Task 13: 2024 Hermes Copper Adult Surveys

Hermes Copper Butterfly Surveys and Translocation Efforts

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Executive Summary

The Hermes copper (*Tharsalea hermes*) is a rare butterfly endemic to San Diego County and northern Baja California. This species is Federally listed as Threatened, with its decline attributed to urbanization, wildfires, and drought throughout its range in the United States. Since most individuals and the two (known) remaining large populations 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 (2024 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 2024, covering more sites than sampled during 2019 – 2023.

The 2024 status of Hermes copper populations is similar to the last couple years, with the addition of an observation in Lawson Valley (and continued observations at Lyons Valley and Lawson Peak). These suggest a local population (occupied habitat) in the Lawson Peak area likely survived the recent drought. However, given these data, the long-term viability of the species still appears to be highly dependent on the Roberts Ranch South-Bell Bluff area.

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Introduction

The Hermes copper (*Tharsalea 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). The species was later listed as Threatened by the USFWS (USFWS 2021). Recently, Zhang et al. (2020) suggested a taxonomic revision, resurrecting *Tharsalea* as the genus for Hermes copper, and has been adapted by Pelham (2023).

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 – 2022 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, 2022). Surveys in 2023 included fewer sites, focusing on sentinel sites and six other sites that we thought had higher chances of being recolonized (Marschalek et al. 2023). 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 than previously known.

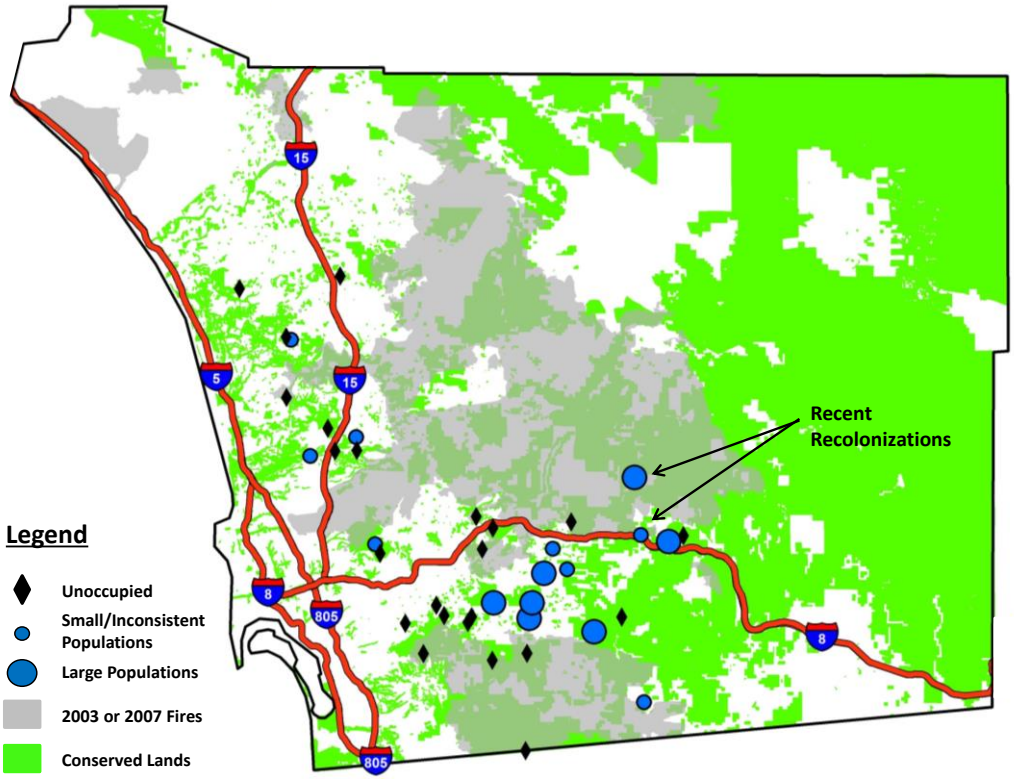

Figure 1. Detections of Hermes copper butterflies on conserved lands, 2010 – 2013. Sampling locations where Hermes copper was not detected are represented by black diamonds. Small and large Hermes copper populations are indicated by different sized circles.

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, 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. In 2024, we conducted surveys in many areas that were sampled in 2010 or later, and have current or historic Hermes copper observations. Due to a few observations of single Hermes copper individuals in locations that did not have recent sightings (e.g. off the sentinel transects at Lawson Peak and Roberts Ranch North), more sites were included compared to 2023 efforts.

Methods

Sentinel Sites

In 2024, 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). In 2024 (as well as 2023), surveys were also conducted at Lawson Peak along roads at higher elevations than the sentinel transect and reported in the "Exploratory Sites" section below. These 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) between 900 to 1500. The location of each Hermes copper observation was recorded with a handheld GPS unit. Initial surveys occurred on 20 May 2024 at Roberts Ranch South because the 2019 – 2023 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.

