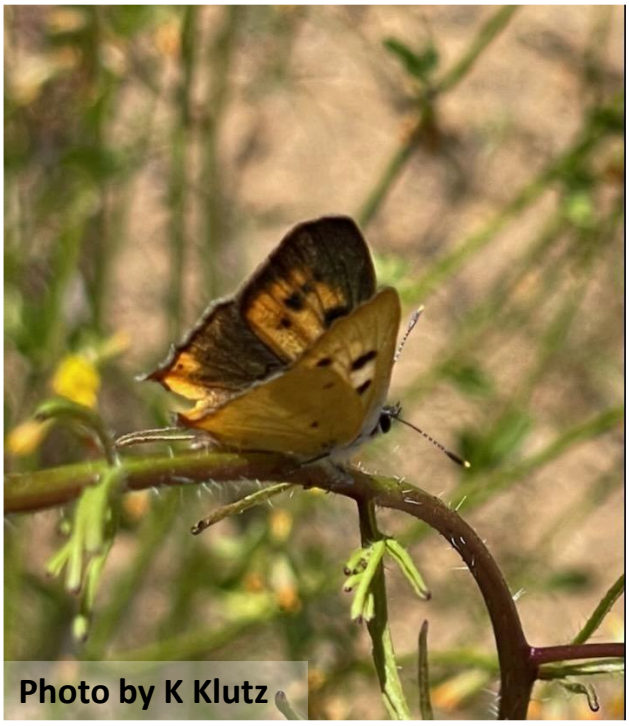
Hermes Copper Butterfly Surveys and Translocation Efforts

Task 7: Hermes Copper Translocations
Task 9: 2022 Hermes Copper Adult Surveys
SANDAG Contract #: 5005783



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Executive Summary

The Hermes copper (*Lycaena hermes*) is a rare butterfly endemic to San Diego County and northern Baja California. This species is threatened by urbanization, wildfires, and drought throughout its range in the United States. Since most individuals and the single (known) remaining large population are found in the southern portion of San Diego County, one large fire could extirpate the species in this country.

Past efforts have contributed to our understanding of the distribution of the Hermes copper, so it is fairly well understood. This includes wildfires in 2003 and 2007 causing several extirpations with few recolonizations, and more recent droughts further restricting the distribution of this butterfly. We conducted widespread surveys in 2018 with the goal of detecting unknown populations; however, conditions were suboptimal due to below average rainfall. Efforts in 2019 and 2020 followed winters with closer to average precipitation. In 2018, one large population (Roberts Ranch South) was discovered to be larger than previously documented. No new populations were documented and there was no evidence of recolonization within the 2003 or 2007 wildfire at selected sites. The objective of this project (2022 surveys) was to further assess the distribution and annual population sizes, possibly with the goal of future translocations of individuals to reestablish populations. We conducted surveys in many of the areas sampled during 2019-2021.

The 2022 status of the Hermes copper populations is similar to the last couple years, with the addition of observations at the San Diego Gas and Electric Substation near Bell Bluff Truck Trail. However, the number of butterflies were lower than past counts at this site and at Roberts Ranch South. Sites with fewer than five individuals have been relatively steady over the last few years. Given these patterns, the long-term viability of the species still appears to be highly dependent on the Robert Ranch South population.

Introduction

The Hermes copper (*Lycaena hermes*) is a rare butterfly endemic to San Diego County and northern Baja California. In April of 2011, the United States Fish and Wildlife Service (USFWS) issued a 12-month finding which concluded that listing the Hermes copper butterfly as threatened or endangered was warranted due to threats of urbanization and wildfires (USFWS 2011). For these reasons, it is currently on the USFWS list of candidate species (USFWS 2011).

Over the years, there have been several efforts to describe the Hermes copper distribution (Figure 1) over large geographic areas (more than one or a few sites/preserves). This started with Thorne (1963) publishing the first distributional map. More recently, since 2002, Marschalek and Deutschman at San Diego State University and now the University of Central Missouri have maintained a research program focusing on this species (e.g. Marschalek and Deutschman 2008, Marschalek and Klein 2010).

Wide-ranging surveys were conducted in 2010 throughout many areas in Cleveland National Forest in preparation for the SDG&E Sunrise Powerlink Project (Chambers Group, Inc. 2011). Considering Chambers Group, Inc. (2011) were able to document several previously unknown large local populations by surveying transects with their locations determined based on infrastructure rather than habitat, there may be other areas occupied by Hermes copper. To investigate further, 2018 surveys were conducted to search for these populations in areas not previously searched. Marschalek and Deutschman (2018b) conducted surveys at 35 transects across a large area of the Hermes copper range. Hermes copper adults were detected at only three of these transects, and only one transect had more than 10 adults.

Surveys in 2019-2021 have included areas with redberry and no historic Hermes copper observations as well as sites with historic observations to monitor the status of the species (Marschalek and Deutschman 2019, Marschalek 2020, 2021). Counts at sentinel sites have declined; however, 95 Hermes copper adults were observed at Roberts Ranch South on a single day and two adults were observed in the Potrero area. The known distribution has not changed drastically over this time.

