San Diego County Hermes Copper (*Lycaena hermes*)
Habitat Conservation and Management Plan

Prepared for:
San Diego Association of Governments

Prepared by:
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Introduction

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. 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, and it is currently on the USFWS list of candidate species (USFWS 2011).

Within San Diego County, the Hermes copper was historically found within the area addressed by the *Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Strategic Habitat Conservation Roadmap* ("MSP Roadmap", San Diego Management and Monitoring Program [SDMMP] 2016), and is designated a Category SL species within this plan. Category SL refers to species determined to be at risk of loss entirely on conserved lands in the MSP area. The MSP area has been divided into 11 management units (MUs) (see Figure 1), and the Hermes copper was historically found in MUs 2, 3, 4, 6, 10, and 11. Most of the historic and recent observations have occurred in MUs 3, 10 and 11.

Purpose

The “MSP Roadmap” is an adaptive management and monitoring framework for prioritized species and vegetation communities in western San Diego County (SDMMP 2016). Large portions of Conserved Lands in western San Diego County are within approved or proposed regional multi-species Habitat Conservation Plans (HCPs)/Natural Communities Conservation Plans (NCCPs). The MSP Roadmap is not limited to species covered under the regional conservation plans, but also includes other sensitive species such as Hermes copper. These conservation plans recognize that biological monitoring and management should extend beyond individual plan boundaries to facilitate regional conservation of an interconnected preserve system for the persistence of rare and sensitive wildlife species and vegetation communities. Management and monitoring of these preserve lands is largely the responsibility of plan participants and varies considerably in methods and timing across the preserve system so that it is not possible to determine the regional status and effectiveness of conservation efforts. The purpose of the MSP Roadmap is to provide a scientifically based strategic plan to determine the status of conserved natural resources across the landscape and to guide regional decision making and funding priorities for managing natural resources on Conserved Lands. The plan prioritizes plant and animal species, vegetation communities, and threats for management. It also provides adaptive management and monitoring goals, objectives, and actions with implementation timelines. It offers a process for coordinated implementation by land managers, conservation groups, and other stakeholders.

The MSP Roadmap does not replace the need for preserve resource management plans, daily maintenance activities at existing preserves, or prior obligations negotiated with the U.S. Fish and Wildlife Service and California Department of Fish and Wildlife (CDFW). Rather, the MSP Roadmap provides a framework for the efficient use of funds, to leverage existing funding, and to assist with regional conservation efforts. It does not assign responsibilities for specific management and monitoring objectives, although it identifies “what” and “where” management is needed. Implementation and funding for MSP Roadmap objectives may be accomplished using multiple resources and entities as long as the land owner(s) and entities are in agreement. Management plans prepared as part of MSP...
Roadmap objectives may be used to inform the development and implementation of preserve resource management plans, annual work plans, and/or area specific management directives (ASMDs).

This document has been prepared to help meet MSP Roadmap Goals and Objectives for management of the Hermes copper in the MSP area (Appendix A and B). It is based on the information currently available for the species, and can be modified as new information is obtained.

Goal: This plan identifies and prioritizes management and restoration needs over the next five years (2017-2021) for the Hermes copper across the entire United States range. It is intended that implementation of high priority management actions in this plan will help to achieve the MSP Roadmap goal for Hermes copper to: “protect, enhance, and restore Hermes copper occupied habitat and historically occupied habitat and the landscape connections between them to create resilient, self-sustaining populations that provide for persistence over the long term (>100 years)”.

This plan fulfills the MSP Roadmap objective: “In 2017, complete a five-year Hermes Copper Management Plan that includes the results from butterfly surveys and habitat assessments and genetic, marking, and translocation studies to develop a management strategy and to identify and prioritize site specific management actions. The plan should employ the modeling results to identify potential fire and climate refugia that may be suitable sites for future translocations and provide specific recommendations for reducing fire risk at occurrences at highest risk.”

This iteration of the plan achieves the first part of the MSP Roadmap objective. The identification of fire and climate refugia and specific recommendations to reduce fire risk will be added as an appendix after the modeling is completed.

Specific management objectives and actions identified in this plan are included in the Management Strategies section.

Approach and Planning Area
This plan provides a summary of what is known regarding the Hermes copper, including life history, historic and current distribution, movement patterns, suitable habitat, and threats. A thorough understanding of the species is necessary to make appropriate adaptive management recommendations in an attempt to alleviate the current threats to the species. To develop this plan, we:

1. Reviewed existing data, including historic Hermes copper locations, recent (2010-2016) survey data, property ownership to identify conserved lands for potential surveys, management, and acquisitions, and
2. Consulted with the wildlife agencies (USFWS, CDFW) and other stakeholders to ensure that the most current information regarding Hermes copper biology, management, regulations, conserved lands, and potential acquisitions were included.

Species Description and Life History
Hermes copper males and females are similar in appearance, with a wingspan of 1 to 1 ¼ inches (Opler and Peterson 1999, Faulkner and Klein 2004). Upper forewings are orange with a brown border and brown spots within the orange patch. Hindwings are brown with some orange on the posterior edge, where a tail is present. The underside of both wings is orange to yellow with some dark spots.
Adults emerge in the late spring after overwintering as eggs and spending a short period of time as caterpillars (Thorne 1963, Faulkner and Klein 2004). Adult emergence is fairly consistent, generally beginning in mid to late May, with the flight period extending to late June or mid-July (Faulkner and Klein 2004, Marschalek and Deutschman 2008, Marschalek and Klein 2010). Emergence appears to be influenced by climatic conditions; however, our understanding of this relationship is incomplete.


During the flight season, Hermes copper adults become active at around 22°C (72°F) (Marschalek 2004, Marschalek and Deutschman 2008). Adult males have a strong preference for openings in the vegetation, including roads and trails, specifically for the north and west sides of openings (Marschalek 2004, Marschalek and Deutschman 2008). This results in a preference to perch on the south and east sides of plants (Marschalek 2004, Marschalek and Deutschman 2008). They tend to remain inactive or sluggish under conditions of heavy cloud cover and cooler weather (Marschalek 2004, Marschalek and Deutschman 2008).

Hermes copper males typically exhibit short movements with the majority of their displacements well under 50 meters (Marschalek 2004, Marschalek and Klein 2010). This behavior is the result of territoriality in males who generally return to an area after being disturbed. The majority of individuals encountered are males. Hermes copper females display remarkably different behavior, exhibiting no territoriality, and do not return to the area after being disturbed. With the majority of data from males, movements over 100 meters are rare, and the longest movement reported for a Hermes copper is just over 1 kilometer (Marschalek and Klein 2010).

Genetic analyses indicate that individuals from all populations are similar. This suggests that the species was once able to disperse across the landscape so that strong local differences did not develop (Strahm et al. 2012, Marschalek et al. 2016). In contrast, few recolonization events following the recent 2003 and 2007 wildfires have been observed. This may indicate that recent habitat fragmentation is currently restricting dispersal (Marschalek et al. 2016).

**Historical and Current Distribution and Abundance**

**Methods**

The historical distribution of Hermes copper was reconstructed using museum specimens, published journal articles, unpublished reports, and personal communications with local biologists. The current distribution has been determined by surveys for Hermes copper adults, starting with Marschalek (2004). This included surveys at historical Hermes copper locations, Hermes copper locations reported by local biologists, and spiny redberry locations present in the San Diego Natural History Museum Plant Atlas. Areas not included in these efforts were private property and those areas that burned in the 2003 or 2007 wildfires. However, surveys have been conducted regularly at historically occupied sites that burned during these fires to document if or when recolonization occurs.
Standardized transects, also referred to as Pollard Walks, are a common butterfly monitoring technique to obtain an annual population index (Pollard 1977). Starting in 2003, standardized transects were established at six sites (Cleveland National Forest-Anderson Road and Wildwood Glen Lane, Crestridge Ecological Reserve, Meadowbrook Ecological Reserve, Rancho Jamul Ecological Reserve, Sycamore Canyon County Park) (Marschalek 2004, Marschalek and Deutschman 2008). In 2007-2016, additional sites were added (Deutschman et al. 2010, 2011; Strahm et al. 2012; Marschalek and Deutschman 2015, 2016A, B, C). From 2003-2007, marking studies at Rancho Jamul Ecological Reserve and Hollenbeck Canyon Wildlife Area were conducted to estimate population sizes (Marschalek 2004, Marschalek and Deutschman 2008, Marschalek and Klein 2010). These marking studies also provided demographic, survival, and movement data.