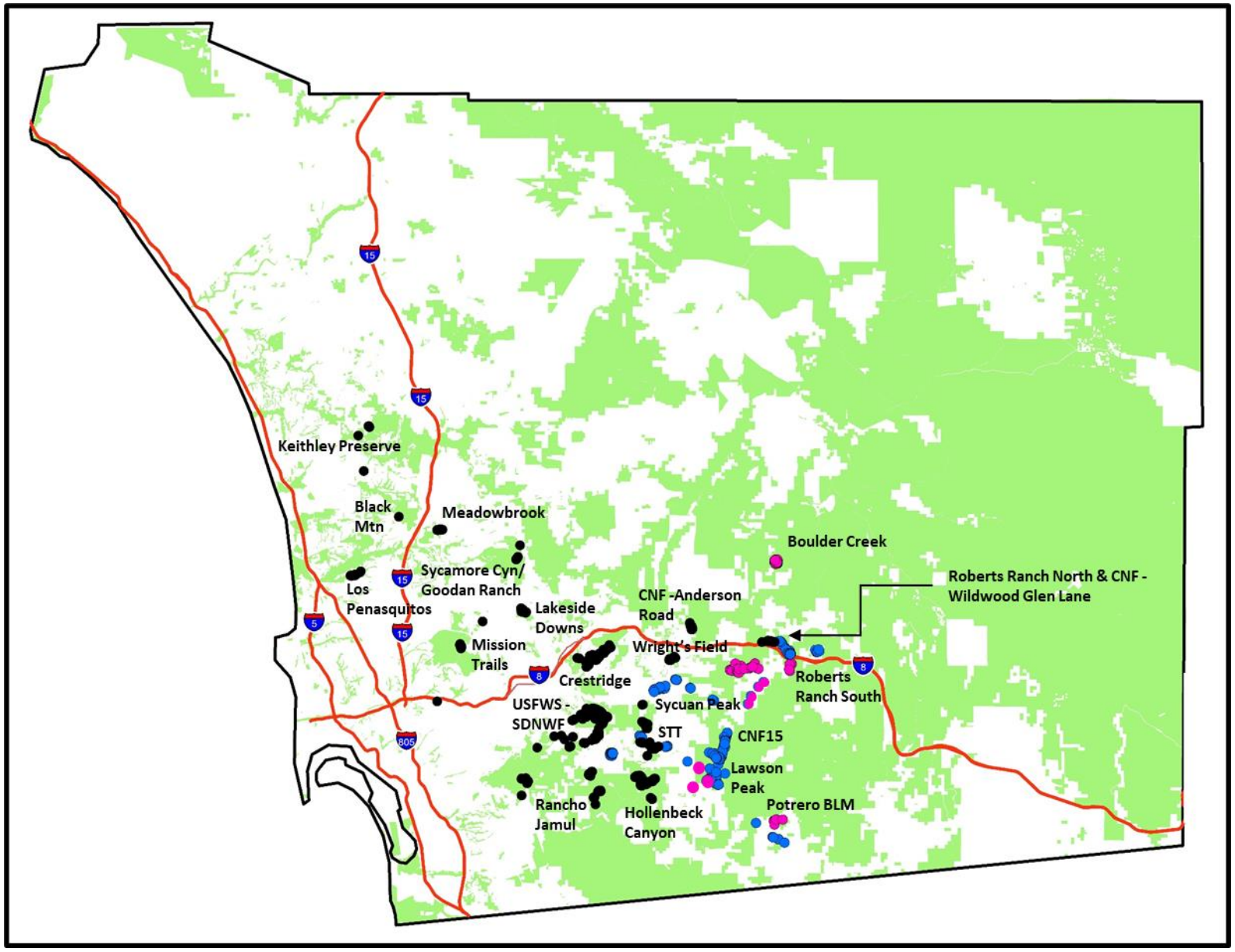

Figure 2. Map of sites that were surveyed for Hermes copper adults in 2024. Purple circles represent extant populations, black circles represent extirpated populations, and blue circles denote sites of unknown status. Status of each site presumed as of August 2024. Green shading are conserved lands (SANDAG).

Exploratory Sites

In 2024, in addition to the five sentinel transects, we conducted surveys for Hermes copper adults at 31 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, 2022; Marschalek et al. 2023). Our goal was to assess 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 May and June 2024.

Results

Sentinel Sites

The first Hermes copper adult observed in 2024 was on 3 June at Roberts Ranch South, when five adults were observed. As was the case in recent years, most Hermes copper observations were at Roberts Ranch South with a maximum count of 66 individuals on 10 June (Figure 3, Table 1). Three adults were observed west of the Roberts Ranch South transect in an area that was searched in 2022 without any observations (one was seen in 2023). No Hermes copper adults were detected at Roberts Ranch North or Sycuan Peak Ecological Reserve in 2024. This is the eighth consecutive year we did not detect adults at the Sycuan Peak transect and the fifth 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 two Hermes copper adults (also see next paragraph for more details regarding this site).

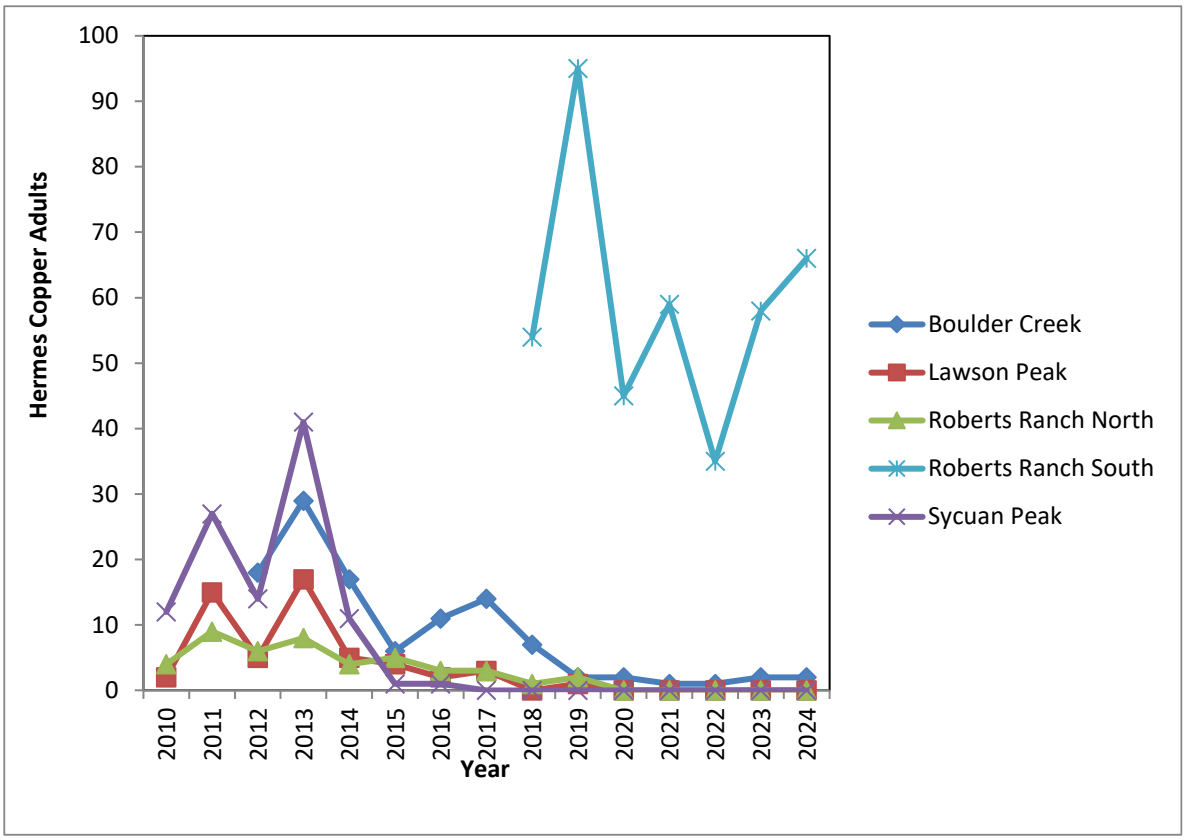

Figure 3. Maximum daily counts of Hermes copper adults at five sentinel sites, 2010 – 2024.

