Species Status Assessment Report
for
Speyeria nokomis nokomis

Prepared by the
U.S. Fish and Wildlife Service Ecological Services
Western Colorado Field Office
Grand Junction, Colorado
March 2023, Version 1.1

Contributors and Acknowledgements

Version 1.1 was produced by Terry Ireland – Colorado Field Office (FO)-Western Team, with assistance of the Speyeria nokomis nokomis Core Team including Lark Willey – Utah FO, Betsy Bainbridge – New Mexico FO, John Nystedt – Arizona FO, Creed Clayton – Colorado FO-Western Team, and Jena Lewinsohn – Region 6. Justin Shoemaker – Region 6, Eliza Gilbert – New Mexico FO and Kurt Broderdorp – Colorado FO-Western Team helped with Version 1.0 of the Species Status Assessment (SSA) and Aimee Crittendon – formerly Colorado FO-Western Team produced the Version 1.0 range map. During writing of Version 1.0 John Guinotte – Region 6 facilitated climate model selection and coordinated with climate modeler Imtiaz Rangwala – North Central Climate Adaptation Science Center & CIRES, University of Colorado, Boulder, who quickly provided climate information for the S. n. nokomis range.

Significant and invaluable input to nearly all aspects of Version 1.0 of the SSA as well as contribution of literature was provided by the Technical Team members including Scott Ellis, Mike Fisher, Steve Cary, Alan Myrup, and Chad Smith. A special thank you goes out to Scott for coordinating with landowners and leading field trips in 2018 and 2019 to determine the status of colonies and collect a few specimens for genetic analysis. Also, thanks to all of the surveyors who provided valuable data for this Version 1.1 of the SSA.

Dr. Paul Opler – Colorado State University (CSU) provided biological information as well as facilitated information on species locations and allowed Scott Ellis to obtain numerous S. nokomis specimens from the Gillette Museum at CSU for genetic analysis. This SSA was also substantially helped by a whole genome analysis and technical input from Dr. Nick Grishin (Howard Hughes Medical Institute and Departments of Biophysics and Biochemistry, University of Texas Southwestern Medical Center) in addition to primary authors Qian Cong (Institute for Protein Design and Department of Biochemistry, University of Washington), and Jing Zhang and Jinhui Shen both from the Departments of Biophysics and Biochemistry, University of Texas Southwestern Medical Center. Without the genomic analysis, range delineation of S. n. nokomis would have remained uncertain as it had been for over a century and areas that are now known to be hybridized S. nokomis would have likely been included in our assessment, skewing results of the population and viability analysis for S. n. nokomis proper.

Authors Note: *Due to disruption by COVID-19 a final genetic report was not written in time for either Version 1.0 or Version 1.1 of the SSA. Therefore, names of a couple populations and some other minor details differ between the draft genetic report (Cong et al. 2019) and both versions of the SSA. Additionally, due to COVID-19 few surveys were conducted in 2020. Furthermore, the Cong et al. (2019) analysis is a draft analysis that hasn't been peer reviewed. The researchers are adding data to their analysis prior to peer review and publication. We will update the SSA as needed with the findings in the published report.*

Suggested reference: U.S. Fish and Wildlife Service. 2023. Species status assessment report for *Speyeria nokomis nokomis*, Version 1.1. March 2023. Grand Junction, Colorado. 80 pp.

EXECUTIVE SUMMARY

This species status assessment (SSA) report communicates the results of the comprehensive biological status review by the U.S. Fish and Wildlife Service (Service) for a subspecies of a silverspot butterfly (*Speyeria nokomis nokomis*) and provides a thorough account of the subspecies' overall viability and, therefore, extinction risk. This SSA report was updated to provide the best available biological information to inform a listing decision, as required by the Endangered Species Act (ESA). The silverspot was proposed for listing on May 5, 2022. Current status information from 2021 and 2022 has been incorporated into Version 1.1 of the SSA.

To evaluate the biological status of *S. n. nokomis*, both currently and into the future, we assessed a range of conditions to allow us to consider the species' resiliency, redundancy, and representation (together, the 3R's).

Based on recent genetic analysis, there are 5 silverspot subspecies in the United States and Mexico with 10 major populations of *S. nokomis* within the United States. The range for *S. n. nokomis* is east-central Utah through western and south-central Colorado and into north-central New Mexico. Due to the new range delineation the former common name, Great Basin silverspot butterfly, is no longer valid as it is not found within the Great Basin; therefore, the subspecies is only currently known by its scientific name. Additional genetic work on some additional specimens, as well as a final genetic report, is expected, but these were not completed in time for Version 1.1 of the SSA.

The silverspot butterfly is relatively large with up to a 3-inch wingspan. The males are typically bright orange on the upper side and females are typically cream to light yellow with brown or black. The underside wings of both sexes have silvery- white spots giving them their generic common name of silverspot butterfly. The butterfly completes its entire life cycle in one year. Chapter 2 provides identification of the different life stages of *S. n. nokomis*, the taxonomy and genetics of the species, the distribution, habitat requirements, life cycle, and ecological needs of individuals, populations, and the species.

Populations of *S. n. nokomis* are known to occur between 5,200 and 8,300 feet. The butterfly requires moist habitats in mostly open meadows with a variety of herbaceous and woody vegetation. *S. n. nokomis* eggs are laid on or near the bog violet (*Viola nephrophylla*/*V. sororia* var. *affinis*), which the larvae feed on exclusively. A variety of flowering plants provide adult nectar sources.

Habitat loss and fragmentation; livestock grazing; human-caused hydrologic alteration; and genetic isolation are considered major factors influencing the species and can affect the 3 R's and species viability. However, if implemented properly, mowing for native hay, grazing, and burning can be compatible and beneficial for *S. n. nokomis*. Populations of *S. n. nokomis* are genetically isolated due to intermittent occurrence of suitable habitats throughout their range.

There are currently 21 colonies grouped into 10 populations that are considered extant and were analyzed for current (and future) condition. Current resiliency for each population ranges from very low (three populations) to high (two populations) with three populations having low resiliency and another two populations having moderate resiliency. Current redundancy is moderate and representation is low – moderate. Chapter 3 assesses the current condition of *S. n. nokomis*.

We considered four plausible future scenarios that include climate model projections out to 2050 as well as conservation measures in two scenarios. In scenario 1, which has relatively mild projected climate change and potential conservation measures, population resiliency is projected to increase with eight populations in moderate condition and two in high condition. Representation and redundancy are projected to increase to moderate in Scenario 1. In Scenario 2, which also includes potential conservation measures, population resiliency is again projected to increase from the current condition with seven populations in moderate condition, two high, and one low. Representation and redundancy are again projected to be moderate under Scenario 2. Climate is projected to change significantly in scenarios 3 and 4, and does not include potential conservation measures, and the subspecies' overall future condition (in term of the 3R's) is projected to decrease from current condition under both scenarios. In scenarios 3 and 4, we project one population will be in moderate condition, two will be low, three very low, and four to be extirpated. Under both scenarios 3 and 4, representation is projected to decrease to low and redundancy decreases to very low. Based on the best available information, the subspecies is projected to be in better overall future condition (in terms of the 3R's) in scenarios in which climate change is mild and potential conservation measures are implemented. Although *S. n. nokomis* has survived through severe and sustained drought over past millennia, future habitat conditions may preclude its survival especially if the climate changes as projected in scenarios 3 and 4. Chapter 4 assesses future condition for *S. n. nokomis*.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Background

The Service published a proposed rule in 1978 to designate *Speyeria nokomis nokomis* as either threatened or endangered under the Endangered Species Act of 1973, as amended (Act). In 1984 it was placed on the category 2 candidate list in a notice of review. Category 2 candidate species comprised taxa for which information was in possession of the Service indicating that a proposal to list the species as endangered or threatened was possibly appropriate, but for which conclusive data on biological vulnerability and threat(s) was not currently available to support proposed rules at the time. Subsequent notices of review in 1989, 1991, and 1994 also included it as a category 2 candidate species. In February 1996, the Service proposed removing all category 2 species in a candidate species notice of review and finalized this action in a December 1996 notice of final decision. This resulted in the removal of *S. n. nokomis* from the candidate list. In 2013, the Service was petitioned to list *S. n. nokomis* by WildEarth Guardians. In 2016, the Service issued a 90-day finding stating that the petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted and announcing our intent to proceed with a status review.

We compiled Version 1.0 of the Species Status Assessment (SSA) (Service 2021, entire) in early 2021 in response to the 90-day finding and to assess the status of *S. n. nokomis*. We proposed to list *S. n. nokomis* as threatened in May 2022. This Version 1.1 of the SSA includes updated survey information and other minor changes (see section 1.4 "What is New in 2023 - Version 1.1" below) to provide the best scientific and commercial data available regarding the species' biology and factors that influence the species' viability. Should this species become listed under the ESA, we intend this report to support all functions of our Endangered Species Program and we will update it again as new information becomes available. The SSA process and this SSA report do not represent a regulatory decision by the Service under the ESA. Instead, this report provides a review of the best available information strictly related to the biological status of *S. n. nokomis* and our scientific evaluation of its current and future condition.

1.2 Analytical Framework

This report summarizes our SSA analysis for *S. n. nokomis* using the SSA framework (Smith et al. 2018). The SSA framework is an analytical framework with three assessment stages depicted in Figure 1 and described below:

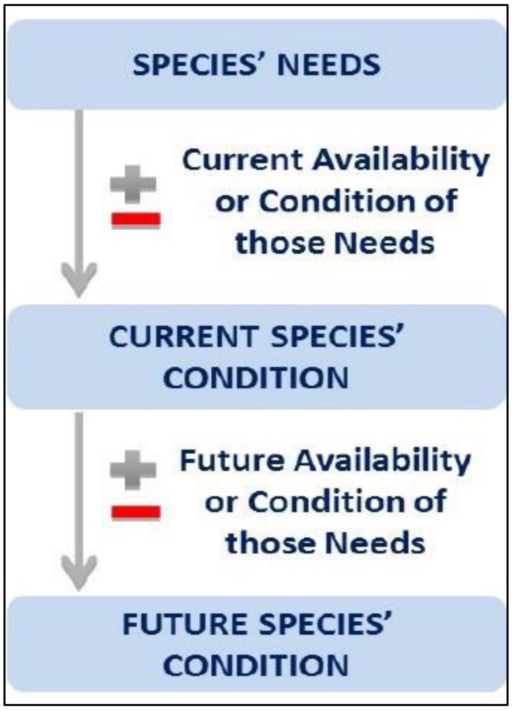

Figure 1. Species status assessment stages. Source: Service (2016)

1. **Species Needs.** An SSA begins with a compilation of the best available biological information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and species levels, based on how environmental factors act on the species and its habitat.

2. **Current Species Condition.** Next, an SSA describes the current condition of the species' habitat and demographics, identified in step one, Species Ecology, and the probable explanations for past and ongoing changes in those needs, such as abundance and distribution within the species' ecological settings (i.e., areas representative of the geographic, genetic, or life history variation across the species range).

3. **Future Species Condition.** Lastly, an SSA forecasts the species' response to probable future scenarios. The SSA characterizes a species' ability to sustain populations in the wild over time (viability) based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings.

To assess viability, we use the conservation biology principles of resiliency, redundancy, and representation, also referred to as the 3R's (Shaffer and Stein 2000; Wolf et al. 2015). Together, the 3R's—and their core parameters of abundance, distribution, and diversity— comprise the key characteristics that contribute to a species ability to sustain populations in the wild over time. When combined across populations, they measure the health and viability of the species as a whole.

1. **Resiliency** is the ability of a species' population to respond to and recover from disturbances and perturbations. These include the normal year-to-year variation in rainfall and temperature, as well as stochastic events such as fire, flooding, and storms. Generally speaking, resilient populations have abundant individuals within habitat patches of adequate size and quality to maintain survival and reproduction in spite of disturbance. Simply stated, resiliency is having the means to recover from "bad years." Connectivity between populations may add to a given population's resiliency through the exchange of individuals or genetic material from neighboring populations.

2. **Redundancy** is the ability of a species to withstand catastrophic events. Redundancy protects species against the unprojectable and highly consequential events for which adaptation is unlikely. In short, it is about spreading the risk. Redundancy is best achieved by having multiple populations widely distributed across the species' range. Having multiple populations reduces the likelihood that all populations would be impacted simultaneously, while having widely distributed populations reduces the likelihood of populations possessing similar vulnerabilities to a catastrophic event. Given sufficient redundancy, no single or multiple catastrophic events are likely to completely wipe-out a species. Thus, the greater redundancy a species has, the more viable it will be.

3. **Representation** describes the ability of a species to adapt to long-term changes in the environment; it is the evolutionary potential or flexibility of a species. Representation is the range of variation found in a species, and this variation (called adaptive diversity) is the source of species' adaptive capabilities. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (environmental variation) of populations across the species' range. The greater the adaptive diversity, the more responsive the species will be over time and thus, the more viable the species will be. Maintaining adaptive diversity includes conserving both the ecological diversity and genetic diversity of a species. Ecological diversity is described by the physiological, ecological, and behavioral variation exhibited by a species across its range. Genetic diversity is defined by the number and frequency of unique alleles within and among populations. In addition to preserving the breadth of adaptive diversity, maintaining evolutionary potential requires maintaining the evolutionary processes that drive evolution; namely, gene flow, genetic drift, and natural selection. Gene flow is expressed through the physical transfer of genes or alleles from one population to another through immigration and breeding. The presence or absence of gene flow can directly affect the size of the gene pool available. Genetic drift is the change in the frequency of alleles in a population due to random, stochastic events. Genetic drift always occurs but is more likely to negatively affect populations that have a smaller effective population size and populations that are geographically spread and isolated from one another. Natural selection is the process by which heritable traits can become more (selected for) or less (not selected for) common in a population based on the reproductive success of an individual with those traits. Natural selection influences the gene pool by determining which alleles are perpetuated in particular environments. This selection process generates the unique alleles and allelic frequencies, which reflect specific ecological, physiological, and behavioral adaptations that are optimized for survival in different environments.

1.3 Materials and Methods

Species experts on (and off) the Technical Team contributed much *S. n. nokomis*-specific information and provided review of this document. We also reviewed literature and obtained original sources when possible.

1.4 What is New in 2023 - Version 1.1

We updated this SSA to include population and colony status information from the 2021 and 2022 field seasons. We also combined the "Intermittent" population status and the "Unknown" population status categories since there was overlap between the two definitions. This changed the resiliency scoring in scenarios 1 and 2 for two populations (Garfield and La Plata) that formerly had an "Intermittent" status because we assumed an extra colony would be discovered for the intermittent populations in those scenarios. Additionally, the La Plata population fell from a moderate to a low resiliency category due to dropping the additional colony. We also added acres of violet-only habitat patches to the size metric if the habitat patches that were within 10 miles of the known colonies. The additional acreage did change the current condition resiliency score for the Garfield Population. We also changed the word "rank" to "score" or "ranking" to "scoring." The headings of the resiliency tables were changed to better define the column headings, although the metrics are the same as in Version 1.0 of the SSA (Service 2021). Other minor grammatical changes have also been made.

CHAPTER 2 – SPECIES ECOLOGY

2.1 Key Findings

Chapter 2 describes what the different life stages of *S. n. nokomis* look like, the taxonomy and genetics of the species, the distribution, habitat requirements, life cycle, and ecological needs of individuals, populations, and the species. *S. n. nokomis* adults are large and showy with the males being bright orange with black markings on the upper side (Figure 2) and the females generally being yellow and brown (Figure 3). The underside of both sexes are slightly different from each other but both have silvery-white spots, particularly on their hindwings (Figures 2 and 3). The butterfly completes its entire life cycle in one year but there are five stages in the butterfly life cycle: the egg; pre-winter 1st instar larva; post-winter 1st – 6th instar larva; pupa; and adult. Description of the eggs, larvae, and pupae are in section 2.2.

Silverspot butterflies are in the Order Lepidoptera (butterflies and moths), the Family Nymphalidae (brush-footed butterflies), and subfamily Heliconiinae. Based on recent genetic analysis, occupied and suitable habitat areas, and the removal of high elevation areas within the subspecies' range, we established a new range for *S. n. nokomis* in this SSA. The genetic work reveals 5 subspecies of *S. nokomis* throughout the U.S. and 10 distinct major populations of *S. n. nokomis* in east-central Utah, western and south-central Colorado, and central New Mexico (Cong et al. 2019, entire).

Populations of *S. n. nokomis* are known to occur between 5,200 and 8,300 feet in mountain valleys or near the base of mountains in floodplains. The butterfly requires moist habitats with a variety of herbaceous and woody vegetation, which provide breeding, feeding, and sheltering sites. Eggs are laid haphazardly on a variety of vegetation including on and near the bog violet (*Viola nephrophylla*/ *V. sororia* var. *affinis*), which the larvae of *S. n. nokomis* feeds on exclusively. The bog violet only grows in wet meadows supported by springs, streams, and near- surface groundwater, which are, in turn, supported by meltwater from valuable mountain snowpack. Light interspersion of willow (*Salix* spp.), other shrubs, or trees in the meadows or somewhat thicker woody vegetation at the margins of meadows appears beneficial for egg laying, as well as providing protection of the violet and larval butterflies. Occasional natural or human-induced disturbance is likely beneficial to set back succession of both woody and herbaceous vegetation, reducing competition and allowing for enhanced growth of violets. A variety of flowering plants are adult nectar sources, providing energy for mate finding, mating, and egg laying.

For populations to be moderately or highly resilient at least 3 colonies with a minimum total of at least 12 acres of habitat per population may be needed. More colonies and larger habitat acreages undoubtedly provide more resiliency. Populations with sufficient suitable habitat and multi-colony metapopulations are likely more resilient than single-colony populations, unless perhaps the single colonies are very large (see brief definition of metapopulation under section 2.4 below). The number of individual butterflies needed in each colony or population to be resilient is not known but the more butterflies the more likely genetic diversity will be maintained in a population and throughout the subspecies.

Populations of *S. n. nokomis* are isolated due to intermittent occurrence of suitable habitats throughout their range. Some of this isolation is likely natural but some is likely due to human fragmentation of habitat. Redundant and resilient populations no more than 10 miles apart and covering different ecological settings (representation) provide a greater chance of naturally maintaining genetic diversity and viability of the subspecies. Representation appears evident through differing elevations of colonies and populations and distinct genetic composition among populations. Distribution of the butterfly was originally obtained using a public database but was refined by species experts on the SSA's Technical Team.

2.2 Species Description

Adults

S. n. nokomis are the largest *Speyeria* and adults have wingspans from 6.3 to 7.9 cm (2.5 to 3.1 inches) (Selby 2007, p. 14). The adults are dimorphic (Figures 2 and 3). The upper side of the male's forewings and hindwings are orange- brown basally and bright orange distally. The upper side of the female's forewings and hindwings are brown to black and cream to yellow. The underside forewing of both sexes is similar, being primarily light brown to orange with the most distal part shifting to cream, yellow, or light orange with a few silvery-white spots, but the female wings typically have a more vibrant orange next to the distal yellow part. The underside hindwing of both sexes has numerous silvery- white spots and is where the generic common name, silverspot butterfly, is derived. These spots are wholly or partially surrounded by dark bands or chevrons. The wings of both sexes also have separate dark vermiculate markings, chevrons, and spots. In addition, the primary features of the male's underside hindwing are light brown to burnt-orange basal discs

(Figure 2 bottom photos). The female's discs are deep olive or brown with a yellow or cream crescent (Figure 3 bottom photos). The males have hairy orange bodies, the females have dark brown or black bodies with light brown to orange heads. The males in the top photos of Figure 2, though different butterflies about 250 miles apart, are nearly identical above but some males can have short feathery extensions from their thorax that are brownish or even green. Both sexes have brownish-orange antennae, and the black clubs are tipped with orange.

Subspecies of *S. nokomis* have historically been morphologically differentiated by the underside hindwing disc, though variation in the discs and rest of the wings and bodies can occur even within a subspecies due to environmental or genetic influences. Future surveyors can attempt to use morphological characteristics to determine subspecies if genetic analysis is not immediately available. However, caution should be used due to variability. General descriptions of hindwing disc colors between *S. nokomis* subspecies are included in Appendix A.

Figure 2. Male *S. n. nokomis* upper side (top photos) and under side (bottom photos). Left-hand photos by Bob Friedrichs, Taos County, Aug. 2022. Upper right photo by Creed Clayton (Service), Grand County Aug. 2022. Bottom right photo by Mike Fisher, Ouray County.

Figure 3. Female *S. n. nokomis* upper side (top photos) and under side (bottom photos). Left-hand photos by Robb Hannawacker, NPS, San Juan County, Aug. 2020. Right-hand photos by Bob Friedrichs, Taos County, Aug. 2022.

Larva

There are six larval stages. Each stage grows by an average of 60 percent and head capsule size increases from 0.35 to 3.5 millimeters (mm) from the first to last stage (Scott and Mattoon 1981, p. 12). Specific lengths of *S. n. nokomis* larva have not been measured (Fisher 2020a, pers. comm.). However, 1st instar larvae of different species of *Speyeria* are described as being 1-2.5mm (Sims 2017, p. 1) and eastern *S. cybele*, which may be as large as *S. n. nokomis* (Fisher 2020a, pers. comm.), may grow to 55mm in their 6th instar stage (Dunford 2007, p. 31). Larvae are "orangish-ochre, dark beneath, with six rows of long orangish-ochre spines, black patches around dorsal and subdorsal spines, two black transverse stripes on the rear of each segment, and orangish-ochre lateral and dorsal stripes; head black, orangish on top rear" (Scott 1986, p. 326; Selby 2007; pp. 14,17). Figure 4 shows a 6th instar larva.

Figure 4. Mature *S. n. nokomis* larva. Photo by Steve Spomer, Mesa County.

Pupae

The pupae of *S. n. nokomis* are "orangish-ochre, with a black transverse serrate band on the front of each abdomen segment (Figure 5). The thorax and most of the wing are primarily black. The top of the thorax has an orangish triangular spot" (Scott 1986, p. 326; Selby 2007, p. 17).

Figure 5. Pupae of S. nokomis from Chuska Mountains, New Mexico. Photo by James Scott (Scott 1986, Color Plate 5; copied from Selby 2007, p. 16).

2.3 Species Taxonomy

Table 1 represents a simple arrangement of the taxonomy of *S. n. nokomis*.

Table 1. Taxonomic classification of *S. n. nokomis*.

Kingdom	Phylum	Class	Order	Family	Genus	Species	Subspecies
Animalia	Arthropoda	Insecta	Lepidoptera	Nymphalidae	Speyeria	nokomis	nokomis

The genus of the species has shifted over time. Edwards (1862) originally assigned the species' genus as *Argynnis* but a subsequent classification named it *Speyeria* (Scudder 1872). However, based on genomic analysis Zhang et al. (2020, pp.1, 17) switched the genus back to Edwards' original name of *Argynnis*. The name change was recently recorded in the Butterflies of America's nationally recognized Catalogue of the Butterflies of the United States and Canada (Pelham 2021). However, the Service typically follows nomenclature as listed in the Integrated Taxonomic Information System (ITIS) and ITIS has not yet changed the genus. Consequently, we will continue to use *Speyeria* in this version of the SSA but will change it to *Argynnis* in a future SSA update when ITIS changes the genus.

A recent whole genome analysis conducted by Cong et al. (2019) has reduced the number of subspecies of *S. nokomis* from six to five as previously described in Selby (2007, p. 13). Additionally, the genetic evidence by Cong et al. (2019) supports information in Selby (2007, p. 11), which suggested (through morphology) that there is a greater degree of genetic mixing with *S. n. apacheana* as one heads further west from western Colorado or with *S. n. nitocris* as one heads further south and southwest from the Four Corners area. Cong et al.'s (2019) analysis consequently suggests that the range of the nominal *S. n. nokomis* does not enter the Great Basin and thus the common name Great Basin silverspot butterfly is a misnomer. Therefore, we are using only the scientific name *S. n. nokomis* when referring to the subspecies addressed in this SSA report, and we use *S. nokomis* to refer to the species in general.