Initially (2003-2007), wildfires greatly influenced the distribution of Hermes copper, as Wildwood Glen Lane and Boulder Creek are the only documented recolonizations following the large wildfires of 2003 and 2007 (Figure 1). Determination of recolonization was based on multiple adults observed over the period of at least two weeks, including female butterflies. More recently, a several year drought appears to have further reduced the distribution of Hermes copper (Marschalek and Deutschman 2018a, 2018b, 2019). The mortality resulting from wildfires and drought, lack of recolonizations following fire or drought, and evidence of restricted dispersal (Marschalek et al. 2016) places the Hermes copper at increased risk of

extinction. Assisted dispersal achieved by translocation of individuals has the potential to mitigate wildfire impacts. The risk of extinction will decrease as the number and spatial extent of populations increase. The long-term viability of this species is dependent on expanding its range, whether natural or assisted, and more urgent that previously known.

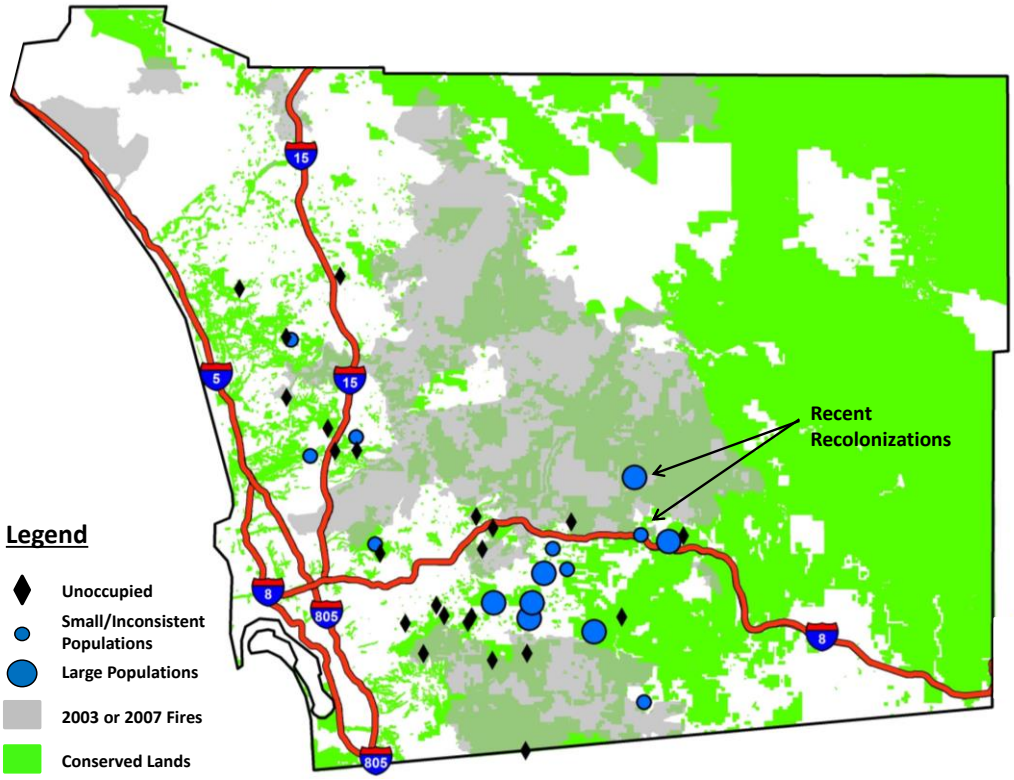

Figure 1. Detections of Hermes copper butterflies on conserved lands, 2010-2013. Sampling locations where Hermes copper was not detected are represented by black diamonds. Small and large Hermes copper populations are indicated by different sized circles.

Recent efforts to translocate Hermes copper from larger populations (San Diego National Wildlife Refuge-McGinty Mountain, a property on Skyline Truck Trail, and Sycuan Peak Ecological Reserve) to an area of suitable habitat at Hollenbeck Canyon Wildlife Area had promising results (Marschalek and Deutschman 2016). In 2014, 11 adults (6 males and 5 females) were translocated to an unoccupied, but suitable patch of habitat. In 2015, of the 14 translocated eggs, 3 were missing from the original clipping and lost prior to the first survey date, 9 eggs exhibited signs consistent with larval eclosion, and 2 eggs remained intact. During the 2015 and 2016 Hermes copper flight season, only one male was detected during surveys at the adult release site and no Hermes copper adults were observed at the egg release site. Continued translocation efforts were attempted but population sizes were too small to capture and move individuals (Marschalek and Deutschman 2016, 2018a, 2019). A recent discovery of a

relatively large population near Potrero may be robust enough to support the removal and translocation of eggs although clearing of vegetation may have severely reduced the population size.

The goal of this project was to further assess the distribution and annual population sizes of Hermes copper, possibly with the goal of future translocations of individuals to reestablish populations. In 2022, we conducted surveys in many areas that were sampled during 2021.

Methods

Sentinel Sites

In 2022, we conducted surveys for Hermes copper adults at five sites we previously designated as sentinel sites (Boulder Creek, Lawson Peak, Roberts Ranch North, Roberts Ranch South, and Sycuan Peak Ecological Reserve) (Figure 2). The sentinel sites are relatively widely spaced across the landscape. This captures a range of climatic conditions throughout much of the Hermes copper range and decreases the likelihood of a single wildfire extirpating all five populations.