Table 1. Maximum counts of Hermes copper adults at five sentinel sites and an additional site that received frequent visits, 2010 – 2024. Sampling at sentinel sites consisted of repeated transects to obtain an accurate maximum count.

Sentinel Sites	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Boulder Creek (routes 2 & 3)	---	---	18	29	17	6	11	14	7	2	2	1	1	2	2
Boulder Creek (loop- includes routes 2 & 3)*	---	---	---	42	19	10	23	24	26	2	3	2	3	2	2
Lawson Peak	2	15	5	17	5	4	2	3	0	1	0	0	0	0	0
Roberts Ranch North	4	9	6	8	4	5	3	3	1	2	0	0	0	0	0
Sycuan Peak	12	27	14	41	11	1	1	0	0	0	0	0	0	0	0
Roberts Ranch South (CNF7)**	---	---	---	---	---	---	---	---	54	95	45	59	35	58	66

" --- " 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.

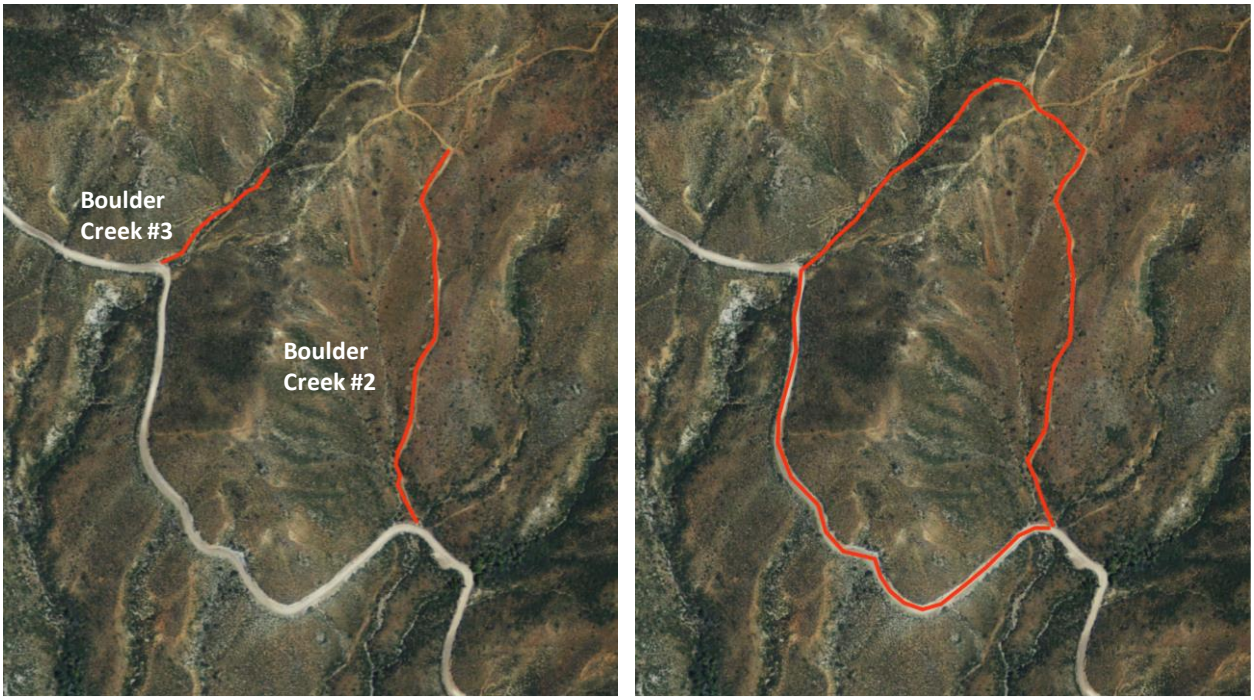

Figure 4. Comparison of survey transects (shown in red) at the Boulder Creek sentinel site. Left: Boulder Creek 2 and Boulder Creek 3 transects were surveyed in 2012. Right: A loop was surveyed in 2013 – 2024, but only Hermes copper counts from transects 2 and 3 were reported in 2013 – 2018 report summary tables.

Exploratory Sites

Surveys were conducted 16 May – 28 June, with Hermes copper adults detected at two of the 31 exploratory transects (Table 2). A maximum count of four Hermes copper adults were observed on the Potrero BLM transect, with another three individuals on a small trail extending off of the original transect on the same day (a total of seven different individuals). 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 – 2024. Five Hermes copper adults were observed at Lawson Peak, at a higher elevation

than the sentinel survey transect. In 2023, a single individual appeared to be moving through this same area.

Table 2. Maximum count of Hermes copper adults and number of surveys for each survey transect at the exploratory sites.

Site	Hermes Copper Maximum Count	Survey Dates
Black Mountain	0	28 May 2024; 10, 21 June 2024
CNF15	0	25, 31 May 2024; 5, 14, 20 June 2024
CNF – Anderson Road	0	30 May 2024; 6 , 13, 17, 26 June 2024
CNF – Wildwood Glen	0	16, 20, 27 May 2024; 3 June 2024
Crestridge Ecological Reserve (3 transects)	0	21, 28 May 2024; 4, 11, 18 June 2024
Keithley Preserve (Elfin Forest)	0	29 May 2024; 5, 10, 20, 27 June 2024
Hollenbeck Canyon Wildlife Area (2 transects)	0	24, 28 May 2024; 7, 14, 21, 26 June 2024
Lakeside Downs	0	30 May 2024; 6 , 13, 18, 26 June 2024
Lawson Peak Extension	**5**	20, 23, 27, 30 May 2024; 3, 6, 10, 13, 17, 20, 24, 27 June 2024
Los Penasquitos (Lopez) Canyon Preserve	0	28 May 2024; 4, 10, 21 June 2024
Meadowbrook Ecological Reserve	0	28 May 2024; 4, 10, 18 June 2024
Mission Trails Regional Park (2 transects)	0	21, 29 May 2024; 5, 12, 19 June 2024
Potrero BLM	**4 (3)***	23, 28 May 2024; 6, 11, 13, 18, 25 June 2024
Rancho Jamul Ecological Reserve (4 transects)	0	24, 31 May 2024; 7, 13, 21 June 2024
Skyline Truck Trail (3 transects)	0	29 May 2024; 4, 12, 18, 25 June 2024
Sycamore Canyon/Goodan Ranch County Park	0	30 May 2024; 6, 13, 18, 26 June 2024
USFWS – Las Montanas (2 transects)	0	31 May 2024; 13, 25 June 2024
USFWS – McGinty Mountain	0	21, 30 May 2024; 5, 12, 20 June 2024
USFWS – Par 4/Steele Canyon	0	23 May 2024; 6,18 June 2024
Wright's Field (2 transects)	0	31 May 2024; 8, 14, 17, 28 June 2024

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

There were additional Hermes copper observations in 2024. This includes two adults observed in eastern Lyons Valley (observation by J Martin), in the same area as in 2023, and one adult on the lower western slope of Lawson Peak at a newly acquired preserve - Skyline Ranch North Phase 2 (observation by SDMMP). Locations (GPS coordinates) of all Hermes copper observations are listed in Appendix A and locations (GPS coordinates) of redberry at this preserve are listed in Appendix B.

