Recovery Plan for the Sacramento Mountains Checkerspot Butterfly (*Euphydryas anicia cloudcrofti*)

U.S. Fish and Wildlife Service
Southwest Region
Albuquerque, New Mexico
December 2025

LESTON JACKS

Digitally signed by LESTON JACKS
Date: 2025.12.16 17:27:36 -06'00'

Approved: _____

Regional Director, Southwest Region
U.S. Fish and Wildlife Service

DISCLAIMER:

Recovery plans delineate such reasonable actions as may be necessary for the conservation and survival of listed species. Plans are published by the U.S. Fish and Wildlife Service (USFWS) and are sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than the USFWS. They represent the official position of the USFWS only after they have been signed by the Regional Director.

Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation.

Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions. Please check for updates or revisions at the websites below before using or citing.

ACKNOWLEDGEMENTS

The recovery planning process, including this Recovery Plan, has benefitted from the advice and assistance of many individuals, agencies, and organizations. Special thanks to Dr. Sarah Rinkevich, Dr. Julie McIntyre, the Sacramento Ranger District, Janelle Alleman, and all the members of the SMCB working group.

Recommended citation:

U.S. Fish and Wildlife Service (USFWS). 2025. Final Recovery Plan for the Sacramento Mountains Checkerspot Butterfly (*Euphydryas anicia cloudcrofti*). New Mexico Ecological Services Field Office. 28 pp.

Table of Contents

INTRODUCTION 4
Brief Life History 4
Primary Threats 5
Current Biological Status of the Species 6
Summary of Current Resiliency, Redundancy, and Representation 8
Resiliency 8
Redundancy 9
Representation 9
Summary of Current Viability 9
Current Conservation Efforts to Date 9
Recovery Priority Number 10
Recovery Strategy 11
Recovery Criteria 11
Recovery Actions 13
Literature Cited 17

INTRODUCTION

This recovery plan revision describes criteria for determining when the Sacramento Mountains checkerspot butterfly (*Euphydryas anicia cloudcrofti*), here after SMCB, should be considered for reclassification from endangered to threatened and to recovered status under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA). It also lists site-specific actions that will be necessary to meet those criteria, and it provides estimates of the time and cost required to carry out those measures needed for recovery. Additionally, summary information on the species' biology and status are included, along with a brief discussion of factors limiting its populations. A Current Condition Assessment Report (USFWS 2022, Version 1.2), which provides a more detailed accounting of the species' status, biology, and threats, is available online at the link provided: https://ecos.fws.gov/ecp/species/1546. A Recovery Implementation Strategy (RIS) will be drafted, once a final Recovery Plan is completed, and will be updated on a routine basis.

Brief Life History

The SMCB is a subspecies of the Anicia checkerspot or variable checkerspot, a species broadly distributed across the western United States (Glassberg 2017; Pohl, Patterson, and Pelham 2016). Other species in the genus are similar in appearance. The SMCB can be distinguished by wide, dark brown, and black bands that separate the orange and white checkered pattern for which the species gets its name. Like all butterfly species, the SMCB undergoes complete metamorphosis, including egg, larvae, pupae, and adult stages. The species has one generation per year (univoltine; USFWS 2023). The SMCB's life cycle is successful when the emergence of adults is synchronized with the development of the host and nectar plants on which it relies (USFWS 2023).

The adult flight period lasts from Mid-June to August. Individuals stagger their emergence, with the number peaking around the second week of the flight season (USFWS 2023). Females lay >400 eggs on New Mexico beardtongue (*Penstemon neomexicanus*) in several clutches (Schaller, Pers. Comm. 2022a). The checkerspot eggs hatch within two weeks, and the larvae collectively create a silken shelter around their host plant, known as a tent (Pratt and Emmel 2010). In the fall, the larvae enter a dormant stage known as diapause, where they stay until conditions warm in the spring (USFWS et al. 2005). In spring, the larvae emerge and begin to feed again before pupating into adults (USFWS 2023). Once emergence of adults takes place, nectar sources are needed like sneezeweed (*Helenium [Hymenoxys] hoopesii*), which is a preferred nectar source.

The SMCB has a narrow range atop the Sacramento Mountain range in south-central New Mexico. The SMCB inhabits high-altitude meadows in the upper-montane and subalpine zone at elevations between 2,380 and 2,750 m (7,800 and 9,000 ft) (USFWS et al. 2005). The SMCB appears to have a stronger affinity for the highest elevation areas in its range, gentle or angled slopes, and south-eastern aspect orientations (McIntyre 2010). Trees usually occur along the periphery of meadows, including various spruce (*Picea* spp.), fir (*Pseudotsuga* spp. and *Abies* spp.), and pine (*Pinus* spp.) (USFS 2014).

Limiting Life History Characteristics:

The SMCB is sensitive to changes in both temperature and precipitation. Changes to the annual timing of precipitation, such as those caused by climate variability, can result in a phenological mismatch between the SMCB's active period and the growth of nectar and host plants (USFWS 2023). New Mexico was in a recent drought for several years, many of which have been the warmest on record (National Oceanic and Atmospheric Administration 2016). Climate variability will likely continue to impact the frequency, strength, and timing of monsoon events throughout the southwest (Colorado-Ruiz et al. 2018).

Recent summer rainfall, snowfall, and corresponding snowpack in the southwestern U.S. have remained well below normal levels (Climate Assessment for the Southwest 2021). Some alpine butterflies need high snowpack levels during diapause to shelter from wind and cold temperatures (Roland et al. 2021). Experts have suggested that the same might be true for the SMCB, as the species likely evolved with higher levels of winter snowpack than are expected over the next decade (Hughes pers. comm. 2021).

Like most butterflies, the SMCB has an extremely high mortality rate between the egg and adult phases. As many as 98 percent of individuals perish in the wild, even under ideal circumstances (Ryan pers. comm. 2021). Similar mortality rates are typical in other butterflies, as the larvae are vulnerable to predation, among other factors (Swengel 1997). Under normal environmental conditions, this trait would not limit the subspecies' viability when high numbers of females are breeding and laying eggs. However, with other compounding factors, high mortality rates limit the species' resiliency (USFWS 2023).

The SMCB has an extremely low dispersal rate and short dispersal distances. Within one study, researchers found that SMCB males dispersed up to 800 meters (half a mile), and most moved shorter distances than this. Of the individuals tracked, 89 percent remained within their native meadow (Pittenger and Yori 2003). Low dispersal rates are typical in *Euphydryas* checkerspots (Ehrlich et al. 1975). However, it is likely that due to low current densities, movement between meadows no longer takes place, thus limiting gene flow.

Preliminary genetic research shows that there has been a divergence between the SMCB and other closely related taxa. There might be a significant diversion from *E. anicia*. However, more information is needed to determine the level of differentiation between the SMCB and other closely related taxa (Ryan 2007). Due to the small population size, there is concern that the SMCB might suffer from low genetic diversity and bottlenecking (Ryan pers. comm. 2022). Similarly, the SMCB may have experienced inbreeding depression and subsequent population collapse (Ryan pers. Comm. 2025).

Primary Threats

As summarized in more detail in the Current Condition Assessment Report (USFWS 2022), we focused our analysis of the SMCB's viability on five primary and several secondary threat factors. Primary factors include altered wildfire regimes, climate variability, incompatible

grazing[1], invasive plants, and recreation. According to the best available data, these are the factors contributing to the decline of the SMCB (USFWS et al. 2005; Forest Service 2020; Ryan pers. comm. 2021; USFS 2017). Evidence indicates strong synergistic and cumulative interactions between these primary factors driving the species' current and future projected conditions. The Current Condition Assessment Report presents a thorough review of the stressors affecting SMCB (USFWS 2022).