Repeated sampling during the adult flight season was used to determine occupancy of spiny redberry patches. This involved at least three survey dates, but preferably up to eight survey dates (two surveys per week for four weeks), during a year with near to above average Hermes copper adult counts at known populations. Drought suppresses adult butterfly numbers so failing to detect Hermes copper adults during dry years (e.g. 2015, 2016) are not interpreted as unoccupied/extirpated. It is possible that the species is occupying the habitat in an immature life stage (Marschalek and Deutschman 2015) which are much harder to detect. Some areas have restricted access so the current status could not be determined may be given the designation of “unknown” status. Based on past surveys, occupancy appears to be relatively stable their status does not change unless there is a clear disturbance (e.g. fire, development).

Results
In the United States, Hermes copper is only found within San Diego County, west of the Cuyamaca Mountains (Thorne 1963, Brown 1991, Faulkner and Klein 2004, Marschalek 2004, Marschalek and Klein 2010). The species also occurs in northern Baja California, Mexico; however, very little is known about its status south of the United States-Mexico border (Thorne 1963, Emmel and Emmel 1973, Marschalek and Klein 2010). Hermes copper has been recorded as far north as near the community of Bonsall, in San Diego County and as far south as Ensenada in Mexico. The species has never been recorded immediately along the Pacific coast, and has not been found above 1300 m elevation (Marschalek and Klein 2010).

The current documented distribution of Hermes copper is reduced compared to documented historic locations (Figure 1). Local extirpations in its western most range appear to be due to habitat loss associated with urban development. Wildfires in 2003 and 2007 resulted in the extirpation of several known populations in the eastern portion of its range (Marschalek and Klein 2010, Strahm et al. 2012). Only two recolonization events have been recorded following these fires, both in Cleveland National Forest (Strahm et al. 2012). Most of the known Hermes copper populations are in a small portion of San Diego County, representing about 9% of the county’s area (Deutschman et al. 2010). Some unknown populations likely exist on private property but these are probably within or close to the current known range of the species.

Some historic locations (e.g. “El Cajon”) are too vague to identify a specific property parcel or spiny redberry patch. Therefore, these cases are not informative for site-specific status assessments. However, these data are still useful for county-level scale investigations such as the species distribution.
Many of the largest populations are no longer present (Marschalek and Klein 2010). Museum records and past surveys have recorded 50 to several hundred individuals counted on a single date for several different populations. Despite these large populations, most local populations numbered fewer than 50 adults (Scott 1986). Adult densities vary from year to year (Marschalek and Klein 2010, Strahm et al. 2012), a common pattern observed with butterflies (Pollard 1988).

Recent surveys indicate that occurrence (presence) of this species is relatively consistent from year to year, especially for larger populations (Deutschman et al. 2011, Table 1). However, adults are not always detected for smaller populations across years (Deutschman et al. 2011, Table 1).

Figure 1. Distribution of the Hermes copper in San Diego County. MSP Management Units are outlined in black and numbered. Only those locations with detailed geographic information are shown as this information is required to assess the status of each population.
Table 1. Daily maximum counts of Hermes copper adult butterflies along a fixed transect.

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<td>not established</td>
<td></td>
</tr>
<tr>
<td>SDNWR- Sweetwater</td>
<td>---</td>
<td>P</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>0</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>not established</td>
<td></td>
</tr>
<tr>
<td>Sycamore Canyon County Park</td>
<td>7</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>1</td>
<td>27</td>
<td>14</td>
<td>41</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>250</td>
<td>2003</td>
</tr>
<tr>
<td>Sycuan Peak Ecological Reserve</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>12</td>
<td>27</td>
<td>14</td>
<td>41</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1628</td>
<td>1970</td>
</tr>
<tr>
<td>Sycuan Peak Ecological Reserve North</td>
<td>---</td>
<td>(2)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>not established</td>
<td></td>
</tr>
<tr>
<td>Wright's Field</td>
<td>---</td>
<td>(3)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>1744</td>
<td>1970</td>
<td></td>
</tr>
</tbody>
</table>

* Differing efforts among years
--- means no survey
"P" means Hermes copper were present but no numbers reported
(#) are observations not from a standardized transect survey
Fire data from CalFire (2015)
Only two natural recolonizations have been detected following the 2003 or 2007 wildfire extirpations. They are both in Cleveland National Forest, at Boulder Creek Road and Wildwood Glen Lane. The single observation at Hollenbeck Canyon Wildlife Area was likely due to translocation efforts (Marschalek and Deutschman 2016C).

Density of adults, whether it was measured by Pollard Index, Max Count, or number of marked individuals, varied greatly among years at Rancho Jamul Ecological Reserve (Table 2). We encountered difficulties estimating population sizes from the marking studies because of low population sizes and there was little mixing of marked and unmarked individuals. In other words, once an individual was marked, it was always detected until it left the area or died. Only rarely was a marked individual not detected, then observed on a later survey. This mixing is valuable for calculating population estimates generated from marking studies. The population size estimates generated from marking also varied, with the Cormack-Jolly-Seber (CJS) models generally providing estimates two times greater than the Jolly-Seber (JS) estimates. In addition, the JS estimates are consistently lower than the total number of marked individuals (minimum known population size) while the CJS is similar to this value, suggesting that the CJS outperforms JS. The 95% confidence intervals also differed between estimates, as the intervals are quite broad for JS and narrower for the CJS models. Overall, the percent of marked butterflies resighted was relatively high, ranging from 39 to 67%.

Although sample sizes are small, population size estimates are highly correlated (Pollard Index-Max Count, $r_s = 0.956, P = 0.025$; Pollard Index-JS, $r_s = 0.931, P = 0.047$; Max Count-JS, $r_s = 0.998, P < 0.001$). Using estimates only from the Rancho Jamul Ecological Reserve site to exclude the substantially larger Hollenbeck Canyon Wildlife Area population, or replacing JS estimates with CJS estimates produced similar results.

Summary of Historical and Current Distribution and Abundance
The current range of Hermes copper is reduced compared to the historic range, primarily due to habitat loss (urbanization) in the western portion and wildfires in the eastern portion. Historically, some local populations were large, with more than 100 individuals present on a single day. Over the last decade (2008-2016), local populations have been much smaller due to habitat, climate (precipitation), or both. Current populations north of Interstate 8 and west of Alpine are difficult to detect as adults are not observed every year. In addition, the maximum number observed is generally less than five individuals. The largest populations, and therefore the majority of Hermes copper individuals, are located between the 2003/2007 wildfire footprints, east of the San Diego metropolitan area and south of Interstate 8, with the exception of three local populations north of Interstate 8 in Cleveland National Forest. This means the species is essentially restricted to an area of San Diego County less than 350 km².

The different monitoring techniques showed a high level of agreement in terms of the relative annual population size. For this reason, any one of the techniques can be used for monitoring, but comparisons among techniques and across years may be complicated. Recent monitoring efforts (Marschalek and Deutschman 2016B) have utilized the Max Count index from transect counts as it is the least time intensive method of those tested.
Table 2. Abundance curve characteristics, population size statistics, and demographic and movement data of the Hermes copper from Rancho Jamul Ecological Reserve (RJER) in 2004-2007 and Hollenbeck Canyon Wildlife Area (HCWA) in 2007. Surveys were infrequent at the end of the 2007 flight seasons.