Discussion

The overall picture of the abundance and distribution of Hermes copper is similar to 2019 – 2023 (Marschalek and Deutschman 2019; Marschalek 2020, 2021, 2022; Marschalek et al. 2023) but still concerning (Figure 2). Despite the observations at Lawson Valley and Lawson Peak, the species still appears to be restricted to the southeastern margin of its historical range due to drought. A fire through Roberts Ranch South and Bell Bluff areas would be of moderate

size considering recent California wildfires, and would result in the loss of the majority of Hermes copper individuals.

A positive trend involves numbers increasing just off of two sentinel sites (Lawson Peak and Roberts Ranch South). Considering that four Hermes copper adults were observed on Lawson Peak, and two areas adjacent to Lawson Peak, it is likely that this area has occupied habitat. This also suggests that Hermes copper was able to survive the recent drought in this area.

Recommendations

We suggest continued monitoring around Lawson Peak including Skyline Ranch North Phase 2, due to the increase in counts on the Lawson Peak Extension transect and the new observation at the new preserve. This also demonstrates that private property at the higher elevations of the Hermes copper historic range have the potential for extant populations. Conserving these lands should be a priority for conservation of this species. Surveys of other conserved lands around and between Lawson Peak and Potrero should be conducted.

Outside of habitat loss, there are two threats to the Hermes copper, wildfires and drought. Recent fires (e.g. the 2020 Valley Fire) 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 return, it is possible that supplemental water will be required to either maintain current population sizes/distribution or enhance other habitat patches for recolonization, or both.

Acknowledgments

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Appendix A. GPS coordinates of Hermes copper adults in 2024.

Date	Site	Latitude	Longitude
3-Jun-2024	Roberts Ranch South	32.808533	-116.613750
3-Jun-2024	Roberts Ranch South	32.808583	-116.61325
3-Jun-2024	Roberts Ranch South	32.8099	-116.606117
3-Jun-2024	Roberts Ranch South	32.81156	-116.605583
3-Jun-2024	Roberts Ranch South	32.811583	-116.605467
6-Jun-2024	Potrero BLM	32.64774	-116.633484
6-Jun-2024	Roberts Ranch South	32.808542	-116.613389
6-Jun-2024	Roberts Ranch South	32.808568	-116.613817
6-Jun-2024	Roberts Ranch South	32.808633	-116.60767
6-Jun-2024	Roberts Ranch South	32.808886	-116.607632
6-Jun-2024	Roberts Ranch South	32.808956	-116.609382
6-Jun-2024	Roberts Ranch South	32.809592	-116.606616
6-Jun-2024	Roberts Ranch South	32.809884	-116.609978
6-Jun-2024	Roberts Ranch South	32.810529	-116.60558
6-Jun-2024	Roberts Ranch South	32.810686	-116.605534
6-Jun-2024	Roberts Ranch South	32.810886	-116.610898
6-Jun-2024	Roberts Ranch South	32.810961	-116.605479
6-Jun-2024	Roberts Ranch South	32.811095	-116.605512
6-Jun-2024	Roberts Ranch South	32.8111	-116.609881
6-Jun-2024	Roberts Ranch South	32.811203	-116.605496
6-Jun-2024	Roberts Ranch South	32.811444	-116.605619
6-Jun-2024	Roberts Ranch South	32.811609	-116.604575
6-Jun-2024	Roberts Ranch South	32.811725	-116.604475
6-Jun-2024	Roberts Ranch South	32.811822	-116.604329
6-Jun-2024	Roberts Ranch South	32.81191	-116.603887
6-Jun-2024	Roberts Ranch South	32.811921	-116.603882
6-Jun-2024	Roberts Ranch South	32.81197	-116.603759
6-Jun-2024	Roberts Ranch South	32.811994	-116.603201
6-Jun-2024	Roberts Ranch South	32.812018	-116.603193
10-Jun-2024	Roberts Ranch South	32.808315	-116.608388
10-Jun-2024	Roberts Ranch South	32.808451	-116.607742
10-Jun-2024	Roberts Ranch South	32.808517	-116.613862
10-Jun-2024	Roberts Ranch South	32.80852	-116.608585
10-Jun-2024	Roberts Ranch South	32.808524	-116.608585
10-Jun-2024	Roberts Ranch South	32.808569	-116.613077
10-Jun-2024	Roberts Ranch South	32.808581	-116.613047
10-Jun-2024	Roberts Ranch South	32.808651	-116.612766
10-Jun-2024	Roberts Ranch South	32.808655	-116.612753
10-Jun-2024	Roberts Ranch South	32.808701	-116.607649