Current Biological Status of the Species

The Current Condition Assessment Report for the SMCB (USFWS 2022, entire) is an evaluation of its biological status and an assessment of the resources and conditions needed to maintain populations over time. We evaluated the species' current condition to assess the species' current viability in terms of its resiliency, redundancy, and representation (the 3Rs). Resiliency is the ability of populations to sustain themselves in the face of stochastic events or for populations to recover from years with low reproduction or reduced survival. It is associated with population size, growth rate, and the quality and quantity of habitats. Redundancy is the ability of the species to withstand catastrophic events, for which adaptation is unlikely, and is associated with the number and distribution of populations. Representation is the ability of a species to adapt to changes in the environment and is associated with its diversity, whether ecological, genetic, behavioral, or morphological.

U.S. Forest Service surveys show that the SMCB historically existed within a range of 82 square kilometers (32 square miles). However, the suitable habitat within this area is approximately two square miles (USFS 2020). We analyzed the SMCB's current condition within ten meadow units based on survey sites identified by the Forest Service (Figure 1). However, one unit (Yardplot) is now private land, reducing the meadow units available for surveys to 9 total.

[1] "Grazing" for the purposes of this document is meant to encompass herbivory by all native and non-native ungulates e.g. feral horses, elk, trespass livestock.

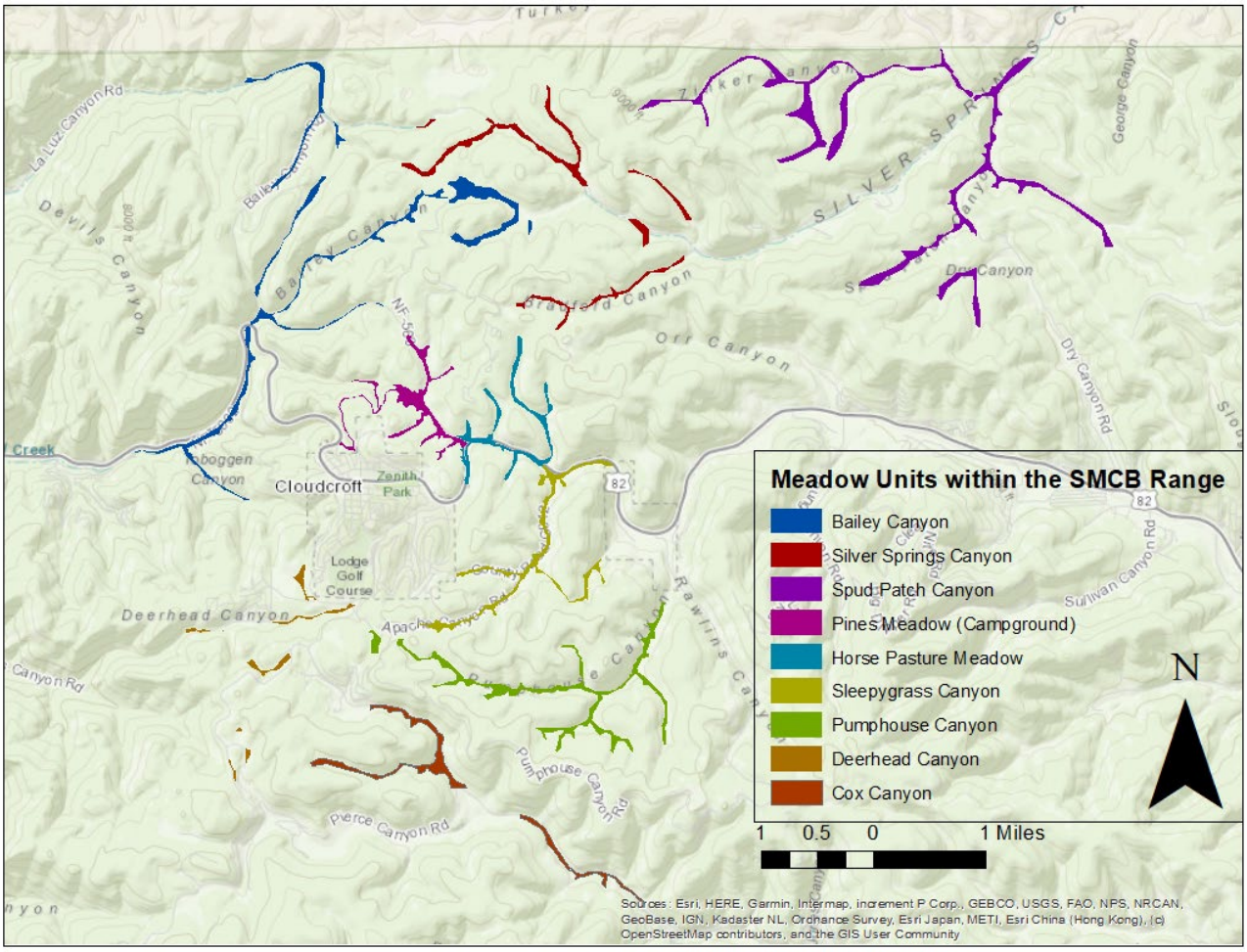


Figure 1. The range of the Sacramento Mountains checkerspot butterfly and the nine meadow units identified by the Forest Service.

The SMCB has declined throughout its range. We consider the species to potentially be extant currently within two of the nine meadow units (USFWS 2023; Figure 2). Extirpations have likely been caused by drought and habitat degradation due to recreation and incompatible grazing of native and non-native ungulates.

