipper recaptures. The total time from the first capture to the subsequent captures is the minimum known lifespan.	11

Executive Summary

This report summarizes our butterfly survey efforts of 2022. Additional analysis of habitat and vegetation data for this project/task are planned for 2023.

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.

In 2021, surveys for Harbison's dun skipper adults were conducted to assess year to year variation in population size and update the status of each local population/site. Surveys focused on the relatively small geographic area where skippers were observed in past years. In 2013-2017, 14 sites had confirmed observations of Harbison's dun skipper adults. All but one of these sites were surveyed in 2021, with Harbison's dun skipper adults observed at only six sites. Population sizes at those six sites were similar to the smallest population sizes recorded during the 2013-2017 surveys.

Based on these surveys in 2021, a subset of sites was selected to perform a mark-recapture study and more accurately estimate population sites. Selected sites included Barrett Lake, Skye Valley, Hollenbeck Canyon Wildlife Area, and Beaver Hollow (San Diego National Wildlife Refuge). Not surprisingly, the number of marked individuals demonstrated larger populations compared to the daily maximum count, but the number of adults were still low. Only a limited number of individuals were recaptured, limiting our ability to accurately estimate population sizes. Additionally, habitat sampling was conducted at several sites during the 2022 flight season. These data, as well as GIS derived data, will be analyzed in 2023.

Overall, transect counts (visual observations) continue to describe small populations when skippers are present. However, the large size and uneven terrain of some riparian oak woodlands, patchy distribution of adult skippers, and shifting locations of San Diego sedge present challenges to accurately categorizing presence/absence and relative population sizes.

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 et al. 2019), with one record from Mexico (Marschalek et al. 2019). 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 described 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 known distribution of the skipper at that time included 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.

Further information about the skipper was obtained by conducting surveys as part of a project funded by a CDFW Local Assistance Grant (Marschalek and Deutschman 2015) and a previous SANDAG contract (Marschalek and Deutschman 2016, 2017a,b). Based on these surveys for larvae and adults in 2013-2017, 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 (Marschalek et al. 2019). In San Diego County, there appears to be a substantial gap near Poway 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 based on historic localities. To the south, the Harbison's dun skipper has been documented in northern Baja California, Mexico. There are a number of threats to the Harbison's dun skipper, including recent extirpations further reducing its distribution, habitat alteration/loss, wildfires, drought, climate change, grazing, and habitat degradation associated with the spread of the goldspotted oak borer (*Agrilus auroguttatus*).

Following surveys in 2021, the status of local populations in San Diego County was updated. Although the previous year (2020-2021 winter) had been relatively dry, there were a couple winters (2018-2019, 2019-2020) that experienced greater precipitation compared to the

extreme drought in 2015-2017 (Williams et al. 2020). The increased precipitation could have provided the opportunity for the skipper to increase population sizes and expand to new areas since the 2017 surveys. Adult Harbison's dun skippers were detected at 6 of 12 sites with weekly surveys, and Recon Environmental, Inc. provided additional observations from three areas on the north side of Otay Mountain. Substantial changes to the specific locations of the sedge at some sites was unexpected and provided challenges with locating skippers, and recent fires likely caused extirpations at other sites.

The objective of surveys in 2022 was to further update the status of populations in San Diego County, as well as utilize a mark-recapture study to more accurately estimate population sizes. Vegetation sampling was also conducted at a number of sites to quantify habitat preferences, and several GIS environmental data layers will be utilized to compare areas of the habitat utilized by adult skippers. This report summarizes data associated with adult skipper surveys, while habitat and vegetation data analysis will be completed in 2023.

Methods

We conducted surveys for Harbison's dun skipper adults at sites where we had previously detected adults (Marschalek et al. 2019). Visual surveys consisted of systematic searches around San Diego sedge patches conducted during periods of appropriate weather (sunny or partly sunny, 24° to 35°C, and modest wind speeds). If skippers were not detected in the immediate area of past observations, a wider area was searched. These surveys provide an index of population size and describe the adult flight season phenology, behavior, and nectar sources.

