U.S. Fish & Wildlife Service

Species Biological Report for Mount Charleston Blue Butterfly (*Icaricia shasta charlestonensis*)

Photos of male (left) and female (right) Mount Charleston blue butterflies courtesy of Corey Kallstrom, U.S. Fish and Wildlife Service.

Acknowledgements

The recovery planning process has benefitted from the advice and assistance of many individuals, agencies, and organizations. We thank the following individuals for their contributions and assistance and apologize to anyone whose name was omitted inadvertently from this list:

Lead Author:

Corey Kallstrom, Southern Nevada Fish and Wildlife Office

Other Contributors:

Susan Cooper, Southern Nevada Fish and Wildlife Office
Bjorn Erickson, Pacific Southwest Regional U.S. Fish and Wildlife Service Office
Michael Senn, Pacific Southwest Regional U.S. Fish and Wildlife Service Office
Daniel Thompson, University of Nevada, Las Vegas
Charles Woodard, United States Department of Agriculture Forest Service

Peer Reviewers:

Matthew Forister (University of Nevada, Reno)
Daniel Rubinoff (University of Hawaii, Mānoa)
Cheryl Schultz (Washington State University, Vancouver)
Daniel Thompson (University of Nevada, Las Vegas)

Literature Citation Should Read as Follows:

U.S. Fish and Wildlife Service. 2023. Species Biological Report for Mount Charleston blue butterfly (*Icaricia shasta charlestonensis*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. 30 pp.

Introduction

This Species Biological Report is a comprehensive review of the biology of Mount Charleston blue butterfly (*Icaricia* (*Plebejus*) *shasta charlestonensis*) and provides a scientific assessment of the species' status and viability, including those factors that impact or are likely to impact the species. This report informs the Recovery Plan for Mount Charleston Blue Butterfly (*Icaricia shasta charlestonensis*) (U.S. Fish and Wildlife Service (USFWS) 2023), which presents our strategy for the conservation of the species. A Recovery Implementation Strategy, which provides an expanded narrative for recovery activities and an implementation schedule, is available at https://ecos.fws.gov. This Species Biological Report and the Recovery Implementation Strategy will be updated on a routine basis as necessary.

Background

The Mount Charleston blue butterfly (*Icaricia* (*Plebejus*) *shasta charlestonensis*) inhabits open areas between zones of mixed coniferous forests and alpine areas, and is endemic to the Spring Mountains in southern Nevada. Evidence of decreasing range and population size and the presence of ongoing threats to Mount Charleston blue butterfly resulted in a petition by The Urban Wildlands Group, Inc. on October 20, 2005 to list the subspecies under the Endangered Species Act as amended (Act). We, the USFWS, listed the Mount Charleston blue butterfly as endangered under the Act throughout its entire range on October 21, 2013 (USFWS 2013) and added the species to the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR §17.11). We designated critical habitat on June 30, 2015 (USFWS 2015a). Information on this process is available in the 90-day finding, 12-month status review, and proposed and final rules to list and designate critical habitat (available at http://ecos.fws.gov/ecp/). The majority of the historic range and all currently occupied locations of the Mount Charleston blue butterfly are on lands managed by the Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, United States Forest Service (Forest Service or USFS for literature). Therefore, close coordination and cooperation will need to occur between the USFWS and Forest Service for recovery to be successful.

Recovery plans focus on restoring the ecosystems on which a species is dependent, reducing threats to the species, or both. A recovery plan constitutes an important USFWS document that presents a logical path to recovery of the species based on what we know about the species' biology and life history, and how threats impact the species. Recovery plans provide guidance to the USFWS, States, and other partners on ways to eliminate or reduce threats to listed species and measurable objectives against which to measure progress towards recovery. Recovery plans are advisory documents, not regulatory documents, and do not substitute for the determinations and promulgation of regulations required under section 4(a)(1) of the Act. A decision to revise the listing status of a species or to remove it from the Federal List of Endangered and Threatened Wildlife (50 CFR §17.11) or Plants (50 CFR §17.12) is ultimately based on an analysis of the best scientific and commercial data available to determine whether a species is no longer an endangered species or a threatened species.

The following sections summarize characteristics of Mount Charleston blue butterfly biology, demography and distribution, population status, and threats that are relevant to recovery. Additional information is available in the 12-month status review, proposed and final listing and critical habitat rule for the species (http://ecos.fws.gov/ecp/), and associated literature.

Species Description and Taxonomy

The Mount Charleston blue butterfly (*Icaricia* (*Plebejus*) *shasta charlestonensis*) is one of six subspecies of the Shasta blue butterfly in the subfamily Polyommatinae and family Lycaenidae (Pelham 2016). The distinctiveness of the Mount Charleston blue butterfly is a result of its isolation in southern Nevada from other Shasta blue butterflies. It was first recognized and described as a subspecies by George Austin in 1980 (Austin 1980). The subspecies was originally described and listed under the Act as the genus *Plebejus*, but based on subsequent phylogenetic, taxonomic, and published work, we more recently recognized and accepted the change to *Icaricia* (USFWS 2015a) based on published works of Vila et al. (2011) and Talavera et al. (2013).

As a subspecies, the adult Mount Charleston blue butterfly is similar in appearance to other Shasta blue butterflies. It has a wingspan of 19 to 26 millimeters (mm) (0.75 to 1 inch (in))(Opler 1999). It is sexually dimorphic; males and females have two distinct forms with a few different wing characteristics. The upperside of males is dark to dull iridescent blue and females are brown with some blue basally with marginal black spots on the hindwings capped basally with orange or orange-brown (Austin 1980, Opler 1999). The uppersides of wings of both sexes have a row of submarginal black spots on the hindwing and a discal black spot on the forewing and hindwing (Austin 1980, Opler 1999). The upperwing discal black spots of the female are more prominent than the males (Austin 1980). The underside of the wings is gray, with a pattern of black spots, brown blotches, and pale wing veins giving it a mottled appearance (Opler 1999). The underside of the hindwing has an inconspicuous band of submarginal metallic spots (Opler 1999). Based on morphology, the Mount Charleston blue butterfly is most closely related to the Great Basin populations of the Minnehaha blue butterfly (Austin 1980), but it can be distinguished from other Shasta blue butterfly subspecies by the presence of a clearer, sharper, and blacker post-median spot row on the underside of the hind wing (Austin 1980, Scott 1986).

Life History and Ecology

Like all butterflies, the Mount Charleston blue butterfly has a complete metamorphosis life cycle where it changes successively between four stages: egg to larva, larva to pupa, and lastly pupa to adult (Opler 1999). The duration of, activity within, and subsequent transition time between each life stage varies depending on environmental conditions; however, the Mount Charleston blue butterfly life cycle requires at least one year (univoltine) to be completed (Austin and Austin 1980) but may be longer (semivoltine). Each life stage requires key resources which are correlated with life history.

Flight is a key aspect of the adult life stage. Butterfly flight allows adults to move within or between habitat patches to obtain resources such as solar radiation, cover (potentially for rest, inclement weather, or escape from predation and other disturbances), nectar for food, mates, and

locations for females to oviposit (lay eggs). Movement between patches of habitat is typically referred to as dispersal (Bowler and Benton 2005). Dispersal has not been documented for the Mount Charleston blue butterfly, but based on information from other similar species, we estimate Mount Charleston blue butterfly dispersal could be up to a maximum of 1000 meters (m) (3281 feet (ft)) (USFWS 2015a). More information is needed on the topic, however, particularly as it relates to connecting habitat patches for recovery efforts.

Within a given year, the flight period and adult life span of the Mount Charleston blue butterfly are short in duration, and when they occur, may vary between areas. The typical adult flight period is early July to mid-August with a peak in late July, although the subspecies has been observed as early as mid-June and as late as mid-September (Austin 1980, Weiss et al. 1997, Boyd and Austin 1999, Pinyon 2011, Andrew et al. 2013, Herrmann 2014, Thompson et al. 2014, Thompson 2018a). The life span of an individual adult may range between 2 and 12 days as has been reported for other closely related species (Arnold 1983). Thus, an individual adult likely does not live throughout the entire flight period.

Adult Mount Charleston blue butterflies fly when conditions are favorable or suitable. During the flight period, adult Mount Charleston blue butterflies typically fly during sunny conditions, which are particularly important for this subspecies given the cooler air temperatures at high elevations (Weiss et al. 1997). Excessive winds deter flight of most butterflies; however, they may not be as influential on the Mount Charleston blue butterfly because of its low flight patterns and short flight distances (Weiss et al. 1997, Pinyon 2011). Flight patterns have been documented as typically within 15 centimeters or less off the ground (Thompson et al. 2014) with distances on the order of 10 to 100 m (33 to 330 ft) (Weiss et al. 1995). Due to their low flight patterns and short flight distances, the likelihood of dispersal for an individual adult Mount Charleston blue butterfly is low; therefore, most individuals likely remain within the same habitat patch to feed, mate, and complete their life cycles.

Adult Mount Charleston blue butterflies rely on plants referred to as nectar plants for food. Males and females are reported to use similar nectar plant species in a given habitat patch including *Erigeron clokeyi* (Clokey's fleabane), *Hymenoxys lemmonii* (Lemmon's bitterweed), *Hymenoxys cooperi* (Cooper's rubberweed) and *Eriogonum umbellatum* var. *versicolor* (sulphur-flower buckwheat) (Weiss et al. 1997, Pinyon 2011, Andrew et al. 2013, Thompson et al. 2014, Thompson 2018a, 2018b, 2022) but have also been observed less frequently to use *Gutierrezia sarothrae* (broom snake weed) and *Petradoria pumila* var. *pumila* (rock-goldenrod) (Thompson 2018a). Other species reported as nectar plants without detailed accounts of the observations include *Antennaria rosea* (rosy pussy toes), *Cryptantha* species (cryptantha), *Ericameria nauseosa* (rubber rabbitbrush), *Erigeron flagellaris* (trailing daisy), *Monardella odoratissima* (horsemint), and *Potentilla concinna* var. *concinna* (alpine cinquefoil) (Boyd and Murphy 2008). Of these nectar plants, *Erigeron clokeyi* is considered an important element of Mount Charleston blue butterfly habitat because it occurs throughout much of the subspecies' range and areas with higher densities of this nectar plant have a higher likelihood of egg occurrence (Andrew et al. 2013, Thompson et al. 2014). Nectar plant abundance is an important component of Mount Charleston blue butterfly habitat because as with other butterfly species, it provides adult food resources to sustain adults. Studies indicate that increasing the abundance of nectar plants may increase egg size and quantity which leads to improved individual fitness and larger population

sizes (Murphy et al. 1983, Hill and Pierce 1989, Cahenzli and Erhardt 2012). Thus, maintaining and improving nectar plant availability for adult Mount Charleston blue butterflies will be an important part of the species' recovery.

