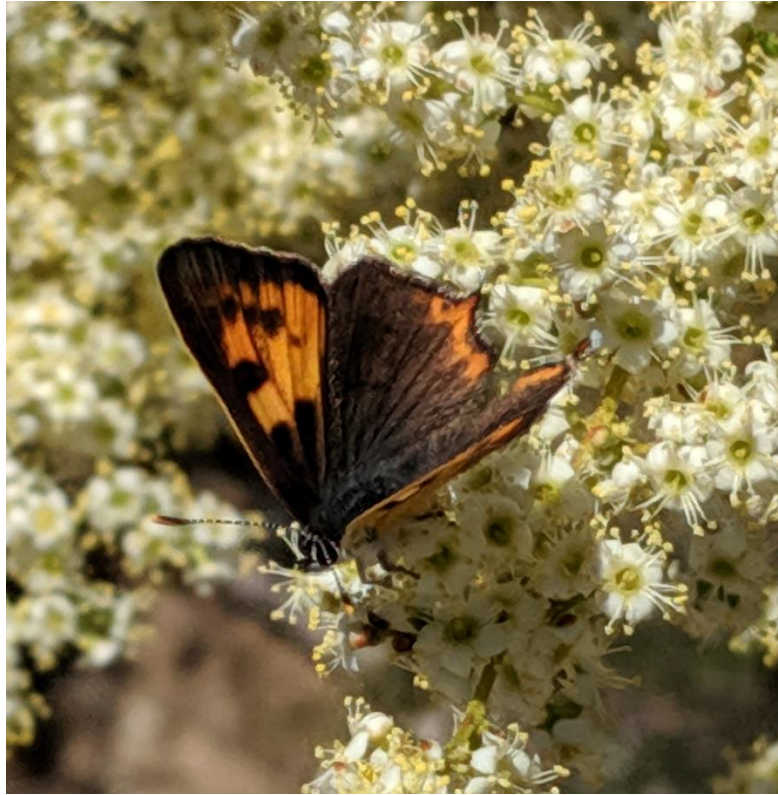


Hermes Copper Surveys

2019 Flight Season



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Executive Summary

This report summarizes and synthesizes Hermes copper surveying efforts led by the University of Central Missouri (Marschalek) and San Diego State University (Marschalek and Deutschman) in 2019. These efforts were funded by SANDAG (contract #: 5005783) and US Fish and Wildlife Service (contract #: F17AC00963), respectively.

The Hermes copper (*Lycaena hermes*) is a rare butterfly endemic to San Diego County and northern Baja California. This species is threatened by recent urbanization and wildfires throughout its range in the United States. Since most individuals and larger populations are found in the southern portion of San Diego County, one large fire could nearly extirpate the species. Wildfires in 2003 and 2007 have already caused extirpations in this region and few recolonizations have been observed. Recent droughts have further restricted the distribution of this butterfly.

Past efforts have contributed to our understanding of the distribution of the Hermes copper so it is fairly well understood. However, there may still be unknown populations. For example, surveys associated with the SDG&E Sunrise Powerlink Project discovered several populations by searching linear transects through Cleveland National Forest without specifically targeting Hermes copper. We conducted widespread surveys in 2018 with the goal of detecting unknown populations; however, conditions were suboptimal due to below average rainfall.

The objective of this project (2019 surveys) was to further assess the distribution and annual population sizes, and expand the current distribution (translocation). We conducted surveys in many of the areas sampled during 2018, but during better conditions as the 2018-2019 winter/spring experienced above average rainfall. Surveys were also conducted at five sentinel sites (as of 2019, the 2018 transect referred to as CNF7 ---now named Roberts Ranch South--- is added to the list of sentinel sites). We also attempted translocation efforts. The above average rainfall allowed us to assess 1) how Hermes copper populations respond to above average rainfall, 2) detection rates in wet and dry years, and 3) translocation techniques.

In contrast to past years when most sites were experiencing very dry conditions that stressed plants and suppressed butterfly numbers (regardless of species), vegetation had abundant leaves and flowers in 2019. The 2019 Hermes copper flight season started around 12 June and extended through the early part of July. This is the latest start to a flight since we started research on the Hermes copper in 2003. Of the 30 transects surveyed, Hermes copper adults were detected along only five transects. Three of these five transects had maximum counts of one or two individuals and a fourth transect had a maximum count of six. As was the case in 2018, the Roberts Ranch South transect (referred to as CNF7 in 2018) had the large majority of observations, with a maximum count of 95 adults.

Despite the improved habitat (vegetation) conditions in 2019, the distribution of Hermes copper retracted from the 2018 and most population sizes declined. The distribution is greatly reduced due to drought, with the species only being found on the southeastern margin of its historic range. Based on data from these 2019 surveys and the trajectories based on past sampling, this butterfly species is in risk of being lost from the United States in the near future.

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 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 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.

Although early 2017-2018 winter rainfall was close to long-term averages, there was little to no rainfall in late winter and spring, likely suppressing 2018 summer adult butterfly numbers. If numbers are greatly suppressed, it increases the probability that a particular habitat is occupied, but the population is not detected (false negative). This could be due to the ability of many insects, including butterflies, to diapause. This is a resting phase in development, providing a mechanism to avoid unfavorable environmental conditions and wait until favorable conditions return. During diapause, insects, particularly butterflies, are very difficult to detect.

Despite recent survey efforts, there are still areas in San Diego County that may have unknown Hermes copper populations or harbor the majority of a known population. Although many sites were surveyed in 2018, it is possible that the continued drought and below average rainfall suppressed Hermes copper adult emergence to a level so low that detection was not possible. Surveying during a flight season that was preceded by a winter and spring with above average rainfall should reduce the risk of false negatives and cause butterflies to exit their diapausing phase.

Wildfires continue to greatly influence 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). The mortality resulting from wildfires, lack of post-wildfire recolonizations, and evidence of restricted dispersal 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 of populations and the geographic extent of populations increases. More recently, a several year drought appears to have further reduced the distribution of Hermes copper (Marschalek and Deutschman 2018a, 2018b). Long-term viability of this species is dependent on expanding its range, whether natural or assisted, and more urgent than previously known.

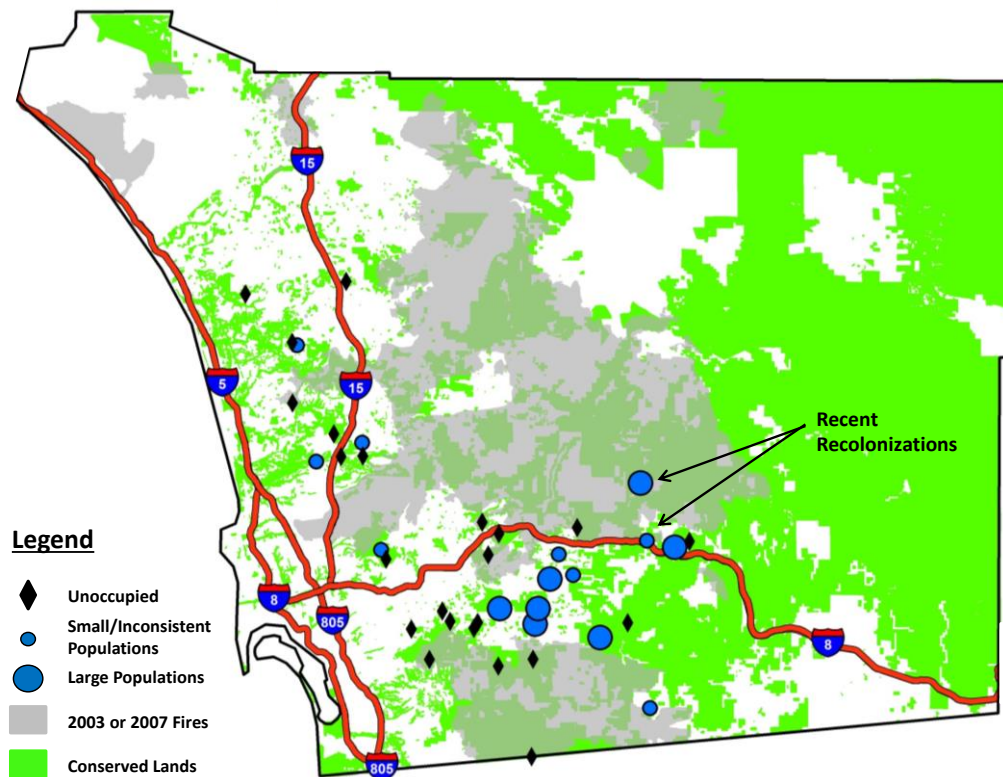


Figure 1. Detections of Hermes copper butterflies on conserved lands, 2010-2013. Sampling locations where Hermes copper was not detected are represented by black diamonds. Small and large Hermes copper populations are indicated by different sized circles.