Based on the results of the 2021 surveys, Barrett Lake, Skye Valley Road, Hollenbeck Canyon Wildlife Area, and Beaver Hollow (San Diego National Wildlife Refuge) were selected as the subset sites for the mark recapture survey. After an initial visual assessment and count of adult skippers, any visible adult skippers were captured and uniquely marked with a felt tip marker, and subsequently released. The proportion of recaptured individuals allowed for the calculation of population estimates following the Jolly-Seber Method. The low sample size (both number of individuals marked and resighted) precluded the use of Program MARK and associated analyses.

Assessment of the Harbison's dun skipper habitat occurred during the 2022 flight season, with data obtained through field measurements and GIS environmental data. Analysis will occur in 2023.

Results

We were able to detect Harbison's dun skipper adults at 7 of 10 sites with weekly surveys (Figure 1, Table 1). Skippers were not detected at Pamo Valley and the habitat appeared very dry, although *Carex spissa* was detected. A single survey at Elfin Survey and Sycuan Peak did not detect skippers, although small amounts of *Carex spissa* were detected at both sites. A large patch of *Carex spissa* that was observed at Sycuan Peak in 2017 was not present in 2021 and 2022 (just a few small sedge plants). Skippers were detected at Skye Valley Road in 2022, which burned in the Valley Fire during September 2020 and had no observations during 2021 surveys, demonstrating a recolonization. The maximum count for sites not included in a marking study was two individuals.

Initial visual surveys conducted immediately prior to capturing/marketing activities indicated similar numbers of adults as in 2021, with Barrett Lake having the highest maximum visual observation of five skipper (Table 1). Capturing and marking adult skippers provides a minimum population size, with Barrett Lake again having the highest number of individuals captured (Table 2).

A total of 63 adults were marked across the six sites, with 32 marked at Barrett Lake. A total of nine skippers were recaptured, with recaptures only occurring at Barrett Lake and Beaver Hollow. The Jolly-Seber population size estimate for Barrett Lake was 36, and 10 at Beaver Hollow. Due to the low recapture rates, estimates were only possible for these two sites. Adult male skippers were caught and recaptured in a higher proportion to females across all sites (Table 3). Of the nine recaptures, six were recaptured once, and three were recaptured for a third time. The average known minimum lifespan (day first captured to day last seen) for recaptured adult skippers was 7.3 days (Table 4).

Vegetation sampling was completed; however, analysis still needs to be performed. Anecdotally, there appeared to be fewer substantial changes to the specific sedge locations from 2021 to 2022 than there were observed from 2017 to 2021. Both the Skye Valley Road and northern Barrett Lake sites, which burned during the Valley Fire in 2020, showed more vegetation growth in 2022 compared to 2021. Very few adult Harbison's dun skippers were observed nectaring, but those that were observed were on California buckwheat (*Eriogonum fasciculatum*).