Cong et al. (2019) also suggests that there are three "segregates" with varying levels of genetic mixing causing them to be intermediate hybrids between the nominal subspecies of *S. n. nokomis*, *S. n. apacheana*, and *S. n. nitocris*. Figures 6 and 7 describe the unaffiliated segregates and names of major populations that make up identified subspecies (Cong et al. 2019, Figure 6, p.7; Figure 9, p. 10). The segregate identified as Population 2 (or Great Basin and Southwest Utah Mountains) is a mix between all three subspecies, though primarily between *S. n. nokomis* and *S. n. apacheana* with minimal transgression of *S. n. nitocris* genes (Cong et al. 2019, Figure 14, p. 17). In fact, the gradation (or cline) is most apparent in Population 2 where the eastern half is more similar to *S. n. nokomis* (orange circles) and the western half is more similar to *S. n. apacheana* (orange squares) (Cong et al. 2019, Figure 6, p. 7). Population 3 (or Uinta Mountains) is a mix between *S. n. nokomis* and *S. n. apacheana*. Population 9 (or Chuska Mountains) is a mix between *S. n. nokomis* and *S. n. nitocris*. These hybrid segregates are not included within the range of *S. n. nokomis* due to the degree of genetic mixing with the other respective subspecies and are unaffiliated with any one subspecies (though they are still *S. nokomis*). Population 1 is subspecies *S. n. apacheana*, Populations 4-8 constitute subspecies *S. n. nokomis*, and Population 10 is *S. n. nitocris*. The other two subspecies *S. n. coerulescens* and *S. n. wenona* are primarily or fully in Mexico and are not shown in Figures 6 or 7.

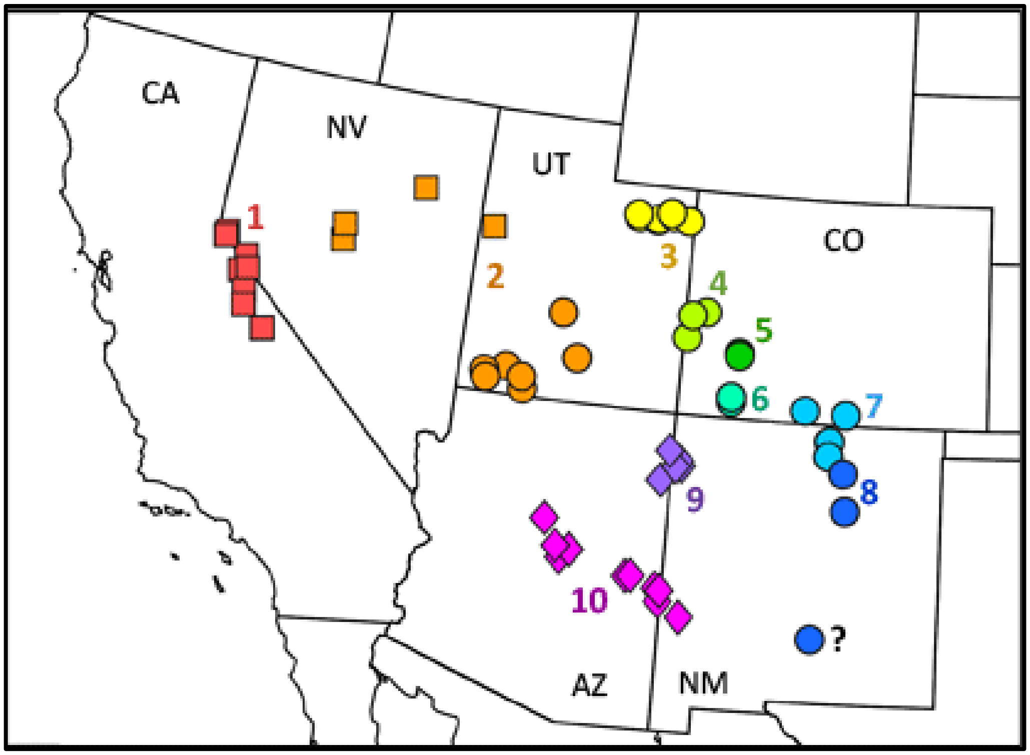

Figure 6. ***S. nokomis*** **populations based on PCA analysis (Cong et al. 2019, Figure 6, p. 7)**

As the climate has warmed and dried since at least the last ice-age over the last several thousand years, it is likely that sub-speciation has occurred since habitat has become fragmented. Consequently, it is likely that introgression of genes into *S. n. nokomis* from the other subspecies or segregate populations no longer occurs or occurs infrequently enough to not swamp the genetic makeup of *S. n. nokomis* thus retaining the subspecies. In fact, as presented in Figures 6 and 7 here and Figure 14 in Cong et al. (2019, p.17) the genetic analysis has been able to detect isolation of populations 4-8 from each other with little sign of interbreeding. Consequently, based on evidence it is likely that sub-speciation due to fragmentation of habitat and genetic isolation has been occurring for centuries and there is little chance that introgression of genes will occur from outside of the *S. n. nokomis* range, or if introgression does occur that it occurs infrequently enough to not substantially alter the genetic makeup of *S. n. nokomis*.

Figure 7 provides names for each of the numbered populations as identified in Cong et al. (2019, Figure 10, p.9). Population names are consistent in this SSA when referring to the unaffiliated segregates (2 – Great Basin and Southwest Utah Mountains; 3 – Uinta Mountains; and 9 – Chuska Mountains) but we use subspecies names for the other populations (1 – *S. n. apacheana*; 4-8 – *S. n. nokomis*; and 10 – *S. n. nitocris*). Due to some genetic differentiation between geographic areas, the subspecies *S. n. nokomis* is divided in Figures 6 and 7 into the five different populations (4-8) but the various analytic tools used in the analysis reveal that the populations are genetically similar enough to constitute the subspecies *S. n. nokomis* (Cong et al. 2019).

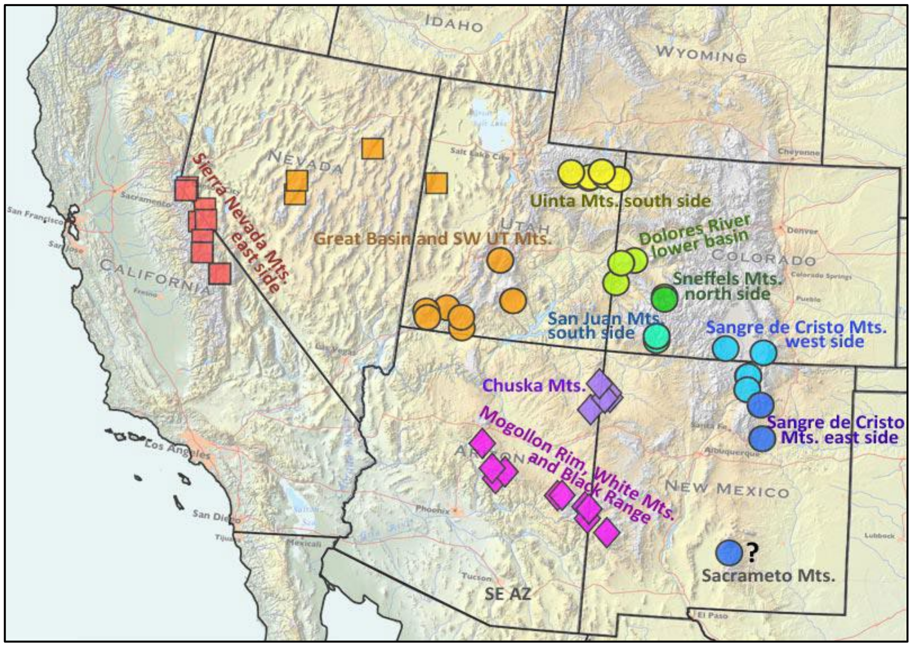

Figure 7. ***S. nokomis*** **population names (Cong et al. 2019, Figure 9, p. 10)**

Cong et al.'s (2019) findings of genetic clines are similar to previously published articles based on morphology (Swisher and Morrison 1969, p. 4; Ferris and Fisher 1971, p. 49). Selby (2007, pp. 11, 18) based his range maps on those two articles. Cong et al. (2019, p.22) point out in their conclusions that the Uinta Mountains Population "could be" included within the range of *S. n. nokomis*. Figure 8 below is a TreeMix analysis which illustrates that, though close to the nominal *S. n. nokomis* range (populations 4-8), the Uinta Mountains Population does branch off from the other populations (Cong et al. 2019, Figure 10, p.11). The genetic proximity is also consistent with the Principal Component Analysis (PCA) in Cong et al. (2019, pp. 4-11). However, one of the lead authors of Cong et al. (2019) stated that his opinion is that the Uinta Mountains Population should not be included in the range of the nominal *S. n. nokomis* (Grishin, 2020a, pers. comm.). Consequently, based on this opinion and the genetic evidence, the Service will not include the Uinta Mountains Population within the range of *S. n. nokomis*. The green line in Figure 8 below indicates that the Sneffels Mts. north side (aka San Juan Mts. North Side) is the suspected type locality for *S. n. nokomis*. Further information on the genetics can be found in Cong et al. (2019, entire) and Appendix B. Additionally, discussion of existing and proposed common names can be found in Appendix C.

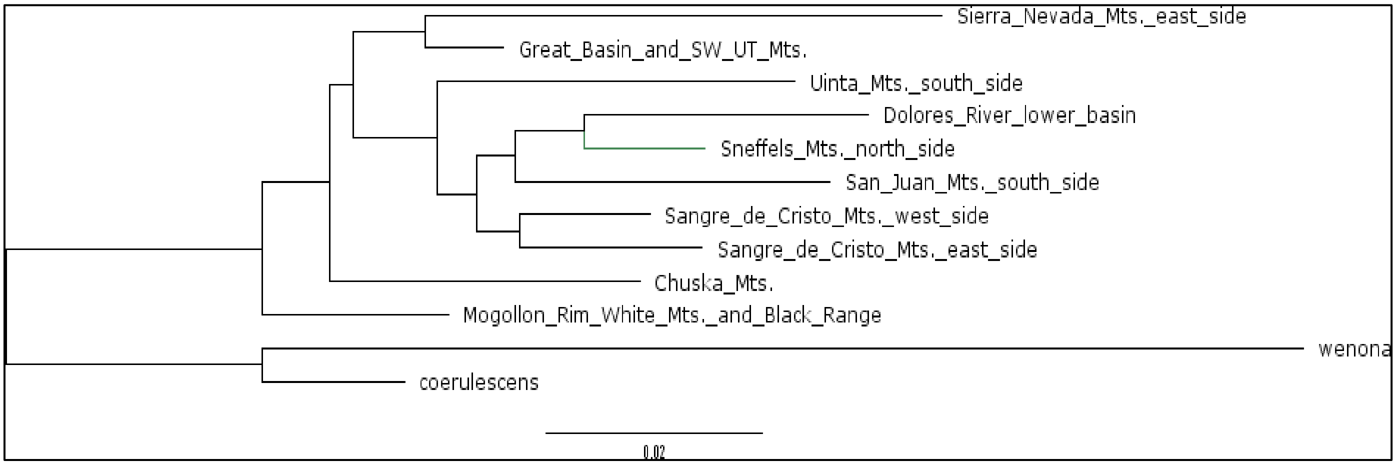

Figure 8. TreeMix analysis showing genetic branching-off of the Uinta Mountains Population (3) from nominal S. n. nokomis populations (4-8) (Cong et al. 2019, Figure 10, p.11).

2.4 Current and Historical Distribution

Establishment and mapping of the Current Range

Based on the best available scientific information per recent genetic work, the range of *S. n. nokomis* is now better understood than it has been in over a century (Cong et al. 2019, entire). As stated in section 2.3, the range now excludes the Great Basin and Southwest Utah Mountains area (Population 2), the Uinta Mountains area (Population 3), and the Chuska Mountains area (Population 9) for which inclusion in the *S. n. nokomis* range was previously uncertain (Selby 2007, Figure 3, p.11, p.14; also see Figure 6 above). The current range map in this Version 1.1 of the SSA (Figure 9) includes margins of the known range where *S. n. nokomis* could possibly be found in the future and removed areas of higher elevations. In this Version 1.1 of the SSA a Concave Hull 50intensity polygon was used to map the outer boundary of the range (Service 2019, entire; Lustig 2023, pers. comm.). A Concave Hull provides a slightly tighter boundary in contrast to a more liberal Convex Hull as used in Version 1.0 (Service 2021).

The range boundary should be recognized as flexible and it may be adjusted in the future based on survey information. Lastly, *S. n. nokomis* has never been known to occur ubiquitously across the range but rather occurs in small, isolated, patches of specific habitat within specific elevations as described further in section 2.5.

Current Populations and Colonies

Major populations 4-8 in Cong et al. (2019, Figure 6, p.7; Figure 6 above) cumulatively represent the range of *S. n. nokomis*. However, within these five major populations, genetic analysis reveals that there is finer subdivision (Cong et al. 2019, Figure 8, p. 9). This finer subdivision identifies eight populations of *S. n. nokomis* that appear to be genetically isolated from one another. These eight populations are named in Cong et al. (2019, Figure 8, p. 9) after their counties of occupation as: Conejos, Costilla, La Plata, Mesa, Montrose, Ouray, San Miguel/Mora, and Taos.

Subsequent to Cong et al. (2019), a colony in Grand County, Utah, was found to be genetically connected to the Mesa Population colonies (Grishin 2020b, pers. comm.). Furthermore, a colony in San Juan County, Utah, was confirmed extant in August 2020 (Hannawacker 2020, pers. comm.) and, though genetic analysis has not been conducted on it yet, due to its proximity and geographic connection we are considering it part of the Montrose Population. Due to these two pieces of information, we changed the name of the Mesa Population (from Cong et al. 2019) to Mesa/Grand and changed the name of the Montrose Population to Montrose/San Juan in Version 1.0 of the SSA (Service 2021). Also, subsequent to Cong et al. (2019) a colony was found in northern New Mexico that is included with the Taos Population in this SSA but future genetic analysis could place it elsewhere (see further discussion under section 3.5 Current Condition by Population). Furthermore, two populations (Archuleta and Garfield) only had *S. n. nokomis* observed there in the past and did not have specimens available for the genetic analysis but are presumed populations based on the large distances from other populations (more than 20 air miles).

If a population consists of more than one colony it is considered a metapopulation since butterflies from the colonies likely interbreed and may frequently or occasionally augment neighboring colonies. However, to be consistent with SSA terminology and for the rest of this report, unless otherwise noted, "population" refers to either the single-colony or multi- colony populations within the range of *S. n. nokomis*.

A colony is defined in this report as an area known to be occupied at some point in time with sufficient bog violets to serve as a production area for *S. n. nokomis* and is largely separated from other habitat areas that produce *S. n. nokomis*. The colony areas also include surrounding nectar sources, so colony habitat areas may be larger than just the area where bog violets occur. We are not including analysis of habitat for stray observations or for extirpated colonies and will only mention them as necessary. Should other potentially extant or new colonies be found, their status and current condition scores will be included in an updated version of the SSA.

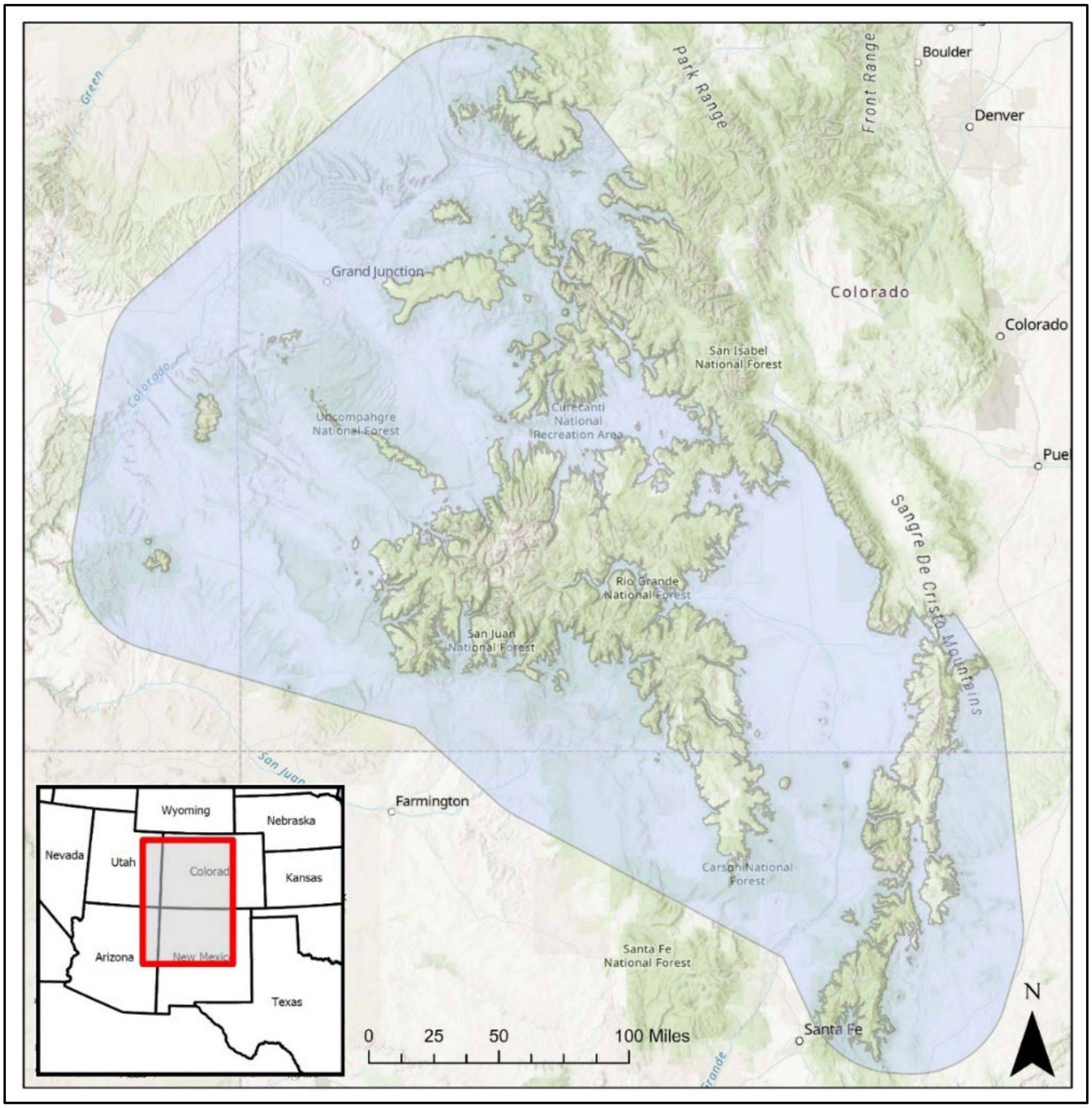

Figure 9. Range of the silverspot butterfly (*Speyeria nokomis nokomis*) in blue. The range excludes elevations above 9,300 feet. Colony and population locations are not shown to protect sensitive species locations.

Historical Colonies

Within the range of *S. n. nokomis* (Figure 9), 5 colonies have been extirpated in 4 different populations. An additional sixth colony (and probable former population) outside of the range as currently defined, is also considered to be extirpated (historical). The five colonies within the range, as currently defined, were extirpated over approximately the last 40 years.

From north to south, the first historical colony is the Unaweep Seep colony, in Colorado, which is part of the Mesa/Grand Population. A shift in vegetation to willow, grass, sedge (*Carex* spp.), and spike rush

(*Eleocharis* sp.) was noted and may have caused elimination of the bog violet and thus extirpation of the colony (Arnold 1989, pp. 9, 14; Ellis 1999, pp. 3, 5, 6). Livestock grazing incompatible with the needs of the bog violet and butterfly may have caused the vegetation to shift, but this is only suspected based on it being the only major human management action on the area, and no in-depth study has been done to confirm this suspicion. Unfortunately, the colony likely became extirpated after Arnold's 1989 study or shortly after 1999 when Ellis (1999, p. 2, 7) noted very few bog violets remaining (no sightings of *S. n. nokomis* were mentioned). No monitoring we are aware of occurred from 2000 until 2017 and there were too few bog violets to support the subspecies and no *S. n. nokomis* were spotted (Ireland and Plank 2017, pers. observation).

The second historical colony was in the Ouray Population in Colorado, which was confirmed to be extirpated in 2022 (Fisher 2022a, pers. comm.).

The third and fourth historical colonies are in the La Plata Population in Colorado. One of these sites was quite large and well known by lepidopterists, but unfortunately became extirpated sometime shortly after 1987 when the Dalton Ranch Golf Club and surrounding subdivisions were built (Ellis and Fisher 2020, pers. comm.). The other colony was smaller and became extirpated after a couple homes were built on the colony site shortly after 1990 (Ellis and Fisher 2020, pers. comm.).

The fifth historical colony used to occur at the historic Beulah townsite in New Mexico and was a large colony in the San Miguel/Mora Population (Scott and Fisher 2014, p. 3). The general location is thought to be known and it appears the colony became extirpated after a number of homes were constructed and logging ceased (Scott and Fisher 2014, p. 3). Based on the evidence, the colony appears to have become extirpated sometime in the 1970s or perhaps 1980s.

The sixth historical colony (and probable former population) is also in New Mexico, and was formerly known as "*S. n. tularosa*" (Holland 2010, pp. 78-81) (see further discussion in Appendix B). The specimens from there are now known to be S. *n. nokomis* (Cong et al. 2019, p. 22).

2.5 Habitat

S. n. nokomis occurs in permanent spring-fed meadows, seeps, marshes, and streamside meadows (Scott 1986, p. 326, Selby 2007 and references therein, p. 22). The only known larval host plant is *Viola nephrophylla/V. sororia* var. *affinis* (bog violet, Figure 10) (Scott 1986, p. 326; Willey 2020, pers. comm.). Other *V. sororia* varieties or subspecies are not synonymous with *V. nephrophylla* (Willey 2020, pers. comm.). Microhabitat for the bog violet is soggy soil in open meadows or under willows (*Salix* spp.) or other shrubs that are typically at the margins of the habitat or sparsely mixed in with herbaceous habitat (Figure 11) (Selby 2007 and references therein, p. 22). Bog violets have also been observed growing on decayed logs (Ireland 2021a, pers. comm.). Associated herbaceous vegetation typically includes sedges, grasses, and forbs (Scott 1986, p. 326; Selby 2007, p. 22). The violet is widely distributed, both latitudinally and elevationally, in the western U.S. but occurs in naturally scarce habitats, subjecting it to threats from development, excessive grazing, or hydrological alteration (Hovanitz 1969, p. 20; Hammond and McCorkle 1983, p.219; Selby 2007, p. 22). Elevation of the bog violet in Utah, Colorado, and New Mexico ranges from 2,750 feet to 11,500 feet, both within and outside of the range of *S. N. nokomis*. Forbs that serve as nectar sources for adult *S. n. nokomis* include native and introduced thistles (*Cirsium* spp., *Carduus* spp., etc.), horsemint (*Agastache* spp.), joe-pye weed (*Eupatorium maculatum*), milkweed (*Asclepias* spp.) and other native or introduced forbs; typically blue and yellow composites (Scott 1986, p. 327; Ellis 1989, p. 18; Selby 2007; p. 23).

S. n. nokomis is likely not as elevationally distributed as the bog violet and is known to occur from roughly 5,200 feet to just over 8,300 feet in elevation but could potentially occur at higher or lower elevations (Ellis and Fisher 2020, pers. comm.).