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, we translocated 11 adults (6

males and 5 females) 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 both the egg and adult release sites. This male was observed at the adult release site. This project extends the previous SANDAG funded project (Marschalek and Deutschman 2016, 2018a), continuing translocation efforts and monitoring sentinel sites.

The goal of this project was to further assess the distribution and annual population sizes, and expand the current distribution (translocation) of Hermes copper. In 2019, we conducted surveys in areas sampled during 2018 that also had spiny redberry (*Rhamnus crocea*) present. Surveys were also conducted at five sentinel sites (as of 2019, transect CNF7 ---Roberts Ranch South--- is added to the list of sentinel sites). We also attempted translocations efforts. The 2018-2019 winter and 2019 spring experienced above average rainfall, allowing for assessments of:

- 1) How Hermes copper populations respond to above average rainfall
- 2) Detection rates in wet and dry years
- 3) Translocation techniques

This report describes the field work conducted during the 2019 Hermes copper flight season, funded by USFWS and SANDAG.

Methods

Sentinel Sites

In 2019, we conducted surveys for Hermes copper adults at four sites we previously designated as sentinel sites (Boulder Creek, Lawson Peak, Roberts Ranch North, and Sycuan Peak Ecological Reserve) (Figure 2). This year, Roberts Ranch South (referred to as CNF7 in 2018) was added to the list of sentinel sites since the other sentinel sites had few to no recent observations and it appears that this is the largest known Hermes copper population. 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 about one time per week and started on 24 May at Sycuan Peak and Boulder Creek. Sycuan Peak was chosen because past survey efforts have shown this area to regularly produce the first adults of the season. However, we did not detect Hermes copper adults at this site in 2017 or 2018 (Marschalek and Deutschman 2017, 2018a) so we closely monitored Boulder Creek, another site with early emergence. Due to cool weather and relative flowering phenology of plants, we also surveyed Roberts Ranch South prior to first Hermes copper detection.

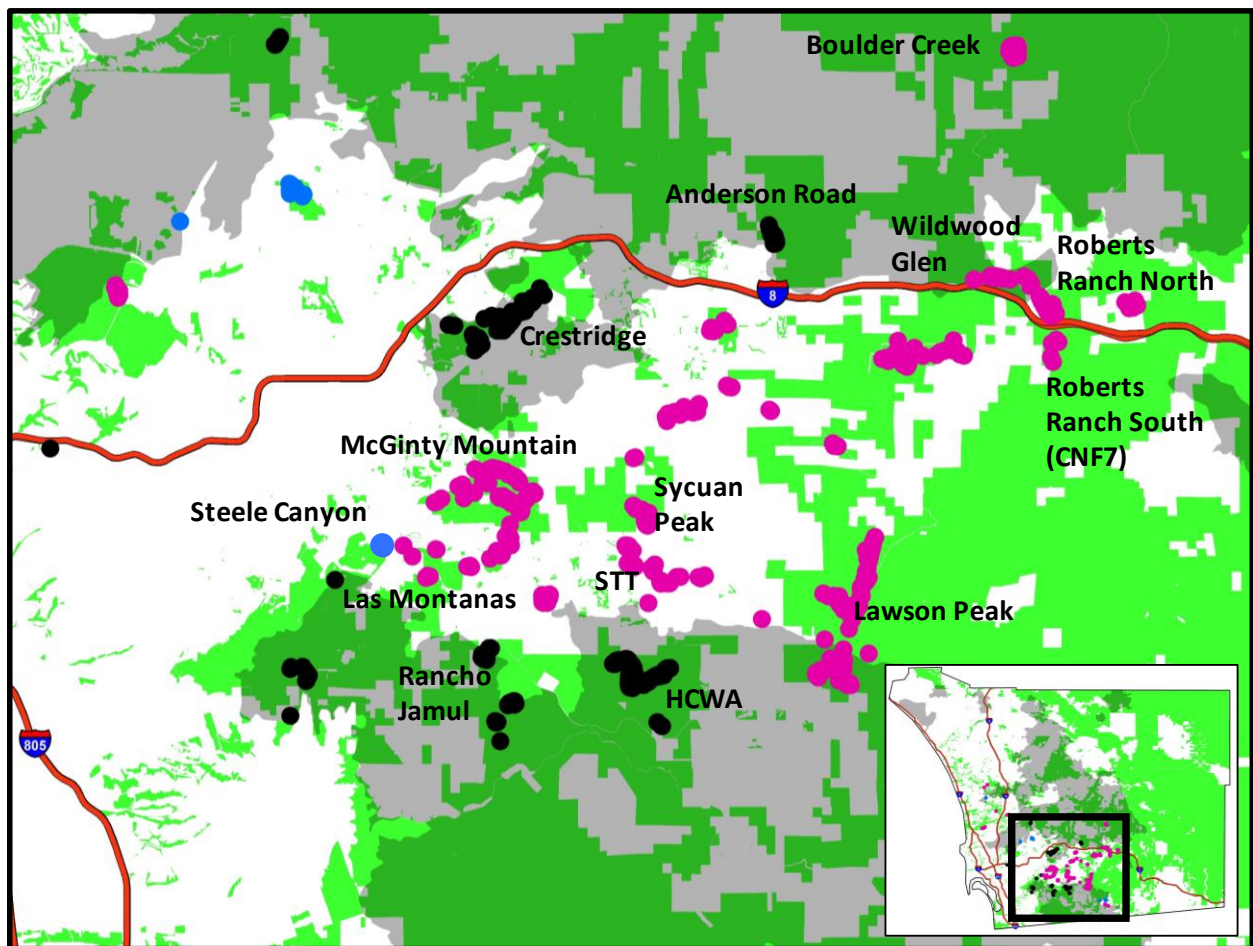


Figure 2. Map of southern Hermes copper populations with an inset of San Diego County. Included on the map are the five sentinel sites (Boulder Creek, Lawson Peak, Roberts Ranch North, Roberts Ranch South, and Sycuan Peak). Also includes are three potential translocation source sites (McGinty Mountain, Skyline Truck Trail [STT], and Sycuan Peak) and the release site (Hollenbeck Canyon Wildlife Area [HCWA]). Purple and black circles represent extant populations and extirpated populations, respectively. Blue circles denote sites of unknown status. Status of each site presumed as of July 2018. Green shading is conserved lands (SANDAG) and dark gray shading maps the footprints of the 2003 and 2007 wildfires.

Once Hermes copper adults were found, we started surveys at the other sentinel and exploratory (see below) sites. At the sentinel sites, sampling occurred at shorter intervals (weather dependent) as counts increased. Once counts started to decline markedly, we stopped surveys at that site.

Exploratory Sites

In 2019, we conducted surveys for Hermes copper adults at 24 transects (Figure 2) determined in consultation with USFWS and USFS biologists and considering 2018 survey efforts and results (Marschalek and Deutschman 2018b). This represents a more focused effort compared to 2018, as sites without spiny redberry adjacent to the transects were not sampled in 2019. Other changes include shortening a transect (Roberts Ranch South/CNF7) and excluding a long transect (CNF8). The Hermes observed on CNF8 in 2018 were likely part of the local population represented by transect CNF7 (now referred to as Roberts Ranch South). Our goal was to access presence/absence of Hermes copper at each site and qualitatively determine the relative population size if present. 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 the four-week flight season (mid June- early July), which was several weeks later than previous years.

Translocation

Surveys for Hermes copper adults occurred at larger populations (San Diego National Wildlife Refuge-McGinty Mountain, a property on Skyline Truck Trail, and Sycuan Peak Ecological Reserve) in an attempt to capture individuals for translocation (Figure 2). We used the same sampling protocols described above. The prolonged dry conditions in 2015-2018 resulted in only a few observations of male Hermes copper adults and precluded us from translocating additional adults or eggs. The same was true for the 2019 flight season.

Surveys for Hermes copper adults are planned for May –June 2020 at the egg and adult release sites at Hollenbeck Canyon Wildlife Area. Searches will focus on the dirt roads that transverse these two areas as well as areas with dense flowering buckwheat. The monitoring for adults is the primary metric of success for the translocation efforts.