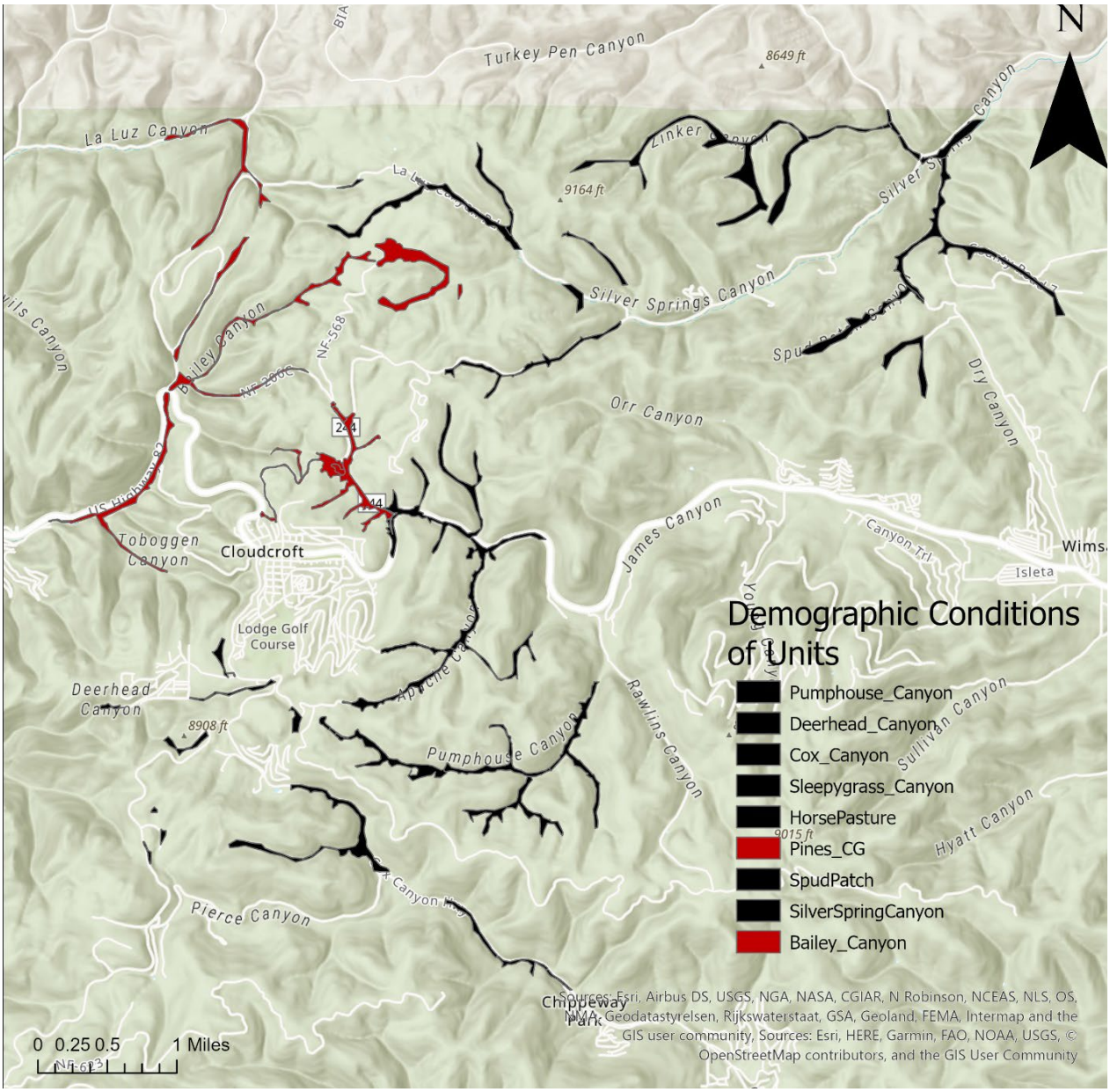


Figure 2. Range wide population status of the Sacramento Mountains checkerspot butterfly.

Summary of Current Resiliency, Redundancy, and Representation

Resiliency

Within the Current Condition Assessment Report, we identified habitat needs at the individual and population levels as host plants, nectar sources, and habitat connectivity (USFWS 2022). Demographic resiliency factors include the density of adult butterflies and larval density. These factors were chosen after consultation with experts and carefully considering available data. Based on survey reports from previous years, most meadow units' demographic factors are very low or extirpated. Based on the five primary threat factors that are currently driving the decline

of the species and the small population numbers, we consider the resiliency of the SMCB to be very low.

Redundancy

We define redundancy for the SMCB as having populations or metapopulations spread across the range. Two potentially extant SMCB populations are located in adjacent meadows of nine documented historical metapopulations within a single representation area. Several individuals have reported witnessing large numbers of SMCB in past years (Cary pers. comm. 2022). Therefore, current redundancy of the butterfly is low and has declined over time (Forest Service 2020; USFWS 2023).

Representation

We define representation for the SMCB as having ecological and genetic diversity. There is little current genetic information available for the SMCB (Ryan and Milligan 2011; Lightfoot pers. comm. 2022). The recent range contraction suggests that most of the original representation present within the species has declined. There is currently one representation area for the butterfly that contains the entire potential range of the species, including the ten meadows discussed previously. The Forest Service has been able to locate the species in two meadows during recent years; however, there is probably no connectivity between these populations. The occupied meadows are among spruce-fir forests, so there are barriers that limit the dispersal of individuals between the populations. This effectively restricts the transfer of genetic material, thus limiting genetic diversity. There was likely greater habitat connectivity between populations in the past due to a more natural fire regime. Currently, overall representation is low and has declined in recent years.

Summary of Current Viability

We used the best available information to assess the current condition of the SMCB. Our goal was to describe the species' needs and assess the viability of the butterfly in terms of resiliency, redundancy, and representation. The SMCB faces various threats, including incompatible livestock grazing, recreation, climate variability, non-native invasive plants, and increased wildfire sizes, severities, and frequencies. For redundancy, potentially two extant populations are located in adjacent meadows in a single representation area, and these two populations, if extant, both have very low resiliency. For representation, the butterfly has limited ecological diversity, existing within one habitat type, which likely limits genetic diversity among the populations. Overall, the threats currently negatively impact the populations' resiliency, making them vulnerable to extirpation, and resulting in further losses of representation and redundancy.

Current Conservation Efforts to Date

The Lincoln National Forest has erected fenced exclosures to protect butterfly habitat areas from grazing. These efforts are currently focused on the two potentially extant units. Botanists involved with the SMCB conservation team are growing plants for habitat restoration. Biologists have begun restoration efforts within exclosures and areas where the checkerspot has most recently been seen to increase the number of nectar sources and host plants available, including

orange sneezeweed and New Mexico beardtongue, to ensure that the individual needs of caterpillars and adult butterflies are met.

The U.S. Forest Service has proposed that forest management plans aimed at reducing tree stocking within forested areas surrounding meadows might also help restore suitable habitat and connectivity throughout the range of the butterfly. Maintaining an edge habitat and connectivity could significantly improve the butterfly's viability in the long term.

In 2022, the ABQ BioPark, BUGarium (an institution accredited by the Association of Zoos and Aquariums) began captive rearing of the SMCB (Walker pers. comm. 2022). Two females and two males were brought into captivity, and both females were successfully mated with the same male (Schaller pers. comm. 2022b). Each female produced more than 400 eggs (Schaller pers. comm. 2022a). Ultimately, 164 larvae hatched, grew, and entered diapause. Thirty larvae did not eclose and entered a second diapause (Schaller pers. comm. 2022c; Appendix I). Three larvae were brought out of a third diapause, where two have died at the time of writing. Now, one larva remains alive from this cohort. The deceased larva has been preserved at -80 F at the Museum of Southwestern Biology at University of New Mexico.

Captive rearing and habitat restoration for the SMCB are immediate recovery actions that the USFWS and concerned partners undertook due to the highly imperiled status of the species (see three R's above). The outcome of these efforts has yet to be determined, and information collected from these efforts will be used to inform the Recovery Implementation Strategy. The current recovery working group has facilitated immediate actions for surveys and captive propagation techniques. Please, see Appendix I for additional immediate recovery actions to be taken.

Recovery Priority Number

The first step to recovering a listed species is to prevent extinction. To balance the risk of extinction and available resources, the USFWS assigns a Recovery Priority Number (RPN) to listed species that ranges from 1 (high priority) to 12 (lower priority) per our 1983 policy (48 FR 43098, September 21, 1983, as corrected in 48 FR 51985, November 15, 1983 (USFWS 1983)). Three criteria are used to evaluate the risk of extinction: the degree of threat, potential for recovery, and the taxonomic uniqueness of the listed species.

We assigned the SMCB an RPN of 6 because it is a subspecies that faces a high degree of threat and has low recovery potential. The threat is high because the SMCB faces immediate extinction if recovery is delayed. We consider recovery potential low at this time, because it will require intensive management with uncertain probability of success, and techniques likely to be needed are still experimental. We do not anticipate that the implementation of recovery actions will conflict with development, other forms of economic activity, or the recovery of other listed species.

RECOVERY

Recovery Strategy

The recovery strategy describes the steps needed to achieve a recovered state of the species. Our recovery strategy for SMCB is one where: 1) the species is able to establish and maintain a sufficiently robust population to provide for future efforts to expand the population size; 2) a sufficient number of populations are established and self-sustaining in their natal environment, reducing the risk of extinction from catastrophic or stochastic events including genetic regression; 3) populations of the SMCB become numerous enough to increase their distribution across the range and are robust enough to maintain or expand genetic and ecological diversity without human intervention.