Our goal was to record the maximum number of Hermes copper adults present on a single day at each site (***maximum count***). All surveys were conducted during periods of appropriate weather (sunny or partly sunny, 20 to 35 degrees C, and modest wind speeds) unless stated otherwise. The location of each Hermes copper observation was recorded with a handheld GPS unit. Initial surveys occurred on 25 May at Roberts Ranch North and Wildwood Glen Lane to assess the flowering phenology of plants and butterfly community. Roberts Ranch South was surveyed shortly after (31 May) because the 2019 – 2021 survey efforts have shown this area to regularly produce the first adults of the season and this site was expected to have Hermes copper adults present due to the relative size of the local population.

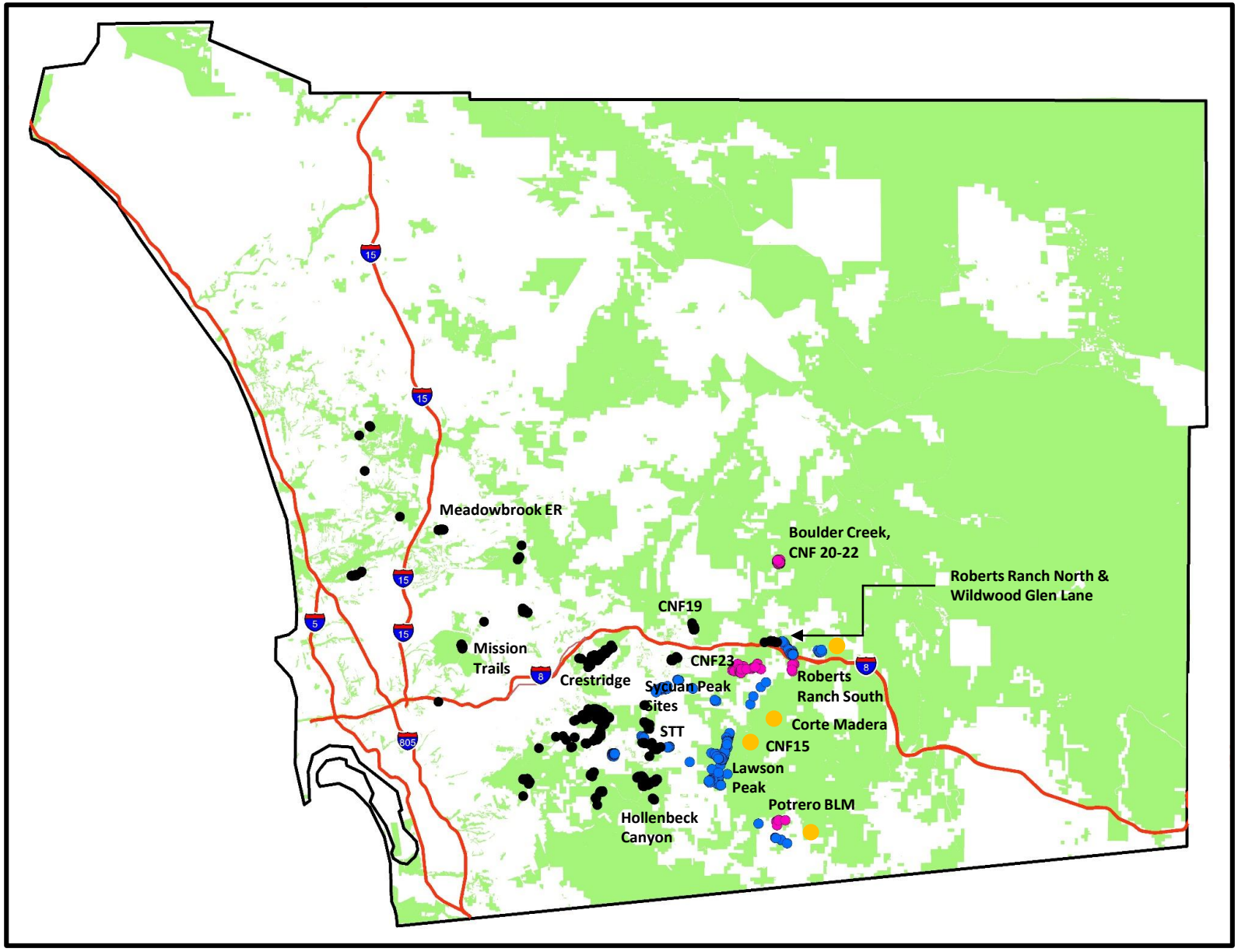

Figure 2. Map of sites that were surveyed for Hermes copper adults in 2022. Purple and black circles represent extant populations and extirpated populations, respectively. Blue circles denote sites of unknown status and orange are sites that have redberry but no historic data regarding Hermes copper occupancy. Status of each site presumed as of August 2022. Green shading are conserved lands (SANDAG).

Exploratory Sites

In 2022, in addition to the five sentinel transects, we conducted surveys for Hermes copper adults at 23 transects (Figure 2) determined in consultation with USFWS and USFS biologists and considering recent survey efforts and results (Marschalek and Deutschman 2019, Marschalek 2020, 2021). Our goal was to access presence/absence of Hermes copper at each site and qualitatively determine the relative population size if present. We also surveyed areas around Corte Madera, Roberts Ranch North, and Roberts Ranch South to determine if Hermes copper adults were using area adjacent to the established transects. The location of each Hermes copper observation was recorded with a handheld GPS unit. All surveys were conducted during periods of appropriate weather (sunny or partly sunny, 20 to 35 degrees C, and modest wind speeds) between 900 to 1500. Each site was surveyed multiple times during June 2022.