Figure 10. Viola nephrophylla/V. sororia var. affinis (bog violet). Photo by Terry Ireland (Service), Aug. 2018

Figure 11. Wet meadow habitat with Lepidopterist Scott Ellis looking at S. n. nokomis in Unaweep Canyon. Photo by Terry Ireland (Service), Aug. 2018

2.6 Life Cycle and Individual Needs

Figure 12 depicts the life cycle of *S. n. nokomis* (Scott and Mattoon 1981, pp. 12, 14; Scott 1986, p. 326-327; Selby 2007, p. 21). Species of *Speyeria*, including *S. n. nokomis*, are univoltine (one brood of offspring per year) (Mattoon et al. 1971, p. 247). Eggs are typically laid in mid-September and take 10-18 days to hatch (Scott and Mattoon 1981, pp. 12, 14; Selby 2007, p. 21). More than 600 eggs may be laid by a single female (Mattoon et al. 1971, p. 248; Opler 2018, pers. comm.). Eggs are laid singly and are typically not clustered though there have been as many as 8 eggs observed (laid singly) on a violet leaf (Arnold 1989, p. 12). In the only known study in nature of *S. n. nokomis* oviposition sites (where eggs are laid), and in order of frequency, eggs were observed being placed on bog violets, miscellaneous vegetation, grasses/sedges, and bark, typically within about three feet of violets (Arnold 1989, pp. 13, 23). Willow stems, trunks, logs, twigs, and debris are also often used as oviposition sites (Selby 2007, p. 24; Ellis 2018a, pers. comm.; Fisher 2020b, pers. comm.). Three feet has been noted for other *Speyeria* taxa to be well within the 1st instar larvae's ability to reach (Arnold 1989, pp. 13). However, based on other's observations it is likely that most ovipositions are within 1 foot of violets (Ellis 2020a, pers. comm.). The substrate on which eggs are laid can be variable as long as the eggs are laid relatively close to the violet because upon spring emergence larvae will start feeding on the violet.

First instar larvae (first larval stage) typically hatch in early October then soon seek shelter for winter diapause (period of suspended development similar to hibernation) (Fisher 2020b, pers. comm.). Just before seeking winter shelter the larvae hydrate by drinking and absorbing water (Myrup 2020a, pers. comm.; Stout 2020). Successful diapause sites occur where the moisture level is not too wet and not too dry (Selby 2007, p. 24; Fisher 2020b, pers. comm.). The 1st instar larvae are in diapause for approximately 225 days. Mortality of *Speyeria* species appears to be very high during winter diapause (Mattoon et al. 1971, p. 248).

Although wintering sites have not been observed in nature it is logical that they seek shelter under leaves and debris at the base of violet plants or willows or other woody vegetation, which may prevent them from being trampled (Ellis 2020a, pers. comm.; Fisher 2020b, pers. comm.). They are known to seek shelter under leaves in artificial conditions (Fisher 2020b, pers. comm.). They have also been observed communally in winter diapause in artificial conditions but due to nature of eggs being laid singly and haphazardly it is suspected that communal winter diapause is rare in nature and potentially only occurs in optimum locations (Fisher 2020b, pers. comm.).

It is thought that microclimate and moisture levels provided by flowing water of springs or streams is sufficient to keep larvae alive during the winter such that insulation from snowpack is not necessary to prevent freezing (Ellis 2020a, pers. comm.). Often within the range of *S. n. nokomis* very cold weather is preceded by snow which may insulate larvae before the coldest temperatures hit the days after the storm. Most of the *S. n. nokomis* are at an elevation that has some snow cover for most of the winter that may help larval survival, but the snow cover is variable enough that the butterfly may have adapted to variable conditions and it may not necessarily be a large factor in larval survival (Ellis 2020a, pers. comm.; Fisher 2020b, pers. comm.). However, higher elevation snowpack is crucial to supply water for springs and streams that *S. n. nokomis* relies on to support its habitat.

In approximately mid-May, when fresh violet leaves are present, the 1st instar larvae emerge from winter diapause and start feeding on the violets until about mid-July. They also shelter on the violets and adjacent debris for approximately two and a half months. During this time frame, the larvae will grow and moult into a 6th instar (Scott and Mattoon 1981, p. 12). The mature instars will then form a chrysalis and enter pupation where they metamorphose into adults. Pupation takes approximately 17 days (Selby 2007, p. 21).

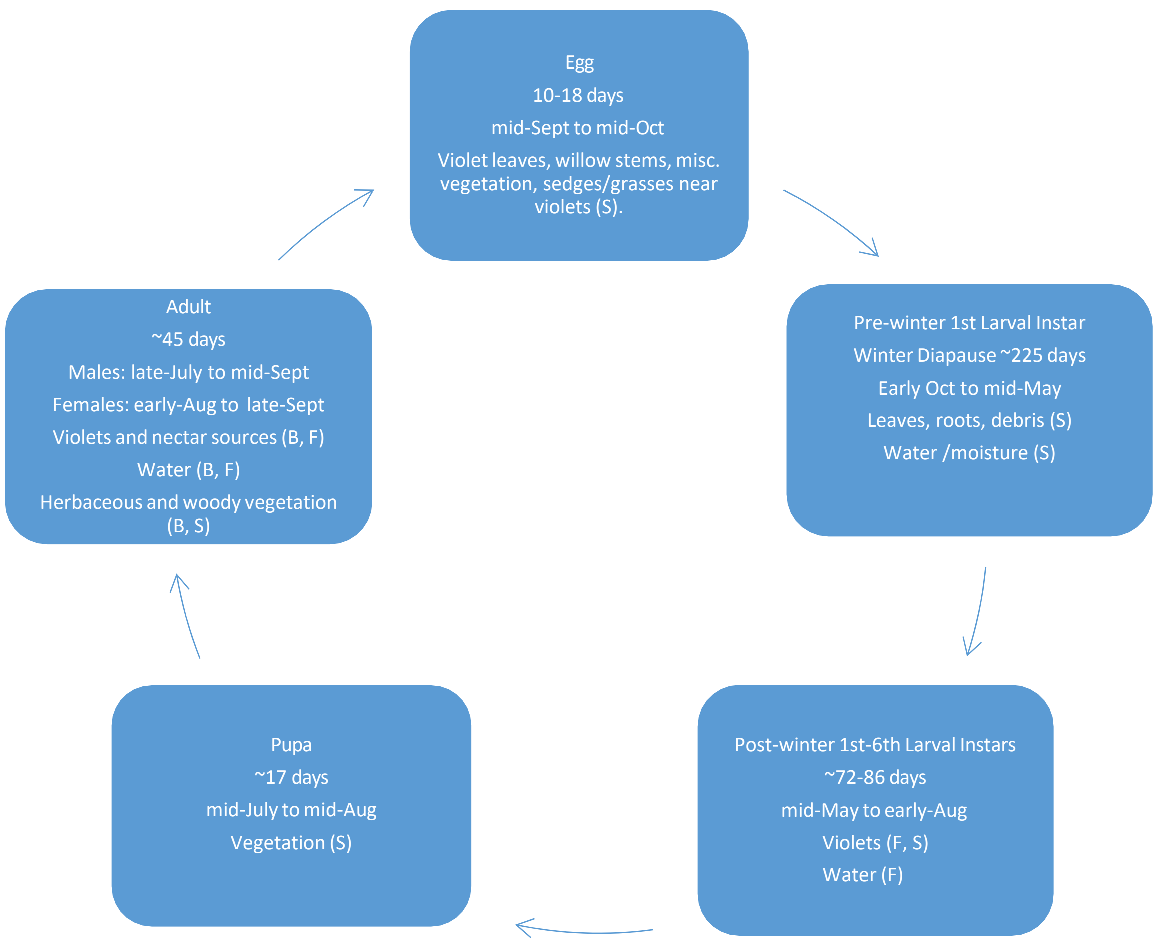

Figure 12. Life cycle diagram including resource needs; B: breeding; F: feeding; S: sheltering (Scott and Mattoon, 1981, pp. 12, 14; Scott 1986, p. 326-327; Selby 2007, p. 21).

At the end of July to mid-August adult butterflies emerge from the pupal case and live approximately 45 days (Selby 2007, p. 21). Males emerge at the end of July or beginning of August and last until about mid-September. Females emerge the first to second week of August and last until about the end of the third week of September (Selby 2007, p.21). The later emergence of females likely maximizes the number of matings for males and reduces the amount of time and energy for females to mate (Scott 1977, pp. 917-921; Scott and Mattoon 1981, p. 15; Selby 2007, p. 21). During this time the adults will nectar on a variety of plants (mostly plants in the Sunflower family (*Asteraceae*)) for energy in mate finding and egg laying.

A survey of this SSA's Technical Team provides a range of temperatures that adult butterflies will fly in to seek mates and nectar, thus revealing physiological limitations. Adult butterflies will fly in temperatures from 50–100°F (Cary 2020a, pers. comm.; Ellis 2020b, pers. comm.; Fisher 2020c, pers. comm.). However, the preferred temperature range appears to be 65–85°F (Ellis 2018b, pers. comm.) and is supported by the additional ranges given by himself and the other Technical Team members. If the temperature is too cold, at or below approximately 50°F, then the silverspot will need to warm up in the sun before it can take flight. When temperatures are hot, between 90–100°F, the silverspot can only fly for short intervals and then must seek shade (Ellis 2020b, pers. comm.; Fisher 2020c, pers. comm.). Consequently, with climate projections suggesting a hotter climate, extended periods with hot temperatures greater than 90°F days could limit reproduction due to more frequent and lengthier time spent shading.

S. n. nokomis males will fly all day, but the best time appears to be approximately late morning from 11:00 AM to 1:00 PM (10:00 AM to 12:00 PM without daylight saving time) (Fisher 2018a, pers. comm.). During that time frame, males will most actively be searching for newly emerged females with which to mate. Females do not fly around much unless disturbed and tend to be more active in the morning and late afternoon. When laying eggs females stay in the grass and bushes near violets. If it begins to cloud up in early afternoon, females get active before it gets too dark and can be seen on the wing more frequently. A thin cloud layer that allows the site to remain bright but cuts the sun intensity is ideal for female activity but rarely occurs on any given day. If the weather is cloudy/rainy little to no activity occurs, but both males and females will heavily nectar the next sunny day (Fisher 2018a, pers. comm.).

To summarize, individual needs of *S. n. nokomis* include wet meadows, supported by springs, seeps, streams, or irrigated areas that contain the bog violet and other herbaceous vegetation. The butterflies may benefit from a light interspersion of willow or other shrubs for shade and for larval shelter. More dense willow and shrubs often surround open meadows where *S. n. nokomis* occurs and, as long as the woody vegetation does not take over the meadows, the margins of denser stands can be beneficial for shade and shelter as well.

2.7 Population Needs

Populations need abundant individuals within habitat patches of adequate size and quality to maintain survival and reproduction. In general, the greater the suitable habitat acreage, and the greater the number of individuals within a population, the greater the resilience. Furthermore, colonies and populations need to be close enough to each other for individuals to breed with each other in order to maintain genetic diversity. A professional estimate is that adult *S. n. nokomis* likely do not disperse more than 5-10 miles and if they fly further than that they will likely not find another colony (Ellis 2020c; 2020d; 2020e, pers. comm.). Additionally, *S. n. nokomis* needs the bog violet to be of sufficient extent and density to support colonies and populations. We are defining colonies in this SSA to mean areas of abundant violets that produce butterflies as well as surrounding habitat with nectar sources. If there is narrow but contiguous nectaring habitat up or down a drainage but without violets (or with only sparse violets) we consider those areas transitional corridors and, though likely valuable for dispersal and genetic connectivity, we do not include those corridors in acreage calculations of a colony.

S. n. nokomis has some populations that have single colonies and some have more than one colony creating a metapopulation. A metapopulation structure is where individuals in colonies are close enough to interbreed and can recolonize temporarily extirpated colonies. Colonies within a functioning metapopulation can be recolonized if local naturally occurring (stochastic) events cause extirpation of a colony. For instance, a flood may extirpate a colony but if there is a nearby source for the bog violet and associated plant species, the area may return to suitable habitat condition and be recolonized by the butterfly.

For *S. n. nokomis* there is very little information on what an adequate-sized habitat patch is, especially if there is only a single colony in a population. A professional estimate for minimum patch size of colonies is 2 acres if the habitat has as reliable groundwater source and has high violet density; 5 acres if violets are less dense due to natural or human-caused variability within a patch (Ellis 2020e, pers. comm.). Although it is possible a single 2- acre or 5-acre patch of habitat could support the butterfly for a period of time, a more resilient population will likely contain at least three colonies of those sizes or greater. A three-colony metapopulation will have a better chance of survival by spreading the risk of extirpation if a natural event occurs at one or two of the colonies. Thus, the remaining one or two colonies can recolonize the extirpated sites assuming suitable habitat remains or reestablishes. Due to natural variability in soil and topographic conditions, it is assumed that it is more likely that an area will have less dense violets than dense violets. Consequently, under this assumption, a minimum amount of habitat for a resilient population may be 12 acres; two colonies 5 acres in size and one colony 2 acres in size. Due to its isolation, a single-colony population likely needs to have many acres of habitat in order to assure there are enough butterflies to maintain genetic diversity and be viable over the long-term. What the specific minimum threshold is for single colonies to remain viable is unknown, but the greater the acreage the greater the resiliency and higher likelihood of viability.

There is also little information on the minimum number of *S. n. nokomis* individuals needed to sustain a colony. There have only been two demographic studies for *S. n. nokomis.* Both occurred at the same locations 10 years apart; 1979 and 1989 (Arnold 1989). The 1989 study found a daily estimate of between 48 and 260 butterflies with two different models at the Unaweep Seep colony (Arnold 1989, p.6, 14). A combined population estimate at the Unaweep Seep colony and another upstream colony in Unaweep Canyon (which is considered two colonies in this SSA due to intervening transitional habitat) resulted in a range of daily abundance from 594 to 2,689 butterflies.

The Unaweep Seep colony population estimate increased from 1979 but detrimental habitat changes were also noted and only 1 of 5 springs at the Unaweep Seep colony were occupied in 1989 (Arnold 1989, pp. 6, 7, 14). Despite a number of individual butterflies and the relatively large area of habitat (approximately 31 acres) the Unaweep Seep colony subsequently became extirpated sometime after 1989, likely due to encroachment of willow, grass, and sedge (Arnold 1989, pp. 9, 14). However, the upstream colonies in the 1989 study had a much higher number of butterflies despite having a smaller combined acreage of about 12.5 acres. Consequently, quality of habitat may have as much weight in determining resiliency of a colony or population as does overall size of a habitat patch or number of individuals. Habitat quality could potentially be measured by density of violets. Indeed, Arnold (1989, p. 20) reveals that the upstream colonies in his study had a much higher abundance of violets. Consequently, populations appear to have greater chance for survival when containing more violets.

Based on observation of grazed and burned properties in Unaweep Canyon, it was determined that occasional or well-managed grazing and burning likely benefit the violet by reducing willows as well as thatch buildup from grasses and sedges (Arnold 1989, p.14; Ellis 1989, pp. 18, 19). Consequently, natural factors or management that leads to early seral stages or at least more open conditions where willow, grass, sedge or other vegetation does not outcompete violets is important to colonies and populations (Huhta et al. 2001, entire; Hellstrom et al. 2003, entire).

S. n. nokomis and other *S. nokomis* subspecies have the ability to move between colonies within a continuous or nearly continuous riparian zone (Arnold 1989, pp. 10, 14; Fleishman et al. 2002, p.708). For example, there used to be six colonies (now five) along a 5-mile stretch in Unaweep Canyon that had likely genetic interchange (Ellis 1989, p. 3). However, these are considered separate colonies due to the natural or human-caused patchiness of bog violets up and down the canyon. In the mark-recapture study by Arnold (1989, pp. 10, 14, 21) in Unaweep Canyon, about 50 percent of the recaptured butterflies had moved between two colonies separated by about 0.75 miles. Based on Arnold's 1989 work, it was estimated that *S. n. nokomis* could easily move at least one mile and, based on this, Ellis (1989, p. 19) further estimated that there was exchange of individuals among all the Unaweep Canyon colonies every one to five years. This also provided the basis for Ellis' professional judgement that colonies or populations further than 5-10 miles from each other are likely isolated (Ellis 2020c; 2020d; 2020e, pers. comm.).

In summary, to be resilient, populations need water to sustain violets for the larvae, occasional or seasonal disturbance by grazing from native ungulates or domestic livestock, or burning, mowing, or non-catastrophic flooding to occasionally remove vegetation that might otherwise crowd out the violets and other nectar plants for the adults. Furthermore, based on expert opinion and evidence from Arnold (1989) and Ellis (1989), the most resilient populations need to be at least 2 acres in size with dense violets or at least 5 acres in size with less dense violets, have a few to several colonies within 0.75 to 5 miles of each other but likely not exceed 10 miles from each other (Ellis 2020e, pers. comm.).

Single-colony populations likely need to have a very large habitat area but might still need occasional immigration from other populations to maintain genetic diversity and resiliency for long-term persistence. Based on the scant evidence, it is unknown what the minimum number of individuals are that are needed to sustain a *S. n. nokomis* colony or population, and even apparent natural but detrimental habitat factors can cause extirpation of seemingly large colonies. Without additional study, there is uncertainty regarding what the minimum viable habitat size is, what density or abundance of bog violets or nectar sources is needed to sustain a colony or population, and the maximum distance between colonies or populations that can be reached for genetic interchange on a regular basis. Furthermore, it is uncertain if even large single-colony populations can be resilient without occasional genetic interchange from other populations.

2.8 Species Needs

To be viable, *S. n. nokomis* needs to have sufficient quality and quantity of habitat for resilient populations, numerous populations to create redundancy in the event of catastrophic events, and broad enough genetic diversity to adapt to changing environmental conditions (representation). The subspecies will have a better chance of long-term viability if the single-colony populations and even the metapopulations occasionally receive individuals from other populations such that genetic interchange occurs and they are able to adapt more readily to environmental changes. Table 2 provides a summary of ecological needs for the subspecies.

Table 2. Ecological requirements for S. n. nokomis viability.

The three R's	Requisites of Viability	Description
Resiliency (ability to withstand stochastic (non-catastrophic natural) events	Consistent water supply to support violets, nectar sources, some shrubs, and microclimate for larval survival.	Water supply is driven by higher elevation snowpack. Springs or near-surface ground water can elevate temperatures and provide appropriate humidity. On-site snow cover can also insulate larvae from freezing and desiccation and might boost larval survival but may not be as important as spring or groundwater presence.
	At least 2 acres of habitat with dense violets or at least 5 acres with less dense violets to support each colony. At least 3 colonies if habitat is small.	Minimum sizes are requirements to maintain viable colony per professional opinion. An assumption is that a metapopulation needs 3 colonies to be resilient and minimum of 12 acres total (one 2-acre patch and two 5-acre patches). Distance between the two most-distal colonies in a metapopulation to maintain genetic interchange should be no more than 20 miles (per genetic evidence) but more likely no more than 5 or 10 miles (per professional opinion).
	Single-colony; likely needs to be large	Minimum size for single colony unknown but the larger the better to have enough individuals to sustain genetic diversity.
	Native or non-native nectar sources	Provide energy for mating, egg-laying, and possible flight to neighboring colony. Density of nectar sources unknown.
Redundancy	Numerous metapopulations or single-colony populations spread out to prevent loss by catastrophic events.	More is better.
Representation (ability to maintain adaptive capacity)	Genetically diverse populations	Genetic diversity can provide adaptation advantages. Genetic connection of populations likely provides greater diversity of genes.
	Distribution of populations throughout their range to capture ecological diversity	Populations in different ecological settings likely provide for adaptative capacity and contribute to viability.

CHAPTER 3 – CURRENT CONDITION

3.1 Key Findings

Habitat loss and fragmentation; livestock grazing; human-caused hydrologic alteration; genetic isolation; climate change; climate events; invasion by non-native plants; larval desiccation; disease; predation; fire, and pesticides are all factors that influence or could influence species viability. Factors have been divided into minor and major categories. One or more major factors are given a single negative score. Although current climate conditions have changed in the last 36 years (Lukas et al. 2014, entire) they are not thought to be severe enough to have influenced current species resiliency or viability and are consequently included as a minor factor in this Current Condition chapter.

Little demographic and habitat information is available so the number of metrics scored for current condition is limited and cause and effect linkages for minor and even major factors are also limited. Consequently, current condition is assessed based on what little published information is available for *S. n. nokomis* and relies on species expert input to a large extent as well as information on other similar species or concepts in scientific literature. Major factors influencing species viability include habitat loss and fragmentation from development or agricultural conversion, grazing, hydrologic alteration, and genetic isolation of colonies and populations. If implemented properly, mowing for native hay, grazing, and burning can be compatible and beneficial for *S. n. nokomis*. Little conservation effort has been directed towards *S. n. nokomis* and the efforts that occurred were both in Mesa County in the Mesa/Grand Population.

There are currently 21 colonies representing 10 populations that are considered extant. There are three populations that have very low resiliency, three populations have low resiliency, two populations have moderate resiliency, and two others have high resiliency. With 10 populations widely distributed redundancy is determined to be moderate and representation is thought to be low – moderate. Thirteen of the 21 colonies representing 6 populations were confirmed to be extant in at least one year from 2018-2022. We are relying on older survey information (pre – 2013) for the other four populations (all single-colony populations) and need at least one or more year's-worth of surveys to confirm existence or extirpation since presence was last detected.

3.2 Materials and Methods

Current conditions are assessed in relation to what *S. n. nokomis* ecological requirements were determined to be in Chapter 2. However, the only measurements available that are consistent across populations are habitat patch size, number of colonies, and approximate distance between colonies within a population from which genetic connectivity can be estimated. Additionally, the presence and potential influence of the three major habitat factors affecting the species (habitat loss and fragmentation, grazing, and hydrologic alteration), were derived from aerial imagery and/or on-the-ground knowledge. Therefore, these metrics are used to characterize the current resiliency condition of populations in this SSA (see section 3.5 "Current Condition by Population" on how metric scores were derived). If in-depth study of habitat parameters, demographic parameters, and other human or natural factors are conducted in the future the SSA can be updated to reflect that new information.

Resiliency scorings and categories are established based on best available information and professional opinion. Habitat patch sizes are estimates but SSA Technical Team experts Scott Ellis, Mike Fisher, and Steve Cary drew habitat polygons themselves or were coordinated with to draw patches between 2018 and 2020 using aerial imagery based on their best estimates of individual colony bog violet areas and primary nectar source areas. Additionally, Robb Hannawacker and Bob Friedrichs (along with Scott Ellis and Steve Cary, respectively) provided input to size of colonies discovered from 2020 to 2022. Determination of the number of colonies within a population in Version 1.0 of the SSA (Service 2021) was primarily based on expert input from Ellis and Fisher (2020, pers. comm.) and for the New Mexico populations with agreement by Cary (2020b, pers. comm.).Status of individual colonies was also confirmed with Ellis and Fisher (2020, pers. comm.) or Fisher himself (2020d, pers. comm.) (see section 3.5 below for updated information).

The whole genome analysis determined that, within *S. n. nokomis* range, there are eight populations (Cong et al. 2019, Figure 8, p. 9). However, we are currently considering there to be an additional two populations for a total of 10 populations. Two of the populations were not included in the analysis by Cong et al. (2019) due to lack of samples (Archuleta and Garfield). Based on distance from other populations (greater than 20 miles) these two will likely remain discrete populations even if future specimens are found and analyzed.

There are six historical colonies known to have been extirpated in about the last 40 years. Beyond briefly mentioning the extirpated colonies, we are not analyzing them in the current or future condition analysis for this SSA. Also, stray sightings will not be considered in the current and future condition analysis for this SSA. Not including the extirpated colonies or stray sightings, we evaluated 21 colonies that make up the 10 single-colony or multi-colony populations.