Due to the current restrictions on the species' population size, distribution, and genetic viability, near-term recovery activities (Appendix I) have been identified that will be achieved through monitoring, adaptive management, captive rearing, advanced reproductive techniques, and targeted protection and restoration strategies. The primary objective is to prevent the species' extinction and protect any existing SMCB colonies for the foreseeable future. Secondary objectives include meeting the downlisting and delisting criteria for the species Initial recovery efforts should focus on:

1. Conduct annual monitoring and inventory of wild populations and habitat to determine where to most effectively direct conservation and restoration efforts.
2. Continue captive-rearing efforts to expand and augment wild populations. Exploration into advanced reproduction techniques (e.g. artificial insemination, cross-breeding, etc.) and technologies (e.g. cryopreservation of tissues, cell lines, gametes) should be considered.
3. Reintroduce and translocate individuals to increase gene flow and establish new self-sustaining populations.
4. Engage partners (including but not limited to the USFS, Tribal Nations, SMCB Working Group, Institute for Applied Ecology, and the ABQ BioPark) to develop and implement conservation plans that alleviate the key threats to the species.
5. Conduct further research into the effects of climate variability and other threats to inform adaptive management for the species.

Recovery Criteria

Downlisting Criteria

The USFWS expect the SMCB to be eligible for downlisting consideration when the following criteria are met:

Downlisting Criterion 1:

> At least 3 self-sustaining, genetically stable populations have been reestablished within 3 of the 9 meadow units or newly identified meadows within the range of SMCB, with 2 of

the 3 populations being established in currently protected meadow systems (Bailey Canyon or Pines Campground). Reestablished would equate to 5 years of continuous occupation by SMCB.

Downlisting Criterion 2:

Each meadow unit supporting a population as described in Downlisting Criterion 1 will maintain or improve habitat suitability for SMCB over a 10-year period to ensure a sufficient level of habitat resiliency to support populations.

Downlisting Criterion 3:

All meadow units that achieve (support) Downlisting Criteria 1 and 2 are protected with long-term (20 years or more) management commitments.

Downlisting Recovery Criterion 4:

Habitat corridors are in place that provide connectivity of at least three of the meadow units to another meadow unit containing suitable habitat.

Rationale

Initiating recovery efforts in the most recently occupied areas, along with an adjacent area to support connectivity, will be essential to the long-term recovery of the SMCB. Specifically, Bailey Canyon and Pines Meadow Campground should serve as initial focal areas for habitat maintenance and restoration. Expanding habitat management into adjacent meadows will facilitate limited but crucial dispersal opportunities for the species.

For reestablishment as mentioned in Downlisting Criterion 1, 5 years of surveys will be needed to ensure presence/absence, as it was recently discovered that the species can survive up to 3 diapause events. This means that while flying adults may not have been observed during recent surveys, the species may still be present but awaiting certain climatic cues for metamorphosis.

Given the current lack of genetic diversity within the population, enhancing representation through managed gene flow between populations will be vital for establishing resilient, self-sustaining populations. Additionally, effective recovery will require addressing both primary and secondary threats within these units to ensure long-term conservation success.

Delisting Criteria

The USFWS expect the SMCB to be recovered and eligible for delisting consideration when the following criteria are met:

Delisting Criterion 1

At least 7 meadow units (see Figure 2 above) have been reestablished with connectivity to other units containing SMCB habitat.

Delisting Criterion 2

Each meadow unit in Delisting Criterion 1 will be managed to a sufficient level of resiliency that SMCB persists after at least 3 drought cycles (i.e. 30 years).

Delisting Criterion 3

Sufficient high-quality habitat is protected with long-term management commitments to support the population complexes necessary to achieve Delisting Criteria 1 and 2.

Rationale

Identifying four additional meadow units—beyond the three previously designated for downlisting—is essential for ensuring long-term viability of the SMCB. These additional units will support species recovery by addressing the three Rs: resiliency, redundancy, and representation. Resiliency will be strengthened by expanding to seven distinct populations, increasing the species' ability to withstand environmental and demographic fluctuations. Three drought cycles are used to help assess the species continued viability in the instance that 2 drought cycles occur close together. Given some time to rebound from environmental oscillations, the species' response will aid us in more accurately measuring the long-term viability of the species via population health. Redundancy will be achieved through the establishment of seven geographically distinct populations, enhancing the species' capacity to endure catastrophic events such as wildfires. Representation will be improved by facilitating connectivity between populations, promoting genetic exchange and adaptation across ecological gradients.

For reestablishment as mentioned in Delisting Criterion 1, 5 years of surveys will be needed to ensure presence/absence, as it was recently discovered that the species can survive as many as three diapause cycles, possibly more. This means that while flying adults may not have been observed during surveys, the species may still be present but awaiting certain climatic cues for metamorphosis.

Furthermore, habitat restoration across all meadow units is critical. Restoration efforts should focus on providing suitable larval forage and nectar sources to support all life stages of the SMCB and ensure population persistence.

Recovery Actions

This recovery plan identifies recovery actions needed to implement the recovery strategy and attain the recovery criteria. Implementation of a recovery action will depend on its priority, availability of funds and resources, coordination with partners, and complexity and logistical constraints. A broad action may have multiple components developed as needed to best coordinate recovery implementation. Specific project-level implementation of these actions will be accomplished through on-the-ground activities, collectively referred to as the Recovery Implementation Strategy (RIS), in coordination with all partners interested and willing to work on implementing the activities. Activities are intended to be adaptable and guide all partners to coordinate recovery implementation and further identify those responsible for each action described in the recovery plan. Because these activities will be described in the RIS, they can be modified as needed without requiring future revision of this recovery plan, so long as they remain consistent with the recovery actions described here.

Recovery actions are the statutorily required, site-specific management actions needed to achieve recovery criteria, as described in section 4(f)(1)(B)(i) of the ESA. The USFWS assigns recovery action priority numbers (1-3) to rank recovery actions. The assignment of priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented. Recovery action priority numbers are based on the following:

Priority 1: An action that must be taken to prevent extinction or to prevent the SMCB from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in SMCB population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the SMCB.

Table 1. Site-Specific Recovery Actions for the SMCB with priority numbers, action number, referenced recovery criteria, action duration and estimated cost.

Priority #	Action #	Site-Specific Recovery Action	Recovery Criteria	Action Duration	Estimated Total Cost (in $1,000s)
1	1	Survey for adult SMCB, focusing on historically most recent high-priority meadows (Bailey Canyon, Bailey Meadow, Pines Campground) and all 9 management units.	1, 2	30 years	1,050
1	2	Expand surveys for adult SMCB in historical and other areas within the Sacramento Mountains.	1, 2	15 years (every other year for 30 years)	150
2	3	Develop a phylogenetic analysis and tree to determine the genetic relationships among the different *E. anicia* subspecies in order to determine which subspecies is most appropriate for cross-breeding with *E. a. cloudcrofti* to maintain some portion of cloudcrofti unique genetics.	1, 2	In progress	80
2	4	Survey for other adult *E. anicia* regional subspecies, collect DNA samples, and collect for captive breeding populations (i.e., sample DNA from capella, carmentis and brucei populations; capture individuals of capella, carmentis and brucei for genetic analysis, captive breeding and rearing).	1, 2	In progress	100
1	5	Locate and/or produce individuals for future repatriation attempts.	1, 2	In progress	200