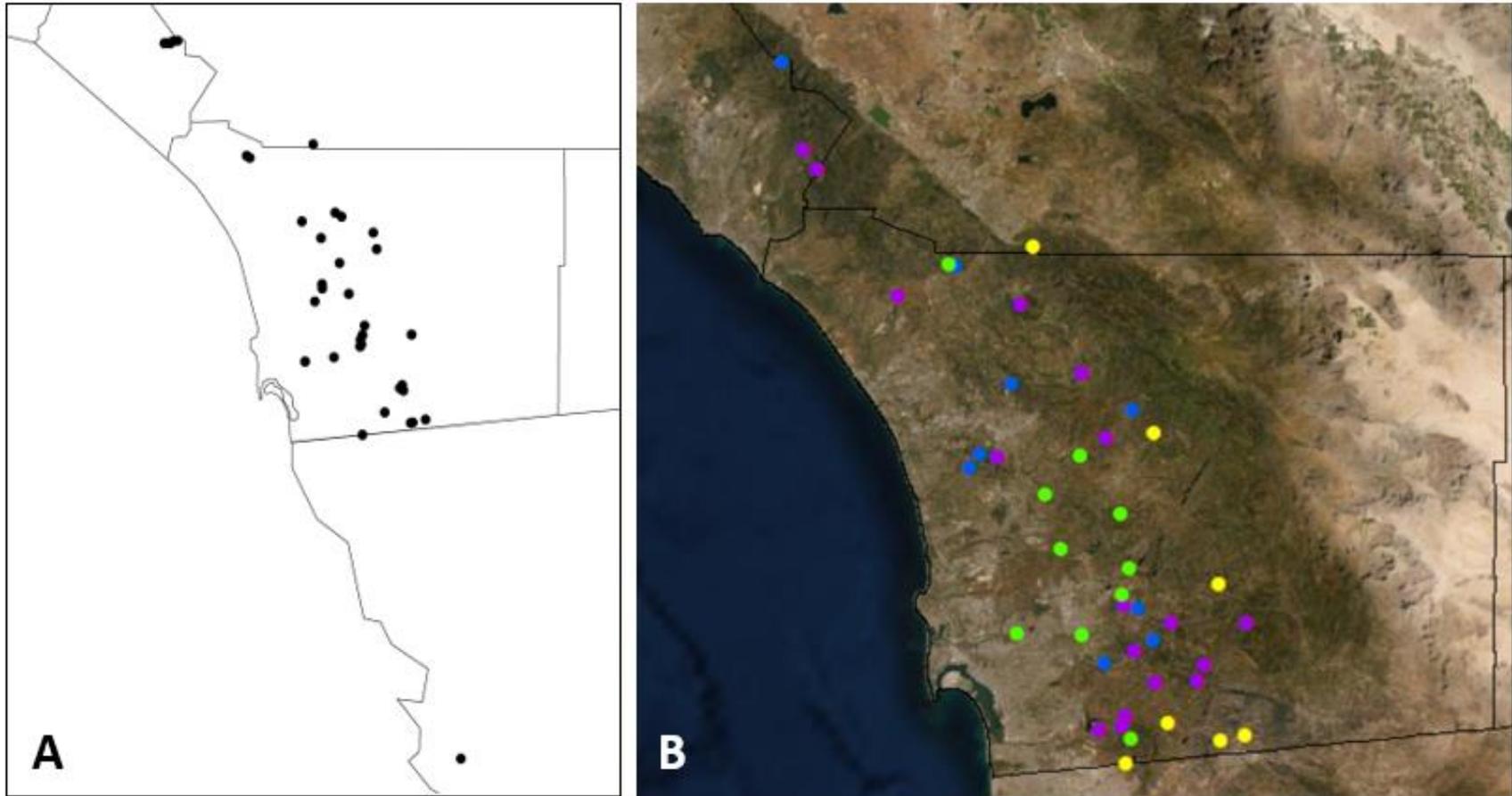


Figure 1. Harbison's dun skipper distribution in 2022. A: Map shows all known locations regardless of current status. B: Map of all known locations in the United States with the most recent status (purple = extant, blue = probably extant but uncertainty exists, green = extirpated, yellow = not surveyed).

Table 1. Comparison of Harbison’s dun skipper annual adult population sizes. Counts in bold represent maximum daily count for weekly surveys while counts not bolded are the highest count among two to three surveys during the flight season (one survey at SDNWR-Las Montanas (South) in 2013, one survey at San Pasqual Academy in 2021, one survey at Elfin Forest and Sycuan Peak Ecological Reserve in 2022).

Location	2013	2014	2016	2017	2021	2022
Barrett Lake	6-8	4	11	1	3	5
Boden Canyon Ecological Reserve	5-6	1	1	1	0	-
Blue Sky Ecological Reserve	0	0	-	-	-	-
Calavera Nature Preserve	0	-	-	-	-	-
Camp Pendleton	-	-	0 (1 pupa)	-	-	-
Carlsbad Highlands Ecol. Reserve	0	-	-	-	-	-
Crestridge Ecological Reserve	1	0	0	0	2	3
Daley Ranch	1	2	4	-	0	-
El Capitan (west of reservoir)	0	-	-	-	-	-
Elfin Forest	-	-	1	-	0	0
Hellhole Canyon County Park	4	1	1	0	2	2
Hollenbeck Canyon Wildlife Area	6-10	5-6	2	3-4	2	2
Lake Hodges	5-6	4	15-20	-	4	2
Loveland Reservoir	8	4-5 or 3-6	3	2	-	-
Pamo Valley (CNF)	1-2	2-3	0	2	2	0
Red Mountain	1	-	0	-	0	-
SDNWR- Beaver Hollow	-	-	-	-	-	2
SDNWR- Las Montanas (South)	2	1	0	-	0	-
San Pasqual Academy	0-1	-	0	-	0	-
Skye Valley Road	2	2	15-17	1	0	1
Sycamore Canyon County Park	0	0	-	-	-	-
Sycuan Peak Ecological Reserve	5-6	2	8-12	-	0	0

