United States Department of the Interior

FISH AND WILDLIFE SERVICE
2369 W Orton Circle, #50
West Valley City, Utah 84119

In Reply Refer to:
FWS/R6/
06E23000-2023-F-0035336

Memorandum

To: Head of Resource and Research Management, Zion National Park

From: Utah Field Supervisor, Ecological Services, U.S. Fish and Wildlife Service, West Valley City, Utah SONYA DYER Digitally signed by SONYA DYER Date: 2023.08.08 15:25:29 -06'00'

Subject: Final Biological Opinion for Zion National Park Zion Canyon South Entrance Area Redesign Project

In accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), this transmits our final biological opinion (BO) on the National Park Service (NPS) Zion Canyon South Entrance Redesign Project (hereafter, Project). Our BO evaluates the effects of the Project to Mexican spotted owl (*Strix occidentalis lucida*) and its designated critical habitat. Our BO is based on information provided in your final biological assessment (BA) dated April 11, 2023, correspondence between our offices, and other sources of information.

The Western yellow billed cuckoo (*Coccyzus americanus occidentalis*) and Southwestern willow flycatcher (*Empidonax traillii extimus*) were also analyzed as part of the BA. We concur with your determinations of may affect, not likely to adversely affect for both species due to the lack of suitable riparian habitat required for breeding, feeding, or sheltering within the Project area. California condor (*Gymnogyps californianus*) was also analyzed as part of the BA, and we concur with your determination of may affect, not likely to adversely affect for this species because the Project actions will not occur near cliffs containing the species, thus direct and indirect effect are unlikely to occur. Additionally, as stated in the BA, conservation measures such as education programs and trash and food storage requirements in the Park will further minimize potential effects to the species. Lastly, you also analyzed Mojave Desert tortoise (*Gopherus agassizzii*) as part of the BA, and we concur with your determination of may affect, not likely to adversely affect due to the lack of suitable habitat within the Project area.

We also determined the proposed action is not likely to jeopardize the continued existence of the monarch butterfly (*Danaus plexippus*). We expect the implementation of the Project and its associated conservation measures to have discountable effects and to increase the amount of potential habitat for the monarch in the Park through revegetation of disturbed areas with native seed mix.

Consultation History

This section summarizes significant steps in the consultation process:

- June 16, 2022: We met with NPS staff to initiate technical assistance on the Project and discuss the proposed action, timelines, and effects to listed species.
- March 2, 2023: We met with NPS to discuss effects determinations and conservation measures for listed species, particularly Mexican spotted owl.
- March 8, 2023: We received a draft BA from your office and provided feedback.
- March 9, 2023: We met with NPS staff to address questions from the draft BA.
- April 11, 2023: We received transmission of the final BA and initiated formal consultation for the Zion National Park South Entrance Redesign Project.

1. Proposed Action

The National Park Service (NPS) Zion National Park (Zion) is proposing to redesign the South Entrance of Zion Canyon. Actions will include realigning the road accessed from the South Entrance Fee Station to the Zion Canyon Visitor Center, expanding the Zion Shuttle Maintenance Facility, reconstructing the South Campground, installing pedestrian trials, and improving accessibility throughout the South Entrance Area. A summary of each of the actions can be found below.

Road and shuttlebus construction:

- Construction of two new roundabouts,
- Construction of new roads, road configurations, and road connections,
- Construction of a new vehicular bridge,
- Upgrading two parking lots and a shuttle bus parking lot,
- Removing and reclaiming an old road,
- Removing an existing bridge,
- Installing culverts, as necessary,
- Replace existing structures with concrete retaining walls and boulder riprap, and
- Tree removal (120) and subsequent revegetation.

Campground construction:

- Demolishing and rehabilitating portions of the S. Entrance campground,
- Construction of a new office building,
- Improving campsite infrastructure and accessibility,
- Construction and renovation of comfort stations,
- Expansion of dump station,
- Construction of new day use picnic areas,
- Construction of short-term parking areas, and
- Removal of 147 to 193 trees and subsequent revegetation.