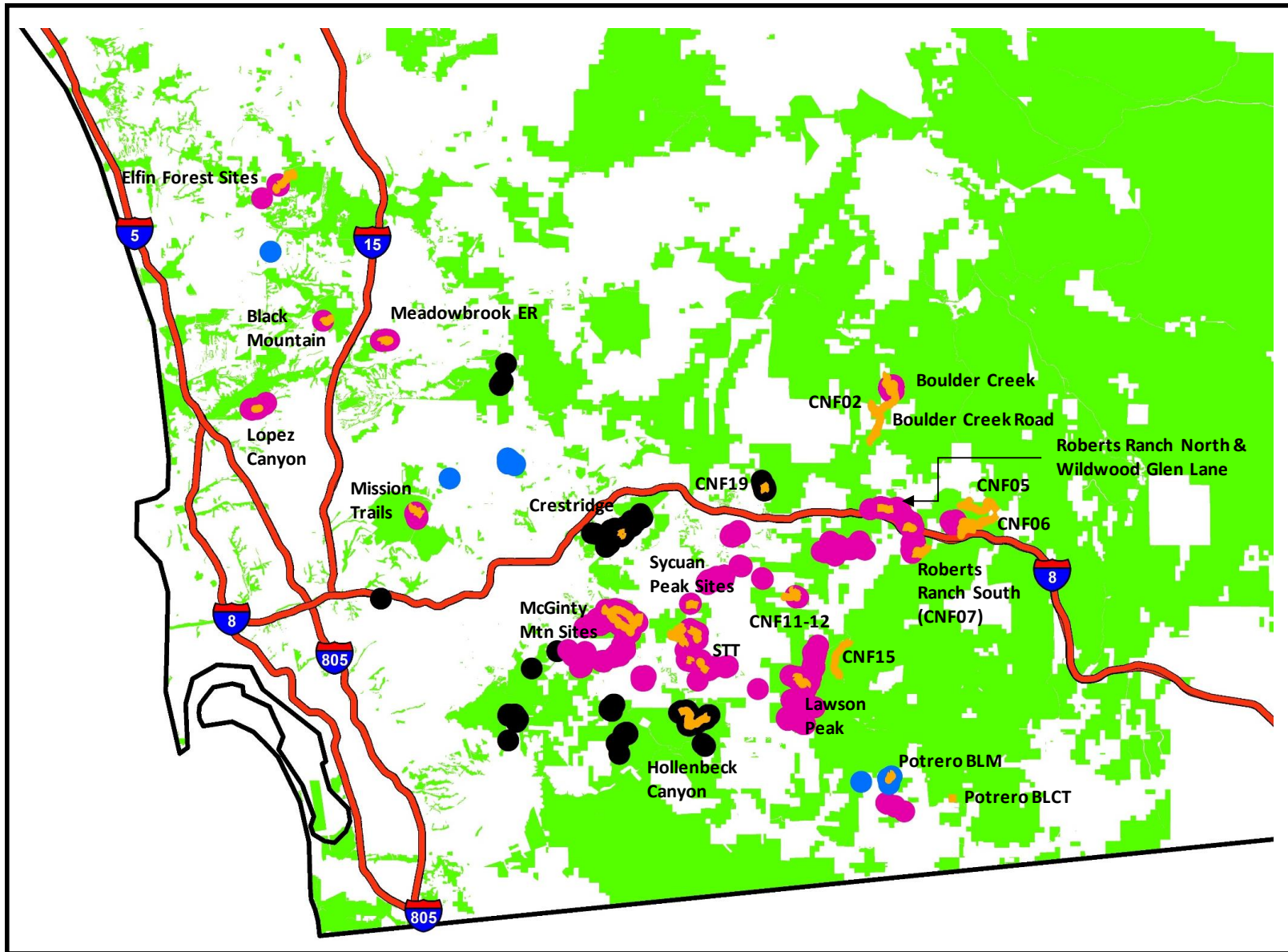


Figure 3. Map of sites that were surveyed for Hermes copper adults in 2019, with survey transect shown in orange and labeled. Purple and black circles represent extant populations and extirpated populations, respectively. Blue circles denote sites of unknown status. Status of each site presumed as of July 2018 (see Figure 6 with updated status). Green shading are conserved lands (SANDAG).

Results

Sentinel Sites

The first Hermes copper adult observed in 2019 was on 14 June at Roberts Ranch South, when 50-55 adults were observed. Nearly all butterflies were bright orange, consistent with being one to two days after emergence. No Hermes copper adults were detected at Sycuan Peak Ecological Reserve and the other sentinel sites had maximum counts of only one or two individuals (Figure 4, Table 1). This is the third consecutive year we did not detect adults at the Sycuan Peak transect, while Lawson Peak was occupied (maximum count of one individual) following a year without detections. Although Roberts Ranch North counts have been low over the years, one individual in 2018 and 2019 is the lowest maximum count we have recorded since regular monitoring started in 2010. At the Boulder Creek sentinel transect, we recorded a maximum count of two Hermes copper adults. This is the lowest count recorded since regular monitoring started in 2012 (also see next paragraph for more details regarding this site). The flight season was about four weeks in length at Roberts Ranch South but shorter (1-3 weeks) at the other sites.

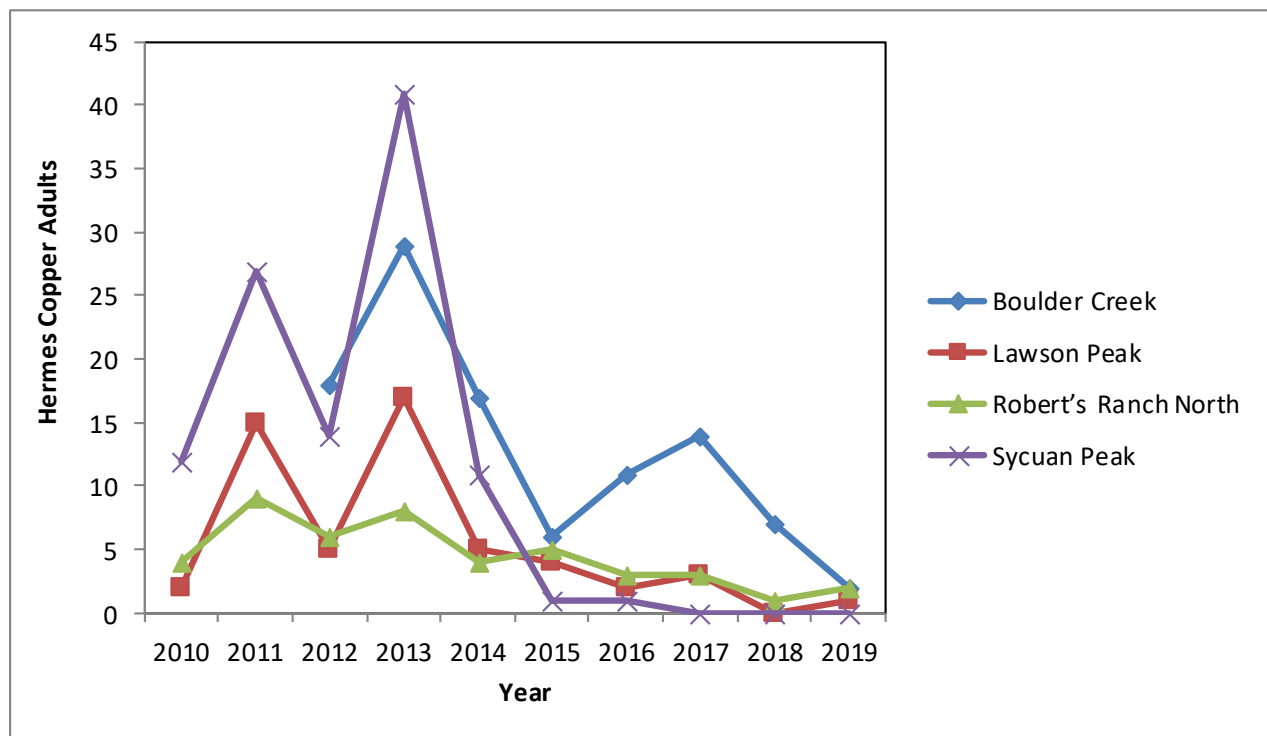


Figure 4. Maximum daily counts of Hermes copper adults at four sentinel sites, 2010-2019 (Roberts Ranch South not shown).

Table 1. Maximum counts of Hermes copper adults at five sentinel sites and an additional site that received frequent visits, 2010-2019. 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
Boulder Creek (routes 2 & 3)	---	---	18	29	17	6	11	14	7	2
Boulder Creek (loop- includes routes 2 & 3)*	---	---	---	42	19	10	23	24	26	2
Lawson Peak	2	15	5	17	5	4	2	3	0	1
Roberts Ranch North	4	9	6	8	4	5	3	3	1	2
Sycuan Peak	12	27	14	41	11	1	1	0	0	0
Roberts Ranch South (CNF7)*	---	---	---	---	---	---	---	---	54	95
Other Visited Site	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Skyline Truck Trail 1	9	---	7	6	7	1	0	3	1	0
Skyline Truck Trail 2	---	---	12	27	9	2	1	2	2	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 5). 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 starting 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 over the last five years.

