5-YEAR REVIEW

Sierra Nevada Bighorn Sheep (*Ovis canadensis sierrae*)

GENERAL INFORMATION:

Species: Sierra Nevada Bighorn Sheep (SNBS; *Ovis canadensis sierrae*)
Date listed: January 3, 2000
FR citation(s): An emergency listing rule, under the Endangered Species Act of 1973, as amended (ESA) was published and became effective on April 20, 1999 (64 FR 19300–19309). The final listing rule was published and became effective on January 3, 2000 (65 FR 20–30). The entity listed was the Sierra Nevada Distinct Population Segment of the California bighorn sheep (*Ovis canadensis californiana*), which was the recognized taxonomic classification (Cowan 1940) at the time of listing. Based on new genetic (Ramey 1993, 1995; Boyce *et al*. 1997, Gutierrez-Espeleta *et al*. 1998) and morphological data (Wehausen and Ramey 1993, 2000), and a reanalysis of Cowan's original data (Ramey 1993), Wehausen *et al*. (2005) recognized the SNBS as a unique subspecies of *O. canadensis* and modified the nomenclature. On August 5, 2008, we designated critical habitat of approximately 417,577 acres in California and announced a taxonomic revision from a distinct population segment of California bighorn sheep to subspecies, *Ovis canadensis sierrae* (73 FR 45534–45604).
Classification: Endangered
Lead Field Office: Reno Fish and Wildlife Office.

BACKGROUND:

Most recent status review: U.S. Fish and Wildlife Service. 2019. Sierra Nevada Bighorn Sheep *Ovis canadensis californiana* (= *Ovis canadensis sierrae*). 5-Year Review: Summary and Evaluation. Reno, Nevada. 20 pp.

FR Notice citation announcing this status review:
U.S. Fish and Wildlife Service. 2023. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 47 Species in California, Nevada, and Oregon; Federal Register 88 56042–56044; August 17, 2023.

ASSESSMENT:

Information acquired since the last status review

This 5-year review was conducted by the U.S. Fish and Wildlife Service's (Service) Reno Fish and Wildlife Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on August 17, 2023 (Service 2023). We also contacted Humboldt-Toiyabe, Inyo, Sequoia, Sierra, and Stanislaus National Forests; Sequoia/Kings Canyon and Yosemite National Parks; Bureau of Land Management (BLM, Bishop); Animal Plant Health Inspection Service (Wildlife Services); California Department of Fish and Wildlife (CDFW); other Fish and Wildlife Offices (Sacramento); and existing Sierra Nevada Bighorn

Sheep Recovery Implementation Team (RIT) members to request any data or information that should be considered in this review. A literature search and a review of information in Service files was conducted. Our understanding of this subspecies has continued to improve through research since the last 5-year review; brief descriptions of several published journal articles are provided in Appendix A.

Background

The SNBS (*Ovis canadensis sierrae*) has been recognized as a unique subspecies of *Ovis canadensis* (Wehausen *et al*. 2005). This subspecies occurs within 14 herd units along portions of the Sierra Nevada of California. At the time of listing, we identified the following primary factors contributing to the endangered status: disease and predation (Factor C) and small population size (Factor E) (Service 2000).

This document briefly describes new information that has become available since the last 5-year review for SNBS (Service 2019). A more thorough discussion on the status of the SNBS over the succeeding years (from 2018 until 2023) can be found in numerous reports/publications that have become available since the last review, and many of these reports/publications are cited in this document.

The new information is primarily from annual reports prepared by the Sierra Nevada Bighorn Sheep Recovery Program led by the CDFW. The Sierra Nevada Bighorn Sheep Recovery Program's recovery activities include conducting SNBS population surveys, monitoring survival and habitat use patterns, collecting collar data from numerous individuals, capturing, and translocating individuals, and identifying resource selection patterns across the Sierra Nevada. Other activities include modeling the risk of disease transmission from domestic sheep and goats to SNBS, determining effects of fire on bighorn sheep forage and habitat use, determining genetic diversity, and monitoring mountain lion movements, predation rates, and population numbers.

The primary focus of this review is new information provided under the Trends in Distribution, Trends in Abundance, and Predation sections.

Trends in Distribution

The Recovery Plan for the Sierra Nevada Bighorn Sheep (*Ovis canadensis californiana*) (Recovery Plan; Service 2007) identified 16 herd units in areas historically occupied by SNBS, which were grouped into 4 recovery units based on natural breaks in habitat distribution. Female occupation of 12 specific herd units out of the 16 is considered essential for recovery of the subspecies because habitat characteristics make these units the most likely areas where recovery will occur (Service 2007). These 12 essential herd units are: Mount Warren, Mount Gibbs (Northern Recovery Unit); Convict Creek, Wheeler Ridge (Central Recovery Unit); Taboose Creek, Sawmill Canyon, Mount Baxter, Mount Williamson, Mount Langley, Olancha Peak (Southern Recovery Unit); and Big Arroyo, Laurel Creek (Kern Recovery Unit).