Pedestrian routes construction:

- Construction of a pedestrian underpass,
- Constructing new trails and trail connections, and
- Realignment and repaving of a trail.

The total area of disturbance is expected to include about 5.6 acres for road improvements, 3.39 acres for upgrading the shuttle facility, 11.92 acres for the campground renovations, and 2.2 acres for pedestrian route improvements. Of this disturbance, about 1.21 acres will be restored after road construction and 13.42 acres will be restored after campground construction. Construction will be phased and is anticipated to last approximately 4 years.

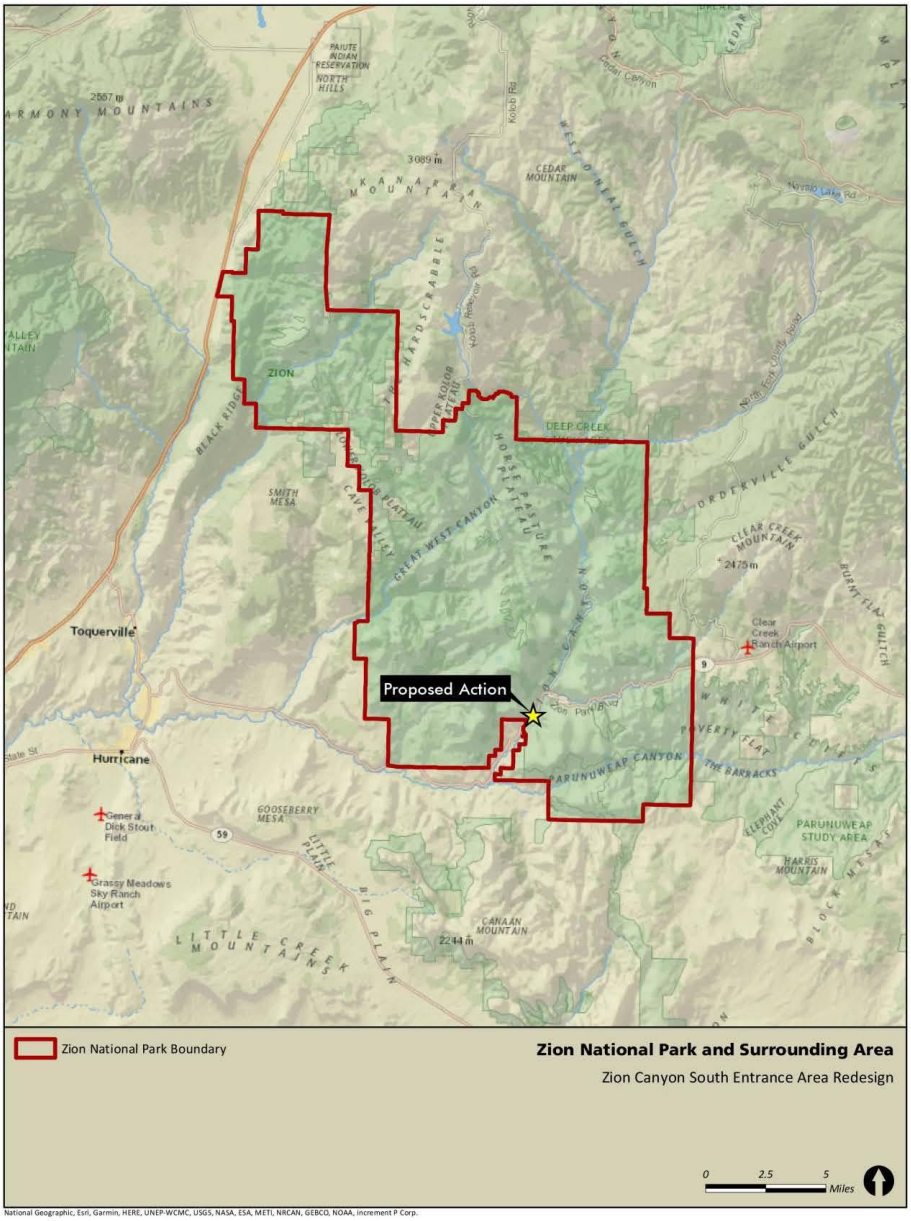

Figure 1. Zion National Park and Surrounding Area.