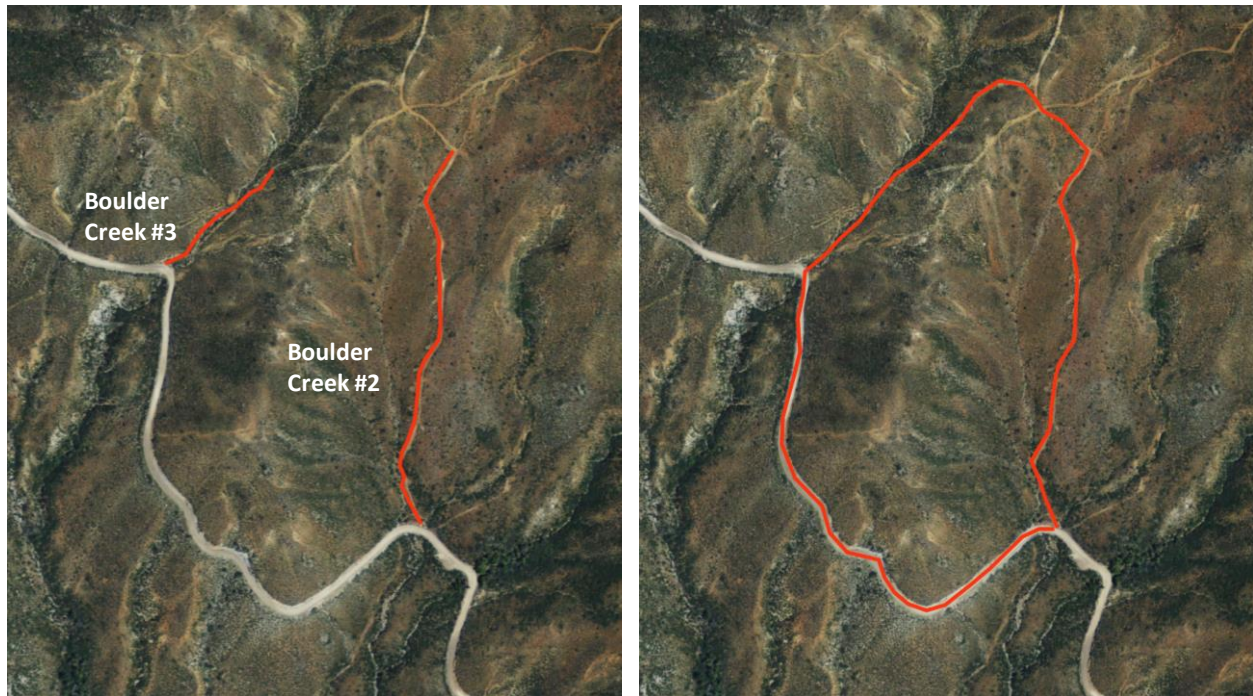


Figure 5. Comparison of survey transects (shown in red) at the Boulder Creek sentinel site. Left: Boulder Creek 2 and Boulder Creek 3 transects were surveyed in 2012. Right: A loop was surveyed in 2013-2019, but only Hermes copper counts from transects 2 and 3 were reported in 2013-2018 report summary tables.

Exploratory Sites

Due to the later than expected start of the flight season, surveys were conducted into the first week of July. With the Roberts Ranch South transect (formerly CNF7) now a sentinel sites, Hermes copper adults were detected at only one of the twenty-four exploratory site (Table 1). This included six (20 June) and five (27 June) Hermes copper adults observed along the public and maintained Boulder Creek Road. At all sites, the condition of the vegetation looked great. Flowering plants were abundant and the spiny redberry shrubs had lots of leaves and new growth.

Table 2. Maximum count of Hermes copper adults and dates of surveys for each survey transect.

Site	Hermes Copper		Survey Dates				
	Maximum Count						
Black Mountain	0		11-Jun-19	17-Jun-19	27-Jun-19	5-Jul-19	
Boulder Creek Road*	6		20-Jun-19	27-Jun-19			
CNF02	0		10-Jun-19	18-Jun-19	25-Jun-19	3-Jul-19	
CNF05	0		13-Jun-19	21-Jun-19	28-Jun-19		
CNF06	0		13-Jun-19	21-Jun-19	28-Jun-19		
CNF11	0		11-Jun-19	17-Jun-19	24-Jun-19		
CNF12	0		11-Jun-19	17-Jun-19	24-Jun-19		
CNF15	0		11-Jun-19	16-Jun-19	25-Jun-19	1-Jul-19	
CNF19	0		11-Jun-19	19-Jun-19	26-Jun-19	5-Jul-19	
CNF- Wildwood Glen Lane	0		18-Jun-19	25-Jun-19	3-Jul-19		
Crestridge ER	0		13-Jun-19	19-Jun-19	26-Jun-19	3-Jul-19	
Elfin Forest	0		12-Jun-19	19-Jun-19	26-Jun-19	3-Jul-19	
Elfin Forest West	0		12-Jun-19	19-Jun-19	26-Jun-19	3-Jul-19	
Lopez Canyon	0		10-Jun-19	21-Jun-19	28-Jun-19	4-Jul-19	
McGinty 1	0		26-Jun-19	4-Jul-19			
McGinty Loop	0		19-Jun-19	26-Jun-19	4-Jul-19		
Meadowbrook ER	0		11-Jun-19	17-Jun-19	27-Jun-19	4-Jul-19	
Mission Trails	0		10-Jun-19	20-Jun-19	30-Jun-19	5-Jul-19	
Potrero BCLT	0		13-Jun-19	20-Jun-19	25-Jun-19		
Potrero BLM	0		13-Jun-19	20-Jun-19	25-Jun-19		
Skyline Truck Trail 1	0		24-May-19	5-Jun-19	11-Jun-19	19-Jun-19	26-Jun-19 2-Jul-19
Skyline Truck Trail 2	0		10-Jun-19	19-Jun-19	26-Jun-19	2-Jul-19	
Sycuan 1	0		18-Jun-19	24-Jun-19	3-Jul-19		
Sycuan 2	0		11-Jun-19	26-Jun-19	3-Jul-19		

*Not the sentinel site

Translocation

We did not detect Hermes copper adults at the three potential source sites (San Diego National Wildlife Refuge-McGinty Mountain, Skyline Truck Trail property, and Sycuan Peak Ecological Reserve). Due to the lack of Hermes copper observations in the Jamul area, we did not attempt translocations. It has always been our goal to reestablish a population at Hollenbeck Canyon Wildlife Area without substantially compromising the viability of source populations.

The weather during the summer of 2019 was cooler and cloudier than previous year. At times, this weather restricted our ability to conduct surveys during optimal conditions (temperature, cloud cover, time of day), particularly at the western most sites. There were few days in May that had any amount of time during the day that was suitable for Hermes copper flight, delaying the late flight season. During the flight season, some days experienced temperatures below 70°F until late in the afternoon. Since most Hermes copper adults cease activity by 1500, this provided a very narrow window to complete surveys and frequently prohibited the sampling of a second transect during the same day.

Discussion

The overall picture of the abundance and distribution of Hermes copper is concerning (Figure 6). Wildfires in 2003 and 2007 greatly reduced the distribution of Hermes copper (Marschalek and Klein 2010). More recently, drought has further reduced the distribution (Marschalek and Deutschman 2017, 2018b). Based on recent surveys, it appears that the Hermes copper is now restricted to the southeastern margin of its historical range. Furthermore, this species is represented by reasonable numbers at only one site (Roberts Ranch South). Species with restricted geographic ranges, narrow habitat tolerances, and small population sizes are the most vulnerable to extinction (Rabinowitz 1981). The Hermes copper fits all three of these categories, with its range and population sizes being further reduced over the last 15 years.