The Recovery Plan downlisting criteria require a minimum of 305 yearling and adult females throughout the four recovery units (50 in the Northern Recovery Unit, 50 in the Central Recovery Unit, 155 in the Southern Recovery Unit, and 50 in the Kern Recovery Unit) (Service 2007).. Measures to prevent contact between domestic sheep/goats and SNBS also need to have been implemented and successful before considering the downlisting of this subspecies (Service 2007).

As indicated in the last 5-year review (Service 2019), by 2016, SNBS occurred in 14 herd units (Greene *et al*. 2016). The specific numeric goals were not met for all of the four recovery units; however, in 2016, specific numeric goals had been met for the Southern and Central Recovery Units (Greene *et al*. 2016). Bubbs Creek and Cathedral Range herd units, while not essential for recovery, contained SNBS and assisted in increasing SNBS numbers and distribution throughout their range. Even with the severe winter conditions of 2016-2017, SNBS ewes continued to occur in 14 herd units; these included Mount Warren, Mount Gibbs, Cathedral Range, Convict Creek, Wheeler Ridge, Taboose Creek, Sawmill Canyon, Mount Baxter, Bubbs Creek, Mount Williamson, Big Arroyo, Laurel Creek, Mount Langley, and Olancha Peak (Greene *et al*. 2017).

During 2018 to 2022, SNBS ewes continued to occupy the above mentioned 14 herd units (Greene *et al*. 2018, Greene *et al*. 2021, Greene *et al*. 2022, Greene *et al*. 2023, Stephenson *et al*. 2023). While occupied herd units met the geographic measure for recovery, only two recovery units, the Southern and Central, met the female numeric measure for recovery during this period inconsistently (Greene *et al*. 2018, Greene *et al*. 2021, Greene *et al*. 2022, Greene *et al*. 2023, Stephenson *et al*. 2023). In 2023, due to severe losses, ewes occupied 9 of the 14 herd units mentioned above (Mount Warren, Mount Gibbs, Wheeler Ridge, Sawmill Canyon, Mount Baxter, Bubbs Creek, Mount Williamson, Mount Langley, and Olancha Peak) (Stephenson 2024). While two recovery units, the Southern and Central, were closest to meeting the female numeric measure for recovery for their units, none of the four recovery units met the female numeric measure for recovery in 2023 (Stephenson 2024).

Trends in Abundance

Estimated SNBS population sizes have been reported as a subset defined by adult and yearling females or as a total population size. Maintaining collars on 30 to 35 percent of SNBS females within each herd unit assists in conducting more accurate population surveys, monitoring reproductive success, and identifying mortality (Greene *et al*. 2016). While the focus of this effort is on females because they drive population dynamics, some males are also collared to monitor disease risk and genetics; the data collected assists in understanding habitat selection, seasonal migration, home range use, and survival (Greene *et al*. 2016). The following information provides a summary of estimates from the last year of the previous 5-year review (2017) and yearly estimates for SNBS by one or both of these two measures from 2018 to 2023. Figure 1 graphs the number of adult and yearling females throughout the range of the SNBS from 2008 through 2023.

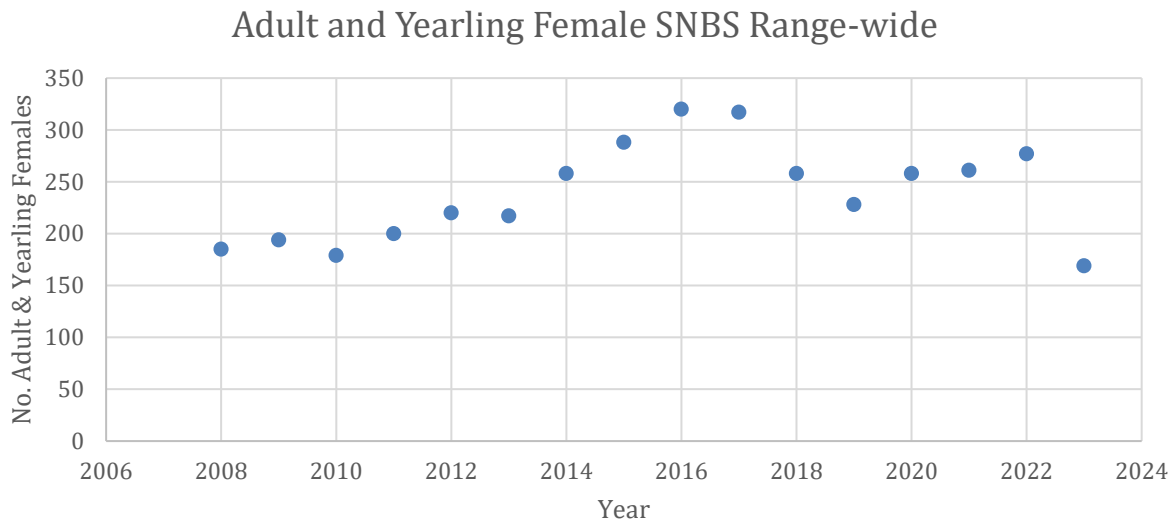

Figure 1. Number of Adult and Yearling Female Sierra Nevada Bighorn Sheep Throughout the Range, 2008-2023