Results

Sentinel Sites

The first Hermes copper adult observed in 2022 was on 31 May at Roberts Ranch South, when 17 adults were observed. Nearly all butterflies were bright orange, consistent with having just emerged, likely 28–29 May. As was the case in recent years, most Hermes copper observations were at Roberts Ranch South; however, the maximum count in 2022 was the lowest in the five years of surveys at this transect. No Hermes copper adults were detected at Lawson Peak, Roberts Ranch North, or Sycuan Peak Ecological Reserve in 2022 (Figure 3, Table 1). This is the sixth consecutive year we did not detect adults at the Sycuan Peak transect, fourth year out of the last five years with no detections at Lawson Peak, and the third consecutive year we did not detect Hermes copper adults at Roberts Ranch North. At the Boulder Creek sentinel transect, we recorded a maximum count of one Hermes copper adult (also see next paragraph for more details regarding this site). Hermes copper adults were present at Roberts Ranch South for our entire sampling period (31 May – 22 June) so the flight season was likely four to five weeks in length at this site. The flight season started about one week later at Boulder Creek compared to Roberts Ranch South, a similar difference to what was observed in 2020 and 2021.

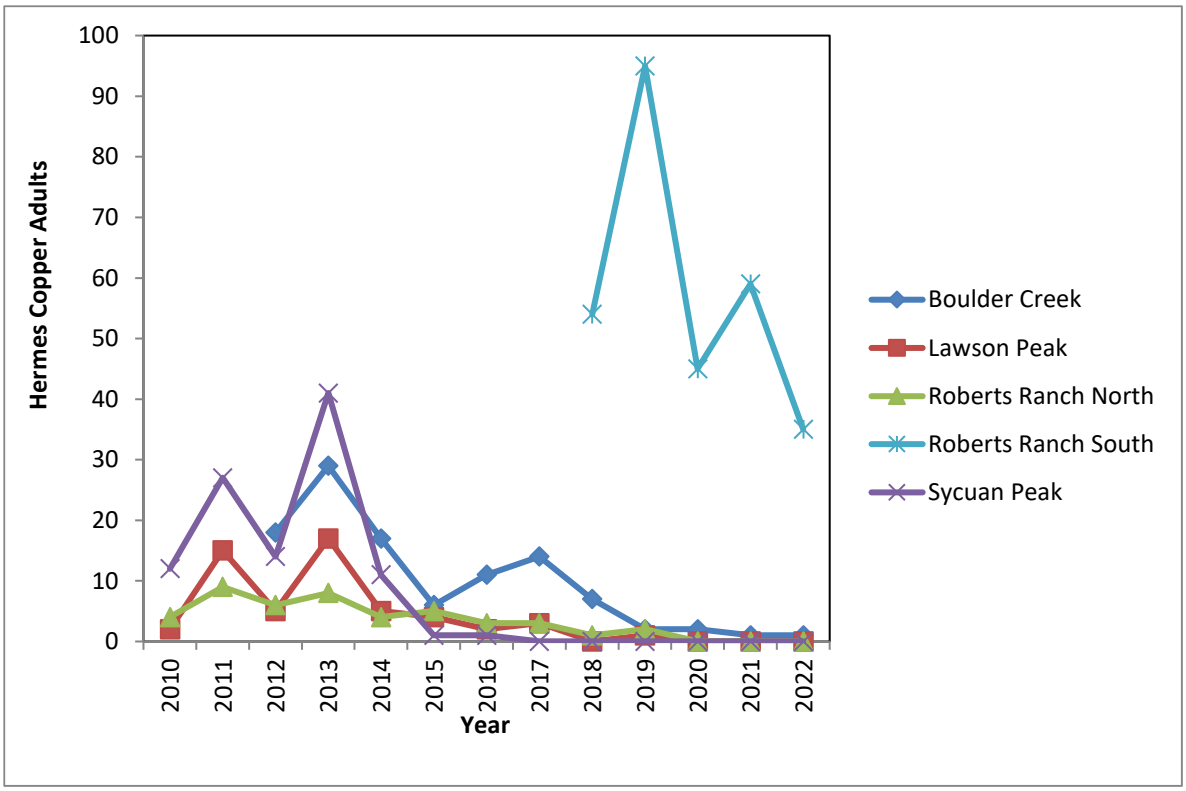

Figure 3. Maximum daily counts of Hermes copper adults at five sentinel sites, 2010–2022.

Table 1. Maximum counts of Hermes copper adults at five sentinel sites and an additional site that received frequent visits, 2010–2022. Sampling at sentinel sites consisted of repeated transects to obtain an accurate maximum count. Sampling at the Skyline Truck Trail site was focused on locating females and did not follow a strict protocol for determining the number of Hermes copper present.

Sentinel Sites	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Boulder Creek (routes 2 & 3)	---	---	18	29	17	6	11	14	7	2	2	1	1
Boulder Creek (loop- includes routes 2 & 3)*	---	---	---	42	19	10	23	24	26	2	3	2	3
Lawson Peak	2	15	5	17	5	4	2	3	0	1	0	0	0
Roberts Ranch North	4	9	6	8	4	5	3	3	1	2	0	0	0
Sycuan Peak	12	27	14	41	11	1	1	0	0	0	0	0	0
Roberts Ranch South (CNF7)**	---	---	---	---	---	---	---	---	54	95	45	59	35
Other Visited Site	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Skyline Truck Trail 1	9	---	7	6	7	1	0	3	1	0	0	0	0
Skyline Truck Trail 2	---	---	12	27	9	2	1	2	2	0	0	0	0

" --- " indicates no survey

* In 2012, two transects (routes 2 & 3) off of Boulder Creek road were surveyed. Starting in 2013, a longer loop that contains both routes 2 & 3 was surveyed to include butterflies that occupied areas along Boulder Creek Road between the two transects.