Table 2. Site totals for 2022 surveys. The Pollard Index represents the total number of adult skippers observed at the site; maximum count is the minimum population at the site (highest daily count); Jolly-Seber estimates were only calculated for those sites with recaptures.

Metric	Barrett Lake	HCWA	Beaver Hollow	Skye Valley	Crestridge	Lake Hodges	Hellhole Canyon
Peak Abundance	1-Jun-22	6-Jun-22	10-Jun-22	6-Jun-22	3-Jun-22	7-Jun-22	18-Jun-22
Pollard Index	44	10	15	6	13	6	2
Max Count	8	3	4	2	5	3	2
Total Marked	32	8	10	4	7	2	-
Jolly-Seber Estimate	36	-	10	-	-	-	-
Recapture Rate	0.22	0	0.2	0	0	0	-

Table 3. Proportion of male and female adult skippers captured and recaptured at each site.

Site	Males	Females	Total	Males Recaptured	Females Recaptured	Total Recaptured	Male Recapture Rate	Female Recapture Rate	Total Recapture Rate
Barrett Lake	26	6	32	6	1	7	0.23	0.17	0.22
Beaver Hollow	9	1	10	2	0	2	0.22	0	0.20
HCWA	6	2	8	-	-	-	-	-	-
Skye Valley	4	0	4	-	-	-	-	-	-
Crestridge	6	1	7	-	-	-	-	-	-
Lake Hodges	2	0	2	-	-	-	-	-	-
Total	53	10	63	-	-	-	-	-	-

Table 4. Adult Harbison’s dun skipper recaptures. The total time from the first capture to the subsequent captures is the minimum known lifespan.

Skipper ID	First Capture	Second Capture	Third Capture	lifespan (min)
3	31-May-22	3-Jun-22	-	4
10	1-Jun-22	10-Jun-22	-	10
16	3-Jun-22	9-Jun-22	-	7
18	3-Jun-22	10-Jun-22	-	7
26	6-Jun-22	10-Jun-22	-	5
35	8-Jun-22	15-Jun-22	17-Jun-22	10
42	9-Jun-22	10-Jun-22	-	2
43	10-Jun-22	17-Jun-22	20-Jun-22	11
48	13-Jun-22	20-Jun-22	22-Jun-22	10
			Average	7.33

Discussion

Historically, local population sizes of the Harbison's dun skipper have been small (Brown and McGuire 1983, Marschalek et al. 2019). We found that the populations were smaller in 2021 and continued to stay small in 2022 based on visual counts. A marking study yielded a higher minimum population size based on the number of captured individuals on a daily and annual basis. Although the number of marked individuals were small, the Jolly-Seber population estimates indicate that more skippers are present than were observed during surveys. We continue to see minor changes to the distribution of San Diego Sedge within riparian oak woodlands, as well as minor changes to the upland habitat. Because some of these riparian oak woodlands are quite large/long, we were unable to search the entire area to determine if adult skippers were congregating in a location different than in 2017. Relatively small changes in the habitat were observed in 2017 (Marschalek and Deutschman 2017b) but was more related to upland vegetation rather than the precise location of the sedge. Due to these changes within and adjacent to riparian oak woodlands the full woodland and adjacent uplands should represent a single management unit.

An observation that is promising for the long-term persistence of the skipper is that adults were found in an area that burned one to two years prior to the sightings. The northern subsite at Barrett Lake and the Skye Valley Road site were occupied in the past (Marschalek and Deutschman 2016) and burned in September 2020 (Figure 2). The northern Barrett Lake site was occupied in 2021 and has apparent connectivity with a drainage to the south that did not burn and is occupied (Figure 3). No skippers were observed at Skye Valley Road in 2021, but a small population was found in 2022.