During the flight period, male Mount Charleston blue butterflies spend much of their time in flight and perching near adult nectar and larval host plants to seek females receptive for mating (Thompson et al. 2014), referred to as a "patrol" mate-locating behavior (Scott 1974, 1986). When the female Mount Charleston blue butterfly is receptive, copulation may occur, and females may oviposit on or near larval host (food) plants after a day. This behavior is similar to what has been reported for other Lycaenid butterflies by Arnold (1983). Thus, resources for adult Mount Charleston blue butterflies are in close proximity to resources for earlier life stages, beginning with locations selected by females to oviposit eggs.

The lifecycle of the Mount Charleston blue butterfly starts when a female oviposits a single egg on a host plant (Thompson et al. 2014). Eggs of the Mount Charleston blue butterfly appear to weakly adhere to the host plant surface and have been observed most typically within basal leaves (Thompson et al. 2014). Occasionally Mount Charleston blue butterfly eggs do not hatch after being deposited (Thompson et al. 2014) and instead, if viable, enter diapause. Eggs oviposited early in the flight period hatch and the larvae will begin to feed. Mount Charleston blue butterfly larvae have been observed by Thompson (2018a, 2022) feeding on *Astragalus calycosus* var. *calycosus* (= var. *mancus*) (Torrey's milkvetch) and *Oxytropis oreophila* var. *oreophila* (mountain oxytrope), and are presumed to feed on *Astragalus platytropis* (broad keeled milkvetch), collectively referred to as larval host plants. Prior to direct observation of feeding by larva on host plants of the first two species, all three species of plants were presumed to be fed on by Mount Charleston blue butterfly larva. These presumptions are based on observations of Mount Charleston blue butterfly eggs on these plant species, observation of adults in close association with these plants (Austin and Leary 2008, Thompson et al. 2014), and experts documenting use of similar plant species by other Shasta blue butterfly subspecies (Emmel and Shields 1980, Austin and Leary 2008, USFWS 2015a). When conditions become too cold and days shorten in early fall, the Mount Charleston blue butterfly larvae enters and remains in diapause (a period of suspended growth or development similar to hibernation) through winter until spring (likely between October and April). As with other Shasta blue butterflies, the Mount Charleston blue butterfly larvae are likely to diapause at the base of its larval host plant or in the surrounding substrate (Emmel and Shields 1980). Recent observations of mature Mount Charleston blue butterfly larva interacting with and in close association with ants may be a sign for potential myrmecphilous[1] interactions and that they may possibly shelter with ants beneath plants (Thompson 2022).

Information about diapause life history characteristics of the Mount Charleston blue butterfly is limited, and the information about diapause in other subspecies of Shasta blue butterflies is inconsistent. Research has indicated Shasta blue butterflies diapause as eggs (Ballmer and Pratt 1988), as partly grown larvae (Emmel and Shields 1980), or as eggs and as larvae (Ferris and Brown 1981, Scott 1986). Eggs of the Mount Charleston blue butterfly have been observed hatched during the summer and unhatched when revisited late into the fall which may indicate

[1] Associated with or benefiting from ants.

that the Mount Charleston blue butterfly may diapause as either egg or larva (Thompson et al. 2014); however, second or additional years of diapause as a larva and eggs has not been confirmed. Prolonged diapause may be possible in some Lepidoptera in response to unfavorable environmental conditions (Scott 1986, Murphy 2006, DataSmiths 2007, Boyd and Murphy 2008), which has been hypothesized for the Mount Charleston blue butterfly as well (Thompson et al. 2014). Boyd and Murphy (2008) suggest the Mount Charleston blue butterfly may be able to delay maturation during drought or the shortened growing seasons that follow winters with heavy snowfall and late snowmelt by remaining as eggs. Thus, diapause for the Mount Charleston blue butterfly may be facultative for egg and larval life stages depending upon environmental conditions.

The following assumes the Mount Charleston blue butterfly goes through facultative development. If sufficient growth of Mount Charleston blue butterfly larvae does not occur after one summer of growth, it may enter diapause again. The Mount Charleston blue butterfly becomes active after leaving diapause (post-diapause) a last time to feed and grow through its last instar (successive stages in which exoskeletons are shed as larva become larger). The total number of instars has been documented as four for other subspecies of Shasta blue butterflies (Ballmer and Pratt 1988). After sufficient growth of the last instar, Mount Charleston blue butterflies enter pupation. Pupation of Mount Charleston blue butterflies likely occurs near the base and under larval host plants with eclosion (emergence from a pupal case) occurring after approximately 14 days as it has been reported for other Shasta blue butterflies (Emmel and Shields 1980). Though not directly observed, the first individuals may enter pupation as early as late May (Thompson 2022) and the last pupating individuals may eclose by late July or early August based on later observations of adults. The emergence of adults then begins a new life cycle for the Mount Charleston blue butterfly. The approximate duration and timing of life stages for a univoltine and biennial life cycle described above for the Mount Charleston blue butterfly are illustrated in graphs in Figure 1. The duration and timing will vary depending upon environmental conditions and other factors affecting each life stage.

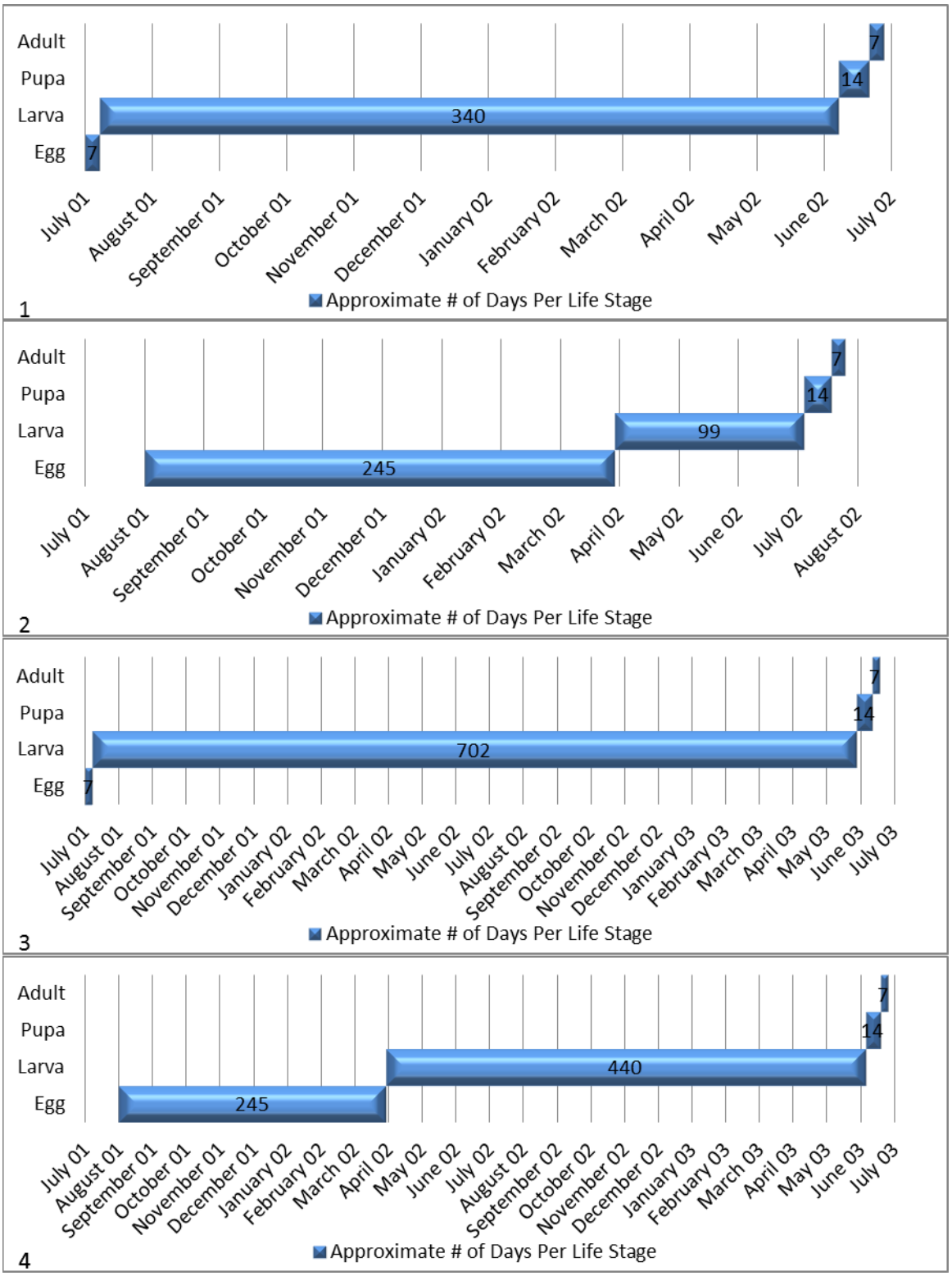

Figure 1. Four potential Mount Charleston blue butterfly life cycles, including duration of life stages and diapause. Diapause may affect the duration (x-axis = month and year) and timing of life stages (y-axis). Larval diapause likely occurs between October and April. As an egg, any length of time greater than 7 days would be in a diapause state. Box 1 is an annual life cycle with larva diapause. Box 2 is an annual life cycle with egg diapause. Box 3 is a biennial life cycle with larva diapause. Box 4 is a biennial life cycle with egg and larva diapause.

Population Trends, Range, and Distribution

Like all butterfly species, both the flight period and number of adult Mount Charleston blue butterfly individuals that emerge and fly to reproduce during a particular year are influenced by a combination of environmental factors that constitute a successful ("favorable") or unsuccessful ("poor") year for the subspecies. Observations indicate that precipitation and temperature are the primary factors that influence the flight period of this subspecies (Weiss et al. 1997, Boyd and Austin 1999) and likely drive fluctuations in population numbers from year to year (Weiss et al. 1997).