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
10-Jun-2024	Roberts Ranch South	32.808777	-116.612558
10-Jun-2024	Roberts Ranch South	32.808779	-116.614453
10-Jun-2024	Roberts Ranch South	32.808796	-116.614479
10-Jun-2024	Roberts Ranch South	32.808841	-116.612522
10-Jun-2024	Roberts Ranch South	32.808845	-116.614623
10-Jun-2024	Roberts Ranch South	32.808882	-116.607639
10-Jun-2024	Roberts Ranch South	32.808901	-116.607631
10-Jun-2024	Roberts Ranch South	32.808927	-116.60922
10-Jun-2024	Roberts Ranch South	32.808935	-116.609361
10-Jun-2024	Roberts Ranch South	32.808984	-116.607595
10-Jun-2024	Roberts Ranch South	32.809071	-116.607599
10-Jun-2024	Roberts Ranch South	32.809154	-116.607285
10-Jun-2024	Roberts Ranch South	32.809202	-116.609726
10-Jun-2024	Roberts Ranch South	32.809241	-116.607062
10-Jun-2024	Roberts Ranch South	32.809306	-116.609823
10-Jun-2024	Roberts Ranch South	32.809324	-116.606899
10-Jun-2024	Roberts Ranch South	32.809328	-116.606899
10-Jun-2024	Roberts Ranch South	32.809417	-116.606791
10-Jun-2024	Roberts Ranch South	32.809628	-116.60655
10-Jun-2024	Roberts Ranch South	32.809662	-116.606524
10-Jun-2024	Roberts Ranch South	32.809725	-116.611704
10-Jun-2024	Roberts Ranch South	32.80989	-116.606102
10-Jun-2024	Roberts Ranch South	32.809973	-116.60606
10-Jun-2024	Roberts Ranch South	32.810007	-116.611346
10-Jun-2024	Roberts Ranch South	32.810348	-116.605629
10-Jun-2024	Roberts Ranch South	32.810425	-116.609838
10-Jun-2024	Roberts Ranch South	32.810515	-116.605549
10-Jun-2024	Roberts Ranch South	32.810685	-116.60556
10-Jun-2024	Roberts Ranch South	32.810858	-116.610898
10-Jun-2024	Roberts Ranch South	32.810979	-116.605513
10-Jun-2024	Roberts Ranch South	32.811017	-116.610568
10-Jun-2024	Roberts Ranch South	32.811092	-116.609772
10-Jun-2024	Roberts Ranch South	32.811093	-116.609755
10-Jun-2024	Roberts Ranch South	32.811296	-116.605489
10-Jun-2024	Roberts Ranch South	32.811421	-116.604926
10-Jun-2024	Roberts Ranch South	32.811462	-116.605597
10-Jun-2024	Roberts Ranch South	32.811475	-116.604735
10-Jun-2024	Roberts Ranch South	32.811536	-116.605361
10-Jun-2024	Roberts Ranch South	32.811578	-116.604598

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
10-Jun-2024	Roberts Ranch South	32.811586	-116.604565
10-Jun-2024	Roberts Ranch South	32.811649	-116.604543
10-Jun-2024	Roberts Ranch South	32.811665	-116.604483
10-Jun-2024	Roberts Ranch South	32.811665	-116.603859
10-Jun-2024	Roberts Ranch South	32.81173	-116.604235
10-Jun-2024	Roberts Ranch South	32.811807	-116.604323
10-Jun-2024	Roberts Ranch South	32.811884	-116.603888
10-Jun-2024	Roberts Ranch South	32.811956	-116.603289
10-Jun-2024	Roberts Ranch South	32.811999	-116.603153
10-Jun-2024	Roberts Ranch South	32.812124	-116.602983
10-Jun-2024	Roberts Ranch South	32.812329	-116.602763
10-Jun-2024	Roberts Ranch South	32.81241	-116.602737
10-Jun-2024	Roberts Ranch South	32.812681	-116.602585
10-Jun-2024	Roberts Ranch South	32.812951	-116.602511
10-Jun-2024	Roberts Ranch South	32.813015	-116.602471
10-Jun-2024	Roberts Ranch South	32.813651	-116.602185
10-Jun-2024	Roberts Ranch South	32.813749	-116.602115
11-Jun-2024	Potrero BLM	32.646409	-116.635154
11-Jun-2024	Potrero BLM	32.646749	-116.63585
11-Jun-2024	Potrero BLM	32.646859	-116.635631
11-Jun-2024	Potrero BLM	32.64691	-116.635443
11-Jun-2024	Potrero BLM	32.647203	-116.634252
11-Jun-2024	Potrero BLM	32.64721	-116.634262
11-Jun-2024	Potrero BLM	32.647711	-116.633591
12-Jun-2024	Boulder Creek	32.926846	-116.631478
12-Jun-2024	Roberts Ranch South	32.808281	-116.608333
12-Jun-2024	Roberts Ranch South	32.808537	-116.613463
12-Jun-2024	Roberts Ranch South	32.808545	-116.613494
12-Jun-2024	Roberts Ranch South	32.808552	-116.61308
12-Jun-2024	Roberts Ranch South	32.808557	-116.613081
12-Jun-2024	Roberts Ranch South	32.808577	-116.612866
12-Jun-2024	Roberts Ranch South	32.8086	-116.607683
12-Jun-2024	Roberts Ranch South	32.808667	-116.612735
12-Jun-2024	Roberts Ranch South	32.808682	-116.614204
12-Jun-2024	Roberts Ranch South	32.808936	-116.607614
12-Jun-2024	Roberts Ranch South	32.808937	-116.609155
12-Jun-2024	Roberts Ranch South	32.80895	-116.607603
12-Jun-2024	Roberts Ranch South	32.808951	-116.609191
12-Jun-2024	Roberts Ranch South	32.809004	-116.612463

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
12-Jun-2024	Roberts Ranch South	32.809099	-116.607593
12-Jun-2024	Roberts Ranch South	32.809225	-116.607109
12-Jun-2024	Roberts Ranch South	32.809253	-116.607104
12-Jun-2024	Roberts Ranch South	32.80929	-116.609812
12-Jun-2024	Roberts Ranch South	32.80935	-116.606861
12-Jun-2024	Roberts Ranch South	32.809417	-116.609976
12-Jun-2024	Roberts Ranch South	32.809524	-116.611906
12-Jun-2024	Roberts Ranch South	32.809785	-116.610056
12-Jun-2024	Roberts Ranch South	32.809929	-116.609949
12-Jun-2024	Roberts Ranch South	32.810091	-116.606005
12-Jun-2024	Roberts Ranch South	32.810113	-116.611339
12-Jun-2024	Roberts Ranch South	32.810128	-116.606013
12-Jun-2024	Roberts Ranch South	32.810683	-116.60975
12-Jun-2024	Roberts Ranch South	32.810706	-116.605535
12-Jun-2024	Roberts Ranch South	32.810858	-116.610887
12-Jun-2024	Roberts Ranch South	32.810907	-116.605484
12-Jun-2024	Roberts Ranch South	32.810961	-116.60551
12-Jun-2024	Roberts Ranch South	32.810986	-116.610542
12-Jun-2024	Roberts Ranch South	32.81099	-116.609572
12-Jun-2024	Roberts Ranch South	32.811054	-116.609869
12-Jun-2024	Roberts Ranch South	32.811068	-116.610365
12-Jun-2024	Roberts Ranch South	32.811076	-116.609727
12-Jun-2024	Roberts Ranch South	32.81108	-116.609901
12-Jun-2024	Roberts Ranch South	32.811098	-116.609806
12-Jun-2024	Roberts Ranch South	32.811159	-116.605486
12-Jun-2024	Roberts Ranch South	32.811237	-116.605442
12-Jun-2024	Roberts Ranch South	32.811292	-116.605502
12-Jun-2024	Roberts Ranch South	32.811352	-116.605498
12-Jun-2024	Roberts Ranch South	32.811358	-116.605502
12-Jun-2024	Roberts Ranch South	32.811364	-116.60551
12-Jun-2024	Roberts Ranch South	32.811531	-116.60561
12-Jun-2024	Roberts Ranch South	32.811537	-116.605199
12-Jun-2024	Roberts Ranch South	32.811594	-116.604539
12-Jun-2024	Roberts Ranch South	32.811607	-116.604578
12-Jun-2024	Roberts Ranch South	32.811675	-116.60449
12-Jun-2024	Roberts Ranch South	32.81171	-116.604454
12-Jun-2024	Roberts Ranch South	32.811969	-116.603558
12-Jun-2024	Roberts Ranch South	32.811993	-116.603152
12-Jun-2024	Roberts Ranch South	32.812002	-116.603159