Figure 2. Valley Fire which occurred in September 2020. A) Southern portion of the Valley Fire near Barrett Lake, B) Barrett Lake northern subsite in June 2021 looking north, C) Barrett Lake northern subsite in June 2022 looking North.



Figure 3. Map of the Barrett Lake area that includes two Barrett Lake subsites. The northern subsite burned in September 2020 and Harbison’s dun skippers were present in June 2021. The southern subsite did not burn.

Conclusions

We continue to see small, isolated populations of Harbison's dun skipper at historic locations in San Diego County. While the marking study did yield higher numbers of adults than visual surveys, the small numbers continued to create issues for making accurate population estimates. Many of the recaptured skippers were observed in close proximity to the original capture location and there was no movement observed among sites.

Most of our work has focused on surveying specific locations where skippers were observed in the past, so these findings do not necessarily represent the entire woodland (habitat patch). These woodlands can range from about 100 meters to several kilometers in length. While time consuming, it would be informative to completely and thoroughly survey entire riparian oak woodlands and the upland habitat to determine all areas used by the adult skippers. The dynamic nature and composition (poison oak and uneven terrain) of the riparian woodlands results in needing more effort to detect adult Harbison's dun skippers compared to other San Diego butterflies. For example, Hermes copper (*Lycaena hermes*) and Quino checkerspot (*Euphydryas editha quino*) are relatively consistently found on the same roads/trails or hilltops, respectively.

Like other butterflies in southern California, population sizes of the Harbison's dun skipper are declining. Studies across the western United States (Forister et al. 2021) and much of North America (Crossley et al. 2021) have found that most butterflies, including both specialist species and relatively common species, have declined over the last several decades. Both studies contributed these trends to increased temperatures and decreased precipitation, resulting in about a 1.6% annual decline (Forister et al. 2021). The western United States has experienced a megadrought over the last two decades, being the second driest 19-year period since 800 CE (Williams et al. 2020). These geographically widespread conditions extending over several decades pose substantial challenges for conservation. For a species that only feeds on a plant that requires more soil moisture than most other plant species, the predicted dry conditions through the end of the century (Global Climate Change Impacts in the United States 2009) will continue to threaten the long-term viability of the Harbison's dun skipper.

Acknowledgements

We would like to thank many people for assistance with this project, including sharing their knowledge of the Harbison's dun skipper, San Diego sedge, permits, and access to reserves. These include, but are not limited to (alphabetically): Bill Bretz, California Department of Fish & Wildlife, City of Chula Vista, City of San Diego, Cleveland National Forest, County of San Diego, Endangered Habitats League, Recon Environmental Inc., Sweetwater Authority, and Escondido

Creek Conservancy, United States Fish and Wildlife Service. Also, much appreciation to David Faulkner and Haakon Hoyer-Neilson for assistance conducting butterfly surveys.

Literature Cited

- Brown, J.W. 1982. Only where the *Carex* grows. *Environment Southwest*. 498:22.
- Brown, J.W. 1991. Sensitive and declining butterfly species (Insecta: Lepidoptera) in San Diego County, California. Draft report prepared for Dudek and Associates. 27 pp.
- Brown, J.W. and W.W. McGuire. 1983. A new subspecies of *Euphyes vestris* (Boisduval) from southern California (Lepidoptera: HesperIIDae). *Transactions of the San Diego Society of Natural History*. 20:57-68.
- Crossley, M.S, O.M. Smith, L.L. Berry, R. Philips-Cosio, J. Glassberg, K.M. Holman, J.G. Holmquest, A.R. Meier, S.A. Varriano, M.R. McClung, M.D. Moran and W.E. Snyder. 2021. Recent climate change is creating hotspots of butterfly increase and decline across North America. *Global Change Biology*. 27:2702-2714.
- Glassberg, J. 2001. *Butterflies Through Binoculars: The West*. Oxford University Press, New York. 374 pages.
- Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. Accessed from: <https://nca2009.globalchange.gov/projected-change-north-american-precipitation-2080-2099/index.html>
- Forister M.L., C.A. Halsch, C.C. Nice, J.A. Fordyce, T.E. Dilts, J.C. Oliver, K.L. Prudic, A.M. Shapiro, J.K. Wilson and J. Glassberg. 2021. Fewer butterflies seen by community scientists across the warming and drying landscapes of the American West. *Science*. 371:1042-1045.
- Marschalek, D.A. and D.H. Deutschman. 2015. Initial investigation of critical biological uncertainties for Harbison's dun skipper (*Euphyes vestris harbisoni*) on conserved lands in San Diego County. California Department of Fish & Wildlife Final Report. 23 pp. + app.
- Marschalek, D.A. and D.H. Deutschman. 2016. Rare butterfly management and conservation planning: Harbison's dun skipper flight season surveys. Final Report for San Diego Association of Governments. 23 pp.
- Marschalek, D.A. and D.H. Deutschman. 2017a. Rare butterfly management and conservation planning: Harbison's dun skipper host plant, larval, and hibernaculum surveys. Final Report for San Diego Association of Governments. 14 pp.
- Marschalek, D.A. and D.H. Deutschman. 2017b. Rare butterfly monitoring and translocation: 2017 Harbison's dun skipper flight season surveys. Final Report for San Diego Association of Governments. 11 pp.