<table>
<thead>
<tr>
<th></th>
<th>RJER</th>
<th>HCWA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td><strong>Abundance Curve &amp; Population Estimates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date of First Observed</td>
<td>12 May</td>
<td>16 May</td>
</tr>
<tr>
<td>Date of Last Observed</td>
<td>14 June</td>
<td>22 June</td>
</tr>
<tr>
<td>Date of Peak Abundance</td>
<td>25 May</td>
<td>25 May</td>
</tr>
<tr>
<td>Length of Flight (days)</td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>Pollard Index</td>
<td>59</td>
<td>150</td>
</tr>
<tr>
<td>Max Count</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td><strong>Demographic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex Ratio (♂:♀)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marked</td>
<td>21:8</td>
<td>40:7</td>
</tr>
<tr>
<td>Observed</td>
<td>42:9</td>
<td>125:12</td>
</tr>
<tr>
<td>Lifespan (days):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>6.4-9.9</td>
<td>10.5-14.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>17-21</td>
<td>23-27</td>
</tr>
<tr>
<td><strong>Movement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median dispersal range (m)</td>
<td>19.6 (1.5-83.8)</td>
<td>34.4 (1.5-108.5)</td>
</tr>
<tr>
<td>Median minimum distance traveled (m)</td>
<td>19.6 (1.5-86.0)</td>
<td>41.9 (1.5-316.3)</td>
</tr>
</tbody>
</table>
Movement
Methods
Hermes copper movement patterns were quantified using mark-release-recapture techniques and population genetic analyses. Marking studies involved repeated transect surveys at a particular site. All adults were captured and marked with an unique color code using felt-tipped pens. The location of each individual and its unique identity were recorded throughout the flight season. Amplified Fragment Length Polymorphic (AFLP) markers were used to assess genetic differences, and the analyses involved the use of Geneland to assign individuals to genetic clusters and $F_{ST}$ calculations to quantify genetic similarities and differences. A total of 321 individuals from 23 locations were used in the genetic analyses.

Results
Through the use of visual marking techniques, most of the detected movements were short distances. The median minimum distance traveled was 34.4 m at Rancho Jamul Ecological Reserve and 17.6 m at Hollenbeck Canyon Wildlife Area, with 316.3 and 1132.0 m representing the greatest minimum distance, respectively. The median dispersal range was 25.8 m at Rancho Jamul Ecological Reserve and 11.3 m at Hollenbeck Canyon Wildlife Area, with 108.5 m and 1132.0 m representing the largest ranges, respectively. A common trend observed was that the individuals that moved the greater distances did so by single long movements between consecutive observations rather than by several shorter movements. The high frequency of short movements resulted from commonly encountering territorial males, sometimes found perched on the same branch on different sampling occasions.

We detected no movement between Rancho Jamul Ecological Reserve and Hollenbeck Canyon Wildlife Area in 2007, the only year of concurrent marking studies. These two sites are separated by 5.7 km which consists of heavily disturbed sage scrub habitat that includes a type conversion to grassland, small hills, and a two-lane highway. We also did not detect movement between two areas of Hollenbeck Canyon Wildlife Area that were separated by 100 m wide oak riparian community and an adjacent 65 m grassland. Both of the hillsides bordering these riparian/grassland communities had relatively high numbers of Hermes copper adults. The habitat between observation locations for the individual that traveled a minimum of 1,132 m is believed to consist of a nearly or completely continuous patch of coastal sage scrub. Due to a subsequent wildfire, we are unable to confirm the vegetation pattern. At Rancho Jamul Ecological Reserve, 2 of 87 marked individuals were found to have traveled between two spiny redberry patches separated by a grassland of about 90 m in width with sparse California buckwheat and no spiny redberry shrubs.

Using the AFLP data, the majority of Hermes copper individuals were genetically similar to each other, with peripheral portions of the distribution containing most of the differences. This provides evidence that the Hermes copper can disperse across much of the landscape, which was not suggested by Thorne (1963) or detected by small-scale marking studies (Marschalek and Deutschman 2008, Marschalek and Klein 2010). These genetic patterns likely reflect historical processes rather than contemporary influences (e.g. habitat fragmentation) as genetic differences reaching detectable levels would probably require more time to accumulate. Individuals from peripheral populations in the northern and western portion of the Hermes copper distribution generally exhibit increased differentiation compared to populations in the central region of their range (McGinty Mountain, Sycuan Peak, and Lawson Peak areas). The southeastern peripheral populations near Potrero appear to have adequate dispersal with
the central region to prevent genetic differentiation. The overall genetic patterns likely reflect historic processes and it is possible that recent impacts, such as habitat fragmentation resulting in increased isolation, have yet to appear in the genetic composition.

Summary of Movement
The marking studies focused mostly on territorial males and intra-spiny redberry patch movements. Most males remained within an area less than 20 meters across. Genetic techniques were required to assess long-distance movements. The genetic structure of Hermes copper indicated that most of the habitat patches were not isolated from one another historically. Genetic differences among populations require time to accumulate so current connectivity was not assessed through genetic techniques. The lack of recolonization following wildfires, despite vegetation/habitat recovery, suggests that recent habitat loss and fragmentation is limiting or preventing dispersal (connectivity).

Habitat Description
Methods
Previous efforts to describe Hermes copper habitat occurred in 2003 (Marschalek 2004) and 2016 (Marschalek and Deutschman 2016A, B). Hermes copper larvae use only spiny redberry as a food plant (Thorne 1963, Brown 1991, Faulkner and Klein 2004) and adults strongly prefer to obtain nectar from California buckwheat flowers (Thorne 1963, Brown 1991, Faulkner and Klein 2004, Marschalek 2004). For these reasons, spiny redberry and California buckwheat have been a focus for vegetation sampling in regards to describing habitat requirements and preferences.

In 2003, a rapid habitat assessment of butterfly transect areas was conducted at six sites (Cleveland National Forest- Anderson Road and Wildwood Glen Lane, Crestridge Ecological Reserve, Meadowbrook Ecological Reserve, Rancho Jamul Ecological Reserve, Sycamore Canyon County Park) (Marschalek 2004). Aspects of habitat (see Table 3) were measured every 20 m on the 250 m butterfly transects and starting 5 m from transect starting points (Figure 2). Each sampling location was recorded with a GPS unit. Measured characteristics fell into three broad categories: general habitat structure, adult nectar source abundance, and larval host plant abundance. When estimating percent cover, ten percent classes were used (e.g. 0-10%, 10-20%...90-100%). To associate Hermes copper use, or densities, with habitat characteristics, each sighting was registered to the nearest vegetation sampling location using a measuring tool in GIS. All habitat variables were included into the model to predict Hermes copper presence.

In 2016, spiny redberry patches were mapped in the same areas as adult Hermes copper adult surveys (see Figure 3 for list of sites). These sites are currently occupied or had historic records of Hermes copper, with the exception of Bette Bendixen which has no previous Hermes copper observations. For areas with few, discrete spiny redberry patches, all patches at the site were included. Other areas had extensive stands of relatively undisturbed native habitat with spiny redberry shrubs. Due to limitations in field time and funding, only redberry patches closest to the butterfly transects were sampled. Standardized mapping units were not established prior to mapping. Within each spiny redberry patch, the abundance and cover of spiny redberry and California buckwheat were recorded, as well as general vegetation composition (Table 4). The site assessments were designed to be rapid and detect large differences in habitat. Individual spiny redberry shrubs were also recorded but associated habitat data were not collected for single, isolated shrubs.
Table 3. Measurements taken at 20 m intervals on survey transects to determine habitat preference of Hermes copper adults in 2003.