Figure 1. Proposed action area and Zion National Park boundary as depicted in Figure 1 of the BA (NPS 2023).

1.1. Action Area

The action area occurs in Washington County, Utah, and is located within Zion National Park, which encompasses approximately 148,733 acres of NPS-managed land. The action area encompasses approximately 1,991 acres, which includes the project footprint plus a 0.5 mi buffer based on noise reduction recommendations found in the Mexican spotted owl recovery Plan (USFWS 2012) and distances required to attenuate loud noises generated by motorized equipment.

1.2. Applicant Committed Conservation Measures

To ensure conservation of listed species and to contribute to the recovery of the species, NPS committed to implement species-specific conservation measures for Mexican spotted owl, California condor, Mojave desert tortoise, and Monarch butterfly (NPS 2023). The NPS also identified Standard Operating Procedures and Best Management Practices to be implemented. We summarize the conservation measures, by species, below.

For Mexican spotted owl:

- Components of the proposed action within a Protected Activity Center (PAC) or within 0.5 mi of a core area will be planned outside of the spotted owl breeding season (March 1 through August 31), and will occur only during daylight hours;
- If an owl is identified in the Project area during construction, the Project area will be surveyed daily until the owl is confirmed to have left the area;
- Mexican spotted owl PACs will continue to be monitored at a minimum once every three years for occupancy and productivity to help track and gauge potential impacts from visitor use.
- Tree removal will occur only in October and November;
- Larger dead/dying trees that are not a hazard to humans or property will be preserved either fully or partially intact to provide habitat for wildlife. Larger logs/woody debris will be left on the ground on-site to provide habitat for rodents, reptiles, and insects.

For California condor:

- If a condor occurs at the Project area, construction will cease until it leaves on its own or until techniques are employed by permitted personnel that results in the individual condor leaving the area. A park-employee monitor will be responsible for this task;
- Compliance with food storage and waste disposal will be achieved at all times. The Project area will be cleaned up at the end of each work period (daily) to reduce the attraction of wildlife;
- Exclude any potential for condor trash ingestion at dumpster areas by installing wildlife-proof dumpsters or trash bins and food storage containers at campsites;
- The Division of Interpretation and Education and the Wildlife Program will continue to provide visitors with opportunities to learn about the California condor, the Condor Recovery Program, and how to minimize visitor effects on condors;
- If euthanasia of wildlife in Zion must occur, lead ammunition and toxins that may affect scavengers such as California condor will not be used.

For Mojave desert tortoise:

- The Division of Interpretation and Education will continue to provide visitors with opportunities to learn about the Mojave desert tortoise, the Desert Tortoise Recovery Program, and how to minimize effects on the desert tortoise;
- If a tortoise occurs in the Project area, construction will immediately cease, and the park Wildlife Biologist ill be contacted immediately to move the individual from the site;
- From April to October, construction personnel will be briefed to check underneath vehicles for tortoises before driving vehicle.

For Monarch butterfly:

- Clearing and grubbing activities will occur only during November through February to avoid the monarch active season;
- Noxious weeds will be controlled and managed to reduce their spread by timing weed spraying to avoid the monarch butterfly breeding season and, when feasible, conducting spot spraying to limit effects on flowering nectar plants; and
- Native seed mixes used during revegetation efforts will include flowering plants and milkweed.

2. Species Accounts, Effects, and Conclusions

2.1. Status of the Species: Mexican Spotted Owl

Species Description

A detailed account of the taxonomy, biology, and reproductive characteristics of the Mexican spotted owl (hereafter, referred to as Mexican spotted owl, spotted owl, and owl) is found in the final listing rule (58 FR 14248, March 16, 1993), the original Recovery Plan (USFWS 1995), and in the revised Recovery Plan (USFWS 2012). We completed a five-year status review in 2013 and recommended no change to the Mexican spotted owl's classification as threatened or its recovery priority number of 9C - a subspecies with a moderate degree of threat and a high potential for recovery (USFWS 2013). The information provided in those documents are included herein by reference.