- Marschalek, D.A., D.K. Faulkner and D.H. Deutschman. 2019. Ecology of the threatened Harbison's dun skipper (*Euphyes vestris harbisoni*) for conservation efforts within a habitat conservation plan. *Journal of Insect Conservation*. 23:331-339.
- United States Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants; Animal notice review. *Federal Register* 50 CFR 17. 54:554-579.
- Williams, A.P, E.R. Cook, J.E. Smerdon, B.I. Cook, J.T. Abatzoglou, K. Bolles, S.H. Baek, A.M. Badger and B. Livneh. 2020. Large contribution from anthropogenic warming to an emerging North American megadrought. *Science*. 368:314-318.

Appendix A: 2022 adult Harbison's dun skipper observations

Date	Site	Latitude	Longitude
1-Jun-22	Beaver Hollow	32.750104	-116.836725
1-Jun-22	Barrett Lake (N)	32.712724	-116.702341
1-Jun-22	Barrett Lake (N)	32.712688	-116.702299
1-Jun-22	Barrett Lake (N)	32.712633	-116.702287
1-Jun-22	Barrett Lake (N)	32.712635	-116.702281
1-Jun-22	Barrett Lake (N)	32.712733	-116.702335
1-Jun-22	Barrett Lake (N)	32.713137	-116.702548
2-Jun-22	Crestridge	32.826282	-116.860501
2-Jun-22	Crestridge	32.826411	-116.860461
3-Jun-22	Barrett Lake (N)	32.713043	-116.70257
3-Jun-22	Barrett Lake (N)	32.71313	-116.702553
3-Jun-22	Barrett Lake (N)	32.713162	-116.702542
3-Jun-22	Barrett Lake (N)	32.712955	-116.702591
3-Jun-22	Barrett Lake (N)	32.712665	-116.702303
3-Jun-22	Beaver Hollow	32.750091	-116.836708
3-Jun-22	Beaver Hollow	32.750106	-116.836731
3-Jun-22	Crestridge	32.826307	-116.860517
3-Jun-22	Crestridge	32.826277	-116.860507
3-Jun-22	Crestridge	32.826478	-116.86038
6-Jun-22	Barrett Lake (N)	32.712722	-116.702329
6-Jun-22	Barrett Lake (N)	32.712729	-116.702324
6-Jun-22	Barrett Lake (N)	32.712893	-116.702545
6-Jun-22	Barrett Lake (N)	32.713008	-116.70259
6-Jun-22	Barrett Lake (N)	32.71313	-116.702556
6-Jun-22	Skye Valley	32.726581	-116.693959
6-Jun-22	Skye Valley	32.726476	-116.693738
6-Jun-22	HCWA1	32.694537	-116.793576
6-Jun-22	HCWA1	32.694518	-116.793587
7-Jun-22	Lake Hodges	33.082924	-117.113773
7-Jun-22	Lake Hodges	33.082851	-117.113985
8-Jun-22	HCWA1	32.694575	-116.793781
8-Jun-22	HCWA1	32.694585	-116.793779
8-Jun-22	Beaver Hollow	32.750094	-116.836725
8-Jun-22	Beaver Hollow	32.750133	-116.836189
8-Jun-22	Beaver Hollow	32.750102	-116.83673
8-Jun-22	Skye Valley	32.726573	-116.69397
8-Jun-22	Barrett Lake (N)	32.712734	-116.702319
8-Jun-22	Barrett Lake (N)	32.713118	-116.702554
9-Jun-22	Barrett Lake (N)	32.713131	-116.702551
9-Jun-22	Barrett Lake (N)	32.712978	-116.702587
9-Jun-22	Barrett Lake (N)	32.713166	-116.702585