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
12-Jun-2024	Roberts Ranch South	32.812014	-116.603869
12-Jun-2024	Roberts Ranch South	32.812019	-116.603867
12-Jun-2024	Roberts Ranch South	32.812026	-116.603871
12-Jun-2024	Roberts Ranch South	32.812061	-116.603098
12-Jun-2024	Roberts Ranch South	32.812061	-116.603088
12-Jun-2024	Roberts Ranch South	32.812159	-116.60297
12-Jun-2024	Roberts Ranch South	32.812348	-116.602751
12-Jun-2024	Roberts Ranch South	32.812455	-116.602673
12-Jun-2024	Roberts Ranch South	32.812687	-116.60256
12-Jun-2024	Roberts Ranch South	32.812798	-116.602516
12-Jun-2024	Roberts Ranch South	32.813513	-116.602205
13-Jun-2024	Lawson Peak Extension	32.722182	-116.72904
13-Jun-2024	Lawson Peak Extension	32.72245	-116.733932
13-Jun-2024	Lawson Peak Extension	32.723146	-116.72661
13-Jun-2024	Potrero BLM	32.647142	-116.634259
13-Jun-2024	Potrero BLM	32.647733	-116.633476
14-Jun-2024	Roberts Ranch South	32.808488	-116.607719
14-Jun-2024	Roberts Ranch South	32.808556	-116.61341
14-Jun-2024	Roberts Ranch South	32.808579	-116.613916
14-Jun-2024	Roberts Ranch South	32.808581	-116.613916
14-Jun-2024	Roberts Ranch South	32.808686	-116.607683
14-Jun-2024	Roberts Ranch South	32.808764	-116.614283
14-Jun-2024	Roberts Ranch South	32.808845	-116.614459
14-Jun-2024	Roberts Ranch South	32.808848	-116.614455
14-Jun-2024	Roberts Ranch South	32.808876	-116.607648
14-Jun-2024	Roberts Ranch South	32.80894	-116.609212
14-Jun-2024	Roberts Ranch South	32.808965	-116.609233
14-Jun-2024	Roberts Ranch South	32.808987	-116.612513
14-Jun-2024	Roberts Ranch South	32.808999	-116.612497
14-Jun-2024	Roberts Ranch South	32.809039	-116.612481
14-Jun-2024	Roberts Ranch South	32.809081	-116.607626
14-Jun-2024	Roberts Ranch South	32.809508	-116.606721
14-Jun-2024	Roberts Ranch South	32.809563	-116.61189
14-Jun-2024	Roberts Ranch South	32.809638	-116.606537
14-Jun-2024	Roberts Ranch South	32.809673	-116.6065
14-Jun-2024	Roberts Ranch South	32.80978	-116.606193
14-Jun-2024	Roberts Ranch South	32.80987	-116.609983
14-Jun-2024	Roberts Ranch South	32.810069	-116.606021
14-Jun-2024	Roberts Ranch South	32.810677	-116.605563

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
14-Jun-2024	Roberts Ranch South	32.810745	-116.609683
14-Jun-2024	Roberts Ranch South	32.810901	-116.60552
14-Jun-2024	Roberts Ranch South	32.810978	-116.609565
14-Jun-2024	Roberts Ranch South	32.811075	-116.609898
14-Jun-2024	Roberts Ranch South	32.811155	-116.609807
14-Jun-2024	Roberts Ranch South	32.811268	-116.605531
14-Jun-2024	Roberts Ranch South	32.811278	-116.605515
14-Jun-2024	Roberts Ranch South	32.811423	-116.605073
14-Jun-2024	Roberts Ranch South	32.811433	-116.605083
14-Jun-2024	Roberts Ranch South	32.811451	-116.605624
14-Jun-2024	Roberts Ranch South	32.811516	-116.605627
14-Jun-2024	Roberts Ranch South	32.811534	-116.615292
14-Jun-2024	Roberts Ranch South	32.811603	-116.604562
14-Jun-2024	Roberts Ranch South	32.811609	-116.604555
14-Jun-2024	Roberts Ranch South	32.811663	-116.604481
14-Jun-2024	Roberts Ranch South	32.811686	-116.60444
14-Jun-2024	Roberts Ranch South	32.811758	-116.604435
14-Jun-2024	Roberts Ranch South	32.81193	-116.603866
14-Jun-2024	Roberts Ranch South	32.811948	-116.603769
14-Jun-2024	Roberts Ranch South	32.811991	-116.603156
14-Jun-2024	Roberts Ranch South	32.812038	-116.60309
14-Jun-2024	Roberts Ranch South	32.81209	-116.603039
14-Jun-2024	Roberts Ranch South	32.812163	-116.602953
14-Jun-2024	Roberts Ranch South	32.812299	-116.602813
14-Jun-2024	Roberts Ranch South	32.812681	-116.602578
14-Jun-2024	Roberts Ranch South	32.812682	-116.60258
14-Jun-2024	Roberts Ranch South	32.812761	-116.602545
14-Jun-2024	Roberts Ranch South	32.812905	-116.602516
14-Jun-2024	Roberts Ranch South	32.813363	-116.602373
14-Jun-2024	Roberts Ranch South	32.813664	-116.602189
14-Jun-2024	Roberts Ranch South	32.81381	-116.602134
14-Jun-2024	Roberts Ranch South	32.813935	-116.602107
17-Jun-2024	Boulder Creek	32.926902	-116.631493
17-Jun-2024	Boulder Creek	32.928239	-116.634866
17-Jun-2024	Lawson Peak Extension	32.72214	-116.729214
17-Jun-2024	Lawson Peak Extension	32.723121	-116.726619
17-Jun-2024	Roberts Ranch South	32.8085	-116.608585
17-Jun-2024	Roberts Ranch South	32.808514	-116.613422
17-Jun-2024	Roberts Ranch South	32.808534	-116.613904