3.3 Factors Influencing Species Viability

Habitat loss and fragmentation; livestock grazing; human-caused hydrologic alteration; genetic isolation; climate change; climate events; invasion by non-native plants, larval desiccation; disease; predation; fire, and pesticides are all factors that influence or could influence species viability. Factors have been divided into minor and major categories. For this SSA, factors considered minor are those that are ongoing and routine, such as larval mortality due to natural predation, or where current observation or evidence does not indicate they have a meaningful impact on species viability and does not support them being placed in major factors. It is possible, however, that with research some minor factors, such as exotic plant invasion or pesticides, could be realized as major factors in the future.

3.3.1. Minor Factors

Exotic Plant Invasion

The Taos Population of *S. n. nokomis* has experienced some invasion by Siberian elm (*Ulmus pumila*) and it would not be unexpected for them to increase especially if changes in climate reduce snowpack and water levels in the wet meadows of the Taos Population (Cary 2020b; 2020c, pers. comm.) or other populations since Siberian elm is widespread in the butterfly's range. Similarly, the extirpated Unaweep Seep colony has had invasion by Himalayan blackberry (*Rubus armeniacus*) and tree-of-heaven (*Ailanthus altissima*) and though not known to occupy other colonies at present, these plant species could invade other colonies (Plank 2020, pers. comm.). Other exotic woody or herbaceous species can rapidly take over habitat (such as Russian olive (*Eleagnus angustifolia*), tamarisk (*Tamarix* spp.), or leafy spurge (*Euphorbia esula*)) and could be an issue, or could become an issue, but there is currently little to no plant data at colonies (Ellis 1989, pp. 14-15).

Some non-native thistles such as Canada thistle (*Cirsium arvense*) occur in or around colonies and can create monocultures (Ellis 1989, p. 14; Selby 2007, p. 30). Efforts have occurred in the west to control exotic thistles but Canada thistles (as well as native thistle) provide a nectar source for *S. n. nokomis*. Additionally, the adventive (exotic but not well-established) bull thistle (*C. vulgare*) and burdock (*Arctium minus*) can provide nectar sources (Ellis 1989, p. 14). Since *S. n. nokomis* use exotic thistles, aggressive control of them has been discouraged (Fisher 2020e, pers. comm.). It does not appear monocultures of Canada thistle or other exotic vegetation have replaced native vegetation beneficial for the butterfly at observed colonies (Ellis and Ireland, pers. observation 2018) but study of plant composition at all the colonies is needed to determine levels of exotic plant presence. Exotic plant invasion is currently placed under the minor category because exotic species are not currently known to be a major factor influencing the species viability.

Climate Events

Climate events are defined in this SSA as events that would happen within the range of normal variability. However, they may still cause reduction of habitat and number of butterflies. A record of other *Speyeria* in Utah indicates that too much rain can reduce numbers of butterflies, but on the other hand may be beneficial to violets which can support greater numbers of butterflies the following year(s) (Myrup 2020b, pers. comm.). Similarly, floods may at least temporarily reduce habitat and vegetation as well as butterfly numbers. For instance, the Lake Fork River in northeast Utah (outside of range of *S. n. nokomis*) flooded in spring 2019 limiting or causing extirpation of butterflies at a known colony in the Uinta Mountains Population (Ellis, Thompson, and Ireland 2019, pers. observation) that had been there the year before (Myrup 2019, pers. comm.). However, the flood event was not outside the norm for past observed flood events in that drainage. This event provides an example of when normal climate events can cause reduction in individual butterflies or temporary extirpation of a colony but are not expected to cause permanent reduction or extirpation. Thus climate events are not expected to reduce the subspecies' viability in the long-term and are considered as a minor factor influencing the species viability.

Climate Change

The climate already appears to be changing within the range of *S. n. nokomis* due to human impacts, with earlier springs and warmer temperatures. Temperature in Colorado increased in the 30 years prior to 2014 by 2°F and increased 2.5°F in the last 50 years (Lukas et al. 2014, p.2). Snowpack, as measured by snow water equivalent, has mostly been below average in Colorado since 2000. The timing of snowmelt and peak runoff has also shifted 1-4 weeks earlier in the last 30 years in Colorado. Furthermore, the Palmer Drought Severity Index has shown an increasing trend in soil-moisture drought conditions due to below average precipitation since 2000 and the warming trend (Lukas et al. 2014, p. 2). More recent analysis using National Oceanic and Atmospheric Administration (NOAA) temperature data shows that much of the northern half of the *S. n. nokomis* range has reached or is above 3.6°F over the long-term average since 1895 and it is reported that average annual flows in the Colorado River Basin have declined by 20 percent over the past century (Eilperin 2020, entire). However, tree ring and other paleoclimate data indicate that there were more severe and sustained droughts prior to recent climate data (since 1900) (Lukas et al. 2014, pp. 2, 3). The butterfly has survived through the more severe past droughts and, despite noted changes in climate over the last 39 years, climate change has, for the most part, not been a detectable factor thus far in reduction of species viability. The exception is the small Archuleta population that has been experiencing prolonged drought conditions combined with grazing-related impacts resulting in lack of hydrologic support (Whiteman 2022, pers. comm.). The other nine populations currently appear to have an adequate water supply despite hydrologic alterations, recent droughts, and drier, current climate conditions (Bainbridge 2022, pers. comm; Ireland 2022a, pers. observation). Consequently, at the present and for the current condition analysis, climate change is considered a minor factor. However, climate appears to be at the verge of becoming a major factor and additional discussion of climate change is in Chapter 4 – Future Condition.

Desiccation of larvae

Desiccation of overwintering larvae may be a stressor if soil moisture and air humidity is too low or if larvae cannot remain hydrated. It is suspected that soil moisture and dead vegetation, along with some air flow, provide suitable conditions that prevent desiccation (Fisher 2020f, pers. comm.). Hydration also appears to be needed prior to 1st instar larvae winter diapause and is achievable if water is available for drinking or if soil or air moisture is sufficient for absorption (Myrup 2020a, pers. comm.; Stout 2020). Snow cover may also provide desiccation prevention and thermal cover although Ellis (2020b, pers. comm.) did not think it was a significant factor. Fisher (2020b, pers. comm.) agreed with Ellis but added that snow cover may be of benefit during extreme cold; however, in general extreme cold in *S. n. nokomis* range is preceded by snow, thus extreme cold may kill some larvae but is likely not a major factor that reduces species viability.

Disease

There are no diseases known to have caused declines or extirpation of colonies/populations of *S. n. nokomis* that we are aware of. However, viruses, bacteria, fungi, etc. have been stated as causing mortality in other butterflies (Scott 1986, p. 70). Artificial rearing has revealed that if there is no air flow in overwintering sites high humidity can also cause mold and mildews that can kill larvae (Fisher 2020f, pers. comm.). In contrast to potential desiccation problems from a warmer/drier climate, or potentially one with less snow and colder temperatures, it is possible heavy rains or climate-change induced rains at abnormal times of year or heavier than normal rains could cause an increase in mortality from mold or mildews (see section 4 below). However, we currently have no data to suggest disease is a factor influencing species viability.

Predation

Specific predators of *S. n. nokomis* have not been observed; however, birds, rodents, reptiles, amphibians, and other insects undoubtedly prey on them or parasitize them resulting in mortality or injury (Scott 1986, pp. 70, 71). The longer growing season already observed due to climate change (Lukas et al. 2014, p. 2) is not thought to be of benefit to the butterfly due to a longer period of exposure to negative survival factors such as predators (and parasitoids) (Fisher 2020f, pers. comm.). It is suspected that more predation or parasitism could already be occurring due to longer growing seasons but we have no evidence that they are currently at a level that is causing reduction of viability of the species, and predation or parasitism are therefore currently considered a minor factor.

Collecting

Butterflies in general are highly sought after by collectors in the illegal animal trade (Kleiner 1995; Hoekwater 1997; Courchamp et al. 2006; O'Neill 2007; Stratton 2012, entire). Collecting has occurred in silverspot colonies, and it is possible collecting in small colonies could negatively affect population resiliency (Ellis 1989, p. 15; Selby 2007, p. 31; Scott 2023, pers. comm.). We know of one colony that was extirpated, in part, from collection by multiple people (Scott 2023, pers. comm.). However, collecting is not currently thought to be a significant stressor for the silverspot because most colonies occur on private land, colony locations are largely unknown to the public, and current collecting pressure is not thought to be extensive (Ellis 2020f, pers. comm.). Collecting is currently considered a minor factor and does not appear to be significantly reducing the subspecies' viability. Efforts should be taken to keep it a minor factor in the future. There is concern with collecting if public land, or even private land, colony locations are revealed in the future. Losing even one of the remaining populations to collection could have a substantial impact on the subspecies' redundancy and representation. We are concerned with the potentially detrimental effects to the subspecies from future collection if silverspot locations, especially smaller populations, are made public, which would facilitate increased collection and potentially cause collection to become a major factor affecting the subspecies' viability.

Prescribed Burning or Wildfire

Direct mortality of butterfly larvae in the litter layer during dormant season burns has been observed in skippers (*Hesperia* spp.) and indirect mortality of larvae resulting from increased exposure to extreme winter conditions after fall burns remove the insulating litter layer has also been observed (Dana 1991, pp. 1, 55). Improperly timed burns can temporarily limit the availability of resources (such as bog violets and nectar sources) or cause delayed blooming or other phenology changes (Selby 2007, pp. 30, 31). Therefore, burns in the summer, fall or early winter (especially in overwintering areas), are likely to negatively influence *S. n. nokomis*. However, there is no evidence that burns have currently impacted *S. n. nokomis* and burns are therefore currently not considered to have influenced species viability. Burns can be beneficial for *S. n. nokomis* as described in section 3.3.3.

Pesticides

Pesticides (insecticides, herbicides, fungicides) have been widely used in the U.S. and could be influencing *S. n. nokomis* populations to some degree. Insecticides such as neonicotinoids and pyrethroids are known to cause impacts to monarch butterflies and their caterpillars (*Danaus plexippus*) and herbicides such as glyphospates affect their host plant milkweeds (*Asclepias syrica*) and could impact the butterfly themselves (Malcolm 2018, p. 281-284; Olaya-Arenas and Kaplan 2019; p. 10-14). In *S. n. nokomis* range there is more haying and grazing than cropland, and as a consequence there may be less application of pesticides on or near colonies than in many parts of the U.S. but the amount and type of pesticide use near *S. n. nokomis* colonies needs to be studied. We currently have some anecdotal evidence that herbicide application has occurred in a couple of colonies in the Ouray Population (Fisher 2022a, pers. comm.). However, it is unknown if the application has reduced nectar sources or the bog violet to an extent that it is affecting butterfly survival in those colonies. We are not aware that mortality of the butterfly, bog violet, or native nectar sources have occurred from pesticide use elsewhere and are not aware that pesticide use has currently reduced the viability of the species.

3.3.2 Major Factors

Habitat Loss and Fragmentation

Habitat loss from golf course and housing development is known to have caused extirpation of two historical colonies north of Durango, Colorado, (Ellis and Fisher 2020, pers. comm.). The remaining known site in the La Plata Population has residential and commercial development across the street from it and one of two drainages supplying it water has relatively new housing and golf courses all around within 1.5 air miles potentially degrading downstream *S. n. nokomis* habitat through hydrologic alteration. Housing development also appears to have been a contributing factor in extirpation of the Beulah, New Mexico, colony (Scott and Fisher 2014, p. 3). It is possible that Rifle Gap Reservoir and Dam degraded and fragmented habitat since one butterfly was sighted at a small wetland downstream of the dam and the reservoir flooded and fragmented habitat upstream. Additional habitat alteration upstream and downstream from a variety of factors also has likely fragmented habitat. Many other colonies/populations have development around them that also either directly encroach on the habitat or likely have caused degradation and fragmentation from homes, roads, hydrologic alteration and habitat conversion.

Agricultural habitat conversion can cause loss or fragmentation of habitat and typically involves mowing native meadows or growing exotic grasses for hay, though a variety of orchards also occur near riparian areas within *S. n. nokomis* range. Although it is unknown if all agricultural conversion has caused habitat to become unsuitable, aerial imagery reveals that agricultural conversion has been extensive within *S. n. nokomis* range. It has likely caused loss of unknown colonies over the last 150 years and has fragmented native habitat resulting in less connectivity between colonies and populations. Annual mowing may be less detrimental than mowing two or three times a summer. One site in the Chuska Mountains Population (out of *S. n. nokomis* range) (Cong et al. 2019) has had *S. nokomis* for many years even though mowing occurs there once a year typically in late August or September (Smith 2019, pers. comm.). Adults are flying then and most females have likely laid eggs by then. There is a fence in the middle of the mowed field that has lots of violets and may serve to protect the eggs from mowing, but there are also a good number of violets in the middle of the field (Smith 2019, pers. comm.). Consequently, the violets appear to largely not be affected by the mowing. Additionally, either the only eggs that survive are along the fence line, or the violets and bases of other vegetation in the mowed part of the field protect the eggs from crushing, or spaces between the tractor tires allow for some of the eggs to not be crushed. Despite potential compatibility with annually mowing native hay fields, agricultural conversion to unsuitable crops or fragmentation of habitat has been extensive. Additionally, direct or indirect effects of development of water diversion structures and removal of water from the natural system for agriculture has undoubtedly reduced habitat available for *S. n. nokomis* and therefore reduced viability of the species. Furthermore, residential and commercial development and other development like roads continues to limit and/or degrade habitat in or adjacent to existing colonies/populations. Habitat loss and fragmentation, therefore, reduces viability of the species.

Livestock Grazing

Livestock grazing may cause habitat loss and degradation if excessive, especially in the naturally scarce habitats of *S. n. nokomis* (Hammond and McCorkle 1983, p. 219). Grazing that is incompatible with *S. n. nokomis* can result from excessive grazing and/or timing of the grazing. Year-round grazing or summer grazing is typically incompatible because livestock graze on the violet leaves, nectar sources, and other vegetation necessary for the butterfly when the larvae and adults need them (Ellis 1999, p. 5). For example, an area explored in 2018 just south of a known site in the Ouray Population, has underlying hydrology and soils beneficial for *S. n. nokomis* but the habitat is unsuitable due primarily to grazing and perhaps to a lesser extent occasional mowing for hay (Figure 13). Bog violet, other forbs, and small willows beneficial for *S. n. nokomis* are evident immediately on the other side of the fence in Figure 13.

Light or moderate grazing in the summer may not cause significant impacts to *S. n. nokomis* colonies, however (Arnold 1989, p. 14). In practice, little summer grazing occurs on the colonies because many ranchers take their cattle or other livestock to higher elevation in the summer where there is better forage (Ireland 2022b, pers. observation).

If one or more kinds of vegetation are too dense it can prevent the bog violet from persisting and thus cause extirpation of the butterfly. This occurred in the Unaweep Seep colony in the Mesa/Grand Population perhaps primarily as result of spike rush invasion of meadows but also seemingly because of grass, sedge and willow invasion (Arnold 1989, pp. 9, 14; Ellis 1999, pp. 3, 5, 6). It is unknown if this would have occurred without grazing or, as the primary human use of the land, if long-term grazing was the factor that shifted vegetation. Without occasional setback of vegetation other herbaceous or woody vegetation could crowd out violets (Huhta et al. 2001, entire; Hellstrom et al. 2003, entire).

Grazing is ongoing in suitable habitat for the species and can limit availability of habitat throughout the range. Though it can be compatible, it is expected to continue to be a major factor influencing species viability.

Figure 13. Grazing in Ouray Population causing habitat unsuitability. Notice bog violet leaves on the fence line. Photo by Terry Ireland (Service), 2018.

Hydrologic Alteration

Hydrologic alteration is also a factor influencing species viability. Hydrologic alteration can result from a variety of sources including diversions for agricultural and domestic use, erosion and stream channel incision caused by livestock grazing, mining, roads, dredging and filling of wetlands, removal of beaver dams, creation and operation of large human-made dams, etc. For example, the only known colony in the Costilla Population has a diversion ditch delimiting its south side that may have reduced the size of the colony, and that ditch and other diversions have allowed for extensive agricultural development in the drainage that has altered native habitat and likely dropped the water table in much of the area. The Garfield Population colony area is near a large dam and reservoir that likely affects the natural hydrology. The La Plata Population has golf course and housing development that likely affects the natural hydrology. The Montrose County colony in the

Montrose/San Juan Population also has had livestock grazing and water diversions occurring in or near it over the last 30 years, which has degraded the quality of the wet meadow areas and lowered the water table (Ellis and Ireland 2018, pers. observation). The colonies in the Ouray, San Miguel/Mora, and Taos populations also have irrigation diversions, housing, roads, trails, and agricultural activities that have likely affected the natural hydrology.

Many drainages in the Sacramento Mountains, where the Mescalero *S. n. nokomis* colony may have occurred, succumbed to incision of streams around 1900, in turn lowering water tables and eliminating wet meadow habitat (Cary 2020d, pers. comm.). Incision of stream channels occurred due to erosion from deforestation, conversion to agricultural and grazing lands, mining, etc. (Cary 2020d, pers. comm.). Beaver were also eliminated around 1900 in the Sacramento Mountains (and other parts of the west), which also undoubtedly caused reduction of water tables and elimination of wet meadow habitat suitable for *S. n. nokomis* or other wetland dependent species (Cary 2020d, pers. comm.). Hydrologic alteration continues to limit suitable habitat and is a major factor influencing the viability of the species.

Genetic Isolation

Isolation can cause detrimental genetic and demographic effects and is a concern for *S. n. nokomis* population resiliency as well as redundancy and representation. Genetic isolation within the analyzed populations of *S. n. nokomis* does not currently appear to be an issue but may be in the future, especially if some populations become extirpated, leaving remaining populations even more isolated than in the current condition (Grishin 2020c, pers. comm.). Lower levels of genetic diversity can reduce the capacity of a population to respond to environmental change and may lead to reduced population fitness, such as longevity and fecundity (Darvill et al. 2006, p. 608). Britten et al. (1994) found low genetic diversity, likely from genetic drift (reduction in alleles of specific genes), in *S. n. apacheana* as a result of genetic isolation and small population sizes. Genetic exchange between and within populations can alleviate problems with genetic drift and also augment populations demographically. In *S. n. apacheana*, Fleischman et al. (2002, p. 708) documented routine dispersal distances up to 4 km (2.5 miles), and 26 percent of the recaptured butterflies had emigrated from the initial patch of capture. Britten et al. (2003, p. 232) stated that this migration appears to play an important role for *S. n. apacheana* populations both demographically and genetically. The benefits of genetic connectivity also apply to undiscovered colonies. Consequently, the ability or inability of *S. n. nokomis* individuals to migrate between colonies and populations is expected to also be of benefit or detriment, respectively, for *S. n. nokomis*.

Cong et al.'s (2019) finding of genetic isolation amongst populations of *S. n. nokomis* suggests reduced population fitness from genetic drift or other reasons could be of concern in the future. All known *S. n. nokomis* populations are at least 24.5 miles from each other and analysis indicates that they are genetically isolated from each other (Cong et al. 2019). Genetic analysis recently revealed that the Grand County colony is genetically similar to the Mesa County colonies and, hence, are part of the same population. Until recently (20-30 years ago) when Unaweep Seep was extant, the Grand County colony and Unaweep Seep colony in Mesa County were just under 20 miles apart. Since alleles within genes can remain in the genome for hundreds or thousands of years, 20-30 years is a short time frame for separation of genetically similar colonies. Therefore, based on the latest scientific evidence (Cong et al. 2019), populations that are at least 20 miles apart are assumed to be separate populations. Currently, the distance between the two closest populations, which we know are genetically different and represent separate populations, is 24.5 air miles (between the Taos and San Miguel/Mora populations in NM). Consequently, and more specifically, the distance where populations of *S. n. nokomis* may not interbreed and thus may not support each other genetically or demographically appears to be somewhere between 20 and 24.5 air miles. The minimum distance of 20 miles, based on findings of Cong et al. (2019), will be used in our analysis of genetic connectivity. The genetic analysis increases the distance from Ellis' professional opinion that colonies/populations further than 10 miles are likely isolated from each other (Ellis 2020e, pers. comm.); however, the shorter the distance the better the chance of genetic and demographic exchange as indicated in section 2.7 through Arnold (1989), Ellis (1989) and Ellis (2020a; 2020d; 2020e, pers. comm.). Genetic connectivity scorings for the current condition (and future condition scenarios) are explained further below in section 3.5. Reasons for isolation, specifically whether from natural fragmentation or human habitat alteration, are not currently known for all colonies. It is also not known how long single colonies may have been isolated from each other. If an isolated colony has enough area of habitat to support a large population, it may be resilient enough to survive without nearby colonies (such as the large Taos colony) and thus remain a viable population for a long time. However, many of the *S. n. nokomis* populations, whether single-colony or multi-colony metapopulations have a limited amount of habitat. It is unknown specifically how long it will take for low genetic diversity to become a threat to *S. n. nokomis* but isolation of populations suggests loss of genetic diversity could be a threat at some point, if loss of populations through lack of demographic support does not occur first, and both are cause of concern for species viability. Table 3 provides a summary of major factors likely to be influencing *S. n. nokomis* populations.

Table 3. Major factors likely to be negatively influencing current populations.

Population	Habitat Loss and Fragmentation	Livestock Grazing	Hydrologic Alteration	Genetic* Isolation
Archuleta		X	X	X
Conejos				X
Costilla	X		X	X
Garfield	X		X	X
La Plata	X		X	X
Mesa(CO)/Grand(UT)	X	X	X	
Montrose(CO)/San Juan(UT)	X	X	X	
Ouray	X	X	X	
San Miguel/Mora	X		X	
Taos	X	X	X	

***This identifies single-colony populations that are at greater risk of genetic isolation issues in the near-term than the multi-colony populations, but all may be at risk at some point in the future since there appears to be genetic isolation between the populations.**

Cumulative effects

By using the SSA framework to guide our analysis of the scientific information documented in the SSA report, we have not only analyzed individual effects on the species, but we have also analyzed their potential cumulative effects. We incorporate the cumulative effects into our SSA analysis when we characterize the current and future condition of the species. Our assessment of the current and future conditions encompasses and incorporates the factors individually and cumulatively. Because the SSA framework considers not just the presence of the factors, but to what degree they collectively influence risk to the entire species, our assessment integrates the cumulative effects of factors.

3.3.3 Beneficial Factors

Mowing

Mowing once per summer or early fall could be beneficial to open the canopy for violets, reduce a buildup of thatch from dead vegetation, and keep woody vegetation from encroaching beyond what is suitable for the butterfly. This would most likely only be beneficial if adequate nectar sources remain in the field or if there are enough within a short distance around the field to supply nectar to the adult butterflies.

Livestock Grazing

Winter and spring grazing (October to mid-April), if not too intense, can be compatible (Arnold 1989, pp. 14-15). This is because removal of thatch from the dead vegetation limits competition in the spring for the violets and can reduce woody vegetation so it does not encroach beyond what is suitable for the butterfly. It also may approximate historical grazing patterns by native ungulates (deer and elk), which come down to lower valleys where there is less snow in the winter. Grazing can potentially also be used to limit invasion of non-native plant species in some circumstances (Weiss 1999, p. 1485). Arnold (1989, p.14) noted that horses grazed an apparently healthy colony in the spring and summer, so some light to moderate grazing that time of year maybe acceptable, though it is unknown if late spring and summer grazing can be beneficial. Additionally, Ellis (2020g, pers. comm.) thought 20-30 percent utilization would be acceptable, though he would prefer to rest pastures entirely in the summer. In contrast, grazing when violets have emerged and are actively growing may be detrimental if livestock readily consume or trample the violets.