As stated in the last 5-year review (Service 2019), the total SNBS population size in 2017 was estimated at 675 (317 yearling and adult ewes; 120 lambs; and 238 rams based on an expected ram:ewe ratio of 0.75) (Greene *et al*. 2017). However, this number did not include the impacts of the severe winter conditions of 2016-2017, and it was later estimated that yearling and adult ewes totaled 273 (Greene *et al*. 2017). The CDFW estimated that approximately 100 females died (about 30 percent of the known female population); however, the end-of-year counts, which included recruitment, indicated a net loss of 56 ewes (Greene *et al*. 2017). Most female mortalities were related to the severe winter conditions (*e.g.*, avalanches, malnutrition) but 17 deaths were due to mountain lions (*Puma concolor*). Nine uncollared and 48 collared ram mortalities were also documented during this period (Greene *et al*. 2017). Collared rams died from unknown causes, avalanches, malnutrition, mountain lion and bobcat predation, and rock falls. There were also 10 mortalities of unknown sex from mountain lion predation and unknown causes. These mortalities resulted in the greatest loss of individuals and loss rangewide ever documented in a single year (Greene *et al*. 2017). The 2016-2017 year ended the 19-year increasing trend for estimated SNBS population numbers throughout the range (Sierra Nevada Bighorn Sheep Foundation 2018).

In 2018, the year-end population (as of April 30, 2018) was estimated as 258 adult and yearling females, 109 lambs, and 145 males or a total population size of 512 (Greene *et al*. 2018). There was a slight decrease in total number of females, possibly due to poor recruitment during the 2016-2017 winter (Greene *et al*. 2018). Based on female minimum counts, the largest herds were Mount Baxter, Sawmill Canyon, and Wheeler Ridge; each had more than 40 females in their herds (Greene *et al*. 2018). The mid-sized herds (Mount Langley, Mount Gibbs, and Olancha Peak) had more than 20 females (Greene *et al*. 2018).

The Mount Langley herd declined from 49 females in 2016 to 24 to 26 females in 2017-2018 (Greene *et al*. 2018). As indicated in the previous 5-year review (Service 2019) and above, the

Mount Langley herd experienced high levels of predation in 2017 by mountain lions (Sierra Nevada Bighorn sheep Foundation 2017). The Mount Langley herd had been serving as a source herd for translocations; the decline in this herd likely will preclude its use as a source herd for some years in the future (Sierra Nevada Bighorn Sheep Foundation 2017). It will not be considered available as a source population until it rebounds (Greene *et al*. 2018) as there must be a minimum of 40 females in a herd for it to be considered a source population for translocation purposes (Few *et al*. 2015). As both Mount Gibbs and Olancha Peak herds have been increasing, they may become source herds in the future (Greene *et al*. 2018).

In 2019, Greene *et al*. (2021) estimated a year-end population (as of April 30, 2019) of approximately 509 total population with about 228 females, 122 lambs, and 162 males. It was estimated that 72 females died in the heavy snow winter of 2018-2019, representing 25 percent of the female population. Snow-caused mortality (starvation, avalanches) was the most common cause of death, resulting in 39 percent of collared female mortalities. Mountain lion predation caused 12 percent of collared female mortality. No herd unit suffered a complete loss of females. Fifty-seven SNBS mortalities were determined (30 collared females, 13 collared males, 14 uncollared). The majority of uncollared mortalities were from predation (N=8), avalanches (N=3) and unknown causes (N=3) Greene *et al*. 2021).

The impacts of winter were variable among herds as little mortality occurred in the Olancha Peak herd. Larger proportional winter impacts occurred in Bubbs Creek, Big Arroyo, Mount Warren, and Cathedral Range herds. The largest numeric losses occurred in Mount Gibbs and Sawmill Canyon herds. The impact of the 2018-2019 winter on survival was slightly less severe, at 25 percent, than during the 2016-2017 winter when it was estimated that 30 percent of yearling and adult females were lost (Greene *et al*. 2021).

For 2020, the estimated year-end population (as of April 30, 2020) included 249 females (which was corrected to 258 in Greene *et al*. 2023), 81 lambs, and 166 males for a total of 486 (which was corrected to 495 in Greene *et al*. 2023) animals (Greene *et al*. 2022). Though a milder winter, the total population declined likely due to the large losses that occurred during the previous 2016-2017 and 2018-2019 winters.