Date	Site	Latitude	Longitude
10-Jun-22	Barrett Lake (N)	32.712657	-116.702275
10-Jun-22	Barrett Lake (N)	32.713116	-116.702562
10-Jun-22	Barrett Lake (N)	32.712812	-116.702469
10-Jun-22	Barrett Lake (N)	32.712977	-116.702586
10-Jun-22	Skye Valley	32.726533	-116.693869
10-Jun-22	Beaver Hollow	32.750723	-116.839059
10-Jun-22	Beaver Hollow	32.750711	-116.839048
10-Jun-22	Beaver Hollow	32.750796	-116.838994
13-Jun-22	Barrett Lake (N)	32.713027	-116.702633
13-Jun-22	Barrett Lake (N)	32.713127	-116.702544
13-Jun-22	Skye Valley	32.726601	-116.693984
13-Jun-22	HCWA1	32.694532	-116.793731
14-Jun-22	Lake Hodges	33.082912	-117.113926
15-Jun-22	HCWA1	32.694467	-116.793692
15-Jun-22	Beaver Hollow	32.7501	-116.836719
15-Jun-22	Beaver Hollow	32.750153	-116.83623
15-Jun-22	Barrett Lake (N)	32.712711	-116.702319
15-Jun-22	Barrett Lake (S)	32.696815	-116.703658
16-Jun-22	Crestridge	32.828545	-116.859016
16-Jun-22	Crestridge	32.826371	-116.860503
17-Jun-22	Barrett Lake (N)	32.713154	-116.702568
17-Jun-22	Barrett Lake (N)	32.712991	-116.702493
17-Jun-22	HCWA1	32.694569	-116.793715
17-Jun-22	Beaver Hollow	32.750118	-116.836715
18-Jun-22	Hellhole Canyon	33.221474	-116.933144
18-Jun-22	Hellhole Canyon	33.221241	-116.932936
20-Jun-22	Barrett Lake (N)	32.713116	-116.702561
20-Jun-22	Barrett Lake (N)	32.712992	-116.7026
20-Jun-22	Barrett Lake (N)	32.712959	-116.702598
22-Jun-22	Barrett Lake (N)	32.713135	-116.702568
22-Jun-22	Barrett Lake (N)	32.713077	-116.702571
22-Jun-22	HCWA1	32.694535	-116.79369
24-Jun-22	Barrett Lake (N)	32.713133	-116.702355
24-Jun-22	Beaver Hollow	32.750667	-116.839028
26-May-22	Barrett Lake (N)	32.7129	-116.70255
26-May-22	Barrett Lake (N)	32.712932	-116.702555
26-May-22	Barrett Lake (N)	32.713122	-116.702564
26-May-22	Barrett Lake (N)	32.713147	-116.702549
26-May-22	HCWA1	32.694558	-116.793716
27-May-22	Barrett Lake (N)	32.713159	-116.702505
27-May-22	Barrett Lake (N)	32.712867	-116.702476
30-May-22	Crestridge	32.826279	-116.860512

Date	Site	Latitude	Longitude
30-May-22	Crestridge	32.826287	-116.860529
30-May-22	Crestridge	32.826287	-116.860511
30-May-22	Lake Hodges	33.083059	-117.11376
30-May-22	Lake Hodges	33.083057	-117.11374
31-May-22	Barrett Lake (N)	32.713143	-116.702559
31-May-22	Barrett Lake (N)	32.712925	-116.702588
31-May-22	Barrett Lake (N)	32.712703	-116.702343