Priority #	Action #	Site-Specific Recovery Action	Recovery Criteria	Action Duration	Estimated Total Cost (in $1,000s)
2	6	Protect and restore host plant patches and pupation sites from human-caused disturbances.	1, 2, 4	5 years	400
2	7	Reduce threats to habitat by reducing host plant herbivory.	1, 2, 4	30 years	100
3	8	Determine where habitat restoration is feasible based on water availability and existing threats at historical sites.	3, 4	Annually for 30 years	150
1	9	Coordinate and collaborate with Federal, state, county, and municipal organizations and private landowners to increase outreach, awareness, and conservation opportunities.	3	30	25
1	10	Research and explore utilizing established and/or immerging assisted reproduction techniques (including but not limited to techniques such as artificial insemination or cross-breeding) or other advanced reproduction technologies.	1,1,2	5 years	100
3	11	Maintain long-term management for the species using rangewide monitoring, maintenance of a captive population, and adapting management strategies as conditions change (e.g. host plant shifts, climate driven changes, or new threats emerge).	2,3	30	Cost borne within other Recovery Actions

Estimated Time and Cost of Recovery

We expect the status of SMCB to improve such that we can achieve recovery (delisting) in approximately 30 years (*i.e.*, 2054). We base this on the estimated time (3 drought cycles) we would need to assess long-term viability for the species to survive and reestablish and stabilize on new or historical sites. Time to recovery is based on the expectation of full funding, implementation as provided for in this recovery plan, and full cooperation of partners.

We estimate $2,355,000 for the total cost of recovery. This is the estimated cost of completing the recovery actions such that the recovery criteria have been met and includes those costs borne by all participating partners. The actions identified in Table 1 are those that, based on the best available science, the USFWS thinks are necessary to achieve recovery of the SMCB. Time and cost for recovery may increase if data indicate decreasing trends at sites, prompting the need for additional recovery actions to identify and mitigate threats.

Literature Cited

Cary, S. 2022. Peer review of the current condition assessment report for the Sacramento Mountains checkerspot butterfly (Euphydryas anicia cloudcrofti)Written.

Climate Assessment for the Southwest. 2021. "January 2021 Southwest Climate Outlook." Online: University of Arizona Cooperative Extension.

Colorado-Ruiz, Gabriela, Tereza Cavazos, José Antonio Salinas, Pamela De Grau, and Rosario Ayala. 2018. "Climate Change Projections from Coupled Model Intercomparison Project Phase 5 Multi-Model Weighted Ensembles for Mexico, the North American Monsoon, and the Mid-Summer Drought Region." *International Journal of Climatology* 38 (15): 5699–5716. https://doi.org/10.1002/joc.5773.

Ehrlich, P., R. White, M. Singer, S. McKechnie, and L. Gilbert. 1975. "Checkerspot Butterflies: A Historical Perspective." *Science* 188 (4185): 221–28. https://doi.org/10.1126/science.1118723.

Forest Service. 2014. "Ecological Response Units of the Southwestern United States." Southwestern Region.

———. 2017. "Sacramento Mountains Checkerspot Butterfly End of Year Report." Annual Report. Lincoln National Forest, Sacramento Ranger District.

———. 2020. "Population Status of the Sacramento Mountain[s] Checkerspot Butterfly and Current Tactics Proposed to Mitigate the Probability of Imminent Extinction." Preliminary Results. Lincoln National Forest.

Glassberg, Jeffrey. 2017. *A Swift Guide to Butterflies of North America*. Second edition. Princeton: Princeton University Press.

Hughes, P. 2021. Communication about Sacramento Mountains checkerspot butterfly survey during inter-agency working group meetings.Verbal.

Lightfoot, D. 2022. Peer review of the current condition assessment report for the Sacramento Mountains checkerspot butterfly (Euphydryas anicia cloudcrofti).

McIntyre, J. 2010. "Habitat Variables, Mammal Interactions, and Recovery Approaches Important to a Rare, New Mexican Butterfly, Euphydryas Anicia Cloudcrofti (Lepidoptera: Nymphalidae)." Dissertation, Albuquerque, New Mexico: University of New Mexico.

National Oceanic and Atmospheric Administration. 2016. "New Mexico." Centers for Environmental Information, State Summaries. Online.

Pittenger, J., and K. Yori. 2003. "Abundance, Population Structure, and Habitat of the Sacramento Mountains Checkerspot Butterfly (Euphydryas Anicia Cloudcrofti Holland and Ferris 1980), with Notes on Life History and Ecology." 2002 project completion report. Blue Earth Ecological Consultants, Inc.: Prepared for the U.S. Forest Service, Lincoln National Forest and the New Mexico State Highway and Transportation Department.

Pohl, Greg R., Bob Patterson, and Jonathan Pelham. 2016. "Annotated Taxonomic Checklist of the Lepidoptera of North America, North of Mexico." https://doi.org/10.13140/RG.2.1.2186.3287.

Pratt, Gordon F., and John F. Emmel. 2010. "Sites Chosen by Diapausing or Quiescent Stage Quino Checkerspot Butterfly, Euphydryas Editha Quino, (Lepidoptera: Nymphalidae) Larvae." *Journal of Insect Conservation* 14 (2): 107–14. https://doi.org/10.1007/s10841-009-9229-y.

Roland, Jens, Alessandro Filazzola, and Stephen F. Matter. 2021. "Spatial Variation in Early-winter Snow Cover Determines Local Dynamics in a Network of Alpine Butterfly Populations." *Ecography* 44 (2): 334–43. https://doi.org/10.1111/ecog.05407.

Ryan, R. 2007. "U.S. Forest Service Study Update Summary for the Sacramento Mountain[s] Checkerspot (Euphydryas Anicia Cloudcrofti)." Department of Biology: New Mexico State University.

———. 2021. Verbal communication during a Sacramento Mountains checkerspot butterfly Working Group meeting: Discussion on when to start surveys for post-diapause larvae.

———. 2022. "RE: SMCB Working Team: Captive Rearing," August 4, 2022.

Ryan, Rachael. 2021. Communication during a meeting with experts while assessing the available information on the Sacramento Mountain checkerspot butterfly (January 28, 2021).Verbal.

Ryan, R., and B. Milligan. 2011. Genetic Study of the Sacramento Mountains Checkerspot Butterfly (Euphydryas aninia cloudcrofti): A Species of Greatest Conservation Need. Prepared for the Share with Wildlife Program New Mexico Department of Game and Fish State Wildlife Grants. pp. All.

Schaller, J.C. 2022a. Meeting at the Albuquerque BioPark to discuss the care of the Sacramento Mountains checkerspot butterflyVerbal.

———. 2022b. "RE: Butterfly Surveys and Collection Effort so Far," 2022.

Schaller, JC. 2022. "SMCB Captive Rearing Updates 8.16.2022," August 16, 2022.

Swengel, Ann. 1997. "Straight Talk about Butterfly Population Biology." North American Butterfly Association.

U.S. Fish and Wildlife Service. 1983. "Endangered and Threatened Species Listing and Recovery Guidelines." *Federal Register* 48 (184): 43098–105.

———. 2016. "USFWS Species Status Assessment Framework: An Integrated Analytical Framework for Conservation. Version 3.4."

———. 2023. "Current Condition Assessment Report for the Sacramento Mountains Checkerspot Butterfly (Euphydryas Anicia Cloudcrofti)." 1.2. Albuquerque, New Mexico: New Mexico Ecological Service Field Office.

U.S. Fish and Wildlife Service, Otero County, The Village of Cloudcroft, and U.S. Forest Service - Lincoln National Forest. 2005. "Conservation Plan for the Sacramento Mountains Checkerspot Butterfly (Euphydryas Anicia Cloudcrofti)." Albuquerque, New Mexico.