<table>
<thead>
<tr>
<th>Category</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Structure</td>
<td>Slope, aspect, # large shrubs&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>% cover: shrubs&lt;sup&gt;1&lt;/sup&gt;, grasses&lt;sup&gt;2&lt;/sup&gt;, bare ground&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Adult Nectaring Sources</td>
<td>% cover: California buckwheat (<em>Eriogonum fasciculatum</em>), chamise (<em>Adenostoma fasciculatum</em>)</td>
</tr>
<tr>
<td>Larval Host Plant (<em>Rhamnus crocea</em>)</td>
<td># of large plants&lt;sup&gt;4&lt;/sup&gt;, % cover</td>
</tr>
</tbody>
</table>

<sup>1</sup> Included any woody vegetation.  
<sup>2</sup> Included any non-woody vegetation.  
<sup>3</sup> Included any non-vegetated area.  
<sup>4</sup> Greater than 1.25 meters in height or diameter.

Figure 2. Vegetation sampling locations (blue boxes) along a butterfly survey transect. Each transect was 250 m in length.
Table 4. Habitat assessment variables used in 2016.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiny Redberry</td>
<td>Number of shrubs, mapped extent</td>
</tr>
<tr>
<td>California Buckwheat</td>
<td>Distribution (evenly distributed, most along road, and/or few patches)</td>
</tr>
<tr>
<td>Vegetation Composition (% cover)</td>
<td>Spiny redberry, California buckwheat, shrubs (includes redberry and buckwheat), non-native grasses, non-native forbs, bare soil</td>
</tr>
<tr>
<td>Trees</td>
<td>Distance to spiny redberry patch, tree species</td>
</tr>
</tbody>
</table>

Results

For the 2003 sampling, the general vegetation structure varied within and among sites (Figure 3). The percent cover of California buckwheat and spiny redberry were relatively low despite sampling in Hermes copper habitat (spiny redberry patches). Habitat was a poor predictor of Hermes copper presence. Site and cover of California buckwheat were the only significant predictors of Hermes copper presence at each sampling location (chi-square = 85.200, p < 0.001, 7 df) (Table 5). The addition of percent cover of grasses or presence of spiny redberry increased the predictive power of the model slightly, however neither were significant. Since sites greatly differed in presence of Hermes copper, models were created for each site. Forward stepwise logistic regression models with a p = 0.15 cutoff resulted in models with different variables and slopes. This indicates that the habitat characteristics measured do not predict adult presence throughout the range of the species.

In 2016, 108 spiny redberry patches were mapped and 30 single spiny redberry shrubs recorded across the 13 southern sites. Up to 180 spiny redberry shrubs were recorded in a single patch, but more patches were represented by a relatively low number of shrubs. A total of 65 spiny redberry patches were mapped and 11 single redberry shrubs were recorded across the 8 northern sites. Up to 90 redberry shrubs were recorded in a single patch, but more patches were represented by a relatively low number of shrubs. Most of the redberry patches had shrub cover that was at least 60%. The analyses placed the sites into three groups: 1) northern, 2) southern that recently burned (2003 or later), and 3) southern that did not recently burn (the northern sites did not completely burn recently).

When comparing vegetation structure across the three site groups, the sites varied most in the percent cover of bare ground. The northern sites and southern burned sites had little bare ground compared to the southern unburned sites (Figure 4). Vegetation cover varied among sites and no clear trend beyond the bare ground pattern was observed (Figure 5).
Figure 3. Percent cover at sampling locations along Hermes copper sampling transects. Hermes copper were present at all six sites at the time of sampling.

Table 5. Comparison of logistic regression models determining the presence of Hermes copper adults.

<table>
<thead>
<tr>
<th>Variable(s)</th>
<th>Deviance ($\chi^2$)</th>
<th>Degrees of Freedom</th>
<th>AIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>72.2</td>
<td>5</td>
<td>62.2</td>
</tr>
<tr>
<td>Site, California buckwheat</td>
<td>85.2</td>
<td>7</td>
<td>71.2</td>
</tr>
<tr>
<td>Site, California buckwheat, spiny redberry</td>
<td>86.7</td>
<td>8</td>
<td>70.7</td>
</tr>
</tbody>
</table>
Figure 4. Comparison of vegetation structure at northern and southern Hermes copper sites, including southern sites that did and did not experience recent wildfires.

Figure 5. Vegetation structure at each site. Dark green bars represent shrub cover, light green bars represent a combination of grasses and forbs (“Herbs”), and gray bars represent bare ground (“Soil”). All sites, with the exception of Bette Bendixen, have had Hermes copper populations.
Overall, the measured habitat characteristics exhibited a relatively high level of variability. The average number of spiny redberry shrubs in each patch varied, as each of the three site categories had locations with few spiny redberry shrubs and locations with many spiny redberry shrubs (Figure 6). Even though measurements were restricted to redberry patches, the percent cover of spiny redberry for each site generally averaged less than 15 percent. The percent cover of California buckwheat was also generally under 15 percent.

Figure 6. Comparison of spiny redberry and California buckwheat at northern and southern Hermes copper sites, including southern sites that did and did not experience recent wildfires. Site averages are reported with error bars representing 1 standard deviation.

Summary of Habitat Description
Hermes copper habitat is variable, with the exception of spiny redberry being a requirement. It also appears that California buckwheat shrubs are required or very beneficial, with buckwheat shrubs more important as the number of native flowering annual plants decreases. A more detailed understanding of suitable habitat is lacking. For example, it is not clear how many spiny redberry and/or California
buckwheat plants are necessary to support a Hermes copper population in a given area, or how abundance and spatial arrangement of plants relate to Hermes copper population sizes.

Threats

Fire
Several local populations were extirpated due to the 2003 and 2007 wildfires but only one (Boulder Creek Road) appears to be recolonized, large, and a self-sustaining population (Marschalek and Klein 2010, Marschalek et al. 2016). Hermes copper adults have been detected at Wildwood Glen Lane, but not since 2012 (Table 1). Wildfires have directly resulted in the loss of populations as well as habitat loss (Marschalek and Klein 2010). This habitat loss may be temporary until the vegetation recovers, or fire may also result in the coastal sage scrub vegetation community being converted into a grassland community (Marschalek and Klein 2010). Many of the extant populations are within an area characterized as having a high risk of fire (USFWS 2011).

Habitat loss or degradation
Hermes copper butterfly is threatened by habitat loss or degradation (USFWS 2011). Historically, habitat loss due to urbanization resulted in the extirpation of several local populations (Wright 1930, Marschalek and Klein 2010). These are generally within the western portion of the Hermes copper distribution. More recently, habitat fragmentation and wildfires have resulted in the loss (type conversion, see “Fire” section) and isolation of the remaining populations throughout the range.

Small populations or lack of connectivity
Further isolation of populations reduces or possibly prevents movement of individuals among these populations which can be a key factor in site occupancy (WallisDeVries 2004). Isolation can also impact the evolutionary pathway of populations and the species by reducing gene flow and subsequently increasing inbreeding (Couvet 2002). Deleterious effects of inbreeding, including reduced survival and fecundity, have been documented in other butterflies (Saccheri et al. 1998, Crnokrak and Roff 1999, Frankham 2005, Vandewoestijne et al. 2008). A restricted range and relatively isolated populations inhibits the species from recovering from stochastic events such as wildfires (USFWS 2011).

Climate change
Although a statistical relationship has not been described, the annual number of Hermes copper adults is greater with more winter/spring precipitation and lower with less precipitation (Marschalek and Deutschman 2016B). From October 2011 to September 2014 represents the driest consecutive three-year period to date (Jones 2015). A reduction in San Diego County precipitation, as predicted with climate change (Li et al. 2014), will likely lead to a reduction in already small annual adult population sizes. This is commonly observed in other butterfly species (Pollard 1988). Climate change has been linked to declines and extinctions in other butterfly species (Forister et al. 2010, Casner et al. 2014, Oliver et al. 2015, Tack et al. 2015).