** Roberts Ranch South, referred to as CNF7 in 2018, transect was shortened in 2019. The 2018 count in this table reflects the number of Hermes copper adults detected on the shorter transect in 2018 (54 compared to 55 in the 2018 report).

Initial surveys at Boulder Creek in 2012 were restricted to two shorter transects. To more completely cover the area, including the public and maintained road, a new transect was created to include both shorter transects and the road (Figure 4). To be consistent, summary tables in previous reports have included only those Hermes copper butterflies detected in the areas of the two shorter transects. This report also presents the counts recorded from the full loop transect that started in 2013 (Table 1). Like Sycuan Peak in 2013, it was one of the largest known populations but has also experienced a decline in numbers since that time.

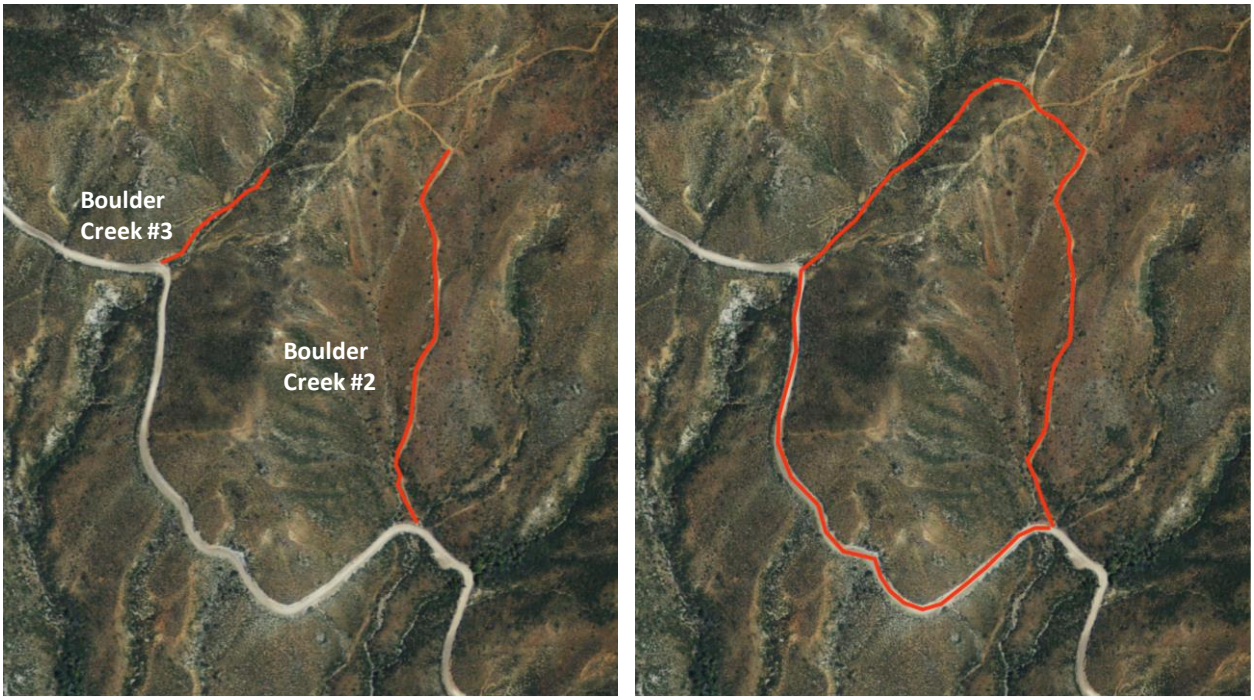

Figure 4. Comparison of survey transects (shown in red) at the Boulder Creek sentinel site. Left: Boulder Creek 2 and Boulder Creek 3 transects were surveyed in 2012. Right: A loop was surveyed in 2013-2022, but only Hermes copper counts from transects 2 and 3 were reported in 2013–2018 report summary tables.

Exploratory Sites

Surveys were conducted 30 May – 22 June, with Hermes copper adults detected at only one of the 23 exploratory transects (Table 2), with a maximum count of four Hermes copper adults observed in the vicinity of the Potrero BLM transect on 10 June. The initial sampling transect at this site was restricted to a public road, but since two Hermes copper adults were observed on a trail extending off of that road in 2020, this area was surveyed in 2021 and 2022. No Hermes were seen in areas adjacent to transects at Corte Madera, Roberts Ranch North, and Roberts Ranch South. Across all survey sites, the condition of the vegetation looked dry but not as

extreme as in 2015-2017. There were fewer flowering plants compared to the last couple years but spiny redberry shrubs had new growth and green leaves, and buckwheat was flowering.

Table 2. Maximum count of Hermes copper adults and number of surveys for each survey transect at the exploratory sites. CDFW surveyed Hollenbeck Canyon, Meadowbrook ER, and Sycuan 1.