Walker, A. 2022. "Penstemon Plants," 2022. Email

APPENDIX I. Interim (near-term) Recovery Activities

Near-term Recovery Strategy

Achieve at least three sustainable populations of SMCB in the wild within previously or currently occupied areas throughout the species' range, including the potentially currently extant populations. Increase population abundance and density within occupied meadow units through reintroductions and translocations. Create habitat connectivity between populations to allow gene flow between populations. Manage gene flow to increase representation within and among all populations.

Initial recovery efforts should focus on the Priority 1 Actions in the Recovery Plan:

1. Annual monitoring and inventory of wild populations and habitat to determine where to most effectively direct conservation and restoration efforts (Recovery Actions 1 and 2).
2. Continue captive-rearing efforts to expand and augment wild populations (Recovery Action 5).
3. Reintroduce and translocate individuals to increase gene flow and establish new self-sustaining populations (Recovery Action 5).
4. Engage partners (including but not limited to the USFS, Tribal Nations, SMCB Working Group, Institute for Applied Ecology, and the Albuquerque BioPark) to develop and implement conservation plans that alleviate the key threats to the species. (Recovery Action 9)
5. Conduct further research and explore established and/or immerging assisted reproduction techniques or other advanced reproduction technologies. (Recovery Action 10)

As of August 2025, a single larva representing the species occurs in captivity. As such, this near-term recovery planning covers the steps to be taken to retain the ability of genetic rescue for the species. Below are steps or options to maximize the limited resources and/or husbandry techniques available to the species with a singular individual.

1. Assess the Remaining Individual

- **Sex**: Identify if the remaining individual is male or female.
- **Stage and health**: Is it healthy enough to complete metamorphosis and breed?
- **Reproductive potential**: Can it produce viable eggs or sperm?
- **Immediate risk**: Extinction

Captive Propagation History

- **2022:**

- Captive propagation began at the Albuquerque ABQ BioPark using 2 female and 2 male individuals collected by biologists. Only one male was observed mating with both females.

- 164 eggs were successfully reared to larvae, all of which entered diapause by the end of the year.

- **2023:**

- 111 larvae emerged from diapause.

- Our first adult hatched on June 15th, 2023. He completed his 2-week lifespan at the BioPark without a female to mate with, then was preserved and moved to the Museum of Southwestern Biology at UNM.

- By the end of the summer in 2023, we had 28 caterpillars remaining. They entered a **second diapause**—a rare and undocumented occurrence for this species.

- We had a second adult hatch on December 17th, 2023. Also a male, he was sent to the USDA Agricultural Research Service in Fargo, North Dakota, for cryopreservation of reproductive tissues.

- The team suspects that the captive environmental conditions may not have been appropriate; artificial light and heat only, no sun, no UV light or infrared for basking, no ability for larvae to move around on a host plant to thermoregulate, and no ability for larvae to choose food from multiple parts of plant foliage. Larvae isolated as individuals in petrie dishes; no ability to interact with other larvae (the semi-social gregarious larvae live together in nature as groups, moving and feeding together), no ability to select food (only one penstemon leaf in a tray per larvae, larvae feed together on a plant and select leaf tissue to feed on) , no fresh air, non-sanitary conditions (microbes) in petrie trays, no use of bleach to clean trays. A serious issue was that the standard small food storage refrigerator used for winter diapause had large temp swings between auto on/off cycles; larvae were exposed to a 40 degree F swing in temps from about 34-74 degrees on a daily basis. That would have prevented winter diapause and excessive metabolic rates.

- **2024:**

    - No wild individuals were collected for propagation (no collections were conducted in 2023).

    - In spring of 2024, 17 caterpillars came out of diapause. Nine of these were sent to Cloudcroft. Zero of the caterpillars in Cloudcroft survived.

    - The third adult hatched on June 7th, 2024, a female this time. She was sent to the USDA Agricultural Research Service in Fargo, North Dakota after a hybridization

attempt with what we believe is Euphydryas anicia carmentis. She did not lay any eggs after mating with this male.

  - Of the remaining larvae, all three entered a **third diapause** (a likely physiological stressor for the larvae due to the inappropriate temperature cycling refrigerator), an event not previously documented in Checkerspot butterflies. One larva died shortly after entering diapause.

  - Remaining captive larvae were placed on entire living penstemon plants and given fresh air and sunshine. Three remaining larvae were placed into a new refrigerator for winter and did diapause successfully.

- **2025:**

  - Two larvae brought out of diapause, placed on plants with sunlight, both fed, grew, one died, one still alive and seems healthy.

  - Survey did not detect any SMCB.

Captive individuals: One known larva (**A1**, 2022 cohort) at ABQ BioPark.

---

2. Expand Genetic Base (If Possible)

- **Look for remnant SMCB populations**: Survey high-probability sites in the Sacramento Mountains or previously occupied areas.
- **eDNA and field surveys**: Use modern tools to detect unseen individuals.
- **Consult historical records**: For potential donor sources or similar subspecies. Perhaps Mescalero Apache Reservation still has wild individuals that could restore population.

---

3. Preserve Genetic Material

- **Cryopreservation**: Freeze any available eggs, larvae, or tissues for future use.
- **Tissue samples**: Store for potential cloning, cell culture, or genomic analysis.
- **Inventory Stored Material**: Some preserved material occur at the BioPark; other preserved material may occur elsewhere.
- **DNA sequencing**: Help evaluate diversity and guide any future assisted breeding or de-extinction efforts.
- **Phylogenetic study**: This will determine the relationship between the 27 subspecies.

- **Potential Genetic Rescue**

    1. **Restore genetic variation** sufficient for population viability.
    2. **Establish a self-sustaining metapopulation** in native range.
    3. **Preserve locally adaptative traits**, especially host plant association and phenology.

---

4. Explore Cloning or Assisted Reproduction

- **Somatic cell nuclear transfer**: Experimental and not yet done in butterflies but theoretically could allow cloning.
- **Hybridization** (last resort): Introduce genes from related subspecies to recreate genetic and ecological functionality.

---

5. Develop Captive Propagation Program (subspecies pilot testing)**

If multiple individuals can be generated:

- **Captive breeding**: Based on what was learned from previous BioPark and Zoo butterfly rearing.
- **Host plant availability**: Ensure consistent supplies of *Penstemon neomexicanus* for larval development.
- **Nectar plant availability**: Ensure nectar sources are available to adults
- **Climate control**: Mimic local outdoor, montane meadow environmental cues (exposure to direct sunlight for at least several hours per day, all day and natural day-length preferred, fresh air and outdoor humidity and temperatures similar to montane meadow, non-natural microbe-free living environment (open air, on plants outdoors in montane meadow); photoperiod, temperature, humidity for proper development and diapause.
- **Other larvae**: rear multiple individuals on the same host plant in order to allow for normal social interactions and gregarious behavior.

**This may need to be conducted at the Albuquerque BioPark Bugarium or San Diego Zoo Wildlife Alliance or Backyard Farms.

---

6. Build a Captive Population

- **Boost numbers**: Using best practices in lepidopteran husbandry (e.g., overwintering larval cohorts).

- **Minimize inbreeding**: Even in a bottleneck, careful pairings and staged releases can slow inbreeding accumulation.