Management Strategies
MSP Roadmap goal for Hermes copper to: “protect, enhance, and restore Hermes copper occupied habitat and historically occupied habitat and the landscape connections between them to create resilient, self-sustaining populations that provide for persistence over the long term (>100 years)”.

16 | P a g e
Based on our current understanding of Hermes copper, the management strategies listed below are designed to alleviate threats to this species and its habitat.

This can be accomplished by:

1) Protecting current populations from wildfires
2) Enhancing existing populations, particularly those that have the smallest population sizes
3) Expanding the current distribution of populations
4) Protecting habitat

Specific management actions and prioritization of these actions are listed in Appendix A.

Protect current populations from wildfires

Pre-fire
Objective: Protect current Hermes copper occupied spiny redberry patches from fire.

Because fire is a major threat to Hermes copper and it appears that restricted dispersal is limiting recolonization, action should be taken to reduce this threat. This could include reducing the number of fires and/or limiting the size of fires. One of the MSP Roadmap fire objectives is developing a Wildfire Ignition Reduction Plan to reduce risk of wildfires at prioritized Hermes copper sites. Upon completion of fire risk and habitat modeling, specific fire management actions for Hermes copper will be prepared and added as an appendix to this plan.

Post-fire
Objective: Restore California buckwheat populations to at least 1 California buckwheat shrub for every 10 spiny redberry shrubs within and adjacent (within 10 meters) of previously Hermes copper occupied spiny redberry patches following a fire. This may not always be required following a fire.

The two important food plants have different post-fire recovery strategies. Spiny redberry is an obligate resprouter (Keeley 1992), while California buckwheat is a facultative seeder as a high proportion (90%) of plants are killed by fire (Zedler et al. 1983, Keeley 2006). Following the 2003 and 2007 wildfires, a reduction of buckwheat and annual forbs, accompanied by an increase of non-native grasses has been observed at certain sites (Marschalek and Klein 2010, Rochester et al. 2010). It appears that those sites that exhibited signs of type conversion had experienced a certain level of degradation prior to the fires. Restoration of these habitats are necessary for recolonization and support of Hermes copper populations. If non-native grass cover is low, allowing for adequate populations of native annual flowering plants, fewer California buckwheat shrubs may be required. These recommendations, including the ratio of at least 1 California buckwheat shrub for every 10 spiny redberry shrubs, are based on the gestalt of Hermes copper habitat in the absence of quantified data. Sites that experienced high buckwheat loss following these fires and have low counts of buckwheat shrubs include (Figure 7):

- Cleveland National Forest- Barber Mountain
- Crestridge Ecological Reserve
- Rancho Jamul Ecological Reserve
- Sycamore Canyon County Park
- USFWS- San Miguel Mountain
Relatively large Hermes copper populations have been observed in degraded habitats (e.g. grazing at Rancho Jamul Ecological Reserve, pre-2003 fire data). In addition, habitat assessments have not identified important components other than spiny redberry and California buckwheat. For these reasons, it appears that restoration should focus on the establishment of redberry and buckwheat. Additional benefits may be obtained by removal of grasses around redberry shrubs and establishing/enhancing populations of summer flowering annual plants. Grass removal will provide bare soil under the redberry shrubs which appears to be a preferred condition for oviposition. Hermes copper adults have a preference for nectaring on buckwheat flowers but have been rarely observed feeding from flowers of other plant species as well (e.g. Adenostoma fasciculatum, Deinandra fasciculata, Gutierrezia sarothrae, Toxicodendron diversilobum). Other flowering plants during the adult flight season would increase food options.

Figure 7. Sites for California buckwheat enhancement.

Enhance existing populations, particularly those that have the smallest population sizes
Objective: Increase the number of spiny redberry shrubs at sites with fewer than 10 Hermes copper adults at peak abundance during a year with average winter precipitation.
The distribution of Hermes copper is geographically limited, so each population is important for their long-term persistence. Having numerous, robust populations spread out across the landscape is important considering the regular occurrence of wildfires. The largest populations exist in the southern portion of San Diego County, from the Jamul area east into Cleveland National Forest. Smaller populations also exist within this region. However, only small populations are currently known from sites at Mission Trails Regional Park and further north. The small populations in the northern portion of the Hermes copper distribution that warrant enhancing include (Figure 8):

- Black Mountain
- Crosby National Golf Course
- Elfin Forest
- Los Penasquitos Canyon Preserve- Lopez Canyon
- Meadowbrook Ecological Reserve
- Mission Trails Regional Park
- Onyx Ridge

Figure 8. Sites with small populations that should be enhanced.
It appears that Hermes copper populations are generally positively correlated with the amount of larval food resources. Results from egg surveys suggest that eggs are not deposited on each shrub, and that eggs are sparsely distributed (only once was a redberry shrub found with more than one Hermes copper egg). Increasing the number of spiny redberry shrubs and expanding the extent of these plants should increase the local Hermes copper population size. This increases larval resources and expands suitable habitat.

Topographic variation should be considered when expanding current spiny redberry patches to provide different microhabitat conditions (e.g. hillsides, ravines, aspect). This has been shown to be important for butterflies (Weiss et al. 1988) and is an important consideration considering climate change. North-facing hillsides with cooler temperatures and increased moisture will likely be of increased importance in the future. Furthermore, spiny redberry tends to grow in deeper soils in with increased moisture (Thorne 1963).

Expand the distribution of populations
Objective: Translocate Hermes copper (eggs or adults) to reestablish or create (when the historical occupancy status is unknown) populations so that the butterfly is as widely distributed as historic conditions.

Wildfires have reduced the number of Hermes copper populations as well as the spatial extent to which this species is reliably found. Habitat loss and fragmentation may be restricting dispersal, therefore limiting recolonization. Dispersal (natural or assisted) to recolonize post-wildfire habitat before other fires extirpate extant populations is a critical need for the conservation of this species. However, assisted dispersal following wildfires may be required to maintain a wide geographic extent to reduce the risk of extinction due to one major catastrophe (e.g. wildfire).

Translocation of individuals to a post-wildfire recovery habitat is currently being explored to determine the efficacy of this method for re-establishing a population (Marschalek and Deutschman 2016C). Not only could this technique mitigate the impacts of fire, but also reduce the risk of extinction due to future fires by expanding the already reduced distribution. The following sites have experienced recent extirpations and are potential candidates for translocations (habitat restoration may be required prior to natural or assisted dispersal for recolonization) (Figure 9):

- Cleveland National Forest- Anderson Road
- Crestridge Ecological Reserve
- Hollenbeck Canyon Wildlife Area (translocations efforts occurring)
- Rancho Jamul Ecological Reserve
- Sycamore Canyon County Park
- USFWS- San Miguel Mountain
- USFWS- Steele Canyon
- USFWS- Sweetwater
Figure 9. Potential sites for translocations to expand the Hermes copper distribution by reestablishing populations following wildfires.

For the southern portion of the Hermes copper range, reestablishment of populations at Cleveland National Forest- Anderson Road (north), Rancho Jamul Ecological Reserve (south), and USFWS- San Miguel Mountain (west) would extend the distribution to the maximum extent of the known historic range. Spiny redberry is found adjacent to the US-Mexico border so Hermes copper could be introduced further south. These areas were likely occupied historically. For the northern populations, fire has impacted Sycamore Canyon County Park and possibility other spiny redberry patches as well. Other locations, within or between (e.g. Lakeside, Santee) the north and south regions could also represent opportunities for translocations provided appropriate habitat is present or restored.