Site	Number of Surveys	Hermes Copper Maximum Count
Boulder Creek Road (2 transects)	2	0
CNF 15	2	0
CNF 19	4	0
CNF 20	4	0
CNF 21	3	0
CNF 22	4	0
CNF 23	1	0
Corte Madera	2	0
Crestridge (3 transects)	4	0
Hollenbeck Canyon Wildlife Area (2 transects)	4	0
Meadowbrook Ecological Researve	2	0
MTRP3	4	0
MTRP4	4	0
Potrero BLM	4	**0 (4)***
Robert's Ranch North **	7	0
STT1	4	0
STT2	4	0
Sycuan 1	4	0
Wildwood Glen	5	0

* Four individuals were observed on a trail off of the original transect

** New transect in vicinity of sentinel site

Other efforts in the county included surveys by D Hartsook and D Faulkner at the San Diego Gas and Electric Substation near Bell Bluff Truck Trail and resulted in the detection of Hermes copper adults (pers. comm. K Winter and D Faulkner). Nine individuals were observed on 3 June 2022, which should have been close to peak numbers based on the phenology of the other sites. There were five individuals observed on 10 June 2022. Historical records from this area exist, including 28 observations on 19 June 2010 (Chambers Group data in USFWS spatial database obtained in 2011). It should be noted that the survey areas differed between 2010 and 2022. An approximation has about 14 of the 2010 observations in the area searched in 2022.

Discussion

The overall picture of the abundance and distribution of Hermes copper is similar to 2019 – 2021 (Marschalek and Deutschman 2019, Marschalek 2020, 2021) but still concerning (Figure 2). Despite the observations at Bell Bluff, the species still appears restricted to the southeastern margin of its historical range due to drought.

Fire continues to threaten this already reduced distribution. The Border 32 Fire in September 2022 was within 700 meters of historic Hermes copper observations on the north side of Potrero Peak (Figure 5). A small fire occurred about 6 kilometers west of Roberts Ranch South in July 2021, and in September 2020, the Valley Fire burned the area between Roberts Ranch South and the Potrero sites and both locations were included in the evacuation area. As fires continue to ignite and burn in this part of San Diego County, it is just a matter of time until the Roberts Ranch South population is extirpated. Considering the low counts at the other sites, it is questionable if they will persist on their own.

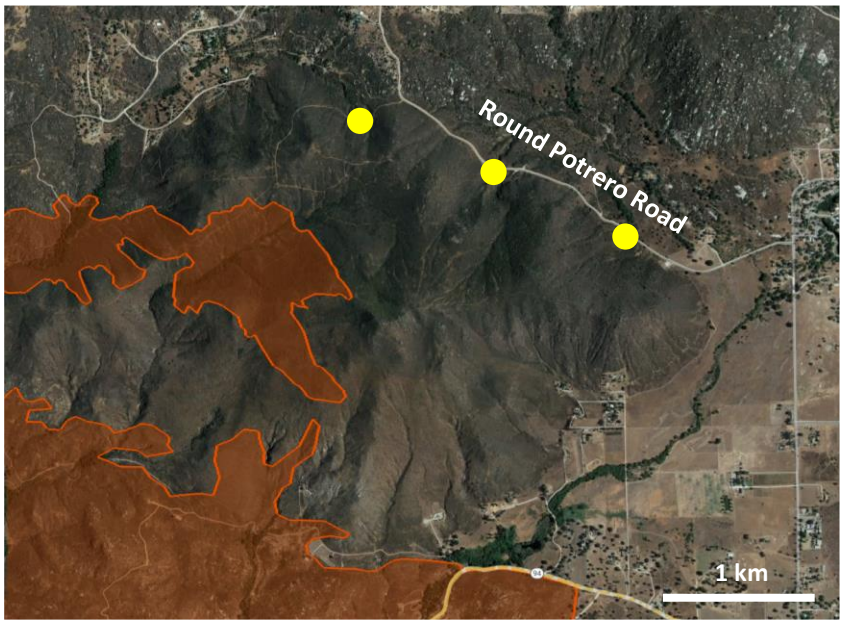

Figure 5. The Border 32 Fire perimeter (FIRIS 2022) and past Hermes copper observations (yellow circles).

Recommendations

Outside of habitat loss, there are two threats to the Hermes copper, wildfires and drought. Recent fires highlight the urgency of translocation efforts as fires have been close to extirpating the last known population where females are reliably observed. It is important for additional

populations to be established to reduce the probability of extinction due to a single fire. Translocations may be difficult due to dry conditions, as this limits the number of source individuals and reduces the probability of reestablishing a population. Drought is the other substantial threat. The lack of winter rains has illustrated the importance of precipitation for new growth on spiny redberry shrubs, which is required for larval feeding. If below average winter rains continue, it is possible that supplemental water is going to be required to either maintain current population sizes/distribution or enhance other habitat patches for recolonization, or both.

Acknowledgments

I would like to thank many people for assistance with this project, including permits, access to reserves, and sharing of data. These include, but are not limited to (alphabetically): Bureau of Land Management, California Department of Fish & Wildlife, City of San Diego, Endangered Habitats League, San Diego Gas and Electric, Sweetwater Authority, United States Fish & Wildlife Service, and United States Forest Service. Also, much appreciation to Rachel Allingham, Christine Beck, David Faulkner, Korey Klutz, and California Department of Fish & Wildlife (Kyle Rice) for assistance conducting butterfly surveys.

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Appendix. GPS coordinates of Hermes copper adults in 2022.