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
17-Jun-2024	Roberts Ranch South	32.808643	-116.612769
17-Jun-2024	Roberts Ranch South	32.808743	-116.607633
17-Jun-2024	Roberts Ranch South	32.808773	-116.607636
17-Jun-2024	Roberts Ranch South	32.80878	-116.614467
17-Jun-2024	Roberts Ranch South	32.808794	-116.612545
17-Jun-2024	Roberts Ranch South	32.808827	-116.61454
17-Jun-2024	Roberts Ranch South	32.808934	-116.609211
17-Jun-2024	Roberts Ranch South	32.809006	-116.612488
17-Jun-2024	Roberts Ranch South	32.809101	-116.612476
17-Jun-2024	Roberts Ranch South	32.809143	-116.607339
17-Jun-2024	Roberts Ranch South	32.809188	-116.607157
17-Jun-2024	Roberts Ranch South	32.809317	-116.606909
17-Jun-2024	Roberts Ranch South	32.809418	-116.609941
17-Jun-2024	Roberts Ranch South	32.809474	-116.60674
17-Jun-2024	Roberts Ranch South	32.809547	-116.611888
17-Jun-2024	Roberts Ranch South	32.809646	-116.606556
17-Jun-2024	Roberts Ranch South	32.810099	-116.606031
17-Jun-2024	Roberts Ranch South	32.810169	-116.605986
17-Jun-2024	Roberts Ranch South	32.810269	-116.60984
17-Jun-2024	Roberts Ranch South	32.810372	-116.605601
17-Jun-2024	Roberts Ranch South	32.810541	-116.609804
17-Jun-2024	Roberts Ranch South	32.810707	-116.605556
17-Jun-2024	Roberts Ranch South	32.810835	-116.610702
17-Jun-2024	Roberts Ranch South	32.810982	-116.605524
17-Jun-2024	Roberts Ranch South	32.811002	-116.610546
17-Jun-2024	Roberts Ranch South	32.811034	-116.609607
17-Jun-2024	Roberts Ranch South	32.811049	-116.609902
17-Jun-2024	Roberts Ranch South	32.811054	-116.609891
17-Jun-2024	Roberts Ranch South	32.811062	-116.610395
17-Jun-2024	Roberts Ranch South	32.811062	-116.610382
17-Jun-2024	Roberts Ranch South	32.811081	-116.610303
17-Jun-2024	Roberts Ranch South	32.811088	-116.605508
17-Jun-2024	Roberts Ranch South	32.811103	-116.60981
17-Jun-2024	Roberts Ranch South	32.81128	-116.605473
17-Jun-2024	Roberts Ranch South	32.81128	-116.605473
17-Jun-2024	Roberts Ranch South	32.811429	-116.605046
17-Jun-2024	Roberts Ranch South	32.811433	-116.605064
17-Jun-2024	Roberts Ranch South	32.811461	-116.605604
17-Jun-2024	Roberts Ranch South	32.811507	-116.615304

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
17-Jun-2024	Roberts Ranch South	32.811507	-116.605617
17-Jun-2024	Roberts Ranch South	32.811512	-116.605623
17-Jun-2024	Roberts Ranch South	32.811513	-116.605623
17-Jun-2024	Roberts Ranch South	32.811558	-116.605455
17-Jun-2024	Roberts Ranch South	32.811633	-116.603882
17-Jun-2024	Roberts Ranch South	32.811692	-116.604203
17-Jun-2024	Roberts Ranch South	32.811763	-116.604437
17-Jun-2024	Roberts Ranch South	32.811804	-116.604376
17-Jun-2024	Roberts Ranch South	32.811912	-116.603907
17-Jun-2024	Roberts Ranch South	32.811914	-116.603909
17-Jun-2024	Roberts Ranch South	32.811982	-116.603211
17-Jun-2024	Roberts Ranch South	32.811999	-116.60317
17-Jun-2024	Roberts Ranch South	32.81215	-116.602966
17-Jun-2024	Roberts Ranch South	32.812613	-116.602617
17-Jun-2024	Roberts Ranch South	32.812687	-116.60259
17-Jun-2024	Roberts Ranch South	32.812735	-116.602574
17-Jun-2024	Roberts Ranch South	32.812739	-116.60257
17-Jun-2024	Roberts Ranch South	32.813025	-116.602502
17-Jun-2024	Roberts Ranch South	32.813348	-116.602365
17-Jun-2024	Roberts Ranch South	32.813681	-116.602183
17-Jun-2024	Roberts Ranch South	32.814817	-116.61593
17-Jun-2024	Roberts Ranch South	32.814844	-116.601631
17-Jun-2024	Roberts Ranch South	32.814857	-116.601586
17-Jun-2024	Roberts Ranch South	32.814916	-116.616067
18-Jun-2024	Potrero BLM	32.647634	-116.633692
18-Jun-2024	Potrero BLM	32.647739	-116.633495
18-Jun-2024	Potrero BLM	32.647767	-116.633412
18-Jun-2024	Potrero BLM	32.648908	-116.632916
20-Jun-2024	Boulder Creek	32.926902	-116.631493
20-Jun-2024	Boulder Creek	32.928239	-116.634866
20-Jun-2024	Lawson Peak Extension	32.722286	-116.730946
20-Jun-2024	Lawson Peak Extension	32.722397	-116.731475
20-Jun-2024	Lawson Peak Extension	32.722491	-116.733823
20-Jun-2024	Lawson Peak Extension	32.72325	-116.726498
21-Jun-2024	Roberts Ranch South	32.808501	-116.613685
21-Jun-2024	Roberts Ranch South	32.808537	-116.613395
21-Jun-2024	Roberts Ranch South	32.808547	-116.613827
21-Jun-2024	Roberts Ranch South	32.808612	-116.614071
21-Jun-2024	Roberts Ranch South	32.808638	-116.614106