Surveys have primarily been conducted for adults and have varied in methodology, effort, frequency, time of year conducted, and sites visited; therefore, we cannot statistically determine population size, dynamics, or trends for the Mount Charleston blue butterfly. The population of Mount Charleston blue butterflies is comprised of all life stages, thus it is greater than the number of adults present within the population in any given year. Surveys that count adults only provide an index of the relative abundance or presence and absence of a population at a location. Figure 2 provides a hypothetical example to illustrate the presence and absence of life stages and their abundance relative to the entire population of Mount Charleston blue butterflies. Many recovery actions for the Mount Charleston blue butterfly will aim to benefit life history requirements of one or more life stages to increase the population.

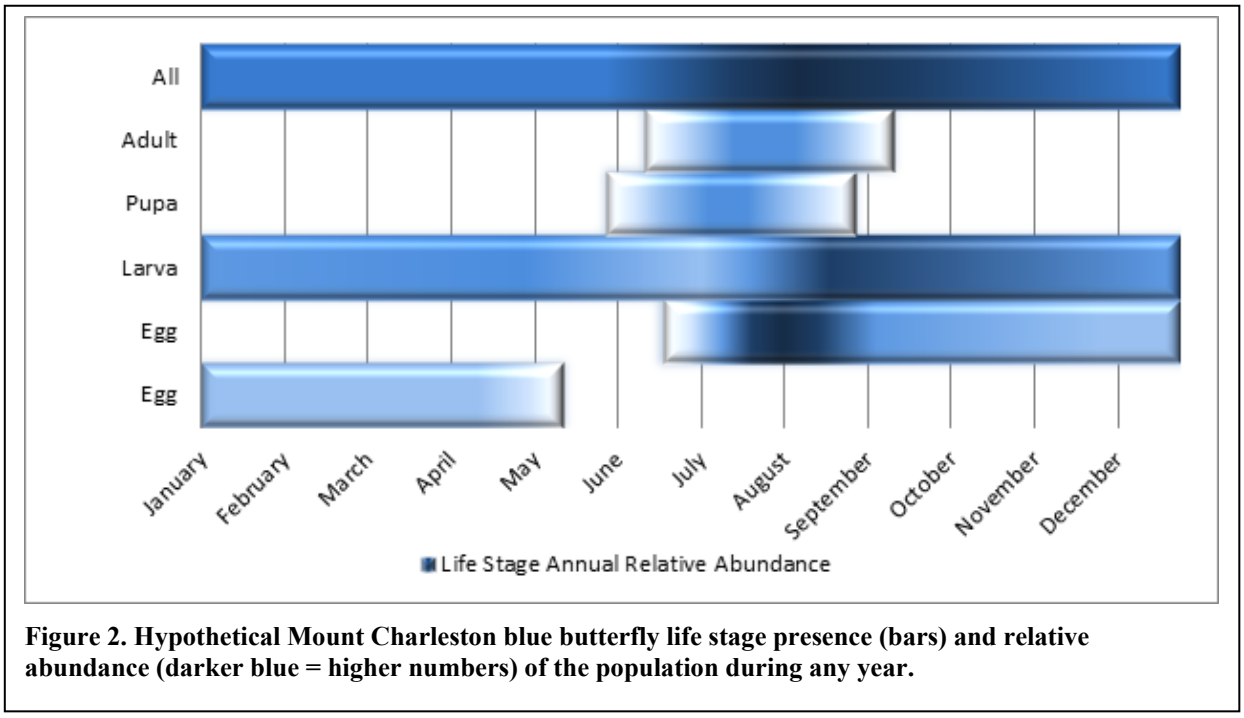

Figure 2. Hypothetical Mount Charleston blue butterfly life stage presence (bars) and relative abundance (darker blue = higher numbers) of the population during any year.

The population size in any given year is likely to be highest during the adult flight period after eggs are laid by females. Similar to other insects, mortality of Mount Charleston blue butterflies will be greatest during early parts of its life history as eggs or young larvae. Larvae are likely to be present year-round, and differences in mortality among generations may occur. After the

population peaks during the flight period, the population of Mount Charleston blue butterfly will decrease as mortality of all life stages occurs throughout the year.

There are no population estimates for the Mount Charleston blue butterfly (number of individuals in each life stage throughout its range) because not all areas have been surveyed, different survey methodologies have been used in the past, and early life stages are difficult to detect. Furthermore, the Mount Charleston blue butterfly can be present in an area of habitat and difficult to observe even after repeated visits during appropriate times and conditions (Thompson et al. 2014, USFWS 2015a). Despite these difficulties, we determined a declining trend of the Mount Charleston blue butterfly based on an increasing number of locations with fewer or no detections of adult butterflies where they had been observed in the past (USFWS 2013).

Due to the lack of abundance information, we use the terms "known occupied" and "presumed occupied," and "presumed extirpated" to describe locations. We define "known occupied" as locations where habitat is present and the Mount Charleston blue butterfly has been observed in successive years. We define "presumed occupied" as locations where habitat is present until it can be demonstrated as "presumed extirpated," which we define as locations where the Mount Charleston blue butterfly has not been recorded through formal surveys or informal observation for more than 20 years and habitat (as defined in the critical habitat designation) is not present. Although we have used a 20-year timeframe to allow detection to determine presence and absence, we now know that surveys may need to be conducted over a period greater than 20 years given the difficulty of detecting the species in any one year. There are 17 historic locations where populations of the Mount Charleston blue butterfly have been known to occur. There were 17 locations identified in the final rule to list the subspecies; however, we have identified and clarified discrepancies that have occurred. Two presumed occupied locations, Youth Camp and Foxtail are reported by Boyd and Murphy (2008) to be the same. We have also determined that Upper Kyle Canyon Ski Area and Old Town were the same location as reported by Andrew et al. (2013). The area currently identified as the Upper Bristlecone Trailhead location was previously labeled as the Lee Canyon holotype in early listing documents (USFWS 2007, 2011, 2012, 2013); however, the Lee Canyon holotype location is the same as the Lee Meadow location (personal communication from Bruce Boyd, November 5, 2012). We no longer consider the Willow Creek area a historic location (see Appendix B). Since the Mount Charleston blue butterfly was listed, three new occupied locations called McFarland and Bonanza Peaks Ridge, Wallace Canyon Ridge, and Sisters South – West Ridge were discovered by Thompson (2018a, 2022) in 2016, 2019, and 2020 respectively, bringing the total number of locations to 17 (Figure 3). Of these 17 locations, eight are known occupied, six are presumed occupied, and three are presumed extirpated (Table 1). Mount Charleston blue butterflies have been observed at presumed and known occupied locations, the latter have had consistent observations in successive years. The eight known occupied locations are South Loop Trail, Lee Canyon Ski Area[2], Foxtail, Bristlecone Trail, Bonanza Trail, Upper Bristlecone Trailhead, , McFarland and Bonanza Peaks Ridge, and Sisters South–West Ridge (Locations 1, 2, 3, 8, 9, 10, 15, and 17 in

[2] This location is referred to in earlier reports and documents based on the business that operated there known as the Las Vegas Ski and Snowboard Resort (LVSSR) that changed its business name to Lee Canyon. The business operates in a smaller area within the Lee Canyon geographic area identified on U.S. Geological Survey topographic maps. To avoid confusion with the broader geographic Lee Canyon location we refer to the smaller business location as Lee Canyon Ski Area.

Table 1). The distribution of Mount Charleston blue butterfly locations in the Spring Mountains is shown in Figure 3.

Most of the locations identified likely represent single populations of the Mount Charleston blue butterfly, but exceptions may exist. At higher elevation locations such as Bonanza Trail and South Loop Trail, some observations of Mount Charleston blue butterflies are a mile or more apart with varying extents of habitat interspersed. These locations may appear as a contiguous population in 'favorable' years because Mount Charleston blue butterfly individuals may be dispersed throughout habitat at the location or discontiguous like subpopulations or separate populations in 'poor' years because fewer individuals are restricted to concentrated or 'core areas' (Pinyon 2011). Areas of poorer quality habitat may be occupied during 'favorable' years (Pinyon 2011) and increase interchange of individuals among subpopulations or within a population. Therefore, areas of poorer quality habitat may be important to the subspecies even though individuals may not be persistently observed there. More research of Mount Charleston blue butterfly population dynamics is needed to inform recovery and population status assessments.

Table 1. Locations at which the Mount Charleston blue butterfly has been detected since 1928, and the status of the butterfly at those locations.

Location ID and Name [1]		First/Last Year Detected	Most Recent Survey Year	Status[2]	Critical Habitat Unit
1	South Loop Trail	1928/2021	2021	Known occupied	1
2	Lee Canyon Ski Area	1963/2021	2021	Known occupied	2
3	Foxtail	1995/2021	2021	Known occupied	2
4	Gary Abbott	1995/2017	2021	Presumed occupied	2
5	Lower Parking	1995/2020	2021	Presumed occupied	2
6	North Loop Trail	1995/1995	2021	Presumed occupied	3
7	Lee Meadows	1965/2020	2021	Presumed occupied	2
8	Bristlecone Trail	1990/2021	2021	Known occupied	2
9	Bonanza Trail	1995/2021	2021	Known occupied	2
10	Upper Bristlecone Trailhead	1963/1921	2021	Known occupied	2
11	Cathedral Rock	1972/1972	2012	Presumed extirpated	
12	Old Town	1965/1972	2012	Presumed extirpated	
13	Deer Creek	1950/1950	2012	Presumed extirpated	
14	Griffith Peak	1995/1995	2021	Presumed occupied	1
15	McFarland and Bonanza Peaks Ridge	2016/2021	2021	Known occupied	
16	Wallace Canyon Ridge	2019/2021	2021	Presumed occupied	
17	Sisters South – West Ridge	2020/2021	2021	Known occupied	2

[1] See Appendix A. Location Names and Background for cross-referencing location names in the report with listing documents and background information.

[2] Species status at each location is defined as follows: known occupied = locations where habitat is present and the Mount Charleston blue butterfly has been observed through formal surveys or informal observation within two successive years; presumed occupied = locations where habitat is present until it can be demonstrated as presumed extirpated as described below; and presumed extirpated = locations where the Mount Charleston blue butterfly has not been recorded through formal surveys or informal observation for more than 20 years and habitat (as defined in the critical habitat designation) is not present. Formal surveys following USFWS-approved protocol must have occurred for at least 6 consecutive years with no detections.