Currently, large source populations exist from McGinty Mountain east through Sycuan Peak, Lawson Peak and north towards Descanso. These populations exhibit a high degree of genetic similarity so they should be appropriate for most translocation efforts. The Cleveland National Forest- Boulder Creek Road population is the only large population that exhibited significant genetic differentiation. For this reason, it may not be an ideal source but should not be precluded due to differences in neutral genetic markers. Sites to the north were also genetically different from other sampled sites. No sites north of Interstate 8
and west of Hwy 67 appear to be large enough to support translocation efforts (i.e. source populations) at this time.

**Protect Habitat**

Objective: Protect habitat from future development or alteration through land acquisition and conservation, and include newly conserved lands into the San Diego County preserve system.

Due to the naturally restricted distribution of Hermes copper and the increasingly fragmented San Diego County landscape, protecting current habitat is important for the long-term persistence of this species. This should include protecting occupied or suspected occupied habitats, but also maintaining or restoring connectivity of spiny redberry patches. Currently, Hermes copper populations are known to occur at several locations on private property and others are likely. The following areas should be considered for acquisition to protect Hermes copper populations, habitats, and connectivity (Figure 9):

- Adjacent to Meadowbrook Ecological Reserve in Poway
- Adjacent to Wright’s Field in Alpine
- South of South Crest Preserve and northwest of McGinty Mountain
- Between McGinty Mountain and Sycuan Peak
- Southeast of Sycuan Peak
- Sycuan Peak Ecological Reserve inholding
- Area around Loveland Reservoir
- Between Hollenbeck Canyon Wildlife Area and Cleveland National Forest
- North of Potrero and Potrero Peak
- Southwest and Southeast of Descanso
Research Needs

Research needs were developed from the current conceptual model for Hermes copper, as biological uncertainties and future research topics were listed (Lewison et al. 2012):

**Biological Uncertainties**
How the spatial distribution of spiny redberry affects occupancy
Female behavior including oviposition preferences and dispersal abilities
Major predators and parasitoids
Mortality factors including predators, parasitoids, roadkill, and others
Overall species dispersal behavior and ability, including impacts on gene flow
Distribution of buckwheat
Future Research Topics
Dispersal, including potential factors influencing dispersal
  - Wind or directed flight
  - Male vs. female
  - Trigger to dispersal flight
  - Landscape features impact to movement
Larval requirements
Habitat requirements
Physiological requirements (light, temperature, etc.)

Since development of the conceptual model, some aspects of current distribution (through landscape genetics techniques) and female oviposition sites have been addressed, but new questions about occupancy of northern sites have arisen. For example, following the 2012 adult flight season, no Hermes copper adults have been detected at the northern sites, which are west of Alpine and north of Interstate 8. To reduce the risk of extirpation due to wildfires, it is important that this portion of the county supports Hermes copper populations. In addition, severe drought conditions suppressed Hermes copper adult emergence at all sites in 2015 and 2016 and likely contributed to the lack of observations. Lastly, work with immature stages continues to be problematic, either due to lack of knowledge for these stages and/or the inability to obtain specimens to work with. Therefore, addressing larval requirements and parasitoids will be difficult until we have a better understanding of immature stages. As with the management strategies, research needs are prioritized (Appendix B).

Translocation
Currently, the translocation of adults or eggs has not conclusively resulted in the reestablishment of a Hermes copper population; however, this may be related to drought conditions. Signs of larval eclosion (emerging from eggs) in 2015 and one adult in the release site in 2016 are promising. Since Hermes copper adult numbers have been suppressed during the recent drought, particularly in the vicinity of the translocation project, a year with greater precipitation is required to fully assess the success of the previous translocations. Additional translocations to supplement the 2014 efforts are also warranted. If successful, translocations can be used to reestablish populations extirpated from wildfires and expand the geographic extent of the species, both reducing the risk of extinction.

Surveys for relatively large spiny redberry patches (greater than 200 shrubs) closer to the United States-Mexico border should be conducted. These habitats could be chosen for future translocations with the goal of establishing a large population and expanding the Hermes copper distribution as far south as possible in the United States. A large population should have a higher probability of long-term persistence compared to a smaller population (due to stochastic factors) and would be able to provide individuals for management and research activities. This area is in the region of Otay Mountain, directly south of SDNWR- San Miguel Mountain, Rancho Jamul Ecological Reserve, and Hollenbeck Canyon Wildlife Area.

Document and Describe Smaller, Northern Populations
The northern Hermes copper populations west of Alpine and north of Interstate 8 represent important populations for the persistence of the species by reducing the chances of extinction due to wildfire in the southern portion of the range. Initial data indicates these populations are small and hard to detect
(Deutschman et al. 2011, Strahm et al. 2012, Marschalek and Deutschman 2016A), and the landscape suggests they are highly isolated. In 2016, habitat and threat assessments were made in these areas but Hermes copper adults were not detected due to drought conditions suppressing butterfly emergence. Adult observations are required to better understand which spiny redberry patches are occupied, as well as determining the local population size. This is a first step before being able to enhance populations (habitat), address connectivity of populations, and assess potential sites for reintroductions.

**Habitat Requirements (Population Size, Connectivity)**

For prioritized and effective landscape conservation planning and habitat restoration, a better understanding of habitat is necessary. This relates to characteristics that drive population sizes and connectivity of spiny redberry patches. The number and spatial arrangement of spiny redberry, California buckwheat, and possibly other variables could be influential. Landscape scale mapping of redberry is required. It is possible that aerial imagery and/or remote sensing technologies could be used to detect spiny redberry shrubs when the plants have small, shiny leaves in the early spring (February) and buckwheat shrubs when flowering in the summer (June).

Increasing connectivity between habitat patches is important for natural dispersal. However, little is known about how most insect species move across complex landscapes so more work is needed before species-specific management can be implemented for Hermes copper.

**Assessing Ability to Survive Drought**

Monitoring of Hermes copper adults at regularly surveyed sites should continue so that we can assess the ability of the species to recover following multiple years of drought. Populations that are less sensitive to drought are more likely to survive and increasingly important considering climate change projections for less precipitation (Li et al. 2014).

**Assessing Ability to Recolonize Following Fire**

Monitoring of Hermes copper adults at historically occupied sites which were extirpated by recent wildfires will inform about natural recolonization ability. Conditions of both the post-wildfire habitats and dispersal corridors are likely to influence recolonization rates. If recolonization events continue to be rare, the importance of translocations and captive populations will be elevated. Likewise, if future fires result in loss of additional population, the importance of these activities will be elevated.

**Survey for Unknown/Additional Populations**

It is likely that the Hermes copper occupies spiny redberry patches that have not been previously discovered and documented. Initial San Diego County-wide surveys (Deutschman et al. 2010, 2011) covered much of the conserved lands, but were unable to survey all areas. Other areas have been recently acquired and incorporated in the regional preserve system. For this reason, surveys for spiny redberry and Hermes copper should be conducted to more completely describe the butterfly’s distribution. However, based on the rich butterfly collecting history of San Diego County, San Diego State University’s surveys, wildfire extirpations, and landscape topography (and associated redberry elevational restrictions), discovering new populations outside of the current extent is unlikely.

There are three areas that are more likely to result in the discovery of new Hermes copper populations (Figure 11). One is Cleveland National Forest and adjacent lands. Recent work in Cleveland National Forest found several areas with Hermes copper with relatively limited and survey linear transects
(Chambers Group, Inc 2011). A second area is near Jamul, CA and immediately east as several surveys required for development projects have resulted in Hermes copper observations. The third area is in the vicinity of Poway and Escondido. This region has experienced less intensive surveys, but that maybe due to less conserved lands and appropriate habitat.

Figure 11. Areas to be considered for future spiny redberry and Hermes copper surveys to discover undocumented Hermes copper populations. These areas are mostly likely to have unknown populations.