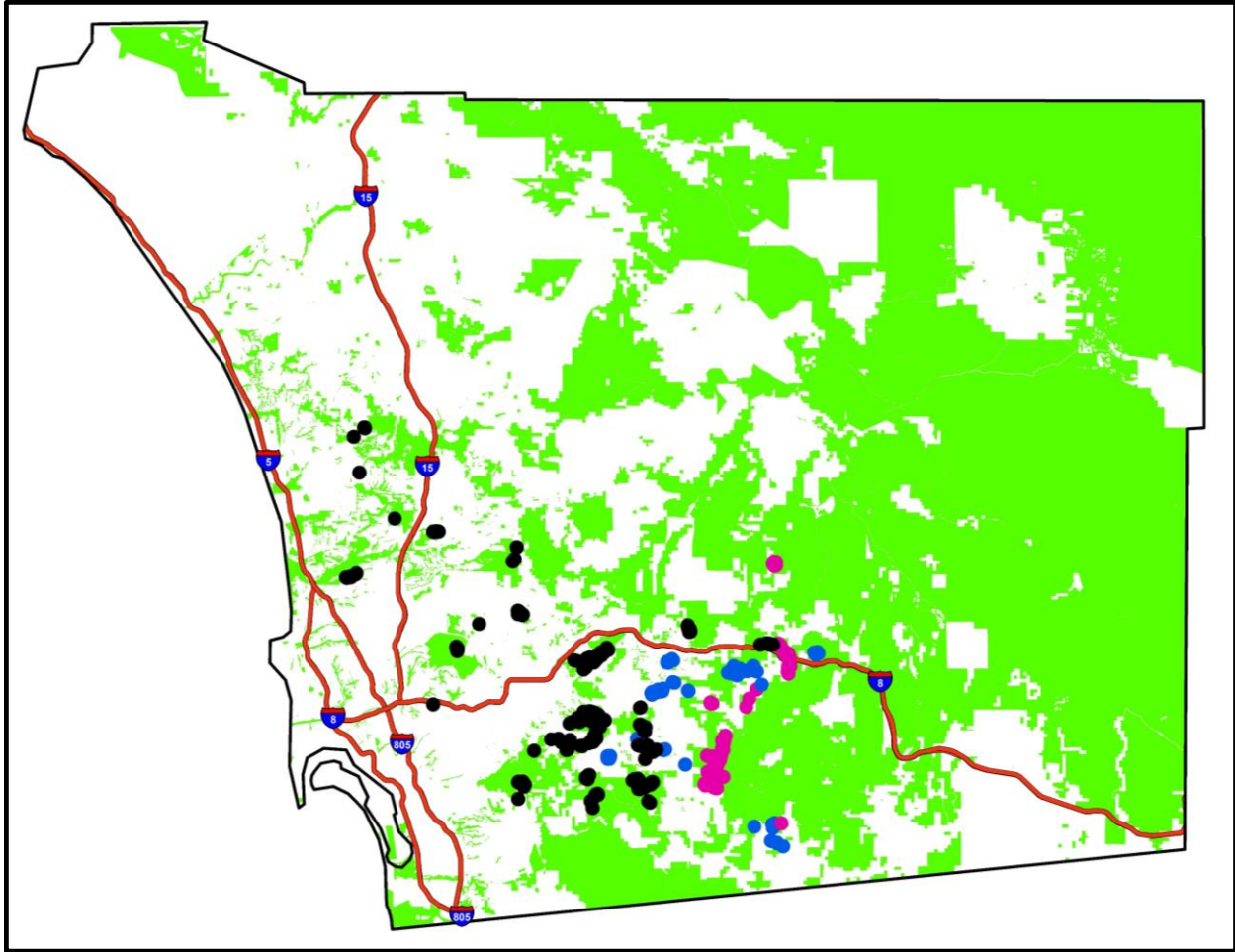


Figure 6. Updated status of local Hermes copper populations based on the most recent survey data. Purple and black circles represent extant populations and extirpated populations, respectively. Blue circles denote sites of unknown status, but most are presumed extirpated. Green shading are conserved lands (SANDAG).

Based on the last 20 years of surveys, fire and drought have extirpated all populations except for those at the highest elevation (furthest east). This is an area where winter and spring rainfall is more dependable. The trend of losing populations in western San Diego County, and persisting populations to the east in the foothills/mountains is similar to another endangered southern California butterfly, the Quino checkerspot (*Quino euphydryas editha*) (Preston et al. 2008). Preston et al. (2008) found that the increased rainfall at these higher elevations helped buffer habitat and associated populations from increasing temperatures.

Despite the 2019 survey being conducted in what appeared to be favorable conditions (above average rainfall, good plant growth), results were similar to 2018. Abiotic factors, such as precipitation and temperature, are well understood to be important in influencing annual population sizes of butterflies (Pollard 1988, Roy et al. 2001). A reasonable expectation was

that Hermes copper counts would increase as conditions were more favorable (more larval food and presumably of higher quality). It would also be reasonable to expect that the 2019 numbers would be similar to 2018, and it would take at least one year with high reproductive success to see an increase in location population sizes. The Roberts Ranch South population appears to have benefited from the increase rainfall, nearly doubling in numbers. There were mild improvements, with Lawson Peak going from zero in 2018 to one in 2019, and Boulder Creek Road from one to six. However, Hermes copper adults were not detected at any new sites in 2019 and few to no Hermes copper adults were detected at most sites.

To determine if there is a relationship between population sizes and extirpation rates, we compiled sites that 1) had previous Hermes copper counts greater than zero, and 2) were surveyed in 2018 and 2019 with sufficient intensity to reliably determine presence/absence (Table 3). Sites that were extirpated due to wildfires were excluded unless Hermes copper adults were observed following the fire. Extirpation due to wildfires is relatively easy to determine, as the vegetation (specifically spiny redberry) is either present or absent immediately after the event. Drought-caused extirpations are less clear due to the natural tendency of annual butterfly population sizes to fluctuate and the ability to diapause depending on the annual weather conditions. Of the 18 sites, the half with the smallest population sizes are extirpated. Even some larger sites have been extirpated. As supported by the 2019 survey results, only those sites at the highest elevations are still extant. Local conditions, rather than population size appear to be more influential in terms of determining resiliency of these population in response to drought.

An argument can be made that the existence of the Hermes copper butterfly is completely dependent on one population (Roberts Ranch South). As was the case after the 2003 and 2007 wildfires, the long-term persistence of this species requires dispersal from refuges to recolonize improved habitats following the particular stressor. Although somewhat confounded with drought, the ability to recolonize following fire has been demonstrated to be low, likely due to habitat fragmentation in many areas (Marschalek and Klein 2010, Marschalek et al. 2016). The same pattern should be expected following drought-caused extirpations. Again, recolonization following an environmental stressor (drought) is required before another wildfire results in the extirpation of maybe just one local population (Roberts Ranch South).

Table 3. Assessment of population size and extirpations. The highest Hermes copper count since 2003 and the 2019 status of sites.

High Count*	Extirpated	Extant
1	Crestridge Ecological Reserve** Hollenbeck Canyon Wildlife Area**	
2	Sycuan Peak (north area)	
3	Elfin Forest Las Montanas North Las Montanas South Wildwood Glen	
7	Lopez Canyon Mission Trails (Kwaay Paay Peak)	
9		Roberts Ranch North
12	Skyline Truck Trail 1	
14	Meadowbrook Ecological Reserve	
17		Lawson Peak
27	McGinty Mountain Skyline Truck Trail 1	
41	Sycuan Peak Ecological Reserve	
42		Boulder Creek**
95		Roberts Ranch South

*High count is not necessarily a peak number of butterflies during a year (max count) as survey intensity may not have been sufficient

**Since Hermes copper individuals were seen at these sites following a wildfire

Based on the low rate of recolonization (Marschalek and Klein 2010), natural dispersal is unlikely throughout most of the historic range and assisted dispersal would be required. Unfortunately, previous translocation efforts appear to have failed due to extreme drought conditions. Continuing the same efforts using the same sites does not appear to be feasible due to the extirpations of what were large source populations. Utilizing Roberts Ranch South as a source population for extirpated populations should be explored to expand the geographic extent of the species. In the dynamic southern California landscape, wildfires are expected and the geographic range of this species needs to expand before the few current populations are lost by future fires.

If there is any uncertainty regarding the status of this species, it is related to the possibility that there is a lag between sufficient rainfall and population sizes increasing. In this case, if there was increased reproduction during 2019, it would not be detected until the 2020 flight season. In the past, the Hermes copper has demonstrated the ability to increase in numbers the year immediately following a drought - see discussion in Marschalek and Deutschman (2015). Future surveys should include the current five sentinel sites to monitor the last remaining large population and to determine if the other populations can recover from the drought. In addition,

it has been several years since the populations at Loveland Reservoir and Wright's Field were surveyed. The status of these two sites should be determined in the near future, but suspected to have experienced the same fate as nearby extirpated populations.

The Hermes copper butterfly in San Diego County has experienced two substantial stressors in the last 20 years, starting with wildfires in 2003 and 2007, and followed by a drought for most of the last decade. Based on the extirpation and recolonization rates, the current configuration of redberry patches and connectivity of these patches outside of Cleveland National Forest does not appear to be sufficient for a resilient population of Hermes copper considering the dynamic San Diego County environment.

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Appendix. GPS coordinates of Hermes copper adults in 2019.