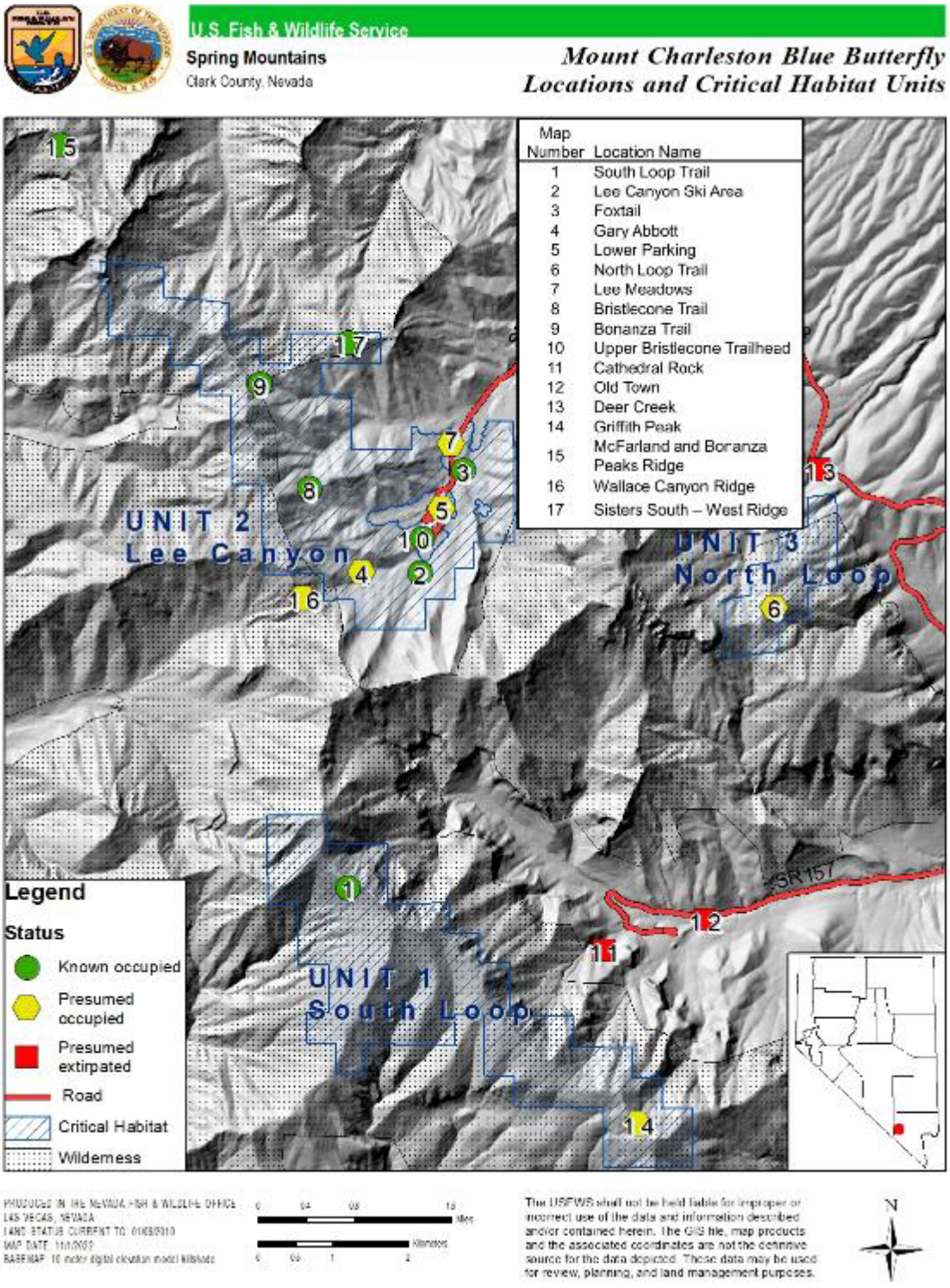

Figure 3. Map of Mount Charleston blue butterfly locations.

Habitat Characteristics and Ecosystem

Natural habitat for the Mount Charleston blue butterfly is described as relatively flat ridgelines above 2,500 m (8,200 ft), but isolated individuals have been observed as low as 2,000 m (6,600 ft) (Weiss et al. 1997). Boyd and Murphy (2008) indicate that areas occupied by the subspecies featured exposed soil and rock substrates on flat to mild slopes with limited or no canopy cover or shading. The vegetation communities supporting the host and nectar plants include white fir-ponderosa pine, bristlecone pine, and alpine (Niles and Leary 2007).

Historic information about Mount Charleston blue butterfly habitat was primarily about its larval host plant(s). Until recently, limited information was available regarding the butterfly's nectar plants or other aspects of its habitat and ecology (Thompson et al. 2014). Niles and Leary (2007) indicate the abundance of the host plants in the Spring Mountains as rare to occasional for *Astragalus platytropis*, and occasional for *Oxoytropis oreophila var. oreophila* and *Astragalus calycosus* var. *calycosus* (Niles and Leary 2007). Within the alpine and subalpine range of the Mount Charleston blue butterfly, Weiss et al. (1997) observed the highest densities of *Astragalus calycosus* var. *calycosus* in exposed areas and within canopy openings and lower densities in forested areas.

In 1995, *Astragalus calycosus* var. *calycosus* plant densities at sites supporting Mount Charleston blue butterflies were on the order of one to five plants per square (sq) m and greater (Weiss et al. 1997). Weiss et al. (1997) stated that plant densities in favorable habitat for the Mount Charleston blue butterfly could exceed more than 10 plants per sq m of *Astragalus calycosus* var. *calycosus*. Thompson et al. (2014) documented between 12.1 and 67.6 host plants per sq m at four Mount Charleston blue butterfly locations (Location numbers 1, 2, 3, and 9 in Table 1).

Weiss et al. (1995) and DataSmiths (2007) indicate that, in some areas, sufficient densities of host and nectar plants may be dependent on old or infrequent disturbances that create open understory and overstory. Overstory canopy within patches naturally becomes higher over time through succession. This succession reduces the occurrence of larval host and nectar plants, gradually making these areas less favorable to the butterfly.

Fire management practices may limit the formation of new habitat for the Mount Charleston blue butterfly. The Forest Service began suppressing fires on the Spring Mountains in 1910 (ENTRIX Environmental Consultants 2008). The more closed canopy and higher density of trees and shrubs currently present throughout the Spring Mountains is likely due to a reduced frequency of fire influenced by fire suppression. Similar habitat changes due to fire suppression have been documented in a proximate mountain range (Amell 2006). Other successional changes that have been documented in the Spring Mountains include increased forested area and changes in forest structure (higher canopy cover, more young trees, and expansion of species less tolerant of fire) (Nachlinger and Reese 1996, Amell 2006, Boyd and Murphy 2008, Denton et al. 2008, Abella et al. 2012). All of these changes result in an increase in tree and shrub cover that is generally less suitable for the Mount Charleston blue butterfly.

The disturbed landscape at Lee Canyon Ski Area provides important habitat for the Mount Charleston blue butterfly (Weiss et al. 1995, 1997). Periodic maintenance (removal of trees and

shrubs) of the ski runs has effectively arrested forest succession on the ski slopes and if properly managed, serves to maintain conditions favorable to the Mount Charleston blue butterfly and to its larval host and nectar plants. However, the ski runs are not specifically managed to benefit habitat for this subspecies, and operational activities may regularly modify Mount Charleston blue butterfly habitat or prevent larval host plants from reestablishing in disturbed areas.

The number of locations with suitable vegetation to support Mount Charleston blue butterflies has been limited and appears to have declined in areas, likely due to the combination of a lack of disturbance and invasive plants. However, locations disturbed by wildfire, such as South Loop Trail by the Carpenter 1 Fire in 2013, have increased as habitat has increased in disturbed areas because of host and nectar plant establishment there (Herrmann 2014, 2017, Thompson 2022) followed by observations of Mount Charleston blue butterflies (Thompson 2022). Both host and nectar plants for the Mount Charleston blue butterfly are present at the locations we consider occupied (Table 1), whereas the vegetation at the presumed extirpated locations no longer includes or has very few host or nectar plants to support the species (Andrew et al. 2013). Overall, many stressors and threats to Mount Charleston blue butterfly habitat are most prevalent and at higher intensities in the Lee Canyon area (2022 p. 104 Table 21). While host and nectar plants are present and relatively abundant in some areas of occupied locations of Lee Canyon Ski Area, Foxtail, Gary Abbott, Lower Parking, Bristlecone Trail, and Upper Bristlecone Trailhead; these locations are threatened by forest canopy growth and encroachment, grass or shrub over-growth, feral horses, and recreation (Andrew et al. 2013, Thompson 2018a, 2022). Other Lee Canyon locations, including Lee Meadow, Lower Parking, and Upper Bristlecone Trailhead have some lower density larval host and nectar plants and habitat that could be improved to enhance occupation by the Mount Charleston blue butterfly.

The Deer Creek and the Kyle Canyon locations of Cathedral Rock and Old Town are presumed extirpated (Table 1) and lack sufficient or any Mount Charleston blue butterfly host or nectar plants (Andrew et al. 2013). While vegetation conditions in the past at presumed extirpated locations are not well documented, we presume these sites contained sufficient host and nectar plants for the Mount Charleston blue butterfly because butterflies were reported to be observed at these locations. Because the vegetation at the majority of the presumed extirpated locations is not likely to be suitable for the Mount Charleston blue butterfly without substantial changes (Andrew et al. 2013), initial efforts for habitat improvement should focus on the sites in Lee Canyon where larval host and nectar plants exist.

Critical Habitat

Approximately 5,214 acres (2,110 ha) of critical habitat were designated for the Mount Charleston blue butterfly on June 30, 2015 (USFWS 2015a), and became effective on July 30, 2015. The three occupied units are (1) South Loop with 2,228 ac (902 ha), (2) Lee Canyon with 2,573 ac (1,041 ha), and (3) North Loop 413 ac (167 ha).

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), “physical and biological features” (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. Later revisions of critical habitat regulations (USFWS 2016) discontinued use of the terms “PCEs” or

"essential features" and rely exclusively on use of the term PBFs. To be consistent with that shift in terminology and in recognition that the terms PBFs, PCEs, and essential habit features are similar in meaning, we are only referring to PBFs herein.