Captive Rearing
Captive rearing should also be explored. This could be used to maintain a captive refugia population as insurance against a large catastrophic event. Rearing may also be a valuable tool to assist in translocation as described above. Hermes copper larvae are extremely difficult to rear in captivity. This was noted as early as the 1930s (Comstock and Dammers 1935, Thorne 1963) and continues to be problematic today (Marschalek and Deutschman 2015). To our knowledge, no one has successfully reared a Hermes copper from egg to adult. This is a critical barrier to several management approaches that are available for other butterfly species.
Current Management Actions

Translocation
San Diego State University initiated a project to evaluate translocation as a management tool for establishing self-sustaining Hermes copper populations (Marschalek and Deutschman 2016C). If successful, this could be a potential management tool to mitigate the impacts of wildfire. Hermes copper were translocated from larger populations (San Diego National Wildlife Refuge-McInty Mountain, a property on Skyline Truck Trail, and Sycuan Peak Ecological Reserve) to an area of suitable habitat at Hollenbeck Canyon Wildlife Area. Hollenbeck Canyon was selected because it had a historic Hermes copper population prior to a recent (2007) wildfire and the vegetation community, including spiny redberry and California buckwheat shrubs, were still present after the fire. The translocation of adults and eggs were assessed separately.

In 2014, 14 eggs and 11 adults (5 females and 6 males) were released in two different areas at Hollenbeck Canyon Wildlife Area. Initial plans included releasing more individuals in 2014 as well as supplementing these releases with similar numbers in 2015 and 2016. Due to a continuing drought that has suppressed adult butterfly numbers, the 2014 release numbers were lower than desired and releases in 2015 and 2016 were not possible.

During the spring of 2015, nine eggs exhibited signs consistent with larval eclosion, three were missing from the original clipping and lost prior to the first survey date, and two eggs remained intact. The two intact eggs were monitored in spring of 2016. One was missing at the start of the monitoring period and the second became brown in color and assumed to be non-viable.

Surveys for Hermes copper adults occurred during the 2015 and 2016 flight seasons at both the egg and adult release sites. The presence of adults is a primary indicator of success. No adults were observed at either site during 2015, but one male was observed in the area where adults were released in 2016. One individual is a low number but equal to the number observed at Sycuan Peak Ecological Reserve, recently one of the largest populations.

Post-fire Restoration
The Harris Fire of October 2007 burned most of the chaparral at Barber and Elena Mountains. A few small unburned patches remained, and the Hermes copper population persisted at low numbers after the fire (Faulkner 2008). Spiny redberry resprouted vigorously after the fire but the fire completely killed a number of California buckwheat shrubs which is not typical. The US Forest Service planned a restoration effort to enhance the buckwheat population to enhance Hermes copper habitat.

The Forest Service contracted for collection of 100 lbs of buckwheat seed from the local area. This was collected in 2009 and was used to seed key areas in February of 2010. Seeding was accomplished by hand-spreading the seed and raking it in. Seeded areas are shown on the map below. Subsequently, recruitment was observed from seed which occurred concurrently with natural recovery and re-sprouting of buckwheat at the site. Buckwheat is typically very successful when introduced as seed (White et al. 1995) so this would appear to be a good restoration method. However, in this instance natural recovery of buckwheat was also occurring, so the seeding was likely not a significant factor in the restoration of the Hermes copper habitat.
Prioritization of Activities

All activities listed in this document are expected to benefit the Hermes copper and help ensure the persistence of this species over the next 100 years in San Diego County. Due to the restricted distribution and relatively small population sizes, protecting the few large populations and working towards reestablishing additional populations (particularly large populations) are most important. Activities of highest priority are assigned a rank of 1, followed by 2 and 3. The prioritized management actions and research needs are listed in Appendix A and B, respectively.

Acknowledgements

I would like to thank the working group that provided valuable information, including: California Department of Fish & Wildlife (Christine Beck, Elyse Levy, David Mayer), San Diego Association of Governments (Keith Greer), San Diego Monitoring and Management Program (Yvonne Moore, Kris Preston), U.S. Fish & Wildlife Service (Alison Anderson, Emily Cate, Eric Porter, Susan Wynn), and U.S. Forest Service (Kirsten Winter).

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Jones J. 2015. California’s most significant droughts: comparing historical and recent conditions. California Department of Water Resources, Sacramento, California, USA.


Wright WS. 1930. An annotated list of the butterflies of San Diego County, California. Transactions of the San Diego Society of Natural History. 6:1–40.

### Appendix A: Site assessments and prioritized management actions

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Manager</th>
<th>MU</th>
<th>Hermes Copper Status</th>
<th>Summary of Habitat Conditions</th>
<th>Management Options*</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Mountain</td>
<td>City of San Diego</td>
<td>6</td>
<td>Possibly extant</td>
<td>Redberry is common throughout portions of Cleveland National Forest, as recorded for the SDGE Sunrise Powerlink Project. Non-native plant cover appears to be low in general.</td>
<td>Protect from fire, enhance redberry population</td>
<td>2, 3</td>
</tr>
<tr>
<td>Cleveland National Forest</td>
<td>USFS</td>
<td>10, 11</td>
<td>Extant</td>
<td>This area burned in 2003 and the native vegetation (little non-native vegetation) appears to have recovered. Redberry is extensive on the western side of the mountain, buckwheat shrubs are present almost exclusively adjacent to the road.</td>
<td>Protect from fire</td>
<td>1</td>
</tr>
<tr>
<td>Cleveland National Forest- Anderson Road</td>
<td>USFS</td>
<td>4</td>
<td>Extirpated (2003)</td>
<td>This area burned in 2003 and the native vegetation appears to have recovered. Redberry is extensive on the lower western side of the mountain near the road. Few buckwheat shrubs are present, primarily near the road.</td>
<td>Translocation</td>
<td>1</td>
</tr>
<tr>
<td>Cleveland National Forest- Barber Mountain</td>
<td>USFS</td>
<td>11</td>
<td>Extant</td>
<td>Enhance buckwheat (in progress)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Cleveland National Forest- Boulder Creek Road</td>
<td>USFS</td>
<td>10</td>
<td>Extant</td>
<td>Protect from fire</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Cleveland National Forest- Lawson Peak</td>
<td>USFS</td>
<td>11</td>
<td>Extant</td>
<td>Protect from fire</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Cleveland National Forest- Roberts Ranch North</td>
<td>USFS</td>
<td>10</td>
<td>Extant</td>
<td>Protect from fire</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Cleveland National Forest- Roberts Ranch South</td>
<td>USFS</td>
<td>11</td>
<td>Extant</td>
<td>Protect from fire</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Cleveland National Forest- Wildwood Glen</td>
<td>USFS</td>
<td>10</td>
<td>Extant</td>
<td>Protect from fire</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Crestridge Ecological Reserve</td>
<td>EHL</td>
<td>3</td>
<td>Extirpated (2003)</td>
<td>Protect from fire, enhance buckwheat population, translocation</td>
<td></td>
<td>2, 3, 1</td>
</tr>
<tr>
<td>Crosby National Golf Course</td>
<td>County of San Diego</td>
<td>6</td>
<td>Likely extirpated (2007)</td>
<td>Enhance redberry population</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Elfin Forest</td>
<td>ECC</td>
<td>6</td>
<td>Extant</td>
<td>Protect from fire, enhance redberry population</td>
<td></td>
<td>1, 2</td>
</tr>
<tr>
<td>Hollenbeck Canyon Wildlife Area</td>
<td>CDFW</td>
<td>3</td>
<td>Reintroduced</td>
<td>Protect from fire, translocation (in progress)</td>
<td></td>
<td>1, 1</td>
</tr>
<tr>
<td>Lakeside Downs</td>
<td>EHL</td>
<td>4</td>
<td>Unknown</td>
<td>Surveys to determine Hermes copper occupancy</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Appendix A: Site assessments and prioritized management actions, continued.