---

7. Restore and Protect Habitat (needs to occur while propagation (5 and 6) is occurring)

The greatest environmental threats to the SMCB appear to be natural habitat and host plant losses due to (these are current hypotheses based on substantial evidence):

1. A history of authorized livestock grazing (since the 1800's) in the montane meadow habitats that has altered the herbaceous vegetation away from former native plant community compositions. Additional issues related to changes caused by grazing include:
2. Unauthorized livestock and trespass livestock are grazing in these areas and are a primary threat in removing most of the above-ground herbaceous biomass in the formerly occupied meadows.
    a. Rocky Mountain elk populations have been increasing steadily in the Sacramento Mountains, according to harvest report information (NMDGF 2025). They may be impacting the meadow vegetation in adverse ways by browsing on host and nectar plants. Rocky Mountain elk were introduced across the state of New Mexico by the New Mexico Department of Game and Fish beginning in 1911 (NMDGF 1967; Findley 1975). The Merriam's Elk subspecies that had evolved in the Sacramento and surrounding Southwestern mountains were extirpated by humans in the 1800s.
3. Soil and hydrological changes due to authorized grazing include soil erosion and compaction, along with soil surface and subsurface alterations which can change or impact the hydrology. Other range infrastructure placements of water diversions and creations of stock tanks can impact soil and water flow. These impacts can result in headcutting, decreased water quality and a reduction of water availability in wetland habitats.

4. Past forest management resulting in high numbers of trees in mixed conifer stands. The forests upslope of the streams and wet meadows may have higher tree densities than those of historic (pre-1800's). This can result in reduction of hydrological surface and subsurface water flow. Encroachment of these mixed conifer trees into the riparian area and wet meadows also has potential to intercept and reduce the water flow compared to historic conditions.

5. Non-native invasive plant species can out-compete native species which were components of plant associations in intact wet meadows. An example of this is the presence of Kentucky bluegrass. Kentucky bluegrass has become dominant across many meadows, thriving under current horse grazing, and is capable of outcompeting native

plants such as *Penstemon* for seedling establishment and occupancy of meadow soil surfaces.

6. Unauthorized recreational activities. The illegal and unauthorized activities in the SMCB meadows include the creation of unauthorized trails, illegal incursions of mechanized and motorized vehicles and other actions specifically prohibited in these sites. These unsanctioned activities cause damage to the soils and hydrology of the sites, introduce non-native invasive plant species, exacerbate existing headcuts in the stream channel, and impair the site's ability to recover.

7. Climate change from anthropogenic global warming. The overall climate has become warmer and drier, and that trend is exhibiting an increase over time. The area has been under a drought condition over the past 30 years. Meadows risk becoming drier due to inconsistent winter snowpacks and sporadic monsoonal rainfall. The observed reduction and inconsistency of the winter snowpack may be the greatest threat to the species and its habitat. This may be due to the direct and indirect adverse impacts on overwintering larvae, with potential physiological disruptions of life-history events for the species. The phonologies' of the eggs, larvae and pupal stages relative to emergence times appear to be based on the historic seasonal timing of moisture and temperature conditions. The changes in the seasonal moisture and temperatures may also cause disruptions to the life-history stages and phenology of Penstemon and Hymenoxys plants relative to foliage production and flowering in synchronization with the SMCB phenologies.

8. Uncharacteristic catastrophic wildfire. Past forest management practices have led to an uncharacteristic density of trees and fire fuels in some locations. Combined with climate change, these become factors that may contribute to uncharacteristic wildfire behavior. Historically, fires in high elevation mixed conifer forests tended to burn with a low-intensity and at a greater frequency along the surface of the forest floor. An uncharacteristic wildfire in the Sacramento Mountains has the potential to result in stand replacement, canopy conversion, and soil penetrating damage. Impacts may include a loss of mixed conifer species, a reduction of native plants and subsequent associations, increased soil erosion and ash and debris flows deposited into streams. The amount of restoration needed for impacted areas could be substantial.

- **Ameliorate threats to species:** Recovery cannot be achieved until at least some subset of the above environmental threats that are causing SMCB population extirpations are improved.

- **Host plant restoration**: Ensure *Penstemon* and *Helenium* are abundant and distributed across high-quality patches.

- **Microclimate buffering**: Improve resilience against drought, invasive plants (e.g., smooth brome), and fire.

Manage unauthorized livestock, permitted grazing and illegal recreation: Coordinate with Lincoln National Forest and local land users.

8. Pilot Reintroduction Efforts

- **Soft release strategies**: Release cage-reared adults with supplemental nectar sources and larval food plants.
- **Monitor survival and reproduction**: Tag or monitor genetically to track success.
- **Stage releases**: Vary locations and timing of releases to buffer against bad weather years.

---

9. Build Toward a Viable Metapopulation

- **Minimum viable population (MVP)**: Target ~1,000–5,000 adults across multiple sites for long-term persistence.
- **Habitat corridors**: Ensure connectivity between populations to allow gene flow and rescue effects. Consider aspects of island biogeography relative to healthy population genetics of the SMCB.
- **Population modeling**: Use Vortex or similar PVA software to guide decision-making.