Burning

Burning of meadows at the right time of year to reduce dead vegetation and knock back woody vegetation to suitable levels for the butterfly can also be beneficial and can possibly increase violet density (Arnold 1989, p. 14; Ellis 1989, p. 14).

Exotic Plant Invasion

Some exotic plants considered invasive or adventive may provide nectar sources that benefit *S. n. nokomis* (Ellis 1989, p. 14; Fisher 2020e, pers. comm.). However, especially with invasive plants, this may only be the case where native nectar sources have been substantially reduced or eliminated.

3.4 Conservation Efforts

The historical Unaweep Seep colony in the Mesa/Grand population was designated as a State Natural Area in 1983 (Ellis 1999, p. 2). The designation brought recognition of the site as a unique natural area and allows for State research and monitoring of the site, including for the silverspot butterfly and bog violet. The BLM also established the Unaweep Seep Research Natural Area (RNA) around the colony in 1983 (Ellis 1989, p. 1). The RNA designation was accompanied by a habitat management plan that provided management objectives for habitats of the silverspot butterfly and other species and also allowed for research and monitoring (Ellis 1989, p. 1). The BLM also designated the RNA as an Area of Critical Environmental Concern through their 2015 Resource Management Plan (RMP; U.S. Bureau of Land Management 2015, pp. 207–208). The RMP closes the area to mechanized travel; prohibits commercial wood product sales, harvesting of forest and woodland products, Christmas tree cutting, and camping; manages the area as a Right-of-Way exclusion area; allows continued livestock grazing; withdraws it from mineral entry; closes it to mineral material disposal, leasing for fluid minerals, and geophysical exploration; and prohibits surface occupancy and surface disturbing activities (with some exceptions). Some monitoring, at least for the bog violet, occurred through 1999 (Ellis 1999, entire), but sometime between 1989 and 1999, the colony became extirpated (Ellis 1999, pp. 2, 7). Little to no monitoring occurred until 2017, when presence/absence surveys for the silverspot butterfly and violet were conducted by the

BLM, the Service, and Colorado Natural Areas Program.

The only other conservation effort that was contemplated was also in the Mesa/Grand Population. An assessment of the butterfly and its habitat for The Nature Conservancy was conducted to determine conservation efforts that could be taken to preserve the butterfly in Unaweep Canyon (Ellis 1989, entire). Management actions including conservation agreements, easements, and fee title acquisitions were recommended, but lack of landowner interest precluded further pursuit of the actions in 1990 (Ellis 2020h, pers. comm.). No other populations or colonies have had conservation efforts directed towards them that we are aware of.

3.5 Current Condition by Population

As described in section 3.2 – Materials and Methods, there are 10 populations we are evaluating for current condition. The only resiliency metrics available across all populations are the cumulative size of the population, number of colonies, genetic connection within the populations, and best estimate of occurrence of the three major habitat-related factors. The patch size and number of colony metrics were scored relative to each other with the assumption that more habitat and more colonies per population will provide more resiliency. Habitat patch sizes are estimates based on expert opinion using aerial imagery or on-the-ground observation and on best estimates of individual colony bog violet areas and primary nectar source areas. Section 2.7 – Population Needs, describes the number of acres needed for population resiliency. For habitat size scorings, based on best available information, and an assumption that not all habitat is high quality, to be more resilient populations need to have at least 12 acres of habitat (in either single- colony populations or cumulatively in metapopulations). Populations with less than 12 acres are considered less resilient and received a scoring of 1. Middle sized colonies (12-66.4 acres for the known populations) received a scoring of 2 since they are more than 12 acres. Only one population (Taos) has a very large number of acres and, based on expert opinion from a Technical Team member, consequently received a scoring of 6 since it is significantly larger than the next largest population. Due to the large habitat size, the colony has high potential for abundant nectar sources and abundant butterflies, thus giving it a higher likelihood of resiliency.

The more colonies in a population, the greater resiliency, because if one or even two of the colonies becomes extirpated then the remaining colony or colonies have an opportunity to recolonize the habitat (assuming habitat remains or returns to suitability). Multiple colony metapopulations are also more likely to have a better chance at maintaining genetic diversity, so a corresponding score was given to each colony in a population for both the number of colonies and for genetic connection within a population. Consequently, the "Number of Colonies" scoring illustrates a metapopulation's higher resiliency but the metapopulations also get a higher scoring by the "Genetic Connection Within a Population" scoring. Conversely, the populations with isolated colonies do not get bumped up in score because they are less likely to maintain genetic diversity. Colonies between 20 and 10 air miles apart will now receive a score of 1. However, based on observation and professional judgement by Ellis (2020e, pers. comm.) it is likely that colonies within 10 miles (and especially within 5 miles) have a better chance to maintain genetic connectivity. Therefore, populations where the two most distal colonies are within 10 miles will receive a "genetic connection within a population" score of 2.

Lastly, a score of -1 is given if a population has one or more major threats identified in the population. Scoring for this category is either 0 (no major threats) or -1 because we do not know enough about the immediacy or extent of threats to each population nor the effects of the threats to each specific population sufficiently enough to definitively state that the threats should be additive (and thus receive a score of -2, -3, or -4). For example, if housing development occurs around a colony, and/or if agricultural activity or grazing occurs, and/or if human-caused alteration of hydrology exists (usually in concert with one of the other major threats) then a -1 habitat factor score is applied. The habitat factor score is only applied to more directly obvious anthropogenic activities in the Current Condition (and future scenarios 1 and 2), not climate change-induced hydrologic changes (i.e., snow pack reduction in projected future scenarios) even though climate change can be attributed to human activity. Further discussion of how climate change-induced hydrologic change is addressed is stated under the Chapter 4 – Future Condition section. Some colonies within the multi-colony populations may or may not have the same factors present as their sister colonies but a negative factor in one colony will nonetheless reduce resiliency in the whole population because the colony presumably contributes less to the population's overall resiliency.

Discussion of the current condition of each population follows, with individual metric scores and total score for each population provided in Table 4. Definitions of current status used for the populations (and colonies) in this SSA are:

- ***Extant***: Adult *S. n. nokomis* observed in one or more of last four years (2019-2022).
- ***Likely Extant***: *S. n. nokomis* observed during surveys in the last 5-9 years and habitat is still present as far as can be determined.
- ***Unknown***: Not surveyed within the last 10 years but adults were present when last surveyed **or** surveyed only once or twice in the last 10 years and adults were not present **and** habitat is still present as far as can be determined. This category now incorporates the "Intermittent" category from Version 1.0 of the SSA (Service 2021).
- ***Likely Extirpated***: Adults not seen in recent survey, though survey of area not complete, and habitat is degraded.
- ***Extirpated***: Adults are not present for numerous years; bog violet may or may not be present. Or, a formerly occupied colony has been destroyed by habitat alteration from human actions.

We presume that populations and colonies whose status is likely extant or unknown still have a chance of being extant and are included along with extant populations in our resiliency analysis. However, some of these areas have not been surveyed recently and because of the annual life cycle of the butterfly it is possible that the colonies or populations are no longer occupied.

Archuleta Population

The Archuleta Population consists of a single colony and was first known in the late 1970's or early 1980's. Fisher (2020d, pers. comm.) visited it in 2019 but was not able to adequately survey it. A brief survey was completed in 2020 but the survey revealed that land outside a grazing exclosure was overgrazed (Johnson, pers. comm. 2020). Surveys were also conducted in 2021 and late in the field season in 2022 with no violets or butterflies found (Johnson 2021; 2022, pers. comm). It's suspected that degradation of the population's habitat has occurred from drying of the habitat as a result of channel incision to the local stream thus producing lack of hydrologic support, historical grazing (resulting in direct drying of habitat and likely exacerbating channel incision), and prolonged drought (Johnson 2021, pers. comm.; Whiteman 2022, pers. comm.). Consequently, the population receives a -1 habitat factor score. Based on survey information since 2019, the status of this population is "likely extirpated" with one more complete survey needed to confirm extirpation. The colony is on private land.

Conejos Population

The Conejos Population is a single colony on a State Wildlife Area. It is of moderate size relative to other populations. Fisher (2020d, pers. comm.) stated that a lepidopterist with knowledge of the species identification visited there in 2019 and found the butterfly, so we consider this population "extant." The colony was surveyed for bog violet on May 25, 2022 (Ireland 2022c, pers. comm.). No bog violets were found, but it may have been a little too early in the year for this area, and a more thorough survey on the south side of the stream would have been beneficial. This is the only population we know of that does not have signs of moderate or extensive human activity near it. Looking at aerial imagery, there is virtually no development and little agriculture upstream of the colony site. A potentially suitable habitat area below the colony was surveyed for a few hours by Scott Ellis and Lydia Thompson in 2019. Grazing appeared minimal and they found extensive sedges but no bog violet, suggesting there are some underlying hydrologic effects not readily apparent (Ellis 2020i, pers. comm.). However, due to presence of water at the colony site and little surrounding human activity, the resiliency score is not reduced by a negative habitat factor.

Costilla Population

The Costilla Population is a single colony originally found by lepidopterist James Scott (Fisher 2020d, pers. comm.) and then reconfirmed in 2010 by Mike Fisher (Ellis and Fisher 2020, pers. comm.). Agricultural hay production occurs extensively both upstream and downstream and a concrete water diversion ditch occurs through the colony. The population area was viewed from the road on May 26, 2022, and the habitat appeared grazed and irrigated with small overland ditches (Ireland 2022c, pers. comm.). Since the colony was not surveyed in 2022 during the adult flight season and since it has been over 10 years since the colony has been surveyed the status is now "Unknown". The colony appears to be on private land but further investigation into ownership is needed.

Garfield Population

The Garfield Population is a single colony represented by an observation of an adult(s) in 2006 by a knowledgeable lepidopterist. The site is near Rifle Gap Reservoir and Dam. It is possible the sighting was a stray but it would have had to come at least 80 air miles from its nearest neighbor, the Mesa/Grand Population, or farther from other populations. Consequently, it is likely, at least in the past, that the location was annually occupied by butterflies on-site or occasionally occupied by adults coming from a nearby colony of unknown location. There is potentially suitable habitat upstream and maybe downstream, though there are a lot of factors affecting riparian habitat in the area (development, agriculture, hydrologic alteration, etc.). There was no data on bog violet occurrence from the 2006 observation, so suitable habitat was estimated at 1 acre. The suspected colony area and the riparian zone approximately 0.5 miles downstream was surveyed for bog violets in May 2021 by Mike Fisher and Terry Ireland (Ireland 2021b, pers. comm.). There were no bog violets seen and it is possible that long-term hydrologic alteration as well as invasion by reed canarygrass (*Phalaris arundinacea*) has eliminated the bog violet from that area. However, a few undetected violets could still occur below the dam and additional survey is needed. An area containing dense violets upstream on State-owned land was discovered in May 2021 (Ireland 2021b, pers. comm.). This area was surveyed for the butterfly in August 2021 by Creed Clayton and Terry Ireland (Ireland 2021c, pers. comm.). No butterflies were seen, but additional surveys are needed. A 21-acre area to the west was surveyed by Scott Ellis and Lydia Thompson in 2022 (Ellis 2022, pers. comm.). Bog violets were present but no butterflies were seen; however, additional surveys are needed. Because additional surveys need to occur before we conclude the colony/population is extirpated we still consider the site as a population. Additionally, we are including the new suitable habitat sites as part of the population since they are within 10 miles of a known colony site, boosting the population acreage from 1 acre, as recorded in Version 1.0 of the SSA (Service 2021) to 25.8 acres in this Version of the SSA. However, we are only considering there to be one colony since no butterflies have yet been detected at the other two suitable habitat sites. Considering the poor quality of the habitat and lack of detection of the violet, the colony may be extirpated; however, with lack of sufficient amount of survey in the two new habitat areas, and some possibility of there still being violets and butterflies, we consider the overall population status as "Unknown". Land ownership at the colony, and about 0.5 air miles downstream, is public.

La Plata Population

The La Plata Population is currently only represented by a single colony; two other colonies formerly occurring there have been extirpated. The extant colony was first found in 1996 by observation-only, from knowledgeable lepidopterists. According to Mike Fisher (Ellis and Fisher 2020, pers. comm.) the remaining colony is occasionally occupied. However, if that is the case it means there is another colony of unknown location nearby supplying adults on occasion. Bog violets have been confirmed here in the past but Scott Ellis (Ellis and Fisher 2020, pers. comm.) did not see any violet-feeding butterflies there in 2019 and did not have access to confirm violet presence. This remaining colony has nearby housing and commercial development and may be impacted by hydrologic alteration upstream. Considering there has only been one recent and negative survey (2019) the colony status is now "Unknown". This colony occurs on private land.

Mesa (CO)/Grand (UT) Population

The Mesa/Grand Population consists of six colonies with extant or unknown status. Five of the colonies occur in Mesa County, Colorado and one occurs in Grand County, Utah. A seventh colony, Unaweep Seep, used to occur downstream and is the lowest elevation of the Mesa County colonies, but it became extirpated likely between 1990 and 2000. All of the colonies in Colorado are on private land. Mike Fisher observed a butterfly at the most-upstream Mesa County colony in 1998 but the colony has not been surveyed since then (Ellis and Fisher 2020, pers. comm.). The habitat still appears suitable, so the colony status is considered "unknown". The second colony downstream had *S. n. nokomis* confirmed present in 2018, were not observed during a survey in 2021, and were confirmed present again in 2022 (Ellis and Ireland 2018, pers. observation; Ireland

2021a, pers. comm.; Ireland 2022d, pers. comm.) so the colony status is “extant”. The third colony downstream was observed from the road in 2018 and a few *S. n. nokomis* were observed so the colony is considered “extant” (Ellis and Ireland 2018, pers. observation). The fourth colony down was not surveyed in 2018 and Scott Ellis is the last known person to observe butterflies there in 1989, but habitat does not appear to have been altered so the status is “unknown”. The fifth Mesa County colony had butterflies observed on it in 2021 (Ireland 2021a, pers. comm.) and 2022 (Ireland 2022d, pers. comm.). The Grand County, Utah, colony was confirmed extant in 2019 (Ellis and Thompson 2019, pers. observation) and was genetically identified as being part of the Mesa Population (Grishin 2020b, pers. comm.).

In 2022, three violet-only patches were discovered within 10 air miles of the Grand County colony. The violet patches were small, totaling just 2.04 acres. These violet-only acreages are added to the overall habitat size, but do not change the habitat size score from Version 1.0 of the SSA (see Table 4). If, after adequate surveys are conducted, no *S. n. nokomis* are found using the habitat patches, they will be removed from the habitat size calculation. The habitat size at the Grand County, Utah colony was reduced from 26.9 acres to 4 acres in 2022 based on on-the-ground observation and mapping. Much of the original acreage mapped by aerial imagery was found to be dense reed canary grass with no violets present. Reed canary grass is also present in some of the 4-acre area with violets (Ireland 2022e, pers. comm.). Several male and female *S. n. nokomis* were observed at this colony in 2022 (Ireland 2022e, pers. comm.). In Version 1.0 of the SSA (Service 2021) we considered the Mesa/Grand Population to be 66.4 acres. With reduction of the Grand County colony from 26.9 acres to 4.0 acres, but addition of the 2.04 acres of violet-only acreage, the total population size is now 45.6 acres.

Besides a dirt road used for recreational purposes the colony in Grand County does not have much development around it and is on public land. It does appear to have some grazing, but it is suspected that it is winter-grazed, so the grazing might be compatible (Ellis and Thompson, pers. observation 2019).

A property above the colony has center pivot irrigation and may draw some water away from the colony, but water supply still appears to be year-round. However, without further information it is uncertain whether the irrigation is actually affecting the colony, because the center pivots are at the apex of a very gentle divide between two drainages and, if surface water is used for the irrigation, most if not all of the surface water flows appear to come from and potentially return into the other drainage. There appears to be a minor drainage or two that flows into the drainage with the colony, and it is unknown if subsurface flows are affected by the irrigation. There is also extensive agriculture, grazing, and some hydrologic alteration in this population within Colorado. Some areas that at least held nectar sources and formed contiguous habitat between colonies have been altered enough by mowing or grazing that habitat has been lost. However, some colonies or areas in between may benefit from occasional mowing. Spring grazing and burning also likely still occur in the colonies and timing of both those activities may be beneficial or at least compatible (Arnold 1989, p. 14, 15; Ellis 1989, pp. 14, 18, 19). However, current management is uncertain.

Montrose (CO)/San Juan (UT) Population

A road cuts through *S. n. nokomis* habitat in the Montrose County portion of this population, creating two patches on either side. No butterflies were seen here in 2018 by Scott Ellis and Terry Ireland (pers. observation 2018). Potentially suitable habitat upstream and downstream was surveyed but most looked like it had been negatively affected by grazing, agricultural conversion, and hydrologic alteration. Prior to 2018, Scott Ellis had not been to the area for 30 years and said the creek has become incised since then and center pivot irrigation systems have been installed to irrigate hay or other crops. The habitat upstream of the road seemed reduced from Ellis's memory and certainly may be if the creek has become incised. The habitat immediately downstream had obvious signs of grazing, but most of the patch could not be surveyed due to brush blocking the view and private land access. Ellis also surveyed the Montrose County colony in 2021 and said it was in even worse shape than it was in 2018 due to dry stream beds from additional irrigation and also perhaps the drought (Ellis 2021, pers. comm.). Nonetheless, an attempt to access and survey potentially suitable habitat further downstream from the road is needed before extirpation can be confirmed.

A colony, previously unknown to FWS, was recently confirmed in August 2020 in San Juan County, Utah (Hannawacker 2020, pers. comm.). This colony is considered genetically connected to the Montrose colony given the distance between them (less than 10 air miles) and a likely hydrologic connection. The addition of this colony changes the status of the Montrose/San Juan Population from "likely extirpated" to "extant"; however, the Montrose colony is still considered likely extirpated.

In Version 1.0 of the SSA (Service 2021) we did not have the San Juan County colony size drawn in time for the SSA and consequently we only applied 0.96 acres based on habitat size of the Montrose colony. In 2021, habitat size for the San Juan colony was drawn as 11 acres (Ellis 2021, pers. comm.) but was estimated to be 21 acres in 2022 based on field observations (Hannawacker 2022, pers. comm.). Consequently, until further on-the-ground mapping is conducted, the difference will be split resulting in the San Juan colony being considered as 16 acres. Additionally, in 2022 three violet-only patches totaling 2.98 acres were discovered within 10 miles of the San Juan County colony and included in the overall habitat size of the Montrose/San Juan Population The addition of the 16 acres for the San Juan colony bumps the size score from a "1" in Version 1.0 of the SSA (Service 2021) to a "2" in this version of the SSA. The total size including the violet-only habitat is approximately 19.9 acres. The addition of a point for the size score also bumps up the overall resiliency score from a 4 to a 5, but that is still considered a moderate resiliency. Scorings for the "Number of Colonies" and "Genetic Connectivity Within a Population" were adjusted in Version 1.0 of the SSA (Service 2021) due to knowledge of those metrics at the time Version 1.0 was being written, so the scoring does not change for those two metrics in this version of the SSA.

Ouray Population

The Ouray Population is a multi-colony population that was recently known to consist of three colonies. However, as of 2022, the middle colony was confirmed as extirpated leaving two colonies (Fisher 2022b, pers. comm.). The middle colony last had *S. n. nokomis* observed on it in 2017 (Fisher 2020d; 2021; 2022b pers. comm.). It is bisected by a paved road, is immediately adjacent to a housing development, and has upstream hydrologic alteration on a tributary that supplies or used to supply water to the colony. It also has as an irrigation ditch along the road, but the ditch happens to be where the most violets were, so the ditch water may have supported this colony for some period of time. Violets were also not seen in 2022 in the middle colony (Fisher 2022b, pers. comm.), perhaps due to excessive growth of other plants, but consequently, the acreage has been removed from the habitat size calculation of the population.

The most southerly and upstream colony had butterflies in it in 2018 (Fisher 2018b, pers. observation). However, no butterflies were seen in four subsequent years of survey (Fisher 2020d; 2020g; 2021; 2022b, pers. comm.). The colony is now “likely extirpated” based on the negative surveys but still needs an additional adequate survey before it’s considered extirpated or extant. The colony is on private lands and appears to be grazed and may have been mowed for hay in the past. It is bordered by a county road.

The most northerly and downstream colony had a female *S. n. nokomis* confirmed there in 2021 (Fisher 2021, pers. comm.) and likely had a female observed there in 2022 (Fisher 2022b pers. comm.). The colony has a paved public trail running through it and some small buildings or sun shelters on it. It may be partially owned by the Town of Ridgway and by BLM, and perhaps by private landowners. However, land ownership needs to be further determined.

The habitat size in Version 1.0 of the SSA (Service 2021) was 59.3 acres but, due to extirpation of the middle colony and apparent lack of violets, is now 38.6 acres. Should violets be rediscovered in the middle colony area the then-current habitat will be added back into the habitat size. The reduction of the habitat size did not affect the “habitat size” score but the “number of colonies” score has been reduced from “3” to “2”. If butterflies are found at the extirpated site in the future, we will also restore the “number of colonies” score. The population status is considered “extant” due to the confirmed and likely observation of a female *S. n. nokomis* by Fisher (2021; 2022b, pers. comm.) on the northern-most colony, but due to only surveying from the public road at the southern colony and due to only a likely sighting at the northern colony additional surveys are needed to better determine its status.

San Miguel/Mora Population

As of 2021, the San Miguel/Mora Population consists of two small single colonies. A small 0.5-acre second colony was found in 2021 (Cary 2021, pers. comm) within 20 miles of the other colony. This increases the “number of colonies” score from 1 to 2 and also provides a “genetic connectivity” score of “1” to the population. The small acreage does not increase the “habitat size” score but the other metric score changes results in the resiliency of “1”in Version 1.0 of the SSA (Service 2021) to a “3” in this version of the SSA. The historical Beulah site used to occur in this population.

The first colony was first discovered in 2003 by Mike Fisher (2020d, pers. comm.). Butterflies were also observed there in 2004, 2006, and 2010. The area was also surveyed in 2019 but it was late in the season so the butterfly could still be there (Fisher 2020d, pers. comm.). However, due to the butterfly not being confirmed there since 2010 the colony status is prescribed as “Unknown”. Mr. Fisher saw a stray butterfly south of this colony so it is possible more butterflies exist in the area. The first colony has some development immediately near it and in the higher hillsides. There has also been hydrologic alteration in the drainage upstream but there is generally not much development upstream. The first colony appears to either be on private land or State Park land, but ownership needs to be further explored.

The second colony appears to be on private land, is encircled by roads and near development. The drainage also has housing development upstream and ditches diverting water for irrigation both upstream and downstream. In 2022 a large fire occurred near the colony; however, despite monsoonal rains and flooding in June 2022 the colony only appeared to have minor deposition of road material on its downstream end (Cary 2022, pers. comm.). The colony also has a significant amount of Canada thistle. Thistles are a preferred nectar source but perhaps should be managed so they don't choke out other vegetation. Since the second colony was observed in 2021 and 2022 the San Miguel/Mora Population is "Extant".

Taos Population

The Taos Population currently has four colonies. The Taos colony is very large (approximately 519 acres). The other three colonies have small habitat areas, 2 acres or less in size. Two colonies were discovered in 2022 (Friedrichs 2022a; 2022b, pers. comm.). The total size of the Taos Population is approximately 522 acres. The large colony was confirmed extant by Steve Cary (2019, pers. comm.).