The PBFs[3] essential to the conservation of the Mount Charleston blue butterfly are identified as:

(1) PBF 1: Areas of dynamic habitat between 2,500 m (8,200 ft) and 3,500 m (11,500 ft) elevation with openings or where disturbance provides openings in the canopy that have no more than 50 percent tree cover (allowing sunlight to reach the ground), widely spaced low (< 15 cm (0.5 ft)) forbs and grasses, and exposed soil and rock substrates. When taller grass and forb plants greater than or equal to 15 cm (0.5 ft) in height are present, the density is less than five per m^2 (0.5 per ft^2).

(2) PBF 2: The presence of one or more species of host plants required by larvae of the Mount Charleston blue butterfly for feeding and growth. Known larval host plants are *Astragalus calycosus* var. *calycosus*, *Oxytropis oreophila* var. *oreophila*, and *Astragalus platytropis*. Densities of host plants must be greater than two per m^2 (0.2 per ft^2).

(3) PBF 3: The presence of one or more species of nectar plants required by adult Mount Charleston blue butterflies for reproduction, feeding, and growth. Common nectar plants include *Erigeron clokeyi*, *Hymenoxys lemmonii*, *Hymenoxys cooperi* and *Eriogonum umbellatum* var. *versicolor*. Densities of nectar plants must occur at more than two per m^2 (0.2 per ft^2) for smaller plants, such as *E. clokeyi*, and above 0.1 per m^2 (0.01 per ft^2) for larger and taller plants such as *Hymenoxys* sp. and *E. umbellatum*. Nectar plants typically occur within 10 m (33 ft) of larval host plants and in combination provide nectar during the adult flight period between mid-July and early August. Additional nectar sources that could be present in combination with the common nectar plants include *Antennaria rosea*, *Cryptantha* sp., *Ericameria nauseosa* ssp., *Erigeron flagellaris* (Trailing daisy), *Guiterrezia sarothrae*[4], *Monardella odoratissima*, *Petradoria pumila* var. *pumila*[2], and *Potentilla concinna* var. *concinna*.

Reasons for Listing and Current Threats

In determining whether to list, delist, or reclassify (change from endangered to threatened status, or *vice versa*) a species under section 4(a) of the Act, we evaluate five major categories of threats to the species: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. The following is a summary of factors that supported Mount Charleston blue butterfly listing (USFWS 2013) and any updates to the information since that time. For more detailed information about each of these threats, please refer to the final rule to list the species (http://ecos.fws.gov/ecp/).

[3] The references and rationale used to determine and characterize the PBF's for the Mount Charleston blue butterfly are provided in the final rule for critical habitat (USFWS 2015, pp. 37416–37419).
[4] This nectar source species is identified as larger and taller species used by Mount Charleston blue butterflies in areas of the Lee Canyon CHU 2 (Thompson 2018b).

Factor A*: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*

In the listing rule (USFWS 2013) and critical habitat finding (USFWS 2015a), we determined habitat loss and modification, resulting from changes in fire regimes and long-term successional changes in forest structure, implementation of recreational development projects and fuels reduction projects, and nonnative plant species are continuing threats to the Mount Charleston blue butterfly's habitat in Upper Lee Canyon. In addition, proposed future activities under a master development plan by the Lee Canyon Ski Area (formerly the Las Vegas Ski and Snowboard Resort) may impact the Mount Charleston blue butterfly and its habitat in Upper Lee Canyon. However, in the final rule designating critical habitat we recognize that properly planned, designed, managed, and implemented activities could have a beneficial effect for the Mount Charleston blue butterfly by creating and improving habitat. We expect continued, active habitat management will be necessary in order for Mount Charleston blue butterfly individuals and populations to be maintained at lower elevation locations.

Factor B: *Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

In the listing rule, we determined that unpermitted and unlawful collection is a threat to the Mount Charleston blue butterfly because of the small number of discrete populations, overall small metapopulation size, close proximity to roads and trails, and restricted range. We expect the threat has been reduced by the Forest Service's closure order on butterfly collection (available at http://www.fs.usda.gov/alerts/htnf/alerts-notices) as well as the USFWS's permitting regulations under section 10(a)(1)(A) of the Act. The USFWS may permit collection of Mount Charleston blue butterfly by issuing 10(a)(1)(A) permits (Recovery permits) to qualified individuals for scientific research to better understand the subspecies long-term survival needs and foster recovery. The Recovery permits have special terms and conditions that are required to prevent substantial impacts to populations of Mount Charleston blue butterfly.

Since the listing of the Mount Charleston blue butterfly, we have issued Recovery permits that authorize collection of individuals, although no healthy individuals have been collected. Two adults have been collected which were observed succumbing to natural mortality while restrained by ants and a spider web (Thompson 2018a) followed by twenty-three senescing adult males (Thompson 2022) for genomic analyses. We have not received any reports that confirm any unpermitted butterfly collection within the closure order area (Woodard 2015, Thompson 2015); however, observation and reporting of unpermitted and unlawful collection are unlikely. Nonetheless, we believe the Forest Service closure order on butterfly collection is effective in reducing the threat of collection on the Mount Charleston blue butterfly. Based on this, we no longer consider collection to be a significant threat to the subspecies.

Factor C*: Disease or Predation*

We are not aware of information specific to the Mount Charleston blue butterfly regarding impacts from disease or predation. Specific research on these topics and their impacts on the Mount Charleston blue butterfly is lacking. Butterflies are generally known to be preyed upon, parasitized, or at risk of disease during one or more of each life stage (Scott 1986); however, we

are not aware of any documentation of such factors affecting the Mount Charleston blue butterfly. As a result, the best available scientific and commercial information does not indicate that disease or predation is a threat to the Mount Charleston blue butterfly.

Factor D*: Inadequacy of Existing Regulatory Mechanisms*

In the listing rule, we determined existing regulatory mechanisms were not adequately protecting the Mount Charleston blue butterfly and its habitat. We recognized the Wilderness Act of 1964 provided some protection because of its prohibitions on development. We also recognized the Forest Service closure order on butterfly collection (signed August 19, 2013) in the Code of Federal Regulations (36 CFR 261.51) would provide a mechanism for law enforcement personnel to enforce a Forest Service Humboldt-Toiyabe General Management Plan provision. We determined other existing regulatory mechanisms (e.g., National Environmental Policy Act of 1969, as amended; National Forest Management Act of 1976, as amended; Spring Mountains National Recreation Area Act; Nevada Revised Statutes; and local land use laws and ordinances) were not providing effective protection to the Mount Charleston blue butterfly and its habitat. Since being listed as endangered, the Act of 1973 as amended, is another regulatory mechanism to address threats to the Mount Charleston blue butterfly. We are not aware of any new regulatory mechanisms that have been enacted since the time of listing that would preclude the need for protection of the species under the Act.

Factor E*: Other Natural or Manmade Factors Affecting Its Continued Existence*

In the listing rule, we identified climate change as a threat to the Mount Charleston blue butterfly, and since then, we determined that feral horses may also be negatively affecting the subspecies and its habitat. Because of its presumed small population and restricted range, any existing threats to the Mount Charleston blue butterfly are likely to be exacerbated by the impact of climate change, which is anticipated to increase drought and extreme precipitation events (see *Factor E* discussion in the listing rule (USFWS 2013)). Small butterfly populations have been documented to have a higher risk of extinction due to random environmental events (Shaffer 1981, Gilpin and Soule 1986, Shaffer 1987). The Mount Charleston blue butterfly is currently in danger of extinction because only three of the 16 historical locations are known to be occupied currently and the seven other locations presumed to be occupied may be at risk of extirpation in the near future because threats are ongoing and persistent to varying degrees at all locations.

In the final rule to designate critical habitat, we responded to comments from the public and peer review about feral (wild) horses, but we did not provide discussion on the mechanisms or other details of this threat. Effects from wild horses have been reported to have occurred since at least 1998 (Boyd and Murphy 2008), as a result of habitat being disturbed and butterflies potentially being harmed and harassed by trampling, wallowing, and burial under fecal piles (Boyd and Murphy 2008, Andrew et al. 2013). Threats from horses are documented to affect nearly all known occupied, presumed occupied, and extirpated Mount Charleston blue butterfly locations (2–5, 7–10, 15–17; see Table 1) in Lee Canyon (Thompson 2022). Based on descriptions from multiple surveys and surveyors including Boyd and Murphy (2008), Andrew et al. (2013), Thompson et al. (2014), and Thompson (2018a, 2022), the exposure and magnitude of this threat is moderate to high at the known occupied locations of Lee Canyon Ski Area and Bonanza.

Conservation Efforts

Conservation efforts that have been or are being implemented for the Mount Charleston blue butterfly include conservation agreements, studies, surveys and monitoring, habitat protection, and planning for habitat restoration and enhancement. Some conservation efforts to reduce or remove threats to the Mount Charleston blue butterfly have been initiated and completed prior to its listing and development of this report, while others are ongoing. A brief summary of these conservation efforts is provided below.

An early conservation effort for the Mount Charleston blue butterfly was its inclusion in a 1998 conservation agreement and subsequent coordination between the Forest Service and USFWS which are discussed in more detail in the 12-month finding and listing rule (USFS et al. 1998, USFWS 2011, 2013). Cooperating agencies may prepare and renew a conservation agreement and strategy for the Spring Mountains NRA in the future if resources and priorities permit.

Habitat protection for an area at the Bristlecone Trail location occurred in 2007 when 1,100 m of fence was constructed along the Upper Bristlecone Trailhead to protect sensitive plant and butterfly habitat that included Mount Charleston blue butterfly host and nectar plants from recreational disturbance (Forest Service 2007). Construction of the fence reduced some threats to habitat caused by recreational disturbance (Factor A) at this location. During the project, approximately 800 m of user-trails were also restored. Interpretive signs were installed to educate the public about rare endemic plants and the Mount Charleston blue butterfly.

Studies and monitoring to better understand the Mount Charleston blue butterfly have occurred since the mid-1990's and are described in the 12-month finding, proposed and final rules for listing and critical habitat (USFWS 2011, 2012, 2013, 2014, 2015a), and the recovery plan (USFWS 2023). More recently between 2010 and 2012, the Mount Charleston blue butterfly was one of four species studied as part of the Spring Mountains Butterfly Life History and Autecology Studies implemented by University of Nevada, Las Vegas (UNLV), (Thompson et al. 2014) to obtain basic biological information for planning and management. The study was implemented under the direction of the Forest Service in cooperation with the USFWS. Work was performed as Phases 1 and 2 of the Spring Mountains Butterfly Life History and Autecology Studies ("Life History and Autecology Studies").