Thirty-one SNBS mortalities were detected (18 collared, 13 uncollared) (Greene *et al*. 2022). The only cause of death identified was predation by mountain lions and one bobcat (N=20); the rest of the mortalities were due to unknown causes.

The Sierra Nevada Bighorn Sheep Foundation (2020) has raised the question and provides some discussion on how the ecosystem upon which the SNBS depends may have been different prior to the arrival of Europeans. Both wolves and grizzly bears occurred within the range of the SNBS. Compared to mountain lions, wolves and both bear species in North America are not effective hunters of bighorn sheep. All three species are dominant to mountain lions. In relatively intact ecosystems in Canada, where no native predators have been extirpated, mountain lions are rare or non-existent. In the United States, after wide-spread extirpation of wolves and grizzly bears, mountain lions have become the top predator and possibly more abundant where not controlled. As a result, the future of SNBS recovery may depend upon strategic control of mountain lions. Development of a predator management plan is a task addressed in the Recovery

Plan (Service 2007). Unfortunately, CDFW has changed its policy regarding predator management, which has resulted in fewer numbers of offending mountain lions (individuals known to have killed SNBS) from being lethally removed. Instead, offending mountain lions are translocated rather than killed.

The Mount Warren herd received six ewes translocated from Wheeler Ridge in the spring. Augmentation of the Mount Warren herd had been delayed for years due to the risk of disease transmitted from domestic sheep. The removal of domestic sheep from two Mono County allotments in 2017 allowed the opportunity for augmentation of this herd. The milder winter conditions also provided suitable conditions for this translocation (Greene *et al*. 2022).

The Olancha Peak herd grew from 23 to 26 females and became the fourth largest herd within the range of the SNBS.

In 2021, the estimated year-end population (as of April 30, 2021) included 260 females, 117 lambs, and 141 males for a total of 518 animals (Greene *et al*. 2023). While this was the second consecutive mild winter, the rangewide collared female population growth rate was lower than expected at 86 percent; this is too low for desired recovery goals (Greene *et al*. 2023).

During this year, 61 captures of SNBS occurred (44 females, 17 males) across 8 herds: Big Arroyo, Convict Creek, Mount Baxter, Mount Gibbs, Mount Williamson, Taboose Creek, Wheeler Ridge, and Olancha Peak. No translocations of these animals occurred. Only the Mount Baxter herd would have had enough females to be a translocation source. Three camera collars were deployed on Mount Baxter females (S544, S585, and S587). A camera collar on a Sawmill Canyon ewe (S541) recorded a lambing event. As the lamb was not seen again, it is unknown if the lamb was viable, quickly preyed upon, or met some other fate (Greene *et al*. 2023). Eighteen mortalities were detected (Greene *et al*. 2023). Seven collared animals were killed by mountain lions (Mount Baxter 5, Mount Langley 1, Wheeler Ridge 1). Six collared animals died from unknown causes (Mount Gibbs 3, Wheeler Ridge 2, Sawmill Canyon 1). One animal died from a rock fall in Mount Gibbs, and three uncollared animals died from predation by mountain lions at Mount Baxter. One capture mortality occurred at Big Arroyo.

Greene *et al*. (2023) mentioned the possibility of a changing predator-prey relationship in the eastern Sierra Nevada. The potential for wolves to recolonize this area in the future could result in further decreased mule deer populations with the assistance from black bears and mountain lions. This reduction in deer populations along with killing of mountain lions by wolves could reduce the mountain lion population. If this occurred, SNBS could experience reduced predation pressure from mountain lions. Sierra Nevada bighorn sheep are expected to experience less predation from wolves due to the presence of escape habitat. The potential recolonization of wolves could represent a historical condition that favors SNBS over mule deer.

In 2022, the estimated year-end population (as of April 30, 2021) included 277 females, 128 lambs, and 152 males for a total of 557 animals (Stephenson *et al*. 2023). The range-wide collared female population grew for the second consecutive year (Stephenson *et al*. 2023).

Thirty-four mortalities were detected, including 18 collared females (Stephenson *et al*. 2023). Mortalities occurred in 11 of 14 herds. Half of the collared mortalities were due to mountain lion predation (13/26). Lion predation occurred in eight herds (Big Arroyo, Convict Creek, Wheeler Ridge, Mount Baxter, Sawmill Canyon, Olancha Peak, Mount Gibbs, Mount Langley). Five mortalities (1 each in Mount Gibbs, Wheeler Ridge, Mount Warren, Mount Baxter, Mount Williamson) were from avalanches, which was surprising for a mild winter. The remaining eight collared bighorn sheep died from unknown causes. There were also eight uncollared bighorn sheep mortalities from five collared mountain lions (L174m, L187m, L200f, L212m, L213m) that occurred in Mount Warren, Mount Baxter, Wheeler Ridge, and Sawmill Canyon herd units.