Date	Site	Latitude	Longitude
31-May-22	Roberts Ranch South	32.80854827	-116.6138531
31-May-22	Roberts Ranch South	32.80862514	-116.6086252
31-May-22	Roberts Ranch South	32.80898626	-116.6124726
31-May-22	Roberts Ranch South	32.81035324	-116.605634
31-May-22	Roberts Ranch South	32.81054972	-116.6055439
31-May-22	Roberts Ranch South	32.81097109	-116.6105348
31-May-22	Roberts Ranch South	32.81107998	-116.6098645
31-May-22	Roberts Ranch South	32.81108708	-116.6098786
31-May-22	Roberts Ranch South	32.81111075	-116.6098419
31-May-22	Roberts Ranch South	32.81134984	-116.6055551
31-May-22	Roberts Ranch South	32.81146838	-116.6039753
31-May-22	Roberts Ranch South	32.81164338	-116.6045581
31-May-22	Roberts Ranch South	32.81192086	-116.6038701
31-May-22	Roberts Ranch South	32.81192606	-116.6038639
31-May-22	Roberts Ranch South	32.81199887	-116.6031987
31-May-22	Roberts Ranch South	32.81263337	-116.6026325
31-May-22	Roberts Ranch South	32.81358771	-116.6021436
1-Jun-22	Roberts Ranch South	32.8085	-116.6138
1-Jun-22	Roberts Ranch South	32.80882	-116.61462
1-Jun-22	Roberts Ranch South	32.80898	-116.61253
1-Jun-22	Roberts Ranch South	32.80912	-116.60753
1-Jun-22	Roberts Ranch South	32.81014	-116.60595
1-Jun-22	Roberts Ranch South	32.81089	-116.61093
1-Jun-22	Roberts Ranch South	32.81089	-116.60548
1-Jun-22	Roberts Ranch South	32.81091	-116.60554
1-Jun-22	Roberts Ranch South	32.81091	-116.60548
1-Jun-22	Roberts Ranch South	32.81096	-116.6106
1-Jun-22	Roberts Ranch South	32.81101	-116.60551
1-Jun-22	Roberts Ranch South	32.81107	-116.6099
1-Jun-22	Roberts Ranch South	32.81107	-116.6099
1-Jun-22	Roberts Ranch South	32.81112	-116.60981
1-Jun-22	Roberts Ranch South	32.81112	-116.60981
1-Jun-22	Roberts Ranch South	32.81118	-116.60545
1-Jun-22	Roberts Ranch South	32.81128	-116.60551
1-Jun-22	Roberts Ranch South	32.81136	-116.60555
2-Jun-22	Potrero BLM	32.64683	-116.6357
6-Jun-22	Boulder Creek	32.92679	-116.6347
6-Jun-22	Boulder Creek	32.92699	-116.63152
6-Jun-22	Boulder Creek	32.92794	-116.63496

Appendix. GPS coordinates of Hermes copper adults in 2022 continued.

Date	Site	Latitude	Longitude
7-Jun-22	Roberts Ranch South	32.80852494	-116.6137846
7-Jun-22	Roberts Ranch South	32.80854043	-116.6138473
7-Jun-22	Roberts Ranch South	32.80854662	-116.6138657
7-Jun-22	Roberts Ranch South	32.80872008	-116.6143263
7-Jun-22	Roberts Ranch South	32.80873247	-116.6143595
7-Jun-22	Roberts Ranch South	32.80878202	-116.614599
7-Jun-22	Roberts Ranch South	32.80884087	-116.6145806
7-Jun-22	Roberts Ranch South	32.80968025	-116.611673
7-Jun-22	Roberts Ranch South	32.80989192	-116.6060876
7-Jun-22	Roberts Ranch South	32.81023158	-116.611275
7-Jun-22	Roberts Ranch South	32.81034598	-116.6055789
7-Jun-22	Roberts Ranch South	32.81049545	-116.6098118
7-Jun-22	Roberts Ranch South	32.81052099	-116.6055735
7-Jun-22	Roberts Ranch South	32.81055373	-116.6055601
7-Jun-22	Roberts Ranch South	32.81062108	-116.611411
7-Jun-22	Roberts Ranch South	32.81084051	-116.6055466
7-Jun-22	Roberts Ranch South	32.81099919	-116.6103389
7-Jun-22	Roberts Ranch South	32.81102143	-116.6105098
7-Jun-22	Roberts Ranch South	32.8114502	-116.6056017
7-Jun-22	Roberts Ranch South	32.81158907	-116.6055413
7-Jun-22	Roberts Ranch South	32.81165199	-116.6038711
7-Jun-22	Roberts Ranch South	32.8117167	-116.6044342
7-Jun-22	Roberts Ranch South	32.81181838	-116.6043066
7-Jun-22	Roberts Ranch South	32.81189788	-116.6039151
7-Jun-22	Roberts Ranch South	32.81195889	-116.6038029
7-Jun-22	Roberts Ranch South	32.81196443	-116.6032419
7-Jun-22	Roberts Ranch South	32.81270393	-116.6026018
7-Jun-22	Roberts Ranch South	32.81290914	-116.6025138
7-Jun-22	Roberts Ranch South	32.81301082	-116.6024457
7-Jun-22	Roberts Ranch South	32.81358577	-116.6022367
7-Jun-22	Roberts Ranch South	32.8136819	-116.6021531
9-Jun-22	Boulder Creek	32.921494	-116.638626
9-Jun-22	Boulder Creek	32.931425	-116.638553
9-Jun-22	Boulder Creek	32.935795	-116.63704
9-Jun-22	Roberts Ranch South	32.808522	-116.613704
9-Jun-22	Roberts Ranch South	32.808532	-116.613756
9-Jun-22	Roberts Ranch South	32.808572	-116.613035
9-Jun-22	Roberts Ranch South	32.808632	-116.614145
9-Jun-22	Roberts Ranch South	32.808674	-116.614204

Appendix. GPS coordinates of Hermes copper adults in 2022 continued.