Date	Site	Latitude	Longitude
14-Jun-19	Roberts Ranch South	32.808464	-116.607716
14-Jun-19	Roberts Ranch South	32.808483	-116.607715
14-Jun-19	Roberts Ranch South	32.808496	-116.608585
14-Jun-19	Roberts Ranch South	32.808673	-116.614224
14-Jun-19	Roberts Ranch South	32.808821	-116.60765
14-Jun-19	Roberts Ranch South	32.808844	-116.614625
14-Jun-19	Roberts Ranch South	32.808855	-116.614642
14-Jun-19	Roberts Ranch South	32.808858	-116.614641
14-Jun-19	Roberts Ranch South	32.808914	-116.607647
14-Jun-19	Roberts Ranch South	32.808927	-116.60918
14-Jun-19	Roberts Ranch South	32.809113	-116.607331
14-Jun-19	Roberts Ranch South	32.809245	-116.607029
14-Jun-19	Roberts Ranch South	32.80931	-116.606909
14-Jun-19	Roberts Ranch South	32.809525	-116.611913
14-Jun-19	Roberts Ranch South	32.809535	-116.606704
14-Jun-19	Roberts Ranch South	32.809612	-116.606563
14-Jun-19	Roberts Ranch South	32.809621	-116.606565
14-Jun-19	Roberts Ranch South	32.809776	-116.611628
14-Jun-19	Roberts Ranch South	32.810091	-116.606053
14-Jun-19	Roberts Ranch South	32.810125	-116.6113
14-Jun-19	Roberts Ranch South	32.810453	-116.605585
14-Jun-19	Roberts Ranch South	32.810489	-116.611301
14-Jun-19	Roberts Ranch South	32.810699	-116.605537
14-Jun-19	Roberts Ranch South	32.810806	-116.605533
14-Jun-19	Roberts Ranch South	32.811039	-116.605505
14-Jun-19	Roberts Ranch South	32.811052	-116.611426
14-Jun-19	Roberts Ranch South	32.811417	-116.605058
14-Jun-19	Roberts Ranch South	32.811433	-116.605603
14-Jun-19	Roberts Ranch South	32.811507	-116.604645
14-Jun-19	Roberts Ranch South	32.811546	-116.605385
14-Jun-19	Roberts Ranch South	32.81161	-116.604539
14-Jun-19	Roberts Ranch South	32.811681	-116.604487
14-Jun-19	Roberts Ranch South	32.811744	-116.604456
14-Jun-19	Roberts Ranch South	32.811766	-116.604257
14-Jun-19	Roberts Ranch South	32.811805	-116.604317
14-Jun-19	Roberts Ranch South	32.811893	-116.603859
14-Jun-19	Roberts Ranch South	32.811998	-116.603178
14-Jun-19	Roberts Ranch South	32.811999	-116.603175
14-Jun-19	Roberts Ranch South	32.812165	-116.60293

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
14-Jun-19	Roberts Ranch South	32.812165	-116.602903
14-Jun-19	Roberts Ranch South	32.812208	-116.602878
14-Jun-19	Roberts Ranch South	32.812695	-116.602566
14-Jun-19	Roberts Ranch South	32.812705	-116.602562
14-Jun-19	Roberts Ranch South	32.81297	-116.602501
14-Jun-19	Roberts Ranch South	32.813053	-116.602494
14-Jun-19	Roberts Ranch South	32.813184	-116.602447
14-Jun-19	Roberts Ranch South	32.813279	-116.602422
14-Jun-19	Roberts Ranch South	32.813358	-116.602394
14-Jun-19	Roberts Ranch South	32.813589	-116.602219
14-Jun-19	Roberts Ranch South	32.813621	-116.602203
14-Jun-19	Roberts Ranch South	32.813752	-116.602147
14-Jun-19	Roberts Ranch South	32.813884	-116.602115
14-Jun-19	Roberts Ranch South	32.814039	-116.60206
14-Jun-19	Roberts Ranch South	32.814046	-116.602056
14-Jun-19	Roberts Ranch South	32.81412	-116.602003
15-Jun-19	Lawson Peak	32.7147	-116.7103
18-Jun-19	Roberts Ranch South	32.808507	-116.613811
18-Jun-19	Roberts Ranch South	32.808534	-116.607682
18-Jun-19	Roberts Ranch South	32.808543	-116.613865
18-Jun-19	Roberts Ranch South	32.808544	-116.613261
18-Jun-19	Roberts Ranch South	32.80855	-116.613862
18-Jun-19	Roberts Ranch South	32.808555	-116.613905
18-Jun-19	Roberts Ranch South	32.808565	-116.6139
18-Jun-19	Roberts Ranch South	32.808571	-116.613184
18-Jun-19	Roberts Ranch South	32.808603	-116.612861
18-Jun-19	Roberts Ranch South	32.808606	-116.612849
18-Jun-19	Roberts Ranch South	32.808772	-116.614441
18-Jun-19	Roberts Ranch South	32.808829	-116.607646
18-Jun-19	Roberts Ranch South	32.80897	-116.612472
18-Jun-19	Roberts Ranch South	32.80901	-116.6076
18-Jun-19	Roberts Ranch South	32.809012	-116.607609
18-Jun-19	Roberts Ranch South	32.809133	-116.607436
18-Jun-19	Roberts Ranch South	32.809147	-116.612457
18-Jun-19	Roberts Ranch South	32.809313	-116.606903
18-Jun-19	Roberts Ranch South	32.809321	-116.6069
18-Jun-19	Roberts Ranch South	32.809517	-116.606708
18-Jun-19	Roberts Ranch South	32.80952	-116.606703
18-Jun-19	Roberts Ranch South	32.809574	-116.61186

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
18-Jun-19	Roberts Ranch South	32.809621	-116.606541
18-Jun-19	Roberts Ranch South	32.809693	-116.6117
18-Jun-19	Roberts Ranch South	32.809752	-116.606276
18-Jun-19	Roberts Ranch South	32.809842	-116.606156
18-Jun-19	Roberts Ranch South	32.809845	-116.606138
18-Jun-19	Roberts Ranch South	32.80988	-116.609962
18-Jun-19	Roberts Ranch South	32.809904	-116.606125
18-Jun-19	Roberts Ranch South	32.810184	-116.611326
18-Jun-19	Roberts Ranch South	32.810346	-116.605624
18-Jun-19	Roberts Ranch South	32.810354	-116.605626
18-Jun-19	Roberts Ranch South	32.810709	-116.609711
18-Jun-19	Roberts Ranch South	32.810899	-116.605506
18-Jun-19	Roberts Ranch South	32.810912	-116.605508
18-Jun-19	Roberts Ranch South	32.81104	-116.61143
18-Jun-19	Roberts Ranch South	32.811095	-116.609849
18-Jun-19	Roberts Ranch South	32.811131	-116.60549
18-Jun-19	Roberts Ranch South	32.81142	-116.604923
18-Jun-19	Roberts Ranch South	32.811423	-116.605043
18-Jun-19	Roberts Ranch South	32.811476	-116.605624
18-Jun-19	Roberts Ranch South	32.811487	-116.603995
18-Jun-19	Roberts Ranch South	32.811512	-116.60468
18-Jun-19	Roberts Ranch South	32.811513	-116.604683
18-Jun-19	Roberts Ranch South	32.81158	-116.604095
18-Jun-19	Roberts Ranch South	32.811627	-116.60387
18-Jun-19	Roberts Ranch South	32.811655	-116.604476
18-Jun-19	Roberts Ranch South	32.811656	-116.604487
18-Jun-19	Roberts Ranch South	32.811657	-116.604474
18-Jun-19	Roberts Ranch South	32.811666	-116.604462
18-Jun-19	Roberts Ranch South	32.811671	-116.604467
18-Jun-19	Roberts Ranch South	32.811683	-116.603881
18-Jun-19	Roberts Ranch South	32.811697	-116.604186
18-Jun-19	Roberts Ranch South	32.811751	-116.604448
18-Jun-19	Roberts Ranch South	32.811788	-116.60439
18-Jun-19	Roberts Ranch South	32.811886	-116.603881
18-Jun-19	Roberts Ranch South	32.811891	-116.603884
18-Jun-19	Roberts Ranch South	32.812013	-116.603161
18-Jun-19	Roberts Ranch South	32.81218	-116.602922
18-Jun-19	Roberts Ranch South	32.812403	-116.602734
18-Jun-19	Roberts Ranch South	32.812666	-116.602604