The severe winter of 2022-2023 resulted in an almost 50 percent loss of adult SNBS (Stephenson 2024). Heavy snows caused most mortalities at the higher elevations due to avalanches, but starvation caused mortalities as well. Forty-two SNBS were documented as preyed upon by mountain lions, mostly on low elevation winter ranges.

Adult and yearling ewes declined to an estimated 169 animals. The total population, which included rams and lambs, numbered approximately 350 (Stephenson 2024). Ewes were not observed in five herds (Cathedral Ridge, Convict Creek, Taboose Creek, Big Arroyo, and Laurel Creek). Rams were observed in three of those herds (Cathedral Ridge, Convict Creek, Taboose Creek). Ewes were not observed in four herds that are considered essential for recovery (Convict Creek, Taboose Creek, Big Arroyo, and Laurel Creek).

Due to the significant loss of SNBS individuals, translocations are likely to be needed in the future in at least two herds in the Northern Recovery Unit (Mount Warren, Mount Gibbs), one herd in the Central Recovery Unit (Convict Creek), one herd in the Southern Recovery Unit (Taboose Creek), and two herds in the Kern Recovery Unit (Big Arroyo, Laurel Creek). Only the Mount Baxter herd had more than 40 females, which would be of sufficient size to support removals. As a result, Mount Baxter is the only herd remaining of the four herds used previously for translocations in the last decade.

Predation

Predation, especially by mountain lions, continue to impact SNBS throughout its range. This section provides brief details regarding mountain lion captures, collaring, mortalities, predation events on SNBS, as well as the documented increase in mountain lion numbers in the eastern Sierra Nevada since the last 5-year review (Service 2019).

Between 2018 and 2022, 6 to 31 mountain lions were captured (with some also collared; Greene *et al*. 2018, Greene *et al*. 2021, Greene *et al*. 2022, Greene *et al*. 2023, Stephenson *et al*. 2023). Also, between 2018 and 2022, SNBS mortalities due to mountain lion predation was documented as at least 11 in 2018 in 6 herds (Greene *et al*. 2018), at least 13 in 2019 in 6 herds (Greene *et al*. 2021), at least 19 in 2020 in 6 herds (Greene *et al*. 2022), at least 10 in 2021 (Greene *et al*. 2023) and at least 20 in 2022 in 7 herds (Stephenson *et al*. 2023). The herds that experienced SNBS mountain lion mortalities during these years included Mount Gibbs, Convict Creek, Wheeler Ridge, Taboose Creek, Sawmill Canyon, Mount Baxter, Mount Williamson, Mount Langley,

Olancha Peak, and Big Arroyo. Forty-two SNBS were documented as preyed upon by mountain lions, mostly on low elevation winter ranges during 2023 (Stephenson 2024).

The minimum number of mountain lions documented in the eastern Sierra Nevada increased annually from 19 to 55 between 2018 and 2022 (Greene *et al*. 2018, Greene *et al*. 2021, Greene *et al*. 2022, Greene *et al*. 2023, Stephenson *et al*. 2023). Fifty-five is the highest minimum count of mountains lions in the eastern Sierra Nevada that has been detected by CDFW.

Translocation of Mountain Lions Documented to Have Preyed Upon SNBS Individuals

Mountain lion predation of SNBS has been and continues to play a significant role in the recovery of SNBS. The Recovery Plan (Service 2007) recognized the need for balanced predator management and includes a task (2.1 Prepare and implement a management plan to temporarily protect Sierra Nevada bighorn sheep herds from predation losses, where needed, until viable herd sizes are reached) to address this. Appendix E of the Recovery Plan (Service 2007) provides additional discussion on this need.

California Department of Fish and Wildlife and its policies addressing predator management, specifically as it relates to SNBS recovery, is a concern. A few years ago, CDFW policy changed to emphasize that the removal of mountain lions (male and female) known to be predating on SNBS would occur through relocation rather than through lethal means. Lethal removal of mountain lions for SNBS protection has not occurred since April of 2017 (Greene *et al*. 2022).

Because of this change, CDFW has been attempting to study mountain lion translocation as a means of non-lethal predation-mitigation strategy (Greene *et al*. 2022). Adult SNBS female survival generally needs to be greater than 90 percent for population growth. This growth may not occur in those herds experiencing mountain lion predation. The CDFW states that they support relocation of mountain lions that prey on SNBS ewes, but it should occur promptly to protect source and small herds (Greene *et al*. 2022). In the short term, mountain lion management is very important for protecting small herds and translocation stock (Stephenson 2024).

Appendix B provides examples of successful and unsuccessful mountain lion translocation events conducted by CDFW during 2020, 2021, and 2022. These situations also raise important factors to consider in mountain lion translocation efforts.