Date	Site	Latitude	Longitude
9-Jun-22	Roberts Ranch South	32.808689	-116.614203
9-Jun-22	Roberts Ranch South	32.808815	-116.614488
9-Jun-22	Roberts Ranch South	32.808829	-116.614528
9-Jun-22	Roberts Ranch South	32.808849	-116.614594
9-Jun-22	Roberts Ranch South	32.808992	-116.612488
9-Jun-22	Roberts Ranch South	32.80912	-116.607562
9-Jun-22	Roberts Ranch South	32.809225	-116.607102
9-Jun-22	Roberts Ranch South	32.809537	-116.611893
9-Jun-22	Roberts Ranch South	32.810006	-116.606054
9-Jun-22	Roberts Ranch South	32.810416	-116.609799
9-Jun-22	Roberts Ranch South	32.810842	-116.60552
9-Jun-22	Roberts Ranch South	32.810863	-116.610905
9-Jun-22	Roberts Ranch South	32.811064	-116.609879
9-Jun-22	Roberts Ranch South	32.81107	-116.609882
9-Jun-22	Roberts Ranch South	32.811112	-116.609814
9-Jun-22	Roberts Ranch South	32.811241	-116.605472
9-Jun-22	Roberts Ranch South	32.811347	-116.60552
9-Jun-22	Roberts Ranch South	32.81141	-116.605568
9-Jun-22	Roberts Ranch South	32.811455	-116.605601
9-Jun-22	Roberts Ranch South	32.811458	-116.605613
9-Jun-22	Roberts Ranch South	32.811541	-116.605416
9-Jun-22	Roberts Ranch South	32.811783	-116.603886
9-Jun-22	Roberts Ranch South	32.811874	-116.603904
9-Jun-22	Roberts Ranch South	32.811897	-116.603892
9-Jun-22	Roberts Ranch South	32.811973	-116.603594
9-Jun-22	Roberts Ranch South	32.811981	-116.603267
9-Jun-22	Roberts Ranch South	32.812904	-116.60251
9-Jun-22	Roberts Ranch South	32.813909	-116.602099
9-Jun-22	Roberts Ranch South	32.814139	-116.602024
9-Jun-22	Roberts Ranch South	32.814344	-116.601872
10-Jun-22	Boulder Creek	32.951948	-116.642316
10-Jun-22	Potrero BLM	32.646779	-116.635757
10-Jun-22	Potrero BLM	32.646813	-116.635681
10-Jun-22	Potrero BLM	32.646942	-116.635235
11-Jun-22	Boulder Creek	32.92691744	-116.6314652
13-Jun-22	Boulder Creek	32.92693214	-116.6315334
13-Jun-22	Potrero BLM	32.64678	-116.63569
13-Jun-22	Roberts Ranch South	32.808473	-116.613758
13-Jun-22	Roberts Ranch South	32.808722	-116.61437

Appendix. GPS coordinates of Hermes copper adults in 2022 continued.

Date	Site	Latitude	Longitude
13-Jun-22	Roberts Ranch South	32.808779	-116.61449
13-Jun-22	Roberts Ranch South	32.808844	-116.614646
13-Jun-22	Roberts Ranch South	32.808854	-116.614666
13-Jun-22	Roberts Ranch South	32.809186	-116.60722
13-Jun-22	Roberts Ranch South	32.80941	-116.611952
13-Jun-22	Roberts Ranch South	32.809491	-116.611926
13-Jun-22	Roberts Ranch South	32.810887	-116.610876
13-Jun-22	Roberts Ranch South	32.81105	-116.609889
13-Jun-22	Roberts Ranch South	32.811133	-116.609791
13-Jun-22	Roberts Ranch South	32.811435	-116.605589
13-Jun-22	Roberts Ranch South	32.811675	-116.604455
13-Jun-22	Roberts Ranch South	32.811677	-116.604438
13-Jun-22	Roberts Ranch South	32.811797	-116.604289
13-Jun-22	Roberts Ranch South	32.811886	-116.603888
13-Jun-22	Roberts Ranch South	32.812922	-116.602491
13-Jun-22	Roberts Ranch South	32.813284	-116.602308
13-Jun-22	Roberts Ranch South	32.813924	-116.602086
15-Jun-22	Roberts Ranch South	32.80849571	-116.6137278
15-Jun-22	Roberts Ranch South	32.80947587	-116.6119411
20-Jun-22	Roberts Ranch South	32.81157	-116.60546
20-Jun-22	Roberts Ranch South	32.81181	-116.60442
20-Jun-22	Roberts Ranch South	32.81195	-116.60373
20-Jun-22	Roberts Ranch South	32.81332	-116.60236
20-Jun-22	Roberts Ranch South	32.8138	-116.60215