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
18-Jun-19	Roberts Ranch South	32.812701	-116.602549
18-Jun-19	Roberts Ranch South	32.812759	-116.602551
18-Jun-19	Roberts Ranch South	32.812809	-116.602549
18-Jun-19	Roberts Ranch South	32.813231	-116.602406
18-Jun-19	Roberts Ranch South	32.813536	-116.602251
18-Jun-19	Roberts Ranch South	32.813548	-116.602247
18-Jun-19	Roberts Ranch South	32.813696	-116.602157
18-Jun-19	Roberts Ranch South	32.814055	-116.602088
18-Jun-19	Roberts Ranch South	32.814509	-116.601836
19-Jun-19	Lawson Peak	32.714732	-116.710241
20-Jun-19	Boulder Creek Road*	32.918372	-116.631368
20-Jun-19	Boulder Creek Road*	32.919265	-116.630946
20-Jun-19	Boulder Creek Road*	32.925297	-116.630806
20-Jun-19	Boulder Creek Road*	32.925298	-116.630788
20-Jun-19	Boulder Creek Road*	32.93001	-116.636897
20-Jun-19	Boulder Creek Road*	32.934356	-116.636971
20-Jun-19	Lawson Peak	32.71476	-116.710183
21-Jun-19	Roberts Ranch South	32.8088	-116.60762
21-Jun-19	Roberts Ranch South	32.808914	-116.60741
21-Jun-19	Roberts Ranch South	32.80906	-116.61245
21-Jun-19	Roberts Ranch South	32.80906	-116.61245
21-Jun-19	Roberts Ranch South	32.80906	-116.61245
21-Jun-19	Roberts Ranch South	32.80916	-116.60719
21-Jun-19	Roberts Ranch South	32.80931	-116.6069
21-Jun-19	Roberts Ranch South	32.8101	-116.606
21-Jun-19	Roberts Ranch South	32.81017	-116.60596
21-Jun-19	Roberts Ranch South	32.81017	-116.60596
21-Jun-19	Roberts Ranch South	32.81071	-116.60553
21-Jun-19	Roberts Ranch South	32.81105	-116.60551
21-Jun-19	Roberts Ranch South	32.81107	-116.61042
21-Jun-19	Roberts Ranch South	32.81107	-116.61042
21-Jun-19	Roberts Ranch South	32.81107	-116.61042
21-Jun-19	Roberts Ranch South	32.81107	-116.61042
21-Jun-19	Roberts Ranch South	32.8112	-116.60548
21-Jun-19	Roberts Ranch South	32.8113	-116.60548
21-Jun-19	Roberts Ranch South	32.81142	-116.6051
21-Jun-19	Roberts Ranch South	32.81142	-116.60501
21-Jun-19	Roberts Ranch South	32.81156	-116.60535
21-Jun-19	Roberts Ranch South	32.81165	-116.60452

*Not associated with standard transect sampling at the Boulder Creek sentinel site.

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
21-Jun-19	Roberts Ranch South	32.81165	-116.60387
21-Jun-19	Roberts Ranch South	32.81165	-116.60387
21-Jun-19	Roberts Ranch South	32.81165	-116.60387
21-Jun-19	Roberts Ranch South	32.81171	-116.60441
21-Jun-19	Roberts Ranch South	32.81198	-116.6032
21-Jun-19	Roberts Ranch South	32.81198	-116.6032
21-Jun-19	Roberts Ranch South	32.81242	-116.60272
21-Jun-19	Roberts Ranch South	32.81264	-116.60258
21-Jun-19	Roberts Ranch South	32.81264	-116.60258
21-Jun-19	Roberts Ranch South	32.8129	-116.60252
21-Jun-19	Roberts Ranch South	32.8129	-116.60252
21-Jun-19	Roberts Ranch South	32.81299	-116.60251
21-Jun-19	Roberts Ranch South	32.81336	-116.60232
21-Jun-19	Roberts Ranch South	32.81336	-116.60232
21-Jun-19	Roberts Ranch South	32.81336	-116.60232
21-Jun-19	Roberts Ranch South	32.81336	-116.60232
21-Jun-19	Roberts Ranch South	32.81361	-116.60217
21-Jun-19	Roberts Ranch South	32.81361	-116.60217
21-Jun-19	Roberts Ranch South	32.81361	-116.60217
24-Jun-19	Roberts Ranch South	32.808507	-116.613741
24-Jun-19	Roberts Ranch South	32.808522	-116.613865
24-Jun-19	Roberts Ranch South	32.808554	-116.613176
24-Jun-19	Roberts Ranch South	32.80856	-116.613111
24-Jun-19	Roberts Ranch South	32.808678	-116.614237
24-Jun-19	Roberts Ranch South	32.808679	-116.614174
24-Jun-19	Roberts Ranch South	32.8087	-116.607661
24-Jun-19	Roberts Ranch South	32.808705	-116.614333
24-Jun-19	Roberts Ranch South	32.808785	-116.614444
24-Jun-19	Roberts Ranch South	32.80883	-116.614526
24-Jun-19	Roberts Ranch South	32.80884	-116.607639
24-Jun-19	Roberts Ranch South	32.808842	-116.607641
24-Jun-19	Roberts Ranch South	32.808876	-116.614631
24-Jun-19	Roberts Ranch South	32.808898	-116.609131
24-Jun-19	Roberts Ranch South	32.808939	-116.612501
24-Jun-19	Roberts Ranch South	32.808997	-116.6125
24-Jun-19	Roberts Ranch South	32.809128	-116.607438
24-Jun-19	Roberts Ranch South	32.809133	-116.607438
24-Jun-19	Roberts Ranch South	32.809294	-116.606899
24-Jun-19	Roberts Ranch South	32.809555	-116.611894

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
24-Jun-19	Roberts Ranch South	32.809723	-116.61173
24-Jun-19	Roberts Ranch South	32.809731	-116.610063
24-Jun-19	Roberts Ranch South	32.809819	-116.611603
24-Jun-19	Roberts Ranch South	32.809862	-116.606125
24-Jun-19	Roberts Ranch South	32.809871	-116.606099
24-Jun-19	Roberts Ranch South	32.809939	-116.609939
24-Jun-19	Roberts Ranch South	32.809942	-116.609941
24-Jun-19	Roberts Ranch South	32.81006	-116.60604
24-Jun-19	Roberts Ranch South	32.810157	-116.605975
24-Jun-19	Roberts Ranch South	32.810182	-116.605936
24-Jun-19	Roberts Ranch South	32.810192	-116.611325
24-Jun-19	Roberts Ranch South	32.810311	-116.611287
24-Jun-19	Roberts Ranch South	32.810342	-116.605624
24-Jun-19	Roberts Ranch South	32.810741	-116.605498
24-Jun-19	Roberts Ranch South	32.810764	-116.609711
24-Jun-19	Roberts Ranch South	32.810767	-116.609706
24-Jun-19	Roberts Ranch South	32.810809	-116.605504
24-Jun-19	Roberts Ranch South	32.810811	-116.605504
24-Jun-19	Roberts Ranch South	32.810913	-116.61063
24-Jun-19	Roberts Ranch South	32.810971	-116.605497
24-Jun-19	Roberts Ranch South	32.810985	-116.610581
24-Jun-19	Roberts Ranch South	32.810995	-116.610553
24-Jun-19	Roberts Ranch South	32.811041	-116.605479
24-Jun-19	Roberts Ranch South	32.811047	-116.609656
24-Jun-19	Roberts Ranch South	32.811053	-116.611421
24-Jun-19	Roberts Ranch South	32.811056	-116.610434
24-Jun-19	Roberts Ranch South	32.811094	-116.609757
24-Jun-19	Roberts Ranch South	32.811106	-116.610305
24-Jun-19	Roberts Ranch South	32.811141	-116.605462
24-Jun-19	Roberts Ranch South	32.811147	-116.605461
24-Jun-19	Roberts Ranch South	32.811377	-116.605532
24-Jun-19	Roberts Ranch South	32.811445	-116.605162
24-Jun-19	Roberts Ranch South	32.811465	-116.604769
24-Jun-19	Roberts Ranch South	32.811493	-116.605608
24-Jun-19	Roberts Ranch South	32.811494	-116.605607
24-Jun-19	Roberts Ranch South	32.811536	-116.605227
24-Jun-19	Roberts Ranch South	32.811559	-116.60538
24-Jun-19	Roberts Ranch South	32.811571	-116.604601
24-Jun-19	Roberts Ranch South	32.811574	-116.604601

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
24-Jun-19	Roberts Ranch South	32.811651	-116.60388
24-Jun-19	Roberts Ranch South	32.811783	-116.60434
24-Jun-19	Roberts Ranch South	32.81183	-116.604332
24-Jun-19	Roberts Ranch South	32.811891	-116.60389
24-Jun-19	Roberts Ranch South	32.81194	-116.603834
24-Jun-19	Roberts Ranch South	32.811952	-116.603632
24-Jun-19	Roberts Ranch South	32.811956	-116.603363
24-Jun-19	Roberts Ranch South	32.81198	-116.603233
24-Jun-19	Roberts Ranch South	32.811981	-116.603229
24-Jun-19	Roberts Ranch South	32.812162	-116.60291
24-Jun-19	Roberts Ranch South	32.812293	-116.602817
24-Jun-19	Roberts Ranch South	32.812397	-116.602725
24-Jun-19	Roberts Ranch South	32.812398	-116.602715
24-Jun-19	Roberts Ranch South	32.812663	-116.602589
24-Jun-19	Roberts Ranch South	32.812745	-116.602556
24-Jun-19	Roberts Ranch South	32.812808	-116.602495
24-Jun-19	Roberts Ranch South	32.812873	-116.602514
24-Jun-19	Roberts Ranch South	32.812904	-116.602506
24-Jun-19	Roberts Ranch South	32.813018	-116.602491
24-Jun-19	Roberts Ranch South	32.813217	-116.602405
24-Jun-19	Roberts Ranch South	32.81333	-116.602372
24-Jun-19	Roberts Ranch South	32.81336	-116.602353
24-Jun-19	Roberts Ranch South	32.813442	-116.602283
24-Jun-19	Roberts Ranch South	32.813539	-116.602249
24-Jun-19	Roberts Ranch South	32.813541	-116.60225
24-Jun-19	Roberts Ranch South	32.813541	-116.602249
24-Jun-19	Roberts Ranch South	32.813638	-116.602188
24-Jun-19	Roberts Ranch South	32.813732	-116.602157
24-Jun-19	Roberts Ranch South	32.813774	-116.602139
24-Jun-19	Roberts Ranch South	32.814009	-116.60208
24-Jun-19	Roberts Ranch South	32.814041	-116.602083
24-Jun-19	Roberts Ranch South	32.814112	-116.602023
24-Jun-19	Roberts Ranch South	32.814459	-116.60183
24-Jun-19	Roberts Ranch South	32.81451	-116.601811
27-Jun-19	Boulder Creek	32.92681	-116.63151
27-Jun-19	Boulder Creek	32.92681	-116.63151
27-Jun-19	Boulder Creek Road*	32.714734	-116.710169
27-Jun-19	Boulder Creek Road*	32.919898	-116.630606
27-Jun-19	Boulder Creek Road*	32.919902	-116.6306

*Not associated with standard transect sampling at the Boulder Creek sentinel site.