There is some development on all but the north side of the Taos colony including housing, roads, water ditches, etc. The second colony is narrow and sandwiched between a small highway to the south and a straightened creek channel and agricultural field to the north. It also has quite a few trees and shrubs in it. The third colony has a secondary road splitting it with hay mowing surrounding one half and the road and hay mowing occurring on two sides of the other half. There appears to be significant water diversion and hayfields both upstream and downstream. The fourth colony has a significant amount of irrigated fields, houses, and commercial development surrounding it. In fact, the land has been so altered around there it's impossible to tell from an aerial view if the colony's water is supplied by a natural spring just upstream or if that is just where the land alteration happens to lessen a bit and the water supply is now a result of irrigation return flows. Determining water supply and any protection afforded the colony will be important. The fourth colony also appears to have had grazing in it by evidence of numerous small trails running through it but it's uncertain if the trails were made by domestic livestock or other animals. There is also a two-track trail that winds through the colony. The four colonies all appear to be on private land.

The four colonies are all within 20 air miles of each other. Based on the distance between colonies we now give the "Genetic Connectivity Within a Population" score a "2" thus bumping it up from a "1" in Version 1.0 of the SSA (Service 2021). The two new colonies also bump up the "Number of Colonies" score from "2" in Version 1.0 of the SSA to "4" in this version. With four colonies being confirmed since 2019 the Taos Population is "Extant".

Resiliency Scoring and Color Codes

Resiliency is scored by individual population. Redundancy and representation are scored for the subspecies as a whole (see Current Condition summary below and Table 13). To illustrate higher or lower resiliency, number scores and corresponding colors for resiliency categories have been established in Table 4 (and Future Condition tables (9-12)) as follows:

Black category – 0's; projected extirpation (future scenarios only); Red category – 1's; very low resiliency;
Orange category – 2 and 3's; low resiliency; Yellow category – 4's to 6's; moderate resiliency;
Green category – 7's and above; high resiliency.

Table 4. Current condition resiliency scorings for S. n. nokomis populations based on habitat size, number of colonies, genetic isolation, and negative habitat factors in each population.

Population Name	Current Population Status	Habitat Size (Acres)	Habitat Size Score	Number of Colonies Score	Within-Population Genetic Connectivity Score	Habitat Factor Score	Population Resiliency
COLORADO/ UTAH							
Archuleta	Likely Extirpated	11.9	**1**	**1**	**0**	**-1**	**1**
Conejos	Extant	39.2	**2**	**1**	**0**	**0**	**3**
Costilla	Unknown	4.3	**1**	**1**	**0**	**-1**	**1**
Garfield*	Unknown	25.8	**2**	**1**	**0**	**-1**	**2**
La Plata	Unknown	5.2	**1**	**1**	**0**	**-1**	**1**
Mesa/Grand (CO/UT)**	Extant	45.6	**2**	**6**	**2**	**-1**	**9**
Montrose/San Juan (CO/UT)***	Extant	19.9	**2**	**2**	**2**	**-1**	**5**
Ouray****	Extant	38.6	**2**	**2**	**2**	**-1**	**5**
NEW MEXICO							
San Miguel/Mora*****	Extant	1.5	**1**	**2**	**1**	**-1**	**3**
Taos******	Extant	522.2	**6**	**4**	**2**	**-1**	**11**

3.6 Summary of Current Condition

Resiliency

Of the 10 populations, three have a very low resiliency, three have a low resiliency, two have a moderate resiliency, and two have a high resiliency score. The very low resiliency populations are all small single-colony populations that have impacts to their habitat. The low resiliency populations are moderate-sized single colony or small two-colony populations that may or may not have impacts to their habitat. The moderate resiliency populations have moderate-sized two-colony populations that have good genetic connectivity due to the colonies within each population being 10 miles or less apart from one another. The high resiliency populations have 4 or more colonies, have moderate to large-sized colonies, and also have good genetic connectivity due to at least two of their colonies within the population being 10 miles or less away from each other.

Redundancy

With 10 populations spread across 284 air miles north to south and 237 air miles east to west, there appears to be adequate redundancy should catastrophic events occur that cause extirpation of one or a few populations. However, if catastrophic events cause extirpation of the Mesa/Grand Population, Taos Population, or even the Ouray Population it could be quite detrimental to the viability of the subspecies because 6 of the remaining populations have very low or low resiliency. Due to the uncertainty as to whether the Archuleta, Costilla, Garfield, La Plata, and even Conejos populations are truly extant, and due to low resiliency of many populations, more populations (and more resilient populations) would contribute to the subspecies' viability. However, assuming all populations are still extant, we consider the current condition of subspecies' redundancy to be moderate.

Representation

Eight butterfly populations were identified based on genetic differentiation (Cong et al. 2019). The other two populations were designated as such because they are more than 20 air miles away from other populations (41 and 80 miles), and it is likely populations more than 20 miles apart are not genetically connected (Ellis, pers. comm., 2020e; Grishin, pers. comm., 2020b). It is likely there is adaptive capacity due to the genetic differences between populations. However, since many of the populations are comprised of a single colony, and all populations appear isolated from one another, genetic drift could be causing limited genetic diversity which is a concern for the subspecies. In general, the bog violet and butterfly occur in the same habitat across the range, but there is some ecological variation because populations occur at different elevations and latitudes, which may contribute to adaptive capacity. This gives the subspecies a low- moderate level of representation overall. Future analysis of ecological settings at all colonies/populations is needed and will better inform levels of representation across the range.

Current Species Viability

There are currently 21 colonies representing the 10 populations that are considered extant. Current resiliency for each population ranges from very low (three populations) to high (two populations) with three populations having low resiliency and another two populations having moderate resiliency. Current redundancy is determined to be moderate and representation is thought to be low – moderate.

CHAPTER 4 – FUTURE CONDITION

4.1 Key Findings

With conservation measures implemented in Scenario 1 and relatively mild projected changes in climate by 2050, subspecies' viability is projected to improve (in terms of the 3R's) relative to the current condition. Conservation efforts under Scenario 2 also help increase subspecies' viability relative to the current condition, but not as much as in Scenario 1 due to a projected moderate change in climate. Climate is projected to change significantly in scenarios 3 and 4 and, thus, subspecies' viability is projected to decrease from the current condition under both scenarios.

4.2 Development of Future Scenarios

In this chapter, we forecast the resiliency of *S. n. nokomis* populations and the redundancy and representation of the subspecies to the year 2050 using a range of plausible future scenarios. We selected 30 years because climate models are thought to be reasonably plausible up to this point and, besides human-caused habitat impacts, are likely to be the biggest driver of changes to resiliency, redundancy, and representation. We use future climate projections down-scaled to southern Colorado and northern New Mexico (Rangwala 2020a, 2020b). Four climate models captured the range of model projections, thus we evaluate four future scenarios, though there could be numerous scenarios. Three of the four models captured use Representative Concentration Pathway (RCP) 4.5, and the other model uses RCP 8.5. RCP 4.5 is considered a medium emissions scenario. RCP 8.5 is considered a high emissions scenario. The higher the emissions the greater chance the climate will change further from the 1971-2000 baseline. Current policies are projected to take us slightly above the RCP 4.5 emission trends by mid-century (Hausfather and Peters 2020, p. 260).

Climate model data and descriptions are presented below in tables 5 and 6 for Colorado and tables 7 and 8 for New Mexico. In layman's terms, the climate model scenarios for both Colorado (which includes eastern Utah) and New Mexico are as follows:

Scenario 1: Warm
Scenario 2: Hot/Dry Summers/Very Wet Winters
Scenario 3: Very Hot/Very Dry Summers/Wet Winters
Scenario 4: Hot/Very Dry Summers/Dry Winters

There is little change in most precipitation metrics compared to the temporal baseline (1971- 2000) in Scenario 1. Most of the currently extant *S. n. nokomis* colonies are in rural to semi-rural areas without a high likelihood of dense development, so county population growth projections likely are not relevant to most populations since most of the growth in a county typically occurs around larger towns or cities. However, in Scenario 3 and 4 we assume development will occur around the colonies/population areas. The four scenarios represent future conditions; Scenario 1 and 2 assume conservation efforts are applied, but Scenario 3 and 4 do not include conservation efforts. Our evaluation of future condition represents a plausible range of expected subspecies' responses, using the results of our Current Conditions analysis (Chapter 3) as the baseline.

With snowpack and snow water equivalent, in particular, providing the majority of the water supply to the populations, droughts or warming and drying of habitat are likely the biggest climate factors driving future *S. n. nokomis* resiliency. Past climate records from tree rings and paleoclimate indicators suggest past droughts were more severe and sustained than any since modern records began around 1900 (Lukas et al. 2014, pp. 2-3). The butterfly has therefore, survived these more severe and prolonged droughts in the past and survived the more recent extreme, but short-term, droughts of 2002 and 2018.

Historically, populations may have been more resilient to survive the droughts of centuries ago because human influence on the landscape was minimal. With human habitat alteration occurring in most populations and the likely resultant isolation of populations there are probably fewer and more isolated colonies and populations of the butterfly now than there once were. Granted, drying and warming of the climate and changing of topography over millennia or at least since the last ice age may have naturally isolated some of the populations. If drying and warming occurs as projected in the four climate models the butterfly may be able to move upslope into more suitable climates, if the bog violet already occurs there (Ellis, pers. comm., 2020c).

Out of four projected climate scenarios to 2050 for the *S. n. nokomis* range in Colorado three of the four suggest extreme droughts (like 2002 or 2018) will occur three or four years out of five (Rangwala 2020a; Table 5). The most optimistic Colorado scenario suggests extreme droughts will occur once every five years. The New Mexico extreme drought projections for three of the four scenarios suggest extreme droughts will occur two to four years out of five, but, the most optimistic drought scenario increases in New Mexico from once every five years to once every three years, which is more frequent than for Colorado (Rangwala 2020b; Table 6).

If it appears hydrology of colonies/populations have been impacted by human activity, a habitat factor score of -1 is applied (though other factors may have also given a -1 score). However, for the future scenarios, climate change induced hydrologic changes are expressed through reduction in acreage size of habitat since, if there is less water, extent of the bog violet in a colony will undoubtedly be reduced and extent of nectar sources will also likely be reduced. We assumed that acreage size will be reduced by the percentage of snowpack reduction in the projected future scenarios, but the actual percent reduction of habitat could be more or less than the percent reduction of snowpack. An intensive long-term study of each colony would be needed to determine actual amount of habitat versus amount of snowpack. We have not attempted to include additional adjustments based on evaporative stress, but if temperatures are higher, that could cause more evaporation and even less available water to the butterfly's habitat.

The summary table below describes changes in the future climate for Colorado by 2050 (2040-2069) relative to the 1971-2000 period under four climate scenarios:

Table 5. Climate Scenarios by 2050 for Silverspot Butterfly (Colorado)

Climate Metric	Scenario 1 (MRI-CGCM3.rcp45)	Scenario 2 (HadGEM2-ES365.rcp45)	Scenario 3 (HadGEM2-ES365.rcp85)	Scenario 4 (IPSL-CM5A-MR.rcp45)	*Historical Value*
Winter Precipitation, inches (% change relative to historical)	1.6 (0)	1.9 (+19)	1.7 (+6)	1.5 (-6)	*1.6 inches*
Summer Precipitation, inches (% change relative to historical)	2.9 (+4)	2.7 (-4)	2.5 (-11)	2.4 (-14)	*2.8 inches*
Coldest Winter Temperature, °F (increases relative to historical by °F)	-2 (1)	3 (6)	6 (9)	3 (6)	*-3 °F*
Hottest Summer Temperature, °F (warmer relative to historical by °F)	98 (3)	101 (6)	104 (9)	101 (6)	*95 °F*
Avg. Winter Minimum Temperature, °F (warmer relative to historical by °F)	20 (2)	24 (6)	26 (8)	24 (6)	*18 °F*
Avg. Summer Maximum Temperature, °F (warmer relative to historical by °F)	89 (3)	93 (7)	96 (10)	92 (6)	*86 °F*
Growing Season Length (#days) (higher relative to historical by #days)	183 (20)	185 (22)	194 (31)	186 (23)	*163 days*
Winter Snowline (ft) (upward shift relative to historical, ft)	6490 (440)	7370 (1320)	7810 (1760)	7370 (1320)	*6050 ft*
Snowpack/Snow Water Equivalent, in (% change relative to historical)	0.09 (-10%)	0.07 (-30%)	0.045 (-55%)	0.05 (-50%)	*0.1 Inches*
Potential Evapotranspiration (Annual), in (% change relative to historical)	47 (+5%)	52 (+15%)	54 (+20%)	52 (+15%)	*45 inches*
Frequency of Extreme Drought Years like 2011/2018	Once in every five years	Three in every five years	Four in every five years	Three in every five years	*Twice between 1980-2018*

Values and projected changes described above are for the location at **38.475°N; 107.907°W** and a mean elevation of **5,780 ft**. Winter is Dec, Jan, Feb; Summer is Jun, Jul, Aug. Dataset: MACA metdata v2 (4-km downscaled climate projections) and gridMET (4-km historical).

Table 6. Description of Climate Scenarios by 2050 for Silverspot Butterfly (Colorado).

Future Climate Scenario	Projected Changes in Climate Metrics
Scenario 1	• Moderate increases in temperatures of 2°F in winter nighttime and 3°F in summer daytime temperatures • Very limited changes in precipitation with no change in winter and slight increases in summer precipitation • Hottest summer daytime high increases by 3°F; severe drought conditions occur once every 5 years • Moderate reductions in winter snowpack (10% lower) • Growing season increases by 3 weeks, and evaporative stress increases by 5%
Scenario 2	• Large increases in temperatures of 6°F in winter nighttime and 7°F in summer daytime temperatures • Large increases in winter (20% more) and slight reduction in summer (5% less) precipitation • Hottest summer daytime high increases by 6°F; severe drought conditions occur three in every 5 years • Large decreases in winter snowpack (30% lower) • Growing season increases by 3 weeks, and evaporative stress increases by 15%
Scenario 3	• Very large increases in temperatures of 8°F in winter nighttime and 10°F in summer daytime temperatures • Small increases in winter (5% more) and moderate decreases in summer (10% less) precipitation • Hottest summer daytime high increases by 9°F; severe drought conditions occur four in every 5 years • Substantial decreases in winter snowpack (55% lower) • Growing season increases by 1 month, and evaporative stress increases by 20%
Scenario 4	• Large increases in temperatures of 6°F in winter nighttime and 6°F in summer daytime temperatures • Small decreases in winter (5% less) but larger reductions in summer (15% less) precipitation • Hottest summer daytime high increases by 6°F; severe drought conditions occur three in every 5 years • Substantial decreases in winter snowpack (50% lower) • Growing season increases by more than 3 weeks, and evaporative stress increases by 15%

Information provided by Imtiaz Rangwala (Imtiaz.Rangwala@colorado.edu) North Central Climate Adaptation Science Center & CIRES, University of Colorado, Boulder

The summary table below describes changes in the future climate for New Mexico by 2050 (2040-2069) relative to the 1971-2000 period under four climate scenarios:

Table 7. Climate Scenarios by 2050 for Silverspot Butterfly (New Mexico)

Climate Metric	Scenario 1 (MRI-CGCM3.rcp45)	Scenario 2 (HadGEM2-ES365.rcp45)	Scenario 3 (HadGEM2-ES365.rcp85)	Scenario 4 (IPSL-CM5A-MR.rcp45)	*Historical Value*
Winter Precipitation, inches (% change relative to historical)	2.0 (0)	2.8 (+40)	2.4 (+20)	1.8 (-10)	*2 inches*
Summer Precipitation, inches (% change relative to historical)	5.6 (-5)	4.9 (-20)	4.5 (-25)	4.1 (-30)	*6 inches*
Coldest Winter Temperature, °F (increases relative to historical by °F)	-5 (4)	-1 (8)	1 (10)	-5 (4)	*-9 °F*
Hottest Summer Temperature, °F (warmer relative to historical by °F)	89 (3)	91 (5)	95 (9)	92 (6)	*86 °F*
Avg. Winter Minimum Temperature, °F (warmer relative to historical by °F)	13 (3)	16 (6)	17 (7)	15 (5)	*10 °F*
Avg. Summer Maximum Temperature, °F (warmer relative to historical by °F)	80 (2)	84 (6)	87 (9)	84 (6)	*78 °F*
Growing Season Length (#days) (higher relative to historical by #days)	129 (12)	153 (36)	167 (50)	157 (40)	*117 days*
Winter Snowline (ft) (upward shift relative to historical, ft)	8200 (900)	9100 (1800)	9400 (2100)	8800 (1500)	*7300 ft*
Snowpack/Snow Water Equivalent, in (% change relative to historical)	0.45 (-10%)	0.43 (-15%)	0.25 (-50%)	0.2 (-60%)	*0.5 Inches*
Potential Evapotranspiration (Annual) (% change relative to historical)	51 (+15%)	53 (+20%)	57 (+30%)	51 (+15%)	*44 inches*
Frequency of Extreme Drought Years like 2002/2018	Once in every three years	Two in every five years	Four in every five years	Three in every five years	***Twice between 1980-2018***

Values and projected changes described above are for the location at **36.737°N; 105.907°W** and a mean elevation of **8,200 ft**. Winter is Dec, Jan, Feb; Summer is Jun, Jul, Aug. Dataset: MACA metdata v2 (4-km downscaled climate projections) and gridMET (4-km historical).

Table 8. Description of Climate Scenarios by 2050 for Silverspot Butterfly (New Mexico)

Scenario 1	• Moderate increases in temperatures of 3°F in winter nighttime and 2°F in summer daytime temperatures • Very limited changes in precipitation with no change in winter and slight decreases in summer (5% less) precipitation • Hottest summer daytime high increases by 3°F; severe drought conditions occur once every 3 years • Moderate reductions in winter snowpack (10% lower) • Growing season increases by 2 weeks, and evaporative stress increases by 15%
Scenario 2	• Large increases in temperatures of 6°F in winter nighttime and 6°F in summer daytime temperatures • Very large increases in winter (40% more) but large decreases in summer (20% less) precipitation • Hottest summer daytime high increases by 5°F; severe drought conditions occur two in every 5 years • Moderate reductions in winter snowpack (15% lower) • Growing season increases by 5 weeks, and evaporative stress increases by 20%
Scenario 3	• Very large increases in temperatures of 7°F in winter nighttime and 9°F in summer daytime temperatures • Large increases in winter (25% more) but large decreases in summer (25% less) precipitation • Hottest summer daytime high increases by 10°F; severe drought conditions occur four in every 5 years • Substantial decreases in winter snowpack (50% lower) • Growing season increases by 7 weeks, and evaporative stress increases by 30%
Scenario 4	• Large increases in temperatures of 5°F in winter nighttime and 6°F in summer daytime temperatures • Moderate decreases in winter (10% less) but much larger reductions in summer (30% less) precipitation • Hottest summer daytime high increases by 6°F; severe drought conditions occur three in every 5 years • Substantial decreases in winter snowpack (60% higher) • Growing season increases by more than 5 weeks, and evaporative stress increases by 15%

Information provided by Imtiaz Rangwala (Imtiaz.Rangwala@colorado.edu) North Central Climate Adaptation Science Center & CIRES, University of Colorado, Boulder.

In addition to increased drought frequency, too much rain at the wrong time, and/or elevated average temperature, could reduce survival or mating potential. As springs get warmer earlier and fall stays warmer longer, the larvae may emerge from diapause earlier or not enter pupation until later than normal. Subsequently, late spring and fall frosts could end up killing active larvae (Ellis, pers. comm., 2020j). Similarly, the larval activity may be asynchronous with the bog violet food source resulting in larval starvation (Ellis, pers. comm., 2020j). Furthermore, a longer activity period could expose the larvae to increased parasitism and predation (Fisher, pers. comm., 2020f). Without data and with variability in microsites, it is extremely difficult to project how these survival factors could be affected and thus there are no scorings for them, but the likely influence of a longer growing season and other climate variables are discussed in the text.

4.2 Scenario 1 – Warm climate with Conservation Efforts

There are several assumptions under each scenario. The first five assumptions below are in respect to habitat and can influence the Habitat Factor Score. The last two assumptions relate to the Within-population Connectivity or Diversity Score. The fifth assumption also addresses the level of snowpack that can influence the Habitat Size and Habitat Size Score. The predicted snowpack change in Scenario 1 (see list of climate metrics below) is small enough we do not think it will change the habitat size but for scenarios 2-4 it will. Scenario 1 assumes:

- No new increase in direct habitat loss by development.
- Existing habitat loss through development does not change.
- Habitat fragmentation by agricultural conversion is reduced or hay mowing occurs no more than annually and allows for improvement in habitat quality.
- Grazing is only conducted in the winter and early spring and at an intensity that is compatible with the needs of the butterfly.
- Efforts made to maintain current hydrology are successful in most populations and no colony size adjustment for slightly smaller reduced snowpack is included due to the lowest extreme drought frequencies.
- The possibility for restoration, and especially creation, of habitat is currently unknown, thus size and number of colonies remains the same with respect to those potential activities.
- Translocation of butterflies to existing colonies, likely first through rearing larvae in a lab, are implemented in accordance with recommendations by geneticists to boost genetic diversity and are successful. The heading for the genetic scoring is now stated as "Genetic Connection or Diversity Within a Population" to account for human translocation efforts boosting diversity.

The Scenario 1 climate model is at an RCP level of 4.5, which is approximately the current RCP level produced by humans. Scenario 1 is the most positive outlook for climate at RCP 4.5. Compared to baseline conditions climate metrics are summarized as follows:

- Winter and summer temperatures will get slightly warmer but highs and averages do not appear to increase much.
- Winter and summer precipitation will stay about the same as baseline conditions.

- The chance of extreme drought rises significantly from the 1980 to 2018 frequency to one in five years for Colorado (CO) or one in three years for New Mexico (NM). Snowpack will decrease moderately (10 percent) in both CO and NM and evaporative stress will increase 5 to 15 percent, respectively.
- Growing season increases 20 days in CO and 12 days in NM.
- Winter snowline goes up in elevation 440 feet in CO but drops 810 feet in NM.

Overall, climate changes in this scenario appear tolerable for *S. n. nokomis* and with conservation efforts, resiliency improves from the Current Condition to moderate for four of the six low or very low resiliency populations. In this scenario, growing season increases 20 days from the baseline in CO and 12 days in NM, and will likely reduce larval survival from disease and predation relative to current conditions. Winter snow cover might help prevent freezing and desiccation of larvae, but due to its long-term variability it is not certain that it necessarily increases survival. Consequently, winter snowlines are summarized but we do not make projections on resiliency based on snow line, and any water contribution this lower elevation snow offers is likely outweighed by benefits of snowpack.

Resiliency scorings result in two low resiliency populations, six moderate, and two high resiliency populations as presented in Table 9. It is assumed that 6 of the 10 populations would have resiliency increased due to increased genetic diversity as a result of translocation of butterflies. It is assumed that five populations would also increase in resiliency from habitat-improving conservation efforts. It is conversely assumed that four of the populations could not be significantly improved through conservation efforts due to existing development near them and retain a -1 habitat factor scoring. Redundancy is expected to remain the same (moderate) compared to the current condition (see Table 13). Representation is expected to improve to moderate through increase in genetic diversity via translocations, but variability would likely still exist amongst all the populations.

This scenario represents a projected increase in viability for the species relative to current conditions due to relatively mild climate change coupled with the addition of conservation efforts improving resiliency, the maintenance of moderate redundancy, and an increase to moderate representation due to conservation efforts. Should conservation measures not be successful or not be implemented as projected in Scenario 1, we would expect resiliency, redundancy, and representation to be similar to the current condition.

Table 9. Resiliency scorings for S. n. nokomis populations under Scenario 1. Current population status is for reference and does not change. Habitat size (acres) and resiliency scores in the following two columns (Habitat Size Score and Number of Colonies Score) remain the same as in Current Condition. Changes from Current Condition occur in the last three columns.