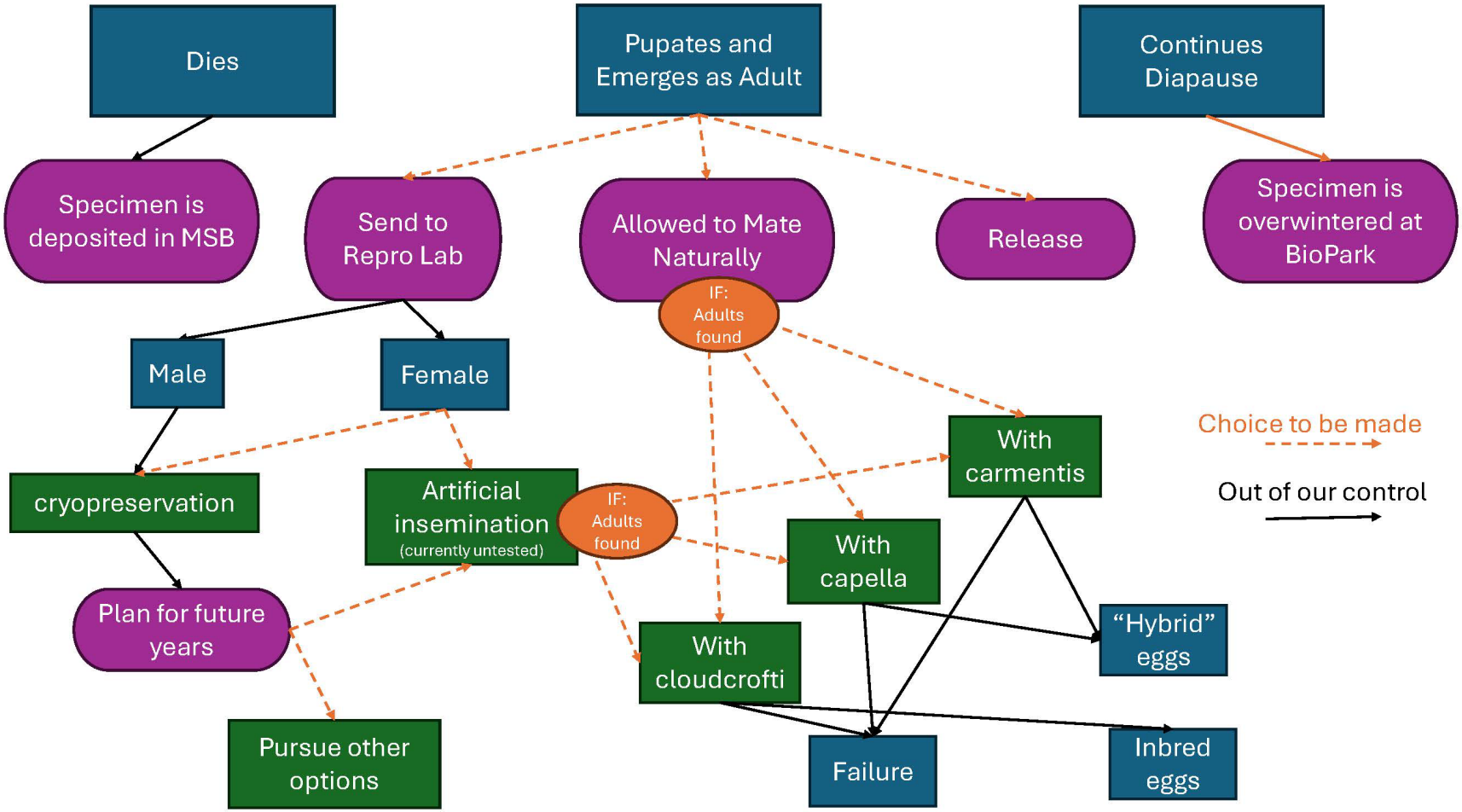
Decision Triggers and Timeline

The table below is a list of possible thresholds that when met may warrant the proposed response starting from a singular individual (as seen in current setting). Some of these triggers are interconnected and more immediate/time-sensitive than others. At time of writing, we currently have a singular individual in captivity. We propose that exploration into cryopreservation of that individual take place immediately in the event it perishes. If the individual develops into an adult, the remaining thresholds are suggested to function as suggested routes to maintain the species.

Threshold	**Response**	**Timeline**
1 individual remains	Begin genetic rescue	Immediate
Surveys result in no SMCB being detected	Habitat restoration to provide suitable areas for species	Immediate
Lone individual ecloses. No viable mates exist	Initiate hybrid testing	Within 6–12 months
Successful hybrids or clones available	Launch captive program	Within 12–18 months

Threshold	Response	Timeline
Captive cohort >50 genetically diverse adults	Begin pilot releases	~3 years post-initiation

Figure 3. Below is a possible decision flowchart containing the options afforded USFWS outlining possible fates of the singular larva currently in captivity.



Appendix II. Responses to Comments Received on Draft Recovery Plan

The following is a list of substantive comments received on the draft Recovery Plan. Some comments warranted minor edits within the final version of the document while others received a clarifying response as to why no change was warranted.

Comment: Recovery actions #6 and #7 should be moved to priority #1.

FWS Response: FWS acknowledges that habitat restoration is essential to the recovery of the species, which is why it is incorporated throughout multiple recovery actions. However, the Recovery Actions are not prioritized or numbered to imply a chronological sequence. Different partners may be better positioned to implement certain actions over others, and progress on multiple fronts is necessary to achieve recovery. Both suitable habitat without individuals and individuals without suitable habitat present significant risks; therefore, advancing all priority actions in parallel is critical.

Comment: The Recovery Plan would be improved by incorporating specific strategies for climate change mitigation.

FWS Response: FWS recognizes the importance of climate change considerations in species recovery. Because climate change mitigation is a rapidly evolving field, the Recovery Plan is written to remain flexible and to allow incorporation of new, emerging, and currently unforeseen approaches that may prove most effective for the species. Prescribing specific mitigation strategies at this time could limit the Plan's adaptability and may become outdated as science and management techniques advance. The Plan's framework ensures that future climate-informed activities can be integrated as they are developed and validated.

Comment: There is a lack of information on how Downlisting Criterion #4 might be achieved.

FWS Response: FWS agrees that increasing habitat connectivity is important to the long-term viability of the species and is the core intent of Downlisting Criterion #4. However, there are multiple potential pathways for achieving improved connectivity, and the most effective approaches may depend on future land use, climate conditions, and partner capacity. Providing a prescriptive, single method at this stage would be unnecessarily limiting and may not reflect the best available science as it evolves. The Recovery Plan is designed to allow for a range of strategies to be developed such that activities can be implemented as opportunities and new information arise.

Comment: Geography as it is related to catastrophic fire should be considered in selecting sites for restoration and re-introduction.

FWS Response: There are many considerations when selecting sites for restoration and re-introductions. Connectivity and fire risks will be among the factors considered when partners collaborate on prioritizing these site selections.

Comment: Herbivory by feral horses is not explicitly included as a threat.

FWS Response: The language has been updated to be more specific as to the nature of the herbivory and its sources.

Comment: The Department recommends providing a more specific example of what would be enough for recovery to be possible instead of just referencing addressing "some subset" of relevant threats to the Sacramento Mountains Checkerspot Butterfly (SMCB) (Page 25, Restore and Protect Habitat section, Ameliorate threats to species sub-section).

FWS Response: These threats and the responses to their amelioration will be interlinked. As one is alleviated another factor may also respond positively or it may compound the issue elsewhere for the species and its habitat. As written, we acknowledge the interconnectedness of these threats and the impacts to the species and its habitat.

Comment: The Department recognizes that there is currently only one SMCB in captivity and requests clarification on how genetic rescue (i.e., "boost[ing] the genetic diversity and/or fitness of small, isolated populations through the introduction of novel genes" [Roitman et al. 2017]) will be undertaken.

FWS Response: USFWS is in discussions with partners on the current techniques afforded a species in this specific situation while also discussing any other means that may become available to the species in the future.

Comment: The unsubstantiated conclusion that authorized cattle grazing in the Lincoln National Forest is a primary threat that must be managed will no doubt lead to cattle producers being unduly burdened with requirements for the restoration and protection of SMCB habitat.

FWS Response: FWS understands the concern regarding how grazing impacts are characterized within the Recovery Plan. The Plan intentionally uses the term "grazing" to refer broadly to all grazing ungulates—including feral horses, elk, trespass cattle, and authorized livestock—because the ecological effects of herbivory on host plants and nectar resources are similar regardless of the source. The intent is not to single out authorized cattle grazing as a primary threat, but to capture the cumulative impacts of all grazing pressures on vegetation essential to the Sacramento Mountains Checkerspot Butterfly. To avoid misunderstanding, additional language has been included to clarify the use of the term "grazing" and ensure it is understood to encompass all native and non-native ungulates contributing to herbivory within the species' habitat.

Comment: High cost and use of taxpayers funds for recovery of Sacramento Mountains checkerspot butterfly.

FWS Response: The Recovery Plan is an advisory document meant to outline the recovery criteria and possible means to achieve them leading to a recovered state for the species. The Recovery Plan is not a regulatory document and as such does not appropriate or allocate any state, Federal, or other taxpayer funds to SMCB recovery actions and activities.

Comment: Restrictive implications of Recovery Plan on private property and tribal lands.

FWS Response: The Recovery Plan is an advisory document meant to outline the recovery criteria and possible means to achieve them leading to a recovered state for the species. The

Recovery Plan is not a regulatory document and as such does not appropriate any state or Federal funds or delineate any Critical Habitat. Any landholdings mentioned in the Recovery Plan are suggestions of the areas within the known species of the range that should maintain some amount of suitable habitat for the species to persist. Other projects that may impact the species (directly or indirectly) would need a Federal nexus that dictates consultation with USFWS via Section 7 (Interagency Consultation) of the Endangered Species Act (as amended, 1973).

Comment: 30-year timeline for recovery is “impractical”.

FWS Response: The Recovery Plan is an advisory document. The 30-year timeframe is to encompass multiple drought periods to insure that the species displays sufficient resiliency to recover from stochastic events such as drought. It is not mandatory for every recovery criterion be met for delisting (i.e. recovery) to occur. Rather, the Recovery Plan functions as an outline of the recovery actions and activities that, when completed, may suggest that a recovered state has been achieved.