Following this study, the two agencies initiated the subsequent Phase 3 (Hurja and Kallstrom 2012) to restore and enhance habitat for butterflies, including the Mount Charleston blue butterfly, in key areas for their conservation and recovery. Areas of upper Lee Canyon were identified for restoration and enhancement of Mount Charleston blue butterfly habitat. Seed collection for host and nectar plant materials to be used for future habitat improvements occurred 2015–2017 (Thompson 2018a) as part of the Phase 3 and UNLV cooperative agreement with the USFWS (#FWS F14AC00677, Modification Number 1). As part of Phase 3, the Forest Service and the UNLV entered a challenge cost share agreement (USFS and UNLV 2015) whereby UNLV provided a report by Thompson and Abella (2016) that described baseline habitat conditions and prescriptions for habitat enhancement, restoration, and augmentation for four butterfly taxa including the Mount Charleston blue butterfly. This report describes desired conditions and methods to guide projects intended to improve habitat conditions. The report

provides information to aid actions that may involve fire, seeding, out-planting, overstory reduction, invasive species control, and soil treatment methods. The phase 3 project was completed in 2019.

The Forest Service completed Autecology Phase IV to produce surveys and documentation for National Environmental Policy Act and further environmental analysis required to implement recommendation from Phase 3 (Miller 2020, USFS 2020). Funding has been approved for the Forest Service (BLM 2021) to implement butterfly habitat restoration and protection projects including areas of habitat for the Mount Charleston blue butterfly in Upper Lee Canyon (USFS 2020).

Surveys of Mount Charleston blue butterfly existing locations and habitat, as well as new potential locations, haves been ongoing to monitor the status of populations and their habitat as well as to plan, evaluate, and minimize impacts of management actions (Miller 2020, Gulley 2022, Thompson 2022).

The Forest Service has completed an analysis for future actions, which may alleviate threats by feral horses (discussed above in Factor E*: Other Natural or Manmade Factors Affecting Its Continued Existence*) to the Mount Charleston blue butterfly and its habitat. In 2013, the Forest Service in cooperation with the Bureau of Land Management (BLM) began preparing an Environmental Assessment in compliance with National Environmental Policy Act of 1969 to address environmental consequences of a proposed agency action to implement a Herd Management Area Plan (USFS and BLM 2013), completed a preliminary analysis in 2021 (USFS and BLM 2021) with a final environmental assessment and decision notice in 2022 (USFS and BLM 2022). The project would emphasize gather and removal of feral horses between 2022-2027 from areas where there is Mount Charleston blue butterfly habitat including Lee Canyon. Design elements to minimize the risk of adverse effects to the Mount Charleston blue butterfly from proposed actions have been developed and approved by the USFWS (2022). Feral horses that habitually use those areas will not be returned to the Spring Mountains Complex. In addition, in 2015, the USFWS concurred with USFS's may affect, not likely to adversely affect determination and conference opinion that the implementation of a fence project in McFarland Canyon, which was to prevent the movement of horses into the Mount Charleston Wilderness and Upper Lee Canyon areas, may have beneficial effects for the Mount Charleston blue butterfly (USFWS 2015b).

Literature Cited

Abella, S., J. Hurja, D. Merkler, C. Denton, and D. Brewer. 2012. Overstory-understory relationships along forest type and environmental gradients in the Spring Mountains of southern Nevada, USA. Folia Geobotanica 47:119–134.

Amell, L. 2006. The Spring Mountains hazardous fuels reduction project silviculture report. Prepared for: Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest.

Andrew, G., M. Glenn, P. Jacoby-Garrett, and D. Thompson. 2013. Surveys and Habitat

Assessment for *Plebejus shasta charlestonensis* (Mount Charleston Blue Butterfly) in the Spring Mountain Range of Nevada (2012 field season). March 6, 2013. Final Revision December 11 (w/new Figures). Final Revi. Submitted to United States Fish and Wildlife Service, Southern Nevada Field Office in cooperation with United States Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area, Las Vegas, Nevada.

Arnold, R. A. 1983. Ecological studies of six endangered butterflies (Lepidoptera, Lycaenidae): island biogeography, patch dynamics, and the design of habitat preserves. University of California Publications in Entomology 99:1–161.

Austin, G. T. 1980. A new *Plebejus* (*Icaricia*) *shasta* (Edwards) from southern Nevada (Lycaenidae). Journal of the Lepidopterists' Society 34:20–24.

Austin, G. T., and A. T. Austin. 1980. Butterflies of Clark County, Nevada. Journal of Research on the Lepidoptera 19:1–63.

Austin, G. T., and P. J. Leary. 2008. Larval hostplants of butterflies in Nevada. Holarctic Lepidoptera 12:1–134.

Ballmer, G. R., and G. F. Pratt. 1988. A survey of the last instar larvae of the Lycaenidae (Lepidoptera) of California. Journal of Research on the Lepidoptera 27:1–81.

BLM. 2021. Round 18 - Southern Nevada Public Land Management Act. Grand Junction, Colorado.

Bowler, D. E., and T. G. Benton. 2005. Causes and consequences of animal dispersal strategies: relating individual behaviour to spatial dynamics. Biological Reviews 80:205–225.

Boyd, B. M., and G. T. Austin. 1999. Final report on butterfly investigations in the Spring Mountains, Nevada, 1998, and a proposed monitoring program for endemic species. Prepared for: U.S. Forest Service, Spring Mountains National Recreation Area, Las Vegas Nevada in cooperation with U.S. Fish and Wildlife Service, Nevada State Office, Reno, Nevada in support of the Conservation Agreement for the Spring Mountains NRA.

Boyd, B. M., and D. D. Murphy. 2008. A report on the status of the Mount Charleston blue butterfly and its essential resources at and adjacent to the Las Vegas Ski and Snowboard Resort -- 2008. Prepared for Las Vegas Ski and Snowboard Resort, Las Vegas, Nevada.

Cahenzli, F., and A. Erhardt. 2012. Enhancing offspring quality or quantity? Different ways for using nectar amino acids in female butterflies. Oecologia 169:1005–1014.

DataSmiths. 2007. Report on butterfly surveys at three locations in the Spring Mountains, Clark County, Nevada. Prepared for U.S. Forest Service, Spring Mountains National Recreation Area, Las Vegas, Nevada.

Denton, C. W., D. G. Brewer, and R. D. Lund. 2008. Field review of plots within the Spring Mountains Humboldt-Toiyabe National Forests September 16-18, 2008. University of

Nevada Las Vegas, Ecological Restoration Institute at Northern Arizona.

Emmel, J. F., and O. Shields. 1980. The biology of Plebejus (Icaricia) shasta in the Western United States (Lycaenidae). Journal of Research on the Lepidoptera 17:129–140.

ENTRIX Environmental Consultants. 2008. Spring Mountains National Recreation Area landscape analysis. Prepared for USDA Forest Service, Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Las Vegas, Nevada.

Ferris, C. D., and F. M. Brown. 1981. Butterflies of the Rocky Mountain States. University of Oklahoma Press, Norman, Oklahoma.

Gilpin, M. E., and M. E. Soule. 1986. Minimum viable populations: processes of species extinction. Pages 19–34 *in* M. E. Soule, editor. Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, Massachusets.

Gulley, K. 2022. Biological assessment for the Camp Lee Canyon Dance Floor Pavilion Construction. Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area, Clark County, Nevada.

Herrmann, C. 2014. Effects of the Carpenter 1 Fire on the Mount Charleston blue butterfly (*Plebejus shasta charlestonensis*) and its habitat. Directorate Resources Assistant Fellow, U.S. Fish and Wildlife Service.

Herrmann, C. R. 2017. Living on the edge: assessing the effects of catastrophic fire on plants utilized by two endemic subspecies of Spring Mountains butterflies. University of Nevada, Las Vegas, Las Vegas, Nevada.

Hill, C. J., and N. E. Pierce. 1989. The effect of adult diet on the biology of butterflies. 1. The common imperial blue, *Jalmenus evagoras*. Oecologia 81:249–257.

Hurja, J., and C. Kallstrom. 2012. SNPLMA Round 14 Conservation Initiative Nomination. Spring Mountains Butterfly Life History and Autecology Studies: Phase 3 Habitat Restoration and Enhancement. Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest and U.S. Fish and Wildlife Service.

Miller, R. 2020. Butterfly autecology Phase IV; Upper Lee Canyon; Mount Charleston blue butterfly (MCBB) habitat surveys, butterfly larval and nectar plant surveys, and threatened, endangered, and sensitive (TES) plant surveys. In collaboration with Benjamin Jacobs and Sarah Kapel. Forest Service and Great Basin Institute.

Murphy, D. 2006. Telephone interview with Dr. Dennis Murphy, University of Nevada, Reno.

Murphy, D. D., A. E. Launer, and P. R. Ehrlich. 1983. The role of adult feeding in egg production and population dynamics of the checkerspot butterfly *Euphydryas editha*. Oecologia 56:257.

Nachlinger, J., and G. A. Reese. 1996. Plant community classification of the Spring Mountains

National Recreation Area Clark and Nye Counties, Nevada. Las Vegas, Nevada.

Niles, W. E., and P. J. Leary. 2007. Annotated checklist of the vascular plants of the Spring Mountains Clark and Nye Counties, Nevada. Mentzelia 8:1–72.

Opler, P. A. 1999. A field guide to western butterflies. Houghton Mifflin Comp, Boston.

Pelham, J. P. 2016. A catalogue of the butterflies of the United States and Canada. Revised 11 March 2016. http://butterfliesofamerica.com/US-Can-Cat.htm.

Pinyon. 2011. Final project report of butterfly monitoring and inventories Spring Mountains National Recreation Area Clark County, Nevada. Prepared by Andrea Sever (PINYON Environmental Engineering Resources, Inc) for Desert Conservation Program, Project #2005-PINYON-570C, Clark County Department of Air Quality and Environmental Management, Las Vegas, Nevada.

Scott, J. A. 1974. Mate-locating behavior of butterflies. American Midland Naturalist 91:103.

Scott, J. A. 1986. The butterflies of North America: a natural history and field guide. Stanford University Press, Stanford, California.

Shaffer, M. 1981. Minimum population sizes for species conservation. BioScience 31:131–134.

Shaffer, M. L. 1987. Minimum viable populations: coping with uncertainty. Pages 69–86 *in* M. E. Soule, editor. Viable Populations for Conservation. Cambridge University Press, Cambridge, England.