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
27-Jun-19	Boulder Creek Road*	32.925507	-116.630693
27-Jun-19	Boulder Creek Road*	32.926274	-116.631229
27-Jun-19	Boulder Creek Road*	32.927874	-116.634954
27-Jun-19	Lawson Peak	32.715404	-116.710441
27-Jun-19	Roberts Ranch North	32.827721	-116.61441
27-Jun-19	Roberts Ranch South	32.80853	-116.61344
27-Jun-19	Roberts Ranch South	32.80855	-116.61314
27-Jun-19	Roberts Ranch South	32.80856	-116.61388
27-Jun-19	Roberts Ranch South	32.80882	-116.61454
27-Jun-19	Roberts Ranch South	32.80883	-116.61453
27-Jun-19	Roberts Ranch South	32.80888	-116.60559
27-Jun-19	Roberts Ranch South	32.80896	-116.61511
27-Jun-19	Roberts Ranch South	32.80954	-116.6119
27-Jun-19	Roberts Ranch South	32.8097	-116.6117
27-Jun-19	Roberts Ranch South	32.80997	-116.60608
27-Jun-19	Roberts Ranch South	32.80997	-116.60608
27-Jun-19	Roberts Ranch South	32.81013	-116.60606
27-Jun-19	Roberts Ranch South	32.81013	-116.60606
27-Jun-19	Roberts Ranch South	32.81013	-116.60606
27-Jun-19	Roberts Ranch South	32.81019	-116.606596
27-Jun-19	Roberts Ranch South	32.81019	-116.606596
27-Jun-19	Roberts Ranch South	32.81019	-116.606596
27-Jun-19	Roberts Ranch South	32.81049	-116.61134
27-Jun-19	Roberts Ranch South	32.81049	-116.61134
27-Jun-19	Roberts Ranch South	32.81049	-116.61134
27-Jun-19	Roberts Ranch South	32.81102	-116.6111
27-Jun-19	Roberts Ranch South	32.81102	-116.6111
27-Jun-19	Roberts Ranch South	32.81102	-116.6111
27-Jun-19	Roberts Ranch South	32.81102	-116.6111
27-Jun-19	Roberts Ranch South	32.81102	-116.6111
27-Jun-19	Roberts Ranch South	32.81112	-116.60547
27-Jun-19	Roberts Ranch South	32.81143	-116.60559
27-Jun-19	Roberts Ranch South	32.81143	-116.60559
27-Jun-19	Roberts Ranch South	32.81143	-116.60559
27-Jun-19	Roberts Ranch South	32.81147	-116.60478
27-Jun-19	Roberts Ranch South	32.81155	-116.60536
27-Jun-19	Roberts Ranch South	32.81155	-116.60536
27-Jun-19	Roberts Ranch South	32.81173	-116.6044
27-Jun-19	Roberts Ranch South	32.81173	-116.6044

*Not associated with standard transect sampling at the Boulder Creek sentinel site.

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
27-Jun-19	Roberts Ranch South	32.81196	-116.60374
27-Jun-19	Roberts Ranch South	32.81196	-116.60374
27-Jun-19	Roberts Ranch South	32.812	-116.60316
27-Jun-19	Roberts Ranch South	32.812	-116.60316
27-Jun-19	Roberts Ranch South	32.81218	-116.60291
27-Jun-19	Roberts Ranch South	32.81266	-116.60258
27-Jun-19	Roberts Ranch South	32.81266	-116.60258
27-Jun-19	Roberts Ranch South	32.81266	-116.60258
27-Jun-19	Roberts Ranch South	32.81412	-116.60204
2-Jul-19	Roberts Ranch South	32.80864	-116.614138
2-Jul-19	Roberts Ranch South	32.808722	-116.614347
2-Jul-19	Roberts Ranch South	32.808759	-116.614442
2-Jul-19	Roberts Ranch South	32.808831	-116.614571
2-Jul-19	Roberts Ranch South	32.808877	-116.614747
2-Jul-19	Roberts Ranch South	32.808879	-116.614741
2-Jul-19	Roberts Ranch South	32.808926	-116.60917
2-Jul-19	Roberts Ranch South	32.809142	-116.607453
2-Jul-19	Roberts Ranch South	32.809236	-116.60705
2-Jul-19	Roberts Ranch South	32.809548	-116.61189
2-Jul-19	Roberts Ranch South	32.809562	-116.610001
2-Jul-19	Roberts Ranch South	32.809892	-116.606129
2-Jul-19	Roberts Ranch South	32.809894	-116.609964
2-Jul-19	Roberts Ranch South	32.810069	-116.606041
2-Jul-19	Roberts Ranch South	32.810218	-116.609783
2-Jul-19	Roberts Ranch South	32.810267	-116.6098
2-Jul-19	Roberts Ranch South	32.810273	-116.609787
2-Jul-19	Roberts Ranch South	32.810508	-116.611298
2-Jul-19	Roberts Ranch South	32.810666	-116.609749
2-Jul-19	Roberts Ranch South	32.81098	-116.610582
2-Jul-19	Roberts Ranch South	32.811071	-116.609881
2-Jul-19	Roberts Ranch South	32.811072	-116.61048
2-Jul-19	Roberts Ranch South	32.811413	-116.605028
2-Jul-19	Roberts Ranch South	32.811445	-116.605589
2-Jul-19	Roberts Ranch South	32.811449	-116.605602
2-Jul-19	Roberts Ranch South	32.811483	-116.605607
2-Jul-19	Roberts Ranch South	32.811493	-116.604012
2-Jul-19	Roberts Ranch South	32.811633	-116.603867
2-Jul-19	Roberts Ranch South	32.811648	-116.603873
2-Jul-19	Roberts Ranch South	32.81165	-116.604505

Appendix. GPS coordinates of Hermes copper adults in 2019 continued.

Date	Site	Latitude	Longitude
2-Jul-19	Roberts Ranch South	32.811689	-116.604177
2-Jul-19	Roberts Ranch South	32.811691	-116.604474
2-Jul-19	Roberts Ranch South	32.811762	-116.603864
2-Jul-19	Roberts Ranch South	32.811793	-116.604386
2-Jul-19	Roberts Ranch South	32.811874	-116.603897
2-Jul-19	Roberts Ranch South	32.811877	-116.603896
2-Jul-19	Roberts Ranch South	32.811899	-116.603885
2-Jul-19	Roberts Ranch South	32.811993	-116.60316
2-Jul-19	Roberts Ranch South	32.812164	-116.602935
2-Jul-19	Roberts Ranch South	32.812195	-116.602869
2-Jul-19	Roberts Ranch South	32.812604	-116.602604
2-Jul-19	Roberts Ranch South	32.812754	-116.602548
2-Jul-19	Roberts Ranch South	32.812754	-116.602543
2-Jul-19	Roberts Ranch South	32.812919	-116.60251
2-Jul-19	Roberts Ranch South	32.812927	-116.602504
2-Jul-19	Roberts Ranch South	32.813024	-116.602483
2-Jul-19	Roberts Ranch South	32.813363	-116.602345
2-Jul-19	Roberts Ranch South	32.813522	-116.60224
2-Jul-19	Roberts Ranch South	32.813525	-116.602241
2-Jul-19	Roberts Ranch South	32.813904	-116.602091
2-Jul-19	Roberts Ranch South	32.813941	-116.602086
2-Jul-19	Roberts Ranch South	32.814119	-116.602016
2-Jul-19	Roberts Ranch South	32.814467	-116.601816
2-Jul-19	Roberts Ranch South	32.814538	-116.601783
5-Jul-19	Roberts Ranch North	32.827721	-116.61441
10-Jul-19	Roberts Ranch North	32.827685	-116.614412
10-Jul-19	Roberts Ranch North	32.827685	-116.614412