Population Name	Current Population Status	Habitat Size (Acres)	Habitat Size Score	Number of Colonies Score	Within-Population Connectivity OR Diversity Score	Habitat Factor Score	Population Resiliency
COLORADO/ UTAH							
Archuleta*	Likely Extirpated	11.9	**1**	**1**	**2**	**-1**	**3**
Conejos	Extant	39.2	**2**	**1**	**2**	**0**	**5**
Costilla	Unknown	4.3	**1**	**1**	**2**	**0**	**4**
Garfield	Unknown	25.8	**2**	**1**	**2**	**-1**	**4**
La Plata	Unknown	5.2	**1**	**1**	**2**	**-1**	**3**
Mesa/Grand	Extant	45.6	**2**	**6**	**2**	**0**	**10**
Montrose/San Juan	Extant	19.9	**2**	**2**	**2**	**0**	**6**
Ouray	Extant	38.6	**2**	**2**	**2**	**-1**	**5**
NEW MEXICO							
San Miguel/Mora	Extant	1.5	**1**	**2**	**2**	**0**	**5**
Taos	Extant	522.2	**6**	**4**	**2**	**-1**	**11**

*Recent information (Johnson 2021; Whiteman 2022, pers. comm.) suggests that grazing, hydrologic alteration (from channel incision), and drought have affected the Archuleta Population causing its status to become “Likely Extirpated”. Therefore, in contrast to Version 1.0 of the SSA (Service 2021) we do not think hydrology can be maintained to support the population.

4.3 Scenario 2 – Hot/Dry Summers/Very Wet Winters with Conservation Efforts

This scenario's habitat-related assumptions are only different than Scenario 1 with regards to the following:

- Efforts are made to maintain current hydrology but, due to drop in snowpack and increase in drought frequency, hydrology is not maintained in areas with extensive agriculture or moderate levels of housing development due to need for water for those two major factors. Projected reduction of snowpack of 30 percent in CO and 15 percent in NM reduce the size of colonies in proportion to that reduction from current condition.

Scenario 2 climate model is based on RCP 4.5, however, since the model is different it projects more severe changes in climate than the Scenario 1 model. Compared to baseline conditions climate metrics are summarized as follows:

- Winter and summer temperatures will increase (5-9°F) over the historical values in both CO and NM.
- Winter precipitation (including rain) will go up significantly by 19 percent in CO and 40 percent in NM.
- Summer precipitation will remain about the same in CO but drop significantly in NM (20 percent).
- Extreme drought is projected to increase in frequency to every two years out of five in CO and every three years out of five in NM.
- Large to moderate decrease in snowpack of 30 percent in CO and 15 percent in NM.
- Growing season will be 3 weeks longer, and there will be 15 percent more evaporative stress in CO, while NM growing season increases by 5 weeks and has a 20 percent increase in evaporative stress.
- Winter snowline goes up in elevation by 1320 feet in CO and 70 feet in NM.

Increases and decreases in climate metrics are very mixed within each model, so the effect to *S. n. nokomis* is difficult to determine. However, climate changes in this scenario are expected to override conservation efforts in some CO populations due primarily to a large decrease in snowpack, but also in NM due primarily to increase in evaporative stress. Both these factors will likely create less water for bog violet survival and/or nutrition, limit bog violet distribution, allow for fewer nectar sources, and possibly increase chance of egg mortality and larval desiccation. Additionally, the higher summer temperatures may reduce the amount of time for mating and nectaring in all populations and perhaps even reduce fecundity. Negative habitat factor scores are thus applied to all populations. We assume genetic diversity efforts will produce the same results as Scenario 1, but this may not be the case if fewer butterflies are available for mating or fewer larvae survive. This scenario's growing season increases relative to Scenario 1 in both CO and, especially, NM and will likely reduce larval survival from disease and predation more so than Scenario 1.

Resiliency scorings for each population follows in Table 10. Population resiliency is generally projected to improve relative to the current condition in this scenario, but there is one more population in the low resiliency category compared to Scenario 1. This is due to a negative habitat factor score being applied to the Costilla population (as well as all but the Conejos Population) from less water availability in CO and NM because of decreased snowpack or other factors in the

Archuleta Population (see Table 9 and 10 footnote). Increased evaporative stress due to higher temperatures as well as more frequent severe drought will likely push even the Conejos Population to a threshold where its resiliency under Scenario 2 is questionable or at least further diminished. Due to already existing habitat conditions the Archuleta Population's existence is tenuous.

We assume in this scenario that successful translocation of butterflies to single-colony populations increases genetic diversity, and the genetic diversity scoring remains high for all populations as in Scenario 1. Under this scenario there are three low, five moderate, and two high resiliency populations. The Mesa/Grand Population resiliency drops a point due to application of the negative factor score from less available water coupled with human development/agricultural need for the water. The Taos Population also drops a point in score because of size reduction due to less snowpack. We assume in Scenario 2 that the climatic conditions are not so severe as to cause extirpation of colonies/populations and decrease redundancy. Representation might improve slightly through increase in genetic diversity via translocations and variability would likely still exist amongst all the populations, but improving diversity could be challenging. Subspecies' viability decreases slightly from Scenario 1 due to a slightly worse climate projection. This scenario represents a projected increase in viability for the subspecies relative to the current condition due primarily to conservation efforts. However, climate change is significant enough under Scenario 2 that resiliency and perhaps even redundancy and representation would decline from current condition without conservation measures.

Table 10. Resiliency scorings for S. n. nokomis populations under Scenario 2. Current population status is for reference and does not change. Habitat size (acres) changes from Scenario 1. Only the Taos Population Habitat Size Score changes. Habitat Factor Scores change from Scenario 1 and so do overall resiliency scores in the last column.

Population Name	Current Population Status	Habitat Size (Acres)	Habitat Size Score	Number of Colonies Score	Within-Population Connectivity OR Diversity Score	Habitat Factor Score	Population Resiliency
COLORADO/ UTAH							
Archuleta*	Likely Extirpated	8.3	**1**	**1**	**2**	**-1**	**3**
Conejos	Extant	27.4	**2**	**1**	**2**	**0**	**5**
Costilla	Unknown	3.0	**1**	**1**	**2**	**-1**	**3**
Garfield	Unknown	18.1	**2**	**1**	**2**	**-1**	**4**
La Plata	Unknown	3.6	**1**	**1**	**2**	**-1**	**3**
Mesa/Grand	Extant	31.9	**2**	**6**	**2**	**-1**	**9**
Montrose/San Juan	Extant	13.9	**2**	**2**	**2**	**-1**	**5**
Ouray	Extant	27.0	**2**	**2**	**2**	**-1**	**5**
NEW MEXICO							
San Miguel/Mora	Extant	1.3	**1**	**2**	**2**	**-1**	**4**
Taos	Extant	443.9	**5**	**4**	**2**	**-1**	**10**

*Recent information (Johnson 2021; Whiteman 2022, pers. comm.) suggests that grazing, hydrologic alteration (from channel incision), and drought have affected the Archuleta Population causing its status to become "Likely Extirpated". Therefore, in contrast to Version 1.0 of the SSA (Service 2021) we do not think hydrology can be maintained to support the population.

Scenario 3 – Very Hot/Very Dry Summers/Wet Winters No Conservation Actions

This scenario is the most pessimistic of the four scenarios in regards to negative climate effects and *S. n. nokomis* viability. Most of the habitat-related assumptions have changed from Scenario 1 and Scenario 2 and are as follows:

- An increase in direct habitat loss due to development occurs, particularly in colonies close to existing housing development.
- Habitat fragmentation due to agricultural conversion remains unchanged from the current condition.
- Greater negative effects from summer grazing occurs because of dry or drought conditions (an increase from current condition) that reduces nectar sources.
- No efforts are made to maintain current hydrology, and, in combination with dry or drought conditions, we assume small colonies (less than 12 acres) will dry up and become extirpated and larger remaining colonies are reduced in size (a decrease in suitable habitat from the current condition).
- All populations receive a negative habitat factor score due to climate-related hydrologic alteration whether there is surrounding development or not.
- No translocations of butterflies are implemented, and we assume genetic diversity is low.

Scenario 3 climate model emissions are based on RCP 8.5, and this model projects more severe changes in climate than Scenario 1 or 2 climate models. Compared to baseline conditions, climate metrics in this scenario are summarized as follows:

- Winter and summer temperatures will increase (7-10°F) over the historical values in both CO and NM.
- Winter precipitation (including rain) will only go up a small amount (5 percent) in CO but increase 25 percent in NM.
- Summer precipitation will have moderate drop of 10 percent in CO and drop significantly in NM (25 percent).
- Extreme drought is projected to occur in both States in four out of five years.
- A substantial decrease in snowpack will occur in both CO (55 percent) and NM (50 percent).
- The growing season will be 4 weeks longer and have 20 percent more evaporative stress in CO, while NM growing season increases 7 weeks and has 30 percent increase in evaporative stress.
- Winter snowline goes up in elevation by 1760 feet in CO and 510 feet in NM.

The only increase that is potentially beneficial in this climate model is an increase in winter precipitation that might modestly ameliorate the hot dry summers, but this is unlikely since snowpack decreases so significantly, droughts occur nearly every year, and evaporative stress increases significantly over baseline conditions in this scenario. No conservation efforts are included in this scenario but even if they were, climate changes in this scenario are expected to override any conservation efforts. The very hot and dry conditions will likely create less water for bog violet survival and/or nutrition, limit bog violet distribution, allow for few nectar sources, and possibly increase the chance of egg mortality and larval desiccation (though overwinter survival could increase slightly). Due to lack of water under this projected climate scenario, we assume the small single-colony populations less than 12 acres have no habitat left in the future and will become extirpated. These are represented in black in Table 11. Additionally, small colonies less than 12 acres in the metapopulations also become extirpated with resultant resiliencies discussed below. The Archuleta, Costilla, and La Plata Populations are all small single-colony populations that currently are not known to have additional violet patches within 10 miles. Consequently, they are all projected to become extirpated under this Scenario.

Although the Conejos Population is a single colony, habitat area is large enough we projected it will persist, though having less water will likely reduce its size, and it receives a -1 habitat factor score under Scenario 3 due to less available water (even though no substantial development or agricultural activities exist around it).

The Garfield Population is a single colony but has two habitat-only patches within 10 miles of the otherwise single colony. The habitat patches are estimated to be 3.75 and 21 acres. The colony with the butterfly is 1 acre. Under this scenario the colony with the butterfly and the small habitat patch disappear due to the dry conditions. The larger 21-acre patch will persist, albeit at a smaller projected size of 9.5 acres due to the 55% snowpack reduction, and allows the Garfield Population to persist at a very low resiliency. This is assuming the butterfly will be found to occupy the habitat patch.

We projected loss of the five colonies under 12 acres in the Mesa/Grand Population and assume the largest colony (17.2 acres) will persist. Due to only having one colony remaining, there will be no genetic connectivity within the population, thus lowering the “Genetic Connectivity” score to 0. In this version of the SSA we decided that habitat with 10 miles of a known colony will be included in the “Habitat Size” calculation. Three habitat patches totaling 2.04 acres were discovered in 2022 within 10 miles of the Grand County colony. However, because all three patches are under 12 acres they are projected to dry out under the climate conditions projected under this scenario, and are not counted in the acreage calculation. Consequently, the loss of colonies, reduced size of the remaining colony to 7.7 acres (due to the 55% reduction in snowpack), and the loss of genetic connectivity result in a very low resiliency for the Population.

We projected that the Montrose/San Juan Population will lose the 0.96-acre colony due to less water in the already degraded drainage. However, due to what appears to be a good water supply and currently estimated size of 16 acres, the San Juan County colony is expected to persist, albeit with a smaller projected habitat size. Similar to the Mesa/Grand Population, there were three habitat patches totaling 2.98 acres discovered in 2022 within 10 miles of the San Juan colony. However, because the three patches are all under 12 acres they are also projected to dry out with the projected climate under this scenario and are not counted in the acreage calculation. Consequently, the 16-acre San Juan colony is the only colony projected to persist, but it will be reduced to 7.2 acres due to the 55% reduction in snowpack. The loss of the colony will negate the genetic connectivity score and the reduced size of the colony and reduced number of colonies will result in a very low resiliency for this Population.

The Ouray Population's middle colony was confirmed extirpated in 2022 and no violets were seen recently at the colony (Fisher 2022b, pers. comm.). As such, the habitat acreage has currently been removed from acreage calculations leaving 38.6 acres in the current condition for the two remaining colonies (which are both 12 acres or more). However, with the 55% snowpack reduction estimated for Scenario 3 it is projected that only 17.4 acres will remain in the two colonies. Nonetheless, the acreage is large enough to continue receiving a score of "2" for the "Habitat Size", the "Number of Colonies" score is "2", and "Genetic Connectivity" also receives a score of "2" because the two colonies are still within 10 miles of each other. The "Habitat Factor" score is reduced by one point due to lower water availability and surrounding development giving the Population a total score of "5". This is a moderate resiliency ranking which is the most resilient population in Scenario 3.

Although the San Miguel/Mora Population had another colony discovered in it in 2021 (Cary 2021, pers. comm.) and is now considered a metapopulation with two colonies, both colonies are small enough (1 acre and 0.5 acres) that it is projected the Population will become extirpated under this scenario.

Lastly, the Taos Population is projected to lose its three small colonies (2.2, 0.5, and 0.5 acres) due to reduced snowpack, which, by leaving only the one large colony removes Taos' genetic connectivity score. Furthermore, with a projected 50 percent reduction in snowpack in the New Mexico portion of the range under this scenario, it is assumed that the 519-acre Taos colony will decrease by a corresponding 50 percent. Therefore, it would be reduced to 259.5 acres and three points in size score.

Additionally, the higher summer temperatures may reduce the amount of time for mating and nectaring in all populations and perhaps even reduce fecundity. The negative habitat factor score is applied to all populations as a result of reduction in hydrology. Genetic diversity will not increase with no conservation efforts, and fewer butterflies will be produced, likely creating worse resiliency. However, we kept the genetic diversity score at "2" for the Ouray Population since, under our assumptions, there are still two or more colonies in each population that are less than 10 miles from each other. This scenario has the longest growing season in both CO and NM and will also likely reduce larval survival due to increased disease and predation relative to scenarios 1 and 2.

Resiliency scorings for each population follow in Table 11. Four of the six populations that previously scored low or very low resiliency under current conditions are expected to become extirpated in Scenario 3. In addition, three populations have a very low resiliency, two are low resiliency, and the Ouray Population retains a moderate resiliency, surpassing the Mesa/Grand and Taos populations as the highest scoring population. Extirpation of colonies will reduce resiliency and redundancy of populations and will also undoubtedly decrease representation in this scenario compared to scenarios 1, 2, and the current condition, causing a decline in species viability.

Table 11. Resiliency scorings for S. n. nokomis populations under Scenario 3. Current population status is for reference and does not change.

Population	Current Population Status	Habitat Size (Acres)	Habitat Size Score	Number of Colonies Score	Within-Population Connectivity OR Diversity Score	Habitat Factor Score	Population Resiliency
COLORADO/ UTAH							
Archuleta	Likely Extirpated	0	**0**	**0**	**0**	**-1**	**0**
Conejos	Extant	17.6	**2**	**1**	**0**	**-1**	**2**
Costilla	Unknown	0	**0**	**0**	**0**	**-1**	**0**
Garfield*	Unknown	9.5	**1**	**1**	**0**	**-1**	**1**
La Plata	Unknown	0	**0**	**0**	**0**	**-1**	**0**
Mesa/Grand**	Extant	7.7	**1**	**1**	**0**	**-1**	**1**
Montrose/San Juan	Extant	7.2	**1**	**1**	**0**	**-1**	**1**
Ouray***	Extant	17.4	**2**	**2**	**2**	**-1**	**5**
NEW MEXICO							
San Miguel/Mora	Extant	0	**0**	**0**	**0**	**-1**	**0**
Taos	Extant	259.5	**3**	**1**	**0**	**-1**	**3**

**Since Version 1.0 of the SSA (Service 2021), on-the-ground mapping decreased the size of the Grand County colony from 26.9 to 4 acres. Consequently, under this scenario the Grand County colony now becomes extirpated in contrast to Version 1.0 of the SSA, leaving only one colony over 12 acres that is not assumed to become extirpated (a 17.2-acre colony). As a result, the Mesa/Grand Population Resiliency slips from a "2" to a "1" and from a "low" to a "very low" resiliency.

Scenario 4 –Hot/Very Dry Summers/DryWinters No Conservation Actions

This scenario is the second-most pessimistic of the four scenarios in regards to negative climate effects and *S. n. nokomis* viability. The habitat-related assumptions do not change from Scenario 3.

Scenario 4 climate model emissions are based on RCP 4.5, but due to less winter and summer precipitation in CO and, especially less snowpack, this scenario is slightly worse for *S. n. nokomis* than Scenario 2 in CO. Interestingly, in NM this model is worse than Scenario 2, because it projects less winter and especially summer precipitation, as well as significantly reduced snowpack even relative to Scenario 3. Overall Scenario 4 is minimally better than

Scenario 3 in some ways but could arguably be considered worse due to less snowpack and less winter and especially less summer precipitation. Compared to baseline conditions, climate metrics are summarized as follows:

- Winter and summer temperatures will increase (4-6°F) over the historical values in both CO and NM.
- Winter precipitation (including rain) will decrease 6 percent in CO and will decrease 10 percent in NM.
- Summer precipitation will have the largest drop of any model, decreasing 14 percent in CO and decreasing significantly in NM (30 percent).
- Extreme drought is projected to occur in both States three out of five years.
- A substantial decrease in snowpack will occur in both CO (50 percent) and NM (60 percent).
- The growing season will be over 3 weeks longer and there will be 15 percent more evaporative stress in CO, while the NM growing season increases 6 weeks and also has a 15 percent increase in evaporative stress.
- Winter snowline goes up in elevation by 1320 feet in CO and 70 feet in NM.

With such significant decrease in snowpack, droughts occurring every three out of five years, and the second or third highest evaporative stress increase over baseline conditions, the climate conditions in this scenario are not favorable for *S. n. nokomis* viability. No conservation efforts are included in this scenario, but even if they were, climate change effects to habitat and the butterfly in this scenario are expected to override any conservation efforts. The very hot and dry conditions will likely create less water for bog violet survival and/or nutrition, limit bog violet distribution, allow for few nectar sources, and possibly increase the chance of egg mortality and larval desiccation. Winter precipitation, if it can even ameliorate summer drought, will not help alleviate the significant reduction in snowpack. Additionally, the higher summer temperatures may reduce the amount of time for mating and nectaring in all populations and perhaps even reduce fecundity. Genetic diversity will not increase with no conservation efforts, and fewer butterflies will be produced, likely creating worse resiliency. This scenario's second longest growing season in both CO and NM will likely reduce larval survival from disease and predation more so than in Scenario 1 and 2, but perhaps not as much as in Scenario 3.

Resiliency scorings for each population follow in Table 12. As in Scenario 3, it is expected that climate change will cause extirpation of all small colonies and populations under 12 acres. The size of habitat in remaining populations increases very slightly in CO populations relative to Scenario 3. Habitat decreases in the Taos Population relative to Scenario 3, but not enough to change the size scoring. With there being slightly less evaporative stress and slightly less frequency of severe drought, remaining populations may, in turn, be slightly more resilient. However, using the scorings in this report, the modest increase in resiliency from Scenario 3 due to climate change does not lead to different resiliency scores because the changes do not cross the score threshold.

Consequently, resiliency scorings are the same with four extirpated populations, three very low resiliency populations, two low resiliency, and only one moderately resilient population. As in

Scenario 3, redundancy of populations is very low and representation is low, also decreasing relative to Scenarios 1, 2, and the Current Condition.

Table 12. Resiliency scorings for S. n. nokomis populations under Scenario 4. Current population status is for reference and does not change. Habitat Size (Acres) changes slightly for most populations but there are no changes from Scenario 3 in the rest of the columns.

Population Name	Current Population Status	Habitat Size (Acres)	Habitat Size Score	Number of Colonies Score	Within-Population Connectivity OR Diversity Score	Habitat Factor Score	Population Resiliency
COLORADO/ UTAH							
Archuleta	Likely Extirpated	0	**0**	**0**	**0**	**-1**	**0**
Conejos	Extant	19.6	**2**	**1**	**0**	**-1**	**2**
Costilla	Unknown	0	**0**	**0**	**0**	**-1**	**0**
Garfield	Unknown	10.5	**1**	**1**	**0**	**-1**	**1**
La Plata	Unknown	0	**0**	**0**	**0**	**-1**	**0**
Mesa/Grand	Extant	8.6	**1**	**1**	**0**	**-1**	**1**
Montrose/San Juan	Extant	8.0	**1**	**1**	**0**	**-1**	**1**
Ouray	Extant	19.3	**2**	**2**	**2**	**-1**	**5**
NEW MEXICO							
San Miguel/Mora	Extant	0	**0**	**0**	**0**	**-1**	**0**
Taos	Extant	207.6	**3**	**1**	**0**	**-1**	**3**

4.4 Summary of Current and Future Conditions

A comparison of resiliency for each population for the current condition and future scenarios is presented in Table 13 along with summaries of redundancy and representation. With conservation measures implemented in Scenario 1 and relatively mild projected changes in climate by 2050, species resiliency, redundancy, representation and thus viability improves from the current condition. In Scenario 2, we project an increase in subspecies' viability from current condition, but not as much as in Scenario 1. Climate is projected to change significantly in scenarios 3 and 4, so resiliency, redundancy, representation and thus subspecies' viability is expected to decrease from current condition.

Table 13. Summary of resiliency, redundancy, and representation for current condition and four future scenarios.

Population	Current Condition Resiliency	Future Scenario 1 Resiliency	Future Scenario 2 Resiliency	Future Scenario 3 Resiliency	Future Scenario 4 Resiliency
Archuleta	1	3	3	0	0
Conejos	3	5	5	2	2
Costilla	1	4	3	0	0
Garfield	2	4	4	1	1
La Plata	1	3	3	0	0
Mesa/Grand	9	10	9	1	1
Montrose/San Juan	5	6	5	1	1
Ouray	5	5	5	5	5
San Miguel/ Mora	3	5	4	0	0
Taos	11	11	10	3	3
Redundancy	Moderate	Moderate	Moderate	Very Low	Very Low
Representation	Low - Moderate	Moderate	Moderate	Low	Low

LITERATURE CITED

Arnold, R.A. 1989. Unaweep Seep butterfly study. Submitted to U.S. Bureau of Land Management, Grand Junction, CO. 29 pp.

Britten, H.B., P.F. Brussard, D.D. Murphy, and G.T. Austin. 1994. Colony isolation and isozyme variability of the western seep fritillary, *Speyeria nokomis apacheana* (Nymphalidae), in the western Great Basin. Great Basin Naturalist 54:97-105.

Britten, H.B., E. Fleishman, G.T. Austin, and D.D. Murphy. 2003. Genetically effective and adult population sizes in the Apache silverspot butterfly, Speyeria nokomis apacheana (Lepidoptera: Nymphalidae). Western North American Naturalist 63:229-235.

Cockerell, W.P. and T.D.A. Cockerell. 1900. A new variety of Speyeria nitocris. Entomological News and Proceedings of the Entomological Section of the Academy of Natural Sciences, Philadelphia. 11:622.

Colorado Natural Heritage Program. 2018. CNHP Tracked Arthropod and Insect Species (scoring). Online at: https://cnhp.colostate.edu/ourdata/trackinglist/arthropods_insects. (Accessed January 31, 2020).

Cong, Q., J. Zhang, J. Shen, S. Ellis, T. Ireland, M.S. Fisher, J.A. Scott, P.A. Opler, and N.V. Grishin. 2019. The genomic landscape of Nokomis silverspot butterfly. A draft report prepared for the U.S. Fish and Wildlife Service. 26 pp.