Talavera, G., V. A. Lukhtanov, N. E. Pierce, and R. Vila. 2013. Establishing criteria for higher-level classification using molecular data: the systematics of Polyommatus blue butterflies (Lepidoptera, Lycaenidae). Cladistics 29:166–192.

Thompson, D. 2018a. Surveys and habitat assessment of Icaricia shasta charlestonensis (Mount Charleston blue butterfly) in the Spring Mountain Range of Nevada, 2015 - 2017 - Final Report. Las Vegas, Nevada.

Thompson, D. 2018b. Habitat characteristics of Icaricia shasta charlestonensis (Mount Charleston blue butterfly) in the Spring Mountain Range of Nevada updated December 2018.

Thompson, D. 2022. Final report: Mount Charleston blue butterfly population and habitat status surveys 2019-2021 (F19AC00089-01). School of Life Sciences, University of Nevada, Las Vegas. Submited to United States Fish and Wildlife Service in cooperation with United States Forest Service, Las Vegas, Nevada.

Thompson, D., and S. Abella. 2016. Spring Mountains butterfly life history and autecology studies: phase III baseline habitat conditions and prescriptions for habitat enhancement, restoration, and augmentation. School of Life Sciences, University of Nevada, Las Vegas. Prepared for Forest Service, Spring Mountains National Recreation Area in cooperation

with U.S. Fish and Wildlife Service, Southern Nevada Fish and Wildlife Office, Las Vegas, Nevada.

Thompson, D., G. Andrew, P. Jacoby-Garrett, H. Stevens, and S. Abella. 2014. Spring Mountains butterfly autecology final report 2010 to 2012. Prepared for USDA Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area. Contract number: AG-9360-S-10-0001. March 30, 2014 revised July 25, 2014.

USFS. 2007. Final project report, Bristlecone Habitat Protection Project, 2005-USFS_SMNRA-490-P.

USFS. 2020. Endemic Butterfly Habitat Restoration & Protection. SNPLMA Round 18 Nomination Conservation Initiatives. USDA Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area.

USFS, and BLM. 2013. Notice of Proposed Action and Opportunity to Comment. Spring Mountains Wild Horse & Burro Complex Herd Management Area Plan Project. Clark and Nye Counties, NV. Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area and Bureau of Land Management, Southern Nevada District.

USFS, and BLM. 2021. Spring Mountains Wild Horse & Burro Complex Herd Management Area Plan. Preliminary Environmental Assessment. Forest Service, Humboldt-Toiyabe National Forest and Bureau of Land Management, Southern Nevada District.

USFS, and BLM. 2022. Spring Mountains Wild Horse & Burro Complex Herd Management Plan: Final Environmental Assessment. Humboldt-Toiyabe National Forest, Forest Service and Southern Nevada District Office, Bureau of Land Management.

USFS, Nevada Department of Conservation and Natural Resources, and U.S. Fish and Wildlife Service. 1998. Conservation Agreement for the Spring Mountains National Recreation Area, Clark and Nye Counties, Nevada.

USFS, and UNLV. 2015. Challenge cost share agreement between the Board of Regents, NSHE, OBO University of Nevada, Las Vegas and the USDA, Forest Service, Humboldt-Toiyabe Nation Forest. FS Agreement No. 15-CS-11041705-026.

USFWS. 2007. 90-day finding on a petition to list the Mt. Charleston blue butterfly as threatened or endangered. Federal Register 72:29933–29941.

USFWS. 2011. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the Mt. Charleston blue butterfly as endangered or threatened. Federal Register 76:12667–12683.

USFWS. 2012. Endangered and threatened wildlife and plants; proposed listing of the Mount Charleston blue butterfly as endangered and proposed listing of five blue butterflies as threatened due to similarity of appearance. Federal Register 77:59518–59540.

USFWS. 2013. Endangered and threatened wildlife and plants; determination of endangered

species status for Mount Charleston blue butterfly. Federal Register 78:57750–57775.

USFWS. 2014. Endangered and threatened wildlife and plants; designation of critical habitat for Mount Charleston blue butterfly (*Plebejus shasta charlestonensis*). Federal Register 79:41225–41245.

USFWS. 2015a. Endangered and threatened wildlife and plants; designation of critical habitat for Mount Charleston blue butterfly (*Icaricia* (*Plebejus*) *shasta charlestonensis*). Federal Register 80:37404–37430.

USFWS. 2015b. Informal consultation, informal conference, and review of conservation agreement species of concern for the McFarland Fence Project, ClarkCounty, Nevada. April 14, 2015. File Nos. 84320-2015-I-0279, 84320-2015-IC-0280, and 84320-2015-CPA-0042.

USFWS. 2016. Definition of destruction or adverse modification of critical habitat. Federal Register 81:7214–7226.

USFWS. 2022. Formal Consultation under Section 7 of the Endangered Species Act for Effects to the Mount Charleston Blue Butterfly for the Spring Mountains Wild Horse and Burro Complex Herd Management Area Plan Project, Clark County, Nevada. 2022-0017990-S7-001.

USFWS. 2023. Recovery Plan for Mount Charleston blue butterfly (Icaricia shasta charlestonensis). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. iv + 7 pp.

Vila, R., C. D. Bell, R. Macniven, B. Goldman-Huertas, R. H. Ree, C. R. Marshall, Z. Bálint, K. Johnson, D. Benyamini, and N. E. Pierce. 2011. Phylogeny and palaeoecology of Polyommatus blue butterflies show Beringia was a climate-regulated gateway to the New World. Proceedings of the Royal Society B: Biological Sciences 278:2737–2744.

Weiss, S. B., A. D. Weiss, D. D. Murphy, and G. T. Austin. 1995. Final report on candidate butterfly taxa of the Spring Mountains.

Weiss, S. B., A. D. Weiss, D. D. Murphy, and G. T. Austin. 1997. Final report on endemic butterflies of the Spring Mountains. Prepared for U.S. Fish and Wildlife Service, Nevada State Office, Reno, Nevada.

Personal Communications Cited

Boyd, B. 2012. Email, shasta +, dated November 5, 2012.

Murphy, D. 2006. Telephone interview with Dr. Dennis Murphy, University of Nevada, Reno.

Thompson D. 2015. Email, Butterfly collecting in the Spring Mountains dated November 5, 2015. Associate Professor, University of Nevada, Las Vegas, Nevada.

Woodard, C. 2015. Email, Butterfly collecting in the Spring Mountains dated November 4, 2015.

Area Wildlife Biologist/Natural Resources Officer, Spring Mountains National Recreation Area, Forest Service. Las Vegas, Nevada.

Appendix A. Location Names and Background

This table reflects the location names used in this recovery plan based on ongoing evaluation of listing documents and associated reports and literature for the Mount Charleston blue butterfly.

Recovery Plan Location Name	Final Listing Rule (USFWS 2013)	Proposed Listing (USFWS 2012)	12-Month (USFWS 2011)	90-Day (USFWS 2007)
1. South Loop Trail	1. South Loop Trail, Upper Kyle Canyon	1. South Loop Trail, Upper Kyle Canyon	1. South Loop Trail, Upper Kyle Canyon	1. South Loop Trail, Kyle Canyon
2. Lee Canyon Ski Area[1]	2. Las Vegas Ski and Snowboard Resort (LVSSR), Upper Lee Canyon	2. Las Vegas Ski and Snowboard Resort (LVSSR), Upper Lee Canyon	2. LVSSR, Upper Lee Canyon	2. LVSSR #1, Lee Canyon
				3. LVSSR #2, Lee Canyon
3. Foxtail[2]	3. Foxtail, Upper Lee Canyon	3. Foxtail, Upper Lee Canyon	3. Foxtail Upper Lee Canyon	4. Foxtail Camp, Lee Canyon
	4. Youth Camp, Upper Lee Canyon	4. Youth Camp, Upper Lee Canyon	4. Youth Camp, Upper Lee Canyon	5. Youth Camp, Lee Canyon
4. Gary Abbott	5. Gary Abbott, Upper Lee Canyon	5. Gary Abbott, Upper Lee Canyon	5. Gary Abbott, Upper Lee Canyon	6. Gary Abbott, Lee Canyon
5. Lower Parking[3]	6. Lower LVSSR Parking, Upper Lee Canyon	6. Lower LVSSR Parking, Upper Lee Canyon	6. Lower LVSSR Parking, Upper Lee Canyon	7. LVSSR Parking, Lee Canyon
6. North Loop Trail[4]	7. Mummy Spring, Upper Kyle Canyon	7. Mummy Spring, Upper Kyle Canyon	7. Mummy Spring, Upper Kyle Canyon	8. Mummy Spring, Kyle Canyon
7. Lee Meadow[5]	8. Lee Meadows, Upper Lee Canyon	8. Lee Meadows, Upper Lee Canyon	8. Lee Meadows, Upper Lee Canyon	9. Lee Meadow, Lee Canyon
8. Bristlecone Trail[6]	9. Bristlecone Trail	9. Bristlecone Trail	N/A	N/A
9. Bonanza Trail	10. Bonanza Trail	10. Bonanza Trail	9. Bonanza Trail	N/A
10. Upper Bristlecone Trailhead[7]	11. Upper Lee Canyon holotype	11. Upper Lee Canyon holotype	10. Upper Lee Canyon holotype	10. Lee Canyon holotype
11. Cathedral Rock*	12. Cathedral Rock, Kyle Canyon	12. Cathedral Rock, Kyle Canyon	11. Cathedral Rock, Kyle Canyon	11. Cathedral Rock, Kyle Canyon
12. Old Town*[8]	13. Upper Kyle Canyon Ski Area	13. Upper Kyle Canyon Ski Area	12. Upper Kyle Canyon Ski Area	12. Kyle Canyon Ski Area
	14. Old Town, Kyle Canyon	14. Old Town, Kyle Canyon	13. Old Town, Kyle Canyon	NA
13. Deer Creek*	15. Deer Creek, Kyle Canyon	15. Deer Creek, Kyle Canyon	14. Deer Creek, Kyle Canyon	14. Deer Creek, Kyle Canyon
Willow Creek**	16. Willow Creek	16. Willow Creek	15. Willow Creek	15. Willow Creek
14. Griffith Peak	17. Griffith Peak	N/A	N/A	N/A
15. McFarland and Bonanza Peaks Ridge	N/A	N/A	N/A	N/A
16. Wallace Canyon Ridge	N/A	N/A	N/A	N/A
17. Sisters South–West Ridge	N/A	N/A	N/A	N/A