While these efforts, provided in Appendix B, indicate translocating offending female mountain lions (and their offspring) may provide some protection for SNBS, these efforts may not occur quickly enough and the lion can continue to kill SNBS prior to translocation, are expensive and time consuming, and may shift mountain lions concerns to another area. Translocating offending male mountain lions appears to be less successful due to their strong homing behavior. The CDFW policy change is impacting SNBS recovery and is essentially providing a preference for an unlisted, wide-ranging species compared to a listed (at Federal and state levels), non-wide-ranging species. A broader discussion of this policy change and its impact on SNBS recovery can be found in the Sierra Nevada Bighorn Sheep Foundation’s newsletter (2023).

Recovery Criteria

Recovery criteria for downlisting and delisting are described in the Recovery Plan for the Sierra Nevada Bighorn Sheep (*Ovis canadensis californiana*) (Service 2007). At the time of this review, downlisting criteria for SNBS have not been met for any of the essential herd units. Therefore, an evaluation of delisting criteria is not applicable.

Conclusion

Since the previous 5-year review for SNBS was prepared (Service 2019), our understanding of this subspecies has continued to improve. Continued monitoring of SNBS across its range between 2018 and 2023 has resulted in documented, stability in distribution and population numbers until 2022 with a subsequent serious loss in distribution and population numbers by 2023. This resulted in SNBS no longer meeting its geographic distribution recovery goal of inhabiting the 12 essential herd units nor its female numeric recovery goals for any of the 4 recovery units during that year. The severe winter of 2022-23, as well as mountain lion predation, have both had an impact on SNBS numbers. Some herds have provided source animals for translocation efforts in the past. Due to the significant reduction in SNBS numbers for various herds, translocations will be necessary in the future, but these translocations will need to be delayed due to lack of animals available in source herds.

Sierra Nevada bighorn sheep population dynamics are driven primarily by adult female survival; the two major types of mortality are snow-related deaths (starvation and avalanches) and mountain lion predation (Greene *et al*. 2023). We cannot control the weather; we can manage predation. Predation in various herds continues to stall population growth and this will impact the ability to translocate individuals. Predator management is likely needed to reduce mountain lion predation and thus provide translocation source animals to meet recovery goals (Gammons *et al*. 2021).

The SNBS population rangewide needs to experience a series of winters where adult mortality is low and lamb production trends upward in several herds, control of predation (mountain lion) to protect small herds and translocation source herds, and the wise use of translocation stock to augment those herds that need animals the most (Sierra Nevada Bighorn Sheep Foundation 2019).

We conclude that the SNBS continues to require the protections of the ESA under its current classification of endangered. While important and significant steps toward recovery have been made, small population size, fragmented distribution of subpopulations, and the continued threat of predation and disease transmission from domestic livestock require the continuation of the ESA's protections.

After reviewing the best available scientific information, we conclude that the Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) remains an endangered species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the ESA and analysis of the status of the species in our most recent status review remains an accurate reflection of the species status.

RECOMMENDATIONS FOR FUTURE ACTIONS:

1. We support CDFW's efforts to address predation concerns and the need to selectively remove mountain lions from SNBS range; however, these efforts should also include continued discussions with CDFW related to their current predation policy (non-lethal methods) and our concern with its impact on the recovery of SNBS.

2. We support the RIT science subteam's effort to complete the predator management plan and its relationship to CDFW's predation policy as it relates to number 1 above.

3. We support CDFW's continued translocation efforts to augment smaller subpopulations and to establish new populations in unoccupied habitat that is necessary for recovery.

4. We continue to support the National Forests and BLM in efforts to restrict domestic sheep and goat grazing near SNBS habitat.

5. We continue to support the National Forests and BLM in performing controlled burning and other habitat improvement projects on winter ranges for the SNBS.

6. We support CDFW's continued research on potential threats to SNBS related to human-recreation disturbance, wildfire impacts on habitat quality, and use of low-elevation winter range.

Field Supervisor, Fish and Wildlife Service

Approve KRISTEN JULE Digitally signed by KRISTEN JULE Date: 2024.08.29 09:06:58 -07'00' Date _____

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APPENDIX A. RESEARCH STUDIES RELATED TO SIERRA NEVADA BIGHORN SHEEP CONDUCTED SINCE THE LAST 5-YEAR REVIEW

Migration

Spitz *et al*. (2020) quantified migratory status (resident vs. migrant) and season-specific (winter vs. summer) differences in resource selection by eight SNBS herds across three spatial scales (population range, individual range, within individual range). Residents showed stronger coarse-scale selection for areas associated with predator avoidance and stronger fine-scale selection for greenness. The pattern for migrants was reversed. Availability of migrant habitat predicted the local prevalence of migration.

Denryter *et al*. (2021a) reported on a movement behavior for altitudinal migration by SNBS, which could be important for demographic and fitness consequences. Three patterns of movement behavior was identified for SNBS: traditional migration, residency, and residency with abbreviated migration. A fourth movement behavior was also identified: vacillating migration (round trips between seasonal ranges between November 1 and May 31 with less variance in elevational movement and generally less distance). The fourth type of movement may have allowed SNBS to increase access to forage with reduced risk of predation without committing to a single strategy for the entire winter. This pattern may be the most flexible and allow SNBS to actively change the range they occupy to balance the risks they are experiencing in real-time associated with predator presence, snowfall, or greenup demonstrating a high level of plasticity.