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
21-Jun-2024	Roberts Ranch South	32.808916	-116.607588
21-Jun-2024	Roberts Ranch South	32.808946	-116.612496
21-Jun-2024	Roberts Ranch South	32.808952	-116.61248
21-Jun-2024	Roberts Ranch South	32.809074	-116.612464
21-Jun-2024	Roberts Ranch South	32.809268	-116.609768
21-Jun-2024	Roberts Ranch South	32.809331	-116.606875
21-Jun-2024	Roberts Ranch South	32.809341	-116.606878
21-Jun-2024	Roberts Ranch South	32.809418	-116.609897
21-Jun-2024	Roberts Ranch South	32.809511	-116.606641
21-Jun-2024	Roberts Ranch South	32.809538	-116.609996
21-Jun-2024	Roberts Ranch South	32.809551	-116.611875
21-Jun-2024	Roberts Ranch South	32.809552	-116.606591
21-Jun-2024	Roberts Ranch South	32.809686	-116.61177
21-Jun-2024	Roberts Ranch South	32.809832	-116.611553
21-Jun-2024	Roberts Ranch South	32.809943	-116.609928
21-Jun-2024	Roberts Ranch South	32.810186	-116.606004
21-Jun-2024	Roberts Ranch South	32.810338	-116.605571
21-Jun-2024	Roberts Ranch South	32.810632	-116.605467
21-Jun-2024	Roberts Ranch South	32.810678	-116.60974
21-Jun-2024	Roberts Ranch South	32.811032	-116.605448
21-Jun-2024	Roberts Ranch South	32.811097	-116.609674
21-Jun-2024	Roberts Ranch South	32.81111	-116.60971
21-Jun-2024	Roberts Ranch South	32.811114	-116.609721
21-Jun-2024	Roberts Ranch South	32.81112	-116.609825
21-Jun-2024	Roberts Ranch South	32.811127	-116.609711
21-Jun-2024	Roberts Ranch South	32.811129	-116.609808
21-Jun-2024	Roberts Ranch South	32.811135	-116.609799
21-Jun-2024	Roberts Ranch South	32.81114	-116.60981
21-Jun-2024	Roberts Ranch South	32.811281	-116.605482
21-Jun-2024	Roberts Ranch South	32.811414	-116.605005
21-Jun-2024	Roberts Ranch South	32.811595	-116.60542
21-Jun-2024	Roberts Ranch South	32.811679	-116.604466
21-Jun-2024	Roberts Ranch South	32.811709	-116.604441
21-Jun-2024	Roberts Ranch South	32.811904	-116.603857
21-Jun-2024	Roberts Ranch South	32.811939	-116.603867
21-Jun-2024	Roberts Ranch South	32.811999	-116.603545
21-Jun-2024	Roberts Ranch South	32.812016	-116.603129
21-Jun-2024	Roberts Ranch South	32.812224	-116.602879
21-Jun-2024	Roberts Ranch South	32.812224	-116.602879

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
21-Jun-2024	Roberts Ranch South	32.812373	-116.602716
21-Jun-2024	Roberts Ranch South	32.812808	-116.602499
24-Jun-2024	Lawson Peak Extension	32.722132	-116.732508
24-Jun-2024	Lawson Peak Extension	32.722367	-116.735378
24-Jun-2024	Lawson Peak Extension	32.722124	-116.732509
24-Jun-2024	Lawson Peak Extension	32.722841	-116.727105
25-Jun-2024	Potrero BLM	32.646703	-116.635887
25-Jun-2024	Potrero BLM	32.647016	-116.634897
25-Jun-2024	Potrero BLM	32.647105	-116.634572
25-Jun-2024	Potrero BLM	32.647629	-116.633691
25-Jun-2024	Potrero BLM	32.647801	-116.633418
27-Jun-2024	Lawson Peak Extension	32.722179	-116.732476
27-Jun-2024	Lawson Peak Extension	32.722321	-116.735827
27-Jun-2024	Lawson Peak Extension	32.722431	-116.734151
27-Jun-2024	Lawson Peak Extension	32.722432	-116.73412
27-Jun-2024	Lawson Peak Extension	32.72316	-116.726583
27-Jun-2024	Roberts Ranch South	32.808508	-116.613418
27-Jun-2024	Roberts Ranch South	32.808557	-116.613937
27-Jun-2024	Roberts Ranch South	32.808559	-116.613933
27-Jun-2024	Roberts Ranch South	32.808648	-116.614185
27-Jun-2024	Roberts Ranch South	32.808655	-116.614179
27-Jun-2024	Roberts Ranch South	32.808777	-116.614532
27-Jun-2024	Roberts Ranch South	32.808966	-116.612493
27-Jun-2024	Roberts Ranch South	32.809091	-116.612476
27-Jun-2024	Roberts Ranch South	32.809097	-116.612479
27-Jun-2024	Roberts Ranch South	32.809486	-116.606757
27-Jun-2024	Roberts Ranch South	32.8095	-116.606727
27-Jun-2024	Roberts Ranch South	32.809694	-116.611744
27-Jun-2024	Roberts Ranch South	32.810219	-116.609795
27-Jun-2024	Roberts Ranch South	32.810819	-116.60552
27-Jun-2024	Roberts Ranch South	32.810996	-116.610543
27-Jun-2024	Roberts Ranch South	32.811065	-116.609909
27-Jun-2024	Roberts Ranch South	32.811101	-116.60972
27-Jun-2024	Roberts Ranch South	32.811126	-116.609803
27-Jun-2024	Roberts Ranch South	32.811441	-116.605599
27-Jun-2024	Roberts Ranch South	32.811442	-116.605598
27-Jun-2024	Roberts Ranch South	32.811568	-116.604109
27-Jun-2024	Roberts Ranch South	32.81174	-116.603892
27-Jun-2024	Roberts Ranch South	32.811776	-116.604403

Appendix A. GPS coordinates of Hermes copper adults in 2024 continued.

Date	Site	Latitude	Longitude
27-Jun-2024	Roberts Ranch South	32.811817	-116.604311
27-Jun-2024	Roberts Ranch South	32.811891	-116.6039
27-Jun-2024	Roberts Ranch South	32.812013	-116.603177
27-Jun-2024	Roberts Ranch South	32.812208	-116.602924
27-Jun-2024	Roberts Ranch South	32.812213	-116.602924
27-Jun-2024	Roberts Ranch South	32.814809	-116.601646
28-Jun-2024	Boulder Creek	32.928251	-116.634781

Other Hermes copper adult observations

Date	Site	Latitude	Longitude
21-Jun-2024	Skyline Ranch North Phase 2	32.743	-116.727
17-Jun-2024	Lyons Valley (east)	32.715524	-116.755672
17-Jun-2024	Lyons Valley (east)	32.715524	-116.755672