* The area was visited in 2012 and searched for Mount Charleston blue butterfly habitat but none were found (Andrew et al. 2013).
** No longer considered a historic location. The area is not suitable to provide habitat to support Mount Charleston blue butterflies but was surveyed in 2012 because blue butterflies from the surrounding area could possibly be observed (Andrew et al. 2013). See Appendix B.
[1] This location has previously been referred to as Las Vegas Ski and Snowboard Resort or LVSSR.
[2] The Foxtail location is reported to be the same as location as Youth Camp by Boyd and Murphy (2008).
[3] This location was previously referred to as "Lower LVSSR Parking".
[4] The name North Loop Trail is used for this location now rather than Mummy Spring because it describes this location more accurately and has been used in more recent reports (e.g. Andrew et al. 2013, Thompson et al. 2014).
[5] This is the holotype location.
[6] This location occurs at the higher elevations of the Bristlecone Trail near the junction with Bonanza Trail but has been reported in Andrew et al. 2013 to include the entire trail between the junction and the Upper Bristlecone Trailhead. The location was first identified by Weiss et al. (1997, p. 10 and Map 3.1).
[7] This location was previously referred to as the "Upper Lee Canyon Holotype" occurs near the Upper Bristlecone Trailhead. The coordinates for the location were derived from Nevada Natural Heritage data beginning with the 90-day; however, the petition is correct whereby Lee Meadow is the "type locality".
[8] The Upper Kyle Canyon Ski Area location is the same as Old Town. The location has been described in earlier reports (Boyd and Austin 1999, Andrew et al. 2013). A ski area labeled on the USGS 1957 Charleston Peak Quadrangle 15-minute series (topographic) map and an "Old Ski Tow" location farther up the Kyle Canyon has likely led to confusion between locations.

Appendix B. Removal of the Willow Creek location from Mount Charleston blue butterfly historic location list

After further evaluation of information, we have determined that the Willow Creek area cannot be reliably considered as a historic location for the Mount Charleston blue butterfly based on the association of specimens and labels within the collections the American Museum of Natural History (AMNH) and reported in the published literature (Ferris 1976, Austin 1980, Emmel and Shields 1980). During the listing process, the USFWS first identified Willow Creek as an extirpated location of the Mount Charleston blue butterfly in the 90-day finding for the petition to list the species (USFWS 2007 p. 29935) based on Austin (1980) and Weiss et al. (1997) as primary references. Subsequent analyses and evaluation of the species status by the USFWS in the 12-month status review, proposed listing, and final listing continued to include this location (USFWS 2011, 2012, 2013).

Before the subspecies was described, the first published account for the Mount Charleston blue butterfly's Willow Creek location was by Ferris (1976 p. 14); however, it provided few details about the location and collection. Subsequently Austin (1980 p. 22), in his description of the subspecies, provided more details about the location listed as "*Willow Creek, 6,000–8,000', 15 July 1928 (15♂ 19♀, Gunder collection in American Museum of Natural History, fide J. F. Emmel)*."[5] Austin (1980 p. 22) also provides clarification on the collection as "*the specimens in the Gunder collection must be part of the series of "several hundred" collected by Morand as mentioned by Garth (1928). The fate of the remaining specimens of this series is unknown to the author.*" Austin's reference was to Garth's (1928 p. 93) report that "*Mr. Morand, who visited Charleston Peak, near Las Vegas, Nevada, in July, brought back several hundred of the rare Plebejus shasta, specimens of the latter being even darker than the normal form comstocki.*" Austin's interpretation that the Mount Charleston blue butterflies in the AMNH collection are from those several hundred that Morand collected from Charleston Peak area and reported by Garth in 1928, would suggest that the Mount Charleston blue butterfly specimens have been attributed to the Willow Creek location in error.[6]

However, Morand whom had been accompanying William Burt during field work including ascents of Charleston Peak ("Scouts climb Mt Charleston" 1928), later published an account that "*Mr. Morand, who was collecting butterflies in the Charleston Mountains, told me that he had seen weasels on two occasions. He reported seeing a weasel near the stream at "Little Falls" and another at Willow Creek while sitting quietly awaiting the appearance of butterflies*" (Burt 1934 pp. 398–399). Though Morand has been confirmed to have conducted field collections at Willow Creek, we are not aware of any other information or details of that work.

Later accounts of the Willow Creek location from the same specimens and their labels (Weiss et al. 1997 p. 10) have suggested Willow Peak located above Willow Creek as an alternative and potentially more apt higher elevation location. This may be historically less plausible based on the description and accounts of Burt (1934 p. 386), who indicated that Morand had been searching for butterflies near Willow Creek.

[5] Emmel and Shields (1980 p. 136) publication shortly later on Shasta blue butterflies added a range for the dates of the Mount Charleston blue butterfly specimens collection to 15–28 July, 1928.

[6] The specimens collected by Frank Morand in 1928 appear to have become a part of the Jeane D. Gunder collection of 27,000 specimens that was acquired by the American Museum of Natural history in 1937 (Wilkinson 1988 p. 158).

Since the1928 surveys for butterflies, there have been no observations of Mount Charleston blue butterflies or its habitat in the Willow Creek and Willow Peak areas (Weiss et al. 1997, Boyd and Austin 1999, Andrew et al. 2013, Thompson et al. 2014, Thompson 2018, 2022). In addition, reviews of surveys for biological or ecological investigations (Nachlinger and Reese 1996, Niles and Leary 2011, METI and RMRS 2013) have not demonstrated host or nectar plant presence within an ecological context to suggest that Mount Charleston blue butterfly habitat or the potential thereof, is present within the Willow Creek or Willow Peak areas. Predicted plant communities by Nachlinger and Reese (1996, Figure 19a) or mid-level existing vegetation types mapped by the Forest Service (USFS n.d.) which could be associated with Mount Charleston blue butterfly habitat are not present in the Willow Creek area.

References

Andrew, G., M. Glenn, P. Jacoby-Garrett, and D. Thompson. 2013. Surveys and Habitat Assessment for *Plebejus shasta charlestonensis* (Mount Charleston Blue Butterfly) in the Spring Mountain Range of Nevada (2012 field season). March 6, 2013. Final Revision December 11 (w/new Figures). Final Revi. Submitted to United States Fish and Wildlife Service, Southern Nevada Field Office in cooperation with United States Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area, Las Vegas, Nevada.

Austin, G. T. 1980. A new *Plebejus* (*Icaricia*) *shasta* (Edwards) from southern Nevada (Lycaenidae). Journal of the Lepidopterists' Society 34:20–24.

Boyd, B. M., and G. T. Austin. 1999. Final report on butterfly investigations in the Spring Mountains, Nevada, 1998, and a proposed monitoring program for endemic species. Prepared for: U.S. Forest Service, Spring Mountains National Recreation Area, Las Vegas Nevada in cooperation with U.S. Fish and Wildlife Service, Nevada State Office, Reno, Nevada in support of the Conservation Agreement for the Spring Mountains NRA.

Burt, W. H. 1934. The mammals of southern Nevada. Transactions of the San Diego Society of Natural History 7:375–428.

Emmel, J. F., and O. Shields. 1980. The biology of *Plebejus* (*Icaricia*) *shasta* in the western United States (Lycaenidae). Journal of Research on the Lepidoptera 17:129–140.

Ferris, C. D. 1976. Revisionary notes on *Plebejus* (*Icaricia*) *shasta* (Edwards). Bulletin of the Allyn Museum 36:1–16.

Garth, J. S. 1928. Report of the Lorquin Entomological Society of Los Angeles. Bulletin of the Southern California Academy of Sciences 27:93–94.

METI and RMRS. 2013. Final program report for 2010-2012: monitoring and evaluation for conserving biological resources of the Spring Mountains National Recreation Area. Page Order Number: AG-3187-D-10-0126 for Contract Number: AG-3187-C-0028. Humboldt-Toiyabe National Forest and the Rocky Mountain Research Station.

Nachlinger, J., and G. A. Reese. 1996. Plant community classification of the Spring Mountains National Recreation Area Clark and Nye Counties, Nevada. Las Vegas, Nevada.

Niles, W. E., and P. Leary. 2011. Flora of the Spring Mountains, Clark and Nye Counties Nevada.

Scouts climb Mt Charleston. 1928, July 12. . Las Vegas Ages:1.

Thompson, D. 2018. Surveys and habitat assessment of *Icaricia shasta charlestonensis* (Mount Charleston blue butterfly) in the Spring Mountain Range of Nevada, 2015 - 2017 - Final Report. Las Vegas, Nevada.

Thompson, D. 2022. Final report: Mount Charleston blue butterfly population and habitat status surveys 2019-2021 (F19AC00089-01). School of Life Sciences, University of Nevada, Las Vegas. Submited to United States Fish and Wildlife Service in cooperation with United States Forest Service, Las Vegas, Nevada.

Thompson, D., G. Andrew, P. Jacoby-Garrett, H. Stevens, and S. Abella. 2014. Spring Mountains butterfly autecology final report 2010 to 2012. Prepared for USDA Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area. Contract number: AG-9360-S-10-0001. March 30, 2014 revised July 25, 2014.

USFS. (n.d.). Spring Mountains National Recreation Area: Mid-level existing vegetation classification and mapping. Intermountain Region, Forest Service, Humboldt-Toiyabe National Forest.

USFWS. 2007. 90-day finding on a petition to list the Mt. Charleston blue butterfly as threatened or endangered. Federal Register 72:29933–29941.

USFWS. 2011. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the Mt. Charleston blue butterfly as endangered or threatened. Federal Register 76:12667–12683.

USFWS. 2012. Endangered and threatened wildlife and plants; proposed listing of the Mount Charleston blue butterfly as endangered and proposed listing of five blue butterflies as threatened due to similarity of appearance. Federal Register 77:59518–59540.

USFWS. 2013. Endangered and threatened wildlife and plants; determination of endangered species status for Mount Charleston blue butterfly. Federal Register 78:57750–57775.

Weiss, S. B., A. D. Weiss, D. D. Murphy, and G. T. Austin. 1997. Final report on endemic butterflies of the Spring Mountains. Prepared for U.S. Fish and Wildlife Service, Nevada State Office, Reno, Nevada.

Wilkinson, R. S. 1988. Cyril Franklin Dos Passos (1887-1986). Journal of the Lepidopterists' Society 42:155–163.