<table>
<thead>
<tr>
<th>Site Name</th>
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<th>MU</th>
<th>Hermes Copper Status</th>
<th>Summary of Habitat Conditions</th>
<th>Management Options*</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawson Valley (Skyline Truck Trail)</td>
<td>EHL</td>
<td>3</td>
<td>Extant</td>
<td>Surprisingly few redberry shrubs have been observed considering the number of Hermes copper adults. Non-native grasses are present but most of the vegetation is composed of shrubs.</td>
<td>Protect from fire</td>
<td>1</td>
</tr>
<tr>
<td>Los Penasquitos Canyon Preserve- Lopez Canyon</td>
<td>City of San Diego</td>
<td>6</td>
<td>Extant</td>
<td>This area has a high cover of non-native grasses, while the area with redberry and buckwheat is relatively discrete. A portion of the redberry burned in 2003.</td>
<td>Protect from fire, enhance redberry population</td>
<td>1, 1</td>
</tr>
<tr>
<td>Loveland Reservoir</td>
<td>Sweetwater Authority</td>
<td>11</td>
<td>Extant</td>
<td>Most of the redberry shrubs are found in several ravines along the north side of the reservoir. Shrub vegetation is relatively common, but these shrubs are relatively low percent cover. Black sage is relatively common, more so than other Hermes copper locations.</td>
<td>Protect from fire, enhance redberry population</td>
<td>1, 3</td>
</tr>
<tr>
<td>Meadowbrook Ecological Reserve</td>
<td>CDFW</td>
<td>4</td>
<td>Possibly extant</td>
<td>The redberry and buckwheat are bordered by non-native grasses (fuel break) on two sides. Black sage is relatively common, more so than other Hermes copper locations.</td>
<td>Protect from fire, enhance redberry population</td>
<td>1, 3</td>
</tr>
<tr>
<td>Mission Trails Regional Park</td>
<td>City of San Diego</td>
<td>4</td>
<td>Possibly extant</td>
<td>Most of the redberry is found within non-native grasslands, while some extends up Kwaay Paay Peak into shrub dominated vegetation. A portion of the redberry burned in 2003.</td>
<td>Protect from fire, enhance redberry population</td>
<td>1, 3</td>
</tr>
<tr>
<td>Onyx Ridge</td>
<td>ECC</td>
<td>6</td>
<td>Possibly extant</td>
<td>This is a dry southern facing hillside with redberry in a drainage. A portion burned in 2007.</td>
<td>Protect from fire, enhance redberry population</td>
<td>1, 3</td>
</tr>
<tr>
<td>Potrero</td>
<td>BLM &amp; Private</td>
<td>11</td>
<td>Unknown</td>
<td>Hermes copper was extirpated from at least four redberry patches in 2003 and at least two patches in 2007. Some areas burned in both 2003 and 2007. The redberry shrubs have recovered following the fires, but most of the other shrubs have not. Non-native grassland is the common vegetation community.</td>
<td>Protect from fire, acquire property adjacent to BLM</td>
<td>1, 1</td>
</tr>
<tr>
<td>Rancho Jamul Ecological Reserve</td>
<td>CDFW</td>
<td>3</td>
<td>Extirpated (2003)</td>
<td>The vegetation is a mixture of shrubs and grassland, both before and after the 2003 fire.</td>
<td>Enhance buckwheat population, translocation</td>
<td>2, 2</td>
</tr>
<tr>
<td>Sycamore Canyon County Park</td>
<td>County of San Diego</td>
<td>4</td>
<td>Extirpated (2003)</td>
<td>The southeastern portion of the hill has 1000s of redberry shrubs, which are also likely present throughout the entire southern aspect of the peak. Redberry is also present on the northern side but the density and extent is unknown. Non-native plant cover is very low, with areas of bare soil common.</td>
<td>Enhance buckwheat population, translocation</td>
<td>3, 3</td>
</tr>
<tr>
<td>Sycuan Peak Ecological Reserve</td>
<td>CDFW</td>
<td>3</td>
<td>Extant</td>
<td>Lower areas are represented by non-native grasslands but the majority is composed of sage scrub on the upper portions of the hillsides.</td>
<td>Protect from fire</td>
<td>1</td>
</tr>
<tr>
<td>USFWS- Las Montanas</td>
<td>USFWS</td>
<td>3</td>
<td>Extant</td>
<td>Over this large area, non-native grasslands, mesic dense sage scrub, and more xeric open sage scrub are present with redberry shrubs. A portion of this area burned in the last 20 years (too small to show up in the state-fire map?). Lower areas are represented by non-native grasslands and the upper portions of the hillsides are represented by sage scrub.</td>
<td>Enhance buckwheat population, translocation</td>
<td>2, 2</td>
</tr>
<tr>
<td>USFWS- McGinty Mountain</td>
<td>USFWS</td>
<td>3</td>
<td>Extant</td>
<td>This area burned in 2007 and has a mixture of non-native grassland and sage scrub habitats.</td>
<td>Enhance buckwheat population, translocation</td>
<td>2, 2</td>
</tr>
<tr>
<td>USFWS- San Miguel Mountain</td>
<td>USFWS</td>
<td>3</td>
<td>Extirpated (2007)</td>
<td>This area burned in 2007 and has a mixture of non-native grassland and sage scrub habitats.</td>
<td>Enhance buckwheat population, translocation</td>
<td>2, 2</td>
</tr>
<tr>
<td>USFWS- Steele Canyon</td>
<td>USFWS</td>
<td>3</td>
<td>Possibly extirpated</td>
<td>A portion of this area burned in the last 20 years (too small to show up in the state-fire map?). Lower areas are represented by non-native grasslands and the upper portions of the hillsides are represented by sage scrub.</td>
<td>Enhance buckwheat population, translocation</td>
<td>2, 3</td>
</tr>
<tr>
<td>USFWS- Sweetwater</td>
<td>USFWS</td>
<td>3</td>
<td>Extirpated (2007)</td>
<td>A portion of this area burned in the last 20 years (too small to show up in the state-fire map?). Lower areas are represented by non-native grasslands and the upper portions of the hillsides are represented by sage scrub.</td>
<td>Enhance buckwheat population, translocation</td>
<td>2, 3</td>
</tr>
</tbody>
</table>
Appendix A: Site assessments and prioritized management actions, continued.

* See "Management Strategies" section for more details.

<table>
<thead>
<tr>
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<th>MU</th>
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<th>Management Options*</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wright's Field</td>
<td>BCLT</td>
<td>3</td>
<td>Extant</td>
<td>This area is mostly a grassland, but there are redberry shrubs north of the grassland where there is a relatively high amount of bare soil. This redberry patch is adjacent and interspersed with a Eucalyptus grove.</td>
<td>Protect from fire, enhance redberry population</td>
<td>1, 2</td>
</tr>
</tbody>
</table>
## Appendix B: Research needs prioritization

<table>
<thead>
<tr>
<th>Research Needs</th>
<th>Priority</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop Translocation Protocols</td>
<td>1</td>
<td>Positive preliminary results and translocation efforts are planned for 2017</td>
</tr>
<tr>
<td>Document and Describe Northern Populations</td>
<td>1</td>
<td>Surveys planned for 2017.</td>
</tr>
<tr>
<td>Assessing Habitat Requirements</td>
<td>1</td>
<td>Work conducted in 2003 &amp; 2016, but future large scale efforts are warranted.</td>
</tr>
<tr>
<td>Assess Ability to Survive Drought</td>
<td>1</td>
<td>Surveys planned for 2017.</td>
</tr>
<tr>
<td>Assess Ability to Recolonize Following Fire</td>
<td>1</td>
<td>Work conducted in 2016 but future work warranted.</td>
</tr>
<tr>
<td>Survey for Unknown/Additional Populations</td>
<td>2</td>
<td>Populations are mapped as they are discovered, but other occupied redberry patches likely exist.</td>
</tr>
<tr>
<td>Captive Rearing</td>
<td>3</td>
<td>Previous work had limited success.</td>
</tr>
</tbody>
</table>