Denryter *et al*. (2021b) evaluated whether energy expenditures by SNBS were consistent with behavioral compensation. Regardless of reproductive condition, female SNBS expended less energy on activities in winter compared with summer, which was consistent with context-dependent behavioral compensation.

Denryter *et al*. (2022) used data from SNBS predicted that animals with high levels of body fat would have high survival regardless of migratory tactic (high-elevation resident, traditional, vacillating). Residents would require larger stores of body fat than migrants; energy stores would be less influential for vacillating migrants. They found that high levels of body fat in fall (greater than or equal to 14 percent for females, greater than or equal to 19 percent for males) resulted in greater than 90 percent survival regardless of migratory tactic. Traditional migrants had higher survival than residents. Vacillating migrants showed almost 100 percent survival with undetectable effect of body fat on survival. Both physiological and behavioral adaptations play a role in potential fitness consequences for individuals and demographic consequences for populations in seasonal environments.

Berger *et al*. (2022) found that perception, migratory propensity of an individual's social group, and an individual's migratory history were the best predictors of migration for SNBS. Short distance altitudinal migration was a response to an individual's perception of conditions on alterative winter range, in part. For long-distance partial migrants, it is unlikely that migratory decisions would be based on sensory cues from a remote range.

Helicopter Capture

Capturing wildlife can have lethal and non-lethal consequences to wildlife. Wagler *et al*. (2022) used data from captures of female SNBS and Rocky Mountain bighorn sheep during 2002 and 2020 to evaluate their survival from helicopter net-gunning. They compared pre- and post-capture survival over a 10-week period as well as capture handling techniques. Direct mortality was 1.36 percent, with 0.54 percent mortality occurring within 3 days following a capture event. This results in an overall 1.90 percent capture-related mortality. Helicopter net-gunning remains an effective and rather safe technique for capture and data collection of bighorn sheep.

Translocation

A known fate survival analysis was used to assess the role of age, sex, habitat, climate, population size, and predation to determine factors that drive adult female SNBS survival (Conner *et al*. 2018). Survival declined with age and varied between males and females based on location. Top models for males and females included spatial separation between the Southern and Central Recovery Units, as well as between Mount Warren and Mount Gibbs located in the Northern Recovery Unit. Top models for females included a measure of predation, avalanche danger, and forage availability risk; while for males, top models included a measure of forage, climate, and avalanche risk. Lack of interactions between age and other covariates suggests that selection of younger female SNBS for translocation may occur due to their higher reproductive value compared to older females without additional negative synergies among age and other factors to consider.

Reproduction and Survivorship

Monteith *et al*. (2018) using measurements of ram horn size and body condition and weight of captured female SNBS that horn growth differed between herds indicating nutritional conditions varied in these herds. The largest and fattest animals were in the Mount Gibbs herd and the smallest and thinnest were in the Mount Warren herd. Nutrition and possibly maternal condition may play important roles in ram horn size.

Stephenson *et al*. (2020) investigated the relationships between body fat, pregnancy, overwinter survival, and population growth in California and Nevada free-ranging bighorn sheep, including data from SNBS. Among 11 subpopulations that included alpine winter residents and migrants, mean ingesta-free body fat of lactating adult females during fall ranged between 8.8 percent and 15.0 percent; mean body fat for non-lactating females range from 16.4 percent to 20.9 percent. For adult females, ingesta-free body fat greater than 7.7 percent in January corresponded with a greater than 90 percent probability of pregnancy. Ingesta-free body fat greater than 13.5 percent during fall yielded a probability of overwinter survival of greater than 90 percent. Mean ingesta-free body fat of lactating females in fall was positively associated with finite rate of population increase over the subsequent year in subpopulations wintering in alpine landscapes. Bighorn sheep with ingesta-free body fat of 26 percent in fall and inhabiting alpine environments possess energy reserves sufficient to meet resting metabolism for 83 days on fat reserves alone. Nutritional condition underlies demography and characterizes the nutritional value of occupied ranges.

Disease

Anderson *et al*. (2022) published a disease risk analysis method to be used to assess risk of domestic sheep grazing in close proximity to SNBS herds and recovery area. The method uses habitat modeling and cost distance analysis to predict where SNBS are likely to travel. This model was compared to earlier unpublished versions of this method and the later model better quantifies the risk of contact between the two species as it characterizes how SNBS prefer to travel through rugged terrain. Domestic sheep grazing allotments that occur in SNBS habitat pose a greater risk even if they are located farther from occupied habitat. There are 16 allotments that occur wholly or partially within the polygon identified as high risk to SNBS. A variety of mitigation measures have been used to mitigate the risk to SNBS to various degrees. Anderson *et al*. (2022) will be updated as SNBS habitat selection and movements change.