Courchamp, F., E. Angulo, P. Rivalan, R.J. Hall, L. Signoret, L. Bull, and Y. Meinard. 2006. Rarity Value and Species Extinction: The Anthropogenic Allee Effect. PLoS Biology 4(12): e415. DOI: 10.1371/journal.pbio.0040415.

Dana, R.P. 1991. Conservation management of the prairie skippers *Hesperia dacotae* and *Hesperia ottoe* – Basic biology and threat of mortality during prescribed burning in spring. Station Bulletin 594-1991 (AD-SB-551-S). Minnesota Agricultural Experiment Station. University of Minnesota, St. Paul. 63pp.

Darvill, B., J.S. Ellis, G.C. Lye, and D. Goulson. 2006. Population structure and inbreeding in a rare and declining bumble bee, *Bombus muscorum* (Hymenoptera: Apidae). Molecular Ecology 15:601-611.

dos Passos, C.F., and L.P. Grey. 1945. A new species and some new subspecies of *Speyeria* (Lepidoptera, Nymphalidae). American Museum Novitates. 1297:1-17.

dos Passos, C.F. and L.P. Grey. 1947. Systematic catalogue of *Speyeria* (Lepidoptera, Nymphalidae) with designations of types and fixations of type localities. American

Museum Novitates 1370:1-57.

Dunford, J.C. 2007. The genus *Speyeria* and the *Speyeria atlantis*/*Speyeria hesperis* complex: species and subspecies accounts, systematics, and biogeography (Lepidoptera: Nymphalidae). A dissertation presented to the graduate school of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy. University of Florida. 245 pp.

Edwards, W.H. 1862. Descriptions of certain species of diurnal lepidoptera, found within the limits of the United States and of British America No. 3. Proceedings of the Academy of Natural Sciences of Philadelphia. 14:221-226.

Ellis, S. 1989. Preserve design for the Nokomis fritillary butterfly colonies, Unaweep Canyon, Mesa County, Colorado. Unpublished report submitted to the Nature Conservancy, Colorado Field Office, and U.S. Bureau of Land Management, Grand Junction, CO. 28 pp. + appendices.

Ellis, S. 1999. The Ecology and Reproductive Biology of the Bog Violet (Viola sororia) within the Unaweep Seep, Mesa County, Colorado. Unpublished report prepared for the Colorado Natural Areas Program. 16 pp.

Eilperin, J. 2020. 2°C: Beyond the limit - This giant climate hot spot is robbing the West of its water. Available at https://www.washingtonpost.com/graphics/2020/national/climate-environment/climate-change-colorado-utah-hot-spot/. (Accessed: August 7, 2020).

Ferris, C.D., and M. Fisher. 1971. A revision of *Speyeria nokomis* (Nymphalidae). Journal of the Lepidopterists' Society. 25:44-52.

Fleishman, E., C. Ray, P. Sjögren-Gulve, C.L. Boggs, and D.D. Murphy. 2002. Assessing the relative roles of patch quality, area, and isolation in projecting metapopulation dynamics. Conservation Biology 16:706-716.

Hammond, P.C. and D.V. McCorkle. 1983(84). The decline and extinction of *Speyeria* populations resulting from human environmental disturbances (Nymphalidae: Argynninae). Journal of Research on the Lepidoptera 22:217-224.

Hausfather, Z. and G.P. Peters. 2020. Emissions - the 'business as usual' story is misleading. Nature 577: 618-620.

Hellstrom,K., A-P Huhta, P. Rautio, J. Tuomi, J. Oksanen, and K. Laine. 2003. Use of sheep grazing in the restoration of semi-natural meadows in northern Finland. Applied Vegetation Science 6: 45-52.

Hoekwater, J. 1997. Butterfly poaching for profit in Baxter State Park, Maine. Northeastern Naturalist 4(3):145-152.

Holland, R. 2010. A new subspecies of *Speyeria nokomis* from the Sacramento Mountains of

New Mexico (Nymphalidae). Journal of Research on the Lepidoptera 42:79-81.

Hovanitz, W. 1969 (1970). Habitat: *Speyeria nokomis*. Journal of Research on the Lepidoptera 8(1):20.

Huhta, A-P., P. Rautio, J. Tuomi, and K. Laine. 2001. Restorative mowing on an abandoned semi-natural meadow: short-term and predicted long-term effects. Journal of Vegetation Science 12: 677-686.

Kleiner, K. 1995. Long arm of the law nets butterfly poachers. New Scientist Online. http://www.newscientist.com/article/mg14619751.500-long-arm-of-the-lawnetsbutterfly-poachers.htm

Lukas, J., J. Barsugli, N. Doesken, I. Rangwala, and K. Wolter. 2014. Climate change in Colorado: A synthesis to support water resources management and adaptation. A Report for the Colorado Water Conservation Board. Western Water Assessment. 114 pp.

Malcolm, S.B. 2018. Anthropogenic Impacts on Mortality and Population Viability of the Monarch Butterfly. Annual Review of Entomology 63:277-302.

Mattoon, S.O., R.D. Davis, and O.D. Spencer. 1971. Rearing techniques for species of *Speyeria* (Nymphalidae). Journal of the Lepidopterists' Society 25:247-255.

NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://explorer.natureserve.org. (Accessed: January 31, 2020).

North American Butterfly Association. 2018. Checklist of North American butterflies occurring north of Mexico. Edition 2.4. Checklist available online at: https://www.naba.org/pubs/enames2_4.html. The first edition introduction and comments are available online at: https://www.naba.org/ftp/check1com.pdf. The second edition introduction and comments are at: https://www.naba.org/ftp/check2com.pdf. (Accessed: January 31, 2020).

Olaya-Arenas, P. and I. Kaplan. 2019. Quantifying Pesticide Exposure Risk for Monarch Caterpillars on Milkweeds Bordering Agricultural Land. Frontiers in Ecology and Evolution 7:223.

O'Neill, H. 2007. Butterfly smuggling loses its king. USA Today Online. http://www.usatoday.com/news/nation/environment/2007-08-18-butterfly-smuggler_N.htm Accessed March 3, 2023

Pelham, J.P. 2021. A catalogue of the butterflies of the United States and Canada. Revised 28 January 2021. Available online at: https://www.butterfliesofamerica.com/US-Can-Cat.htm. (Accessed February 9, 2021).

Rangwala, I. 2020a. Climate scenarios by 2050 for silverspot butterfly (Colorado). North Central Climate Adaptation Science Center & CIRES, University of Colorado, Boulder. 2 pp.

Rangwala, I. 2020b. Climate scenarios by 2050 for silverspot butterfly (New Mexico). North Central Climate Adaptation Science Center & CIRES, University of Colorado, Boulder. 2 pp.

Redish, L. and O. Lewis. 2019. Native Languages of the Americas - Legendary Native American Figures: Nokomis (Nokoma). Available online at: http://www.native-languages.org/nokomis.htm. (Accessed April 2, 2020).

Scott, J.A. 1977. Competitive exclusion due to mate searching behavior, male-female emergence lags and fluctuation in number of progeny in model invertebrate populations. The Journal of Animal Ecology 46:909-924.

Scott, J.A. 1986. The butterflies of North America – A natural history and field guide. Stanford University Press, Stanford, California. 583 pp.

Scott, J.A. and M. S. Fisher. 2014. *Speyeria* (*Speyeria) nokomis nokomis*: geographic variation, metapopulations, and the origin of spurious specimens (nymphalidae). Papilio (New Series) #21. ISSN 2372-9449. 32 pp.

Scott, J.A. and S.O. Mattoon. 1981 (1982). Early stages of *Speyeria nokomis* (Nymphalidae). Journal of Research on the Lepidoptera 20:12-15. Available at: https://biodiversitylibrary.org/page/53386463. (Accessed: February 5, 2020).

Scudder, S.H. 1872. A systematic revision of some of the American butterflies; with brief notes on those known to occur in Essex Co., Mass. 4th Annual Report of the Peabody Academy of Sciences (1871):24-82.

Selby, G. 2007. Great Basin silverspot butterfly (*Speyeria nokomis nokomis* [W.H. Edwards]): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available at: http://www.fs.fed.us/r2/projects/scp/assessments/greatbasinsilverspotbutterfly.pdf. (Accessed March 16, 2016).

Shaffer, M.L., and B.A. Stein. 2000. Safeguarding our precious heritage. Precious heritage: the status of biodiversity in the United States. Oxford University Press, New York. Pp. 301-321.

Sims, S.R. 2017. *Speyeria* (Lepidoptera: Nymphalidae) conservation. Insects 8:1-13.

Smith, D.R., Allan, N.L., McGowan, C.P., Szymanski, J.A., Oetker, S.R., & Bell, H.M. 2018. Development of a species status assessment process for decisions under the US Endangered Species Act. Journal of Fish and Wildlife Management 9:302-320.

Stout, T. 2020. Overwintering techniques: Refrigerator - *Speyeria* unfed first instars. Available at: http://www.raisingbutterflies.org/overwintering-techniques/refrigerator-Speyeria-unfed-first-instars/. (Accessed July 2, 2020).

Stratton, M. 2012. World's largest butterfly disappearing from Papua New Guinea rainforests. The Guardian. July 30, 2012. Available online: World's largest butterfly disappearing from Papua New Guinea rainforests | Butterflies | The Guardian. Accessed March 3, 2023.

Swisher, A.L., and W.L. Morrison. 1969. News of the Lepidopterists' Society. 15 April Number 3:4.

U.S. Bureau of Land Management (BLM). 2015. Approved Resource Management Plan and Approved Travel Management Plan for the Bureau of Land Management Grand Junction Field Office. BLM/CO/PL-15/016. Grand Junction, Colorado. 220 pp. excluding appendices.

U.S. Fish and Wildlife Service (Service). 2016. Service Species Status Assessment Framework: an integrated analytical framework for conservation, Version 3.4 dated August 2016.

U.S. Fish and Wildlife Service (Service). 2019. Service Refined Range Maps for Threatened and Endangered Species. Standard Operating Procedure. September 2019. 16 pp.

U.S. Fish and Wildlife Service (Service). 2021. Species status assessment report for Speyeria nokomis nokomis, Version 1.0. Grand Junction, Colorado. 74 pp. + v.

Weiss, S.B. 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species. Conservation Biology 13(6): 1476-1486.

Wolf, S., B. Hartl, C. Carroll, M.C. Neel, and D.N. Greenwald. 2015. Beyond PVA: why recovery under the Endangered Species Act is more than population viability. Bioscience 65:200-207.

Zhang, J., Q. Cong, J. Shen, P.A. Opler, and N.V. Grishin. 2020. Genomic evidence suggests further changes of butterfly names. The Taxonomic Report of the International Lepidoptera Survey 8:1-41.

Personal Communications

Bainbridge, Betsy. 2022. Chat between Betsy Bainbridge and Terry Ireland regarding water supply to New Mexico *S. n. nokomis* colonies (11.01.2022; 2:04 PM).

Cary, Steve. 2019. Email titled "Taos surveys" (9.5.2019; 3:41 PM).

Cary, Steve. 2020a. Attached response to email titled "Climate call 10:30 AM Thursday (tomorrow)" (4.15.2020; 3:51 PM).

Cary, Steve. 2020b. Email titled "Taos xx and location database (again)" (3.27.2020; 11:53 AM).

Cary, Steve. 2020c. Email titled "Habitat size scores and threats to *S. n. nokomis*" (6.24.2020; 10:54 AM).

Cary, Steve. 2020d. Email titled "Cause of stream degradation in the Sacramentos" (7.4.2020; 11:05 AM).

Cary, Steve. 2021. Email titled "nokomis sightings" (8.11.2021; 5:30 PM).

Cary, Steve. 2022. Email titled "nokomis check-up" (8.14.2022; 4:35 PM)

Ellis, Scott. 2018a. Verbal communication on where *S. n. nokomis* typically lay eggs (8.7.2018).

Ellis, Scott. 2018b. Email titled "Daily flight pattern" (6.19.2018; 9:41 AM).

Ellis, Scott and Terry Ireland. 2018. Personal observation regarding degraded condition of the Montrose County colony (8.7.2018).

Ellis, Scott and Lydia Thompson. 2019. Personal observation regarding confirmation of the Grand County colony (9.26.2019).

Ellis, Scott, Lydia Thompson, and Terry Ireland. 2019. Personal observation regarding flood effects to a *S. nokomis* colony in the Uintah Mountains (8.22.2019).

Ellis, Scott. 2020a. Email titled "Habits of *nokomis*" (4.2.2020; 12:34 PM).

Ellis, Scott. 2020b. Attached response to email titled "Responses to climate questions" (4.15.2020; 1:54 PM).

Ellis, Scott. 2020c. Attached response for email titled "*S. nokomis* dispersal distances" (3.19.2020; 4:30 PM).

Ellis, Scott. 2020d. Email titled "Silverspot flight over non-habitat" (4.19.2020; 10:03 AM).

Ellis, Scott. 2020e. Email titled "Resiliency scorings" (5.31.2020; 5:25 PM).

Ellis, Scott. 2020f. Email titled "Collection" (6.20.2020; 5:42 PM).

Ellis, Scott. 2020g. Email titled "Grazing and haying in nokomis habitat" (11.13.2020; 6:50 PM).

Ellis, Scott. 2020h. Email titled "TNC conservation efforts" (7.13.2020; 10:39 AM).

Ellis, Scott. 2020i. Email titled "Grazing or hydrologic alteration on Conejos County colony"

(7.12.2020; 7:32 AM).

Ellis, Scott. 2020j. Email titled "Larval hydration and larval growing season" (4.21.2020; 6:22 PM).

Ellis, Scott. 2022. Email titled "xx Creek" (9.14.2022; 7:50 AM).

Ellis, Scott and Mike Fisher. 2020. Verbal communication while confirming *S. n. nokomis* locations on webex (3.23.2020).

Fisher, Mike. 2018a. Email titled "Daily flight pattern" (6.19.2018; 9:05 AM).

Fisher, Mike. 2018b. Personal observation regarding presence of *S. n. nokomis* at a Ouray Population colony (8.8.2018).

Fisher, Mike. 2020a. Email titled "Larval lengths" (4.6.2020; 5:43 PM).

Fisher, Mike. 2020b. Email titled "Habits of *nokomis*" (4.2.2020; 7:09 PM).

Fisher, Mike. 2020c. Attached response to email titled "Climate questions for S. n. nokomis" (4.15.2020; 11:29 AM).

Fisher, Mike. 2020d. Verbal communication while confirming *S. n. nokomis* locations on webex (3.24.2020).

Fisher, Mike. 2020e. Email titled "Silverspot flight over non-habitat" (4.19.2020; 1:28 PM).

Fisher, Mike. 2020f. Email titled "Larval hydration and larval growing season" (4.21.2020;1:34PM).

Fisher, Mike. 2020g. Email titled "Nokomis surveys" (11.14.2020; 12:30 PM).

Fisher, Mike. 2021. Verbal communication of singular 2021 survey of Ouray colonies (9.2021).

Fisher, Mike. 2022a. Email titled "Nokomis colony in Ouray Population" (9.9.2022; 2:23 PM).

Fisher, Mike. 2022b. Email titled "Pics" (8.27.2022; 12:55 PM).

Friedrichs, Bob. 2022a. Email titled "What do you think?" (8.5.2022; 2:26 PM).

Friedrichs, Bob. 2022b. Email titled "More Frits!" (8.25.2022; 1:17 PM).

Grishin, Nick. 2020a. Email regarding "Uinta Mts Population and NMSU Specimen", specifically on his opinion whether the Uinta Mountains Population should be included in the range of *S. n. nokomis* (3.15.2020; 10:37 PM).

Grishin, Nick. 2020b. Email titled "S. nokomis list of questions" regarding colony in Grand County, Utah, being genetically part of the Mesa Population (9.2.2020; 4:29 PM).

Grishin, Nick. 2020c. Verbal communication during a discussion on *S. n. nokomis* genetics (9.2.2020).

Hannawacker, Robb. 2020. Email titled "Speyeria nokomis population at Grand County colony Utah". (9.15.2020; 12:49 PM).

Hannawacker, Robb. 2022. Email titled "Size of Grand County colony" (9.7.2022; 10:06 AM).

Ireland, Terry and Heidi Plank. 2017. Personal observation of Unaweep Seep, August 2017.

Ireland, Terry. 2021a. *Speyeria nokomis nokomis* survey notes, Mesa/Grand Population, August 25, 2021. 1p.

Ireland, Terry. 2021b. Email titled "RE: U.S. Fish & Wildlife Service will survey Garfield County colony for bog violet plants on May 6" (5.13.2021; 2:25 PM).

Ireland, Terry. 2021c. *Speyeria nokomis nokomis* survey notes, Rifle Creek, Colorado, August 20, 2021. 2pp.

Ireland, Terry. 2022a. Personal observation of water conditions for Colorado and Utah *S. n. nokomis* colonies.

Ireland, Terry. 2022b. Personal observation of grazing activity on Colorado and Utah *S. n. nokomis* colonies.

Ireland, Terry. 2022c. Bog violet (*Viola nephrophylla*) survey notes, Conejos and Costilla populations, May 25 and 26, 2022. 1p.

Ireland, Terry. 2022d. *Speyeria nokomis nokomis* survey notes, Mesa/Grand Population, September 2, 2022. 1p.

Ireland, Terry. 2022e. *Speyeria nokomis nokomis* survey notes, Mesa/Grand Population, August 12, 2022. 1p.

Johnson, Aran. 2020. Email titled "Round Meadow silverspot butterfly surveys" (12.21.2020; 4:24 PM).

Johnson, Aran. 2021. Email titled "Silver spot butterfly" (12.13.2021; 10:03 AM).

Johnson, Aran. 2022. Email titled "Round Meadow nokomis survey (10.12.2022; 4:15 PM).

Lustig, Elliot. 2023. Chat between Elliot Lustig and Terry Ireland regarding method used for drawing Version 1.1 *S. n. nokomis* range map (2.23.2023; 7:17 AM).

Myrup, Alan. 2019. Verbal communication on presence of *S. nokomis* at Lake Fork River in 2018 (8.29.2019).

Myrup, Alan. 2020a. Email titled “Soil moisture” (4.23.2020; 10:46 PM).

Myrup, Alan. 2020b. Attached response for email titled “Climate questions for *S. n. nokomis*” (4.14.2020; 10:56 PM).

Nystedt, John. 2020a. Email regarding “Sp no no nova name”, specifically Ojibwe/Chippewa occurring in Montana and Ojibway language potentially extending to *S. n. nokomis* type locality (2.10.2020; 9:52 AM).

Nystedt, John. 2020b. Email regarding “Sp no no nova name”, specifically etymology of, and online link to, Ojibway/Chippewa language for potential common name “Grandmother” or “Grand” silverspot (2.10.2020; 7:56 AM).

Opler, Paul. 2018. Email regarding “*Speyeria nokomis* genetics”, specifically *S. n. nokomis* ability to lay several hundred eggs (6.6.2018; 9:18 AM).

Plank, Heidi. 2020. Email titled “Draft *Speyeria nokomis nokomis* Species Status Assessment for review” (8.21.2020; 2:29 PM).

Scott, James. 2023. Email titled “Over-collection at Unaweep Seep” (1.31.2023; 10:21 AM).

Smith, Chad. 2019. Verbal communication on mowing effects to *S. nokomis* (8.1.2019).

Whiteman, Steve. 2022. Email titled “Silverspot butterfly surveys” (9.15.2022, 10:22 AM).

Willey, Lark. 2020. Email regarding “Viola questions”, specifically Utah Botanists’ consensus that *Viola sororia* var. *affinis* is a synonym of *V. nephrophylla* (1.15.2020; 9:56 AM).

APPENDICES

Appendix A. *S. nokomis* Subspecies Hindwing Disc Colors

Descriptions in the table below for *S. n. apacheana*, *coerulescens*, *nitocris*, and *nokomis* were taken from (Selby 2007, p. 16, and references therein). The *S. n. wenona* hindwing disc description is from dos Passos and Grey (1945, p. 1) where they originally labeled the butterfly as its own species (*S. wenona*). A subsequent article by dos Passos and Grey (1947, pp. 5, 10) placed *S. wenona* as a subspecies, *S. n. wenona*. The table below excludes the junior subjective synonym *S. n. carsonensis*, contained in Selby (2007, p. 16), since it is no longer considered a separate subspecies (Cong et al. 2019, pp. 1, 5, 21; also see Appendix B).

Comparison of *S. nokomis* subspecies hindwing disc coloration (Selby 2007 and references therein; dos Passos and Grey 1945).

Subspecies	Male	Female
S. n. apacheana	Yellowish buff	Light olive-green
S. n. coerulescens	Red-brown	Brown to green
S. n. nitocris	Deep reddish-brown	Black
S. n. nokomis	Light brown	Deep olive
S. n. wenona	Light brown overlaid with light olivaceous green	Green, similar to female *S. n. nokomis*

Appendix B. Additional Genetic Information

Cong *et al*. (2019, pp. 1, 5, 21) determined that *S. n. carsonensis* (California/Nevada) was the same as *S. n. apacheana* and should therefore be regarded as a junior subjective synonym. They also analyzed old specimens labeled as *S. n. nigrocaerulea* (Cockerell and Cockerell 1900, pp. 622) and *S. n. tularosa* (Holland 2010, pp. 78-81) from north-central and supposedly south-central ("Mescalero") New Mexico, respectively. However, Cong et al. (2019, p. 12) found these specimens were genetically similar to *S. n. nokomis* and are also both considered junior subjective synonyms. This supports Scott and Fisher (2014, p. 22) who also concluded *S. n. nigrocaerulea* and *S. n. tularosa* were objective synonyms of *S. n. nokomis* for reasons other than genetics. Furthermore, Cong et al. (2019) confirmed *S. n. coerulescens* and *S. n. wenona* as distinct subspecies. With *S. n. apacheana*, *nitocris*, and *nokomis* as the other three confirmed subspecies, the most current information available in Cong et al. (2019) identify five subspecies of *S. nokomis* rather than six as indicated in Selby (2007, p.13).

Appendix C. Discussion of Existing and Proposed Common Names of *S. n. nokomis*

The common name Nokomis fritillary has generally been used for the full species *S. nokomis* (North American Butterfly Association 2018). It is also often used for the subspecies *S. n. nokomis* (NatureServe 2019) but Great Basin silverspot butterfly has also been a common name attributed to the subspecies (Colorado Natural Heritage Program 2018, NatureServe 2019, Selby 2007 and references therein). Western seep fritillary has also been used for the full species or different subspecies (Scott 1986, p. 326).

Some common names specific to *S. n. nokomis*, whose range is now more restricted based on Cong et al. (2019), have been offered up by Cong et al. (2019 p. 2), the SSA Technical Team members or the Service's Core Team for this SSA. Cong et al. (2019, p. 2) and previous authors or scientists suggest the Nokomis silverspot, Seep silverspot, or Granny silverspot. Additional names suggested by this SSA's Technical Team or Core Team include the Colorado Plateau silverspot, the Sneffel's Silverspot (referring to a mountain near its apparent type locality) the Eastern nokomis fritillary, or the Grand butterfly. The Granny silverspot is derived from Native American languages because Nokomis or Nookomis in Ojibway (Chippewa) Algonquin, Ottowa, Menominee, and Potawatomi Tribes refers to a wise woman or grandmother (Redish and Lewis 2019). The Ojibway (or Ojibwe), extend to Montana (John Nystedt, Service, pers. comm., 2020a) so it is possible the etymology of "Granny" or "Grandmother silverspot" made it into native language in the west where *S. nokomis* resides. "Grand silverspot" gives deference to the names Granny or Grandmother silverspot since a "Grand" can refer to a grandparent (John Nystedt, Service, pers. comm., 2020b). However, we will leave it up to species experts, taxonomists, and committees of butterfly associations and societies to debate an appropriate common name for *S. n. nokomis* and perhaps the other subspecies and unaffiliated segregates (populations 2, 3, and 9).