Predation

Dellinger *et al*. (2019) addressed mountain lion management and conservation issues in California at a large scale. In California, mountain lions are genetically and demographically at risk in one region and stable and negatively impacting listed endangered species in another. No formal plan exists in California to address these diverse scenarios. Habitat selection was quantified at two special scales. At the home range scale, habitat was selected to meet energetic demands. Within the home range scale, mountain lions avoided areas of human activity. Approximately 170,085 square kilometers of suitable habitat for mountain lions, depending on season, occurs in California. Fifty percent of this habitat is unprotected, meaning it could be potentially developed. These habitat models would help in the development of a state-wide conservation and management plan for mountain lions in California.

Gammons *et al*. (2021) evaluated the relationship between mountain lion predation and SNBS female SNBS survival rates for three source herds in the Southern Recovery Unit, compared mountain lion abundance and female SNBS survival among years of varying predation, provided a range of estimated times for the Mount Langley herd to recover to a translocation source herd, and determine if removal rates of mountain lions exceeded sustainable harvest guidelines. They found that mountain lion predation had impeded SNBS recovery by reducing female survival rates and thus population growth and by preying on individuals that could have been used for translocation. Female survival rates are below the necessary level to ensure population growth. Since predation is related to mountain lion abundance, monitoring mountain lion populations could provide managers with advance knowledge of potential periods of high predation. Mountain lion removal rates so far have been well below what would be needed to reduce the population in the eastern Sierra. Mountain lion removal may be required to assist SNBS recovery for the foreseeable future.

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APPENDIX B. TRANSLOCATIONS OF MOUNTAIN LIONS DOCUMENTED TO HAVE PREYED UPON SNBS INDIVIDUALS

In May of 2020, CDFW translocated a transient female subadult mountain lion, L172. She was originally captured in the Wheeler Ridge herd unit, killed a SNBS ram shortly after being captured, and eventually traveled north to Mount Warren herd unit. She was translocated because she was deemed too great a risk for this herd. She was captured and translocated to the Slinkard/Little Antelope Wildlife Area. She initially traveled north, but turned south to the Mount Warren herd unit, and then quickly turned north again to establish a home range east of Lake Tahoe.

In January of 2021, mountain lion male, L147, was translocated to Slinkard/Little Antelope Wildlife Area after he killed an adult ewe in Sawmill Canyon herd unit (Greene *et al*. 2023). Typical homing behavior was shown as he promptly headed south towards his previous home. In late February, he was captured again. He was translocated to the Mescal Range about 200 miles southeast of where he was caught. He again showed homing behavior as he headed northwest towards his previous home. Mountain lion male, L176, was captured after killing three SNBS in the Mount Baxter herd unit; he was also translocated to the Mescal Range. He also showed homing behavior and was recaptured near China Lake and translocated in the San Bernardino National Forest.

Subsequently, both animals died. Male L147 was found dead, emaciated, suggesting starvation. Male L176 was euthanized when found in an emaciated condition. These translocations provided important information regarding the strong homing behavior displayed by male mountain lions as well as the importance of prey availability at release sites. Stephenson *et al*. (2023) further addressed these translocations by clarifying that these males were moved to areas where adequate prey was available, but during homing they traveled in areas that provided less abundant food resources. It is also important to note, that male mountain lions will normally decline in body condition as they become focused on finding mates in their previous home rather than finding food.

In contrast, female mountain lion, L168 and her two 6-month old subadults (L198, L199) were captured on Mount Baxter winter range and translocated together to Slinkard/Little Antelope Wildlife Area. The adult female had previously preyed on at least one SNBS, and she was suspected of previously raising SNBS-killing offspring. Approximately 2 months after their relocation, the group was found together still in their new home. Not long after, the adult female was killed by a vehicle on Hwy 395. While Hwy 395 had also bisected her previous home range, major roadways should also be considered in release site locations. Her young were too small to be fitted with collars so their fates are unknown.

Mountain lion (L200f) and her two subadults (L209f, L210f) were moved to the San Bernardino Mountains in early 2022 (Stephenson *et al*. 2023). By the summer of 2022, all three animals were alive and had established new home ranges. No conflicts occurred and none have displayed homing instincts.

While these efforts indicate translocating offending female lions (and their offspring) may provide some protection for SNBS, these efforts may not occur quickly enough and the lion can continue to kill SNBS prior to translocation, are expensive, time consuming, and may shift mountain lions concerns to another area. Translocating offending male mountain lions appears to be less successful for reasons mentioned above as well as additional ones. The policy change is impacting SNBS recovery and is essentially providing a preference for an unlisted, wide-ranging species compared to a listed (at the Federal and state levels), non-wide-ranging species. A broader discussion of this policy change and its impact on SNBS recovery can be found in the Sierra Nevada Bighorn Sheep Foundation's newsletter (2023).

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