The Mexican spotted owl is one of three subspecies of spotted owl recognized by the American Ornithologists' Union (AOU 1957). The other two subspecies are the northern (*S. o. caurina*) and the California spotted owl (*S. o. occidentalis*). The Mexican spotted owl occurs in forested mountains and canyon lands in Utah, Colorado, Arizona, New Mexico, and the western portions of Texas. The species also occurs in several States of Mexico.

Life History and Population Dynamics

Mexican spotted owls breed sporadically and do not nest every year (Ganey 1988). Courtship begins in March and eggs are laid in late March or, more typically, early April. Incubation begins shortly after the first egg is laid and is performed entirely by the female. Female spotted owls incubate for approximately 30 days and eggs usually hatch in early May (Ganey 1988). Females brood their young almost constantly, leaving their nests for only brief periods during the night (Forsman et al. 1984; Delaney et al. 1999a).

Spotted owls have one of the lowest clutch sizes among North American owls (Johnsgard 1988); females lay one to three eggs, two being the most common. Nestling owls fledge from four to five weeks after hatching, from early to mid-June in most cases (Ganey 1988). Three weeks after leaving the nest owlets can feed on their own (Forsman et al. 1984).

Spotted owls are "perch and pounce" predators (Forsman et al. 1976). Their prey items include woodrats, mice, voles, rabbits, gophers, bats, birds, reptiles, and arthropods. Spotted owls dwelling in canyons of the Colorado Plateau take more woodrats and fewer birds than do spotted owls from other areas (Ward and Block 1995; Willey and Willey 2010).

The Mexican spotted owl's life history is characterized by high and reasonably constant adult survival rates, low juvenile survival rates, and relatively low and highly variable reproductive rates (USFWS 2012). These life history characteristics allow owls to reproduce when conditions are favorable and to survive unfavorable periods with little or no reproduction, a strategy that has been coined "bet-hedging" (e.g., Boyce 1986; Franklin et al. 2000). In the rocky-canyon habitats in southern Utah, Mexican spotted owls exhibit higher occupancy and recolonization rates and lower extirpation rates at mesic (wet) sites (e.g., Cedar Breaks and Zion) than xeric (dry) sites (e.g., Grand Staircase – Escalante or Capitol Reef), suggesting mesic sites are more stable (i.e., constant occupancy) than xeric sites (Willey and Willey 2010; Hockenbary 2011). Mesic habitats may also have more favorable microclimates and habitat structure, roost and nest sites, and diverse habitats for the owl's prey.

Status and Distribution

In 1993, we listed the Mexican spotted owl as threatened under the ESA (58 FR 14248, March 16, 1993). We developed the first recovery plan in 1995, and revised it in 2012 (USFWS 1995, USFWS 2012).

The 2012 Recovery Plan identifies five Ecological Management Units (EMUs; Figure 2) in the United States, based on: physiographic provinces, biotic regimes, perceived threats to habitat or individual birds, administrative boundaries, and owl distribution (USFWS2012). The five EMUs are: Colorado Plateau, Southern Rocky Mountains, Upper Gila Mountains, Basin and Range-West, and Basin and Range-East.

In the U.S., most owls are found on National Forest lands. However, in most areas of the Colorado Plateau EMU, owls are found only in rocky-canyon habitats, which primarily occur on NPS and Bureau of Land Management (BLM) administered lands (USFWS 2012).

The revised Recovery Plan (USFWS 2012) identifies 1,324 known owl sites in the United States. An owl site is an area used by a single or a pair of adult or subadult owls for nesting, roosting, or foraging. There were 758 known owl sites from 1990 to 1993, and 1,222 owl sites from 1990 to 2004 in the United States. The increase in number of known owl sites is mainly a product of new owl surveys being completed within previously un-surveyed areas. Thus, an increase in abundance in the species range-wide cannot be inferred from these data. We estimate owl sites in the United States represent 97 percent of the known total range-wide population (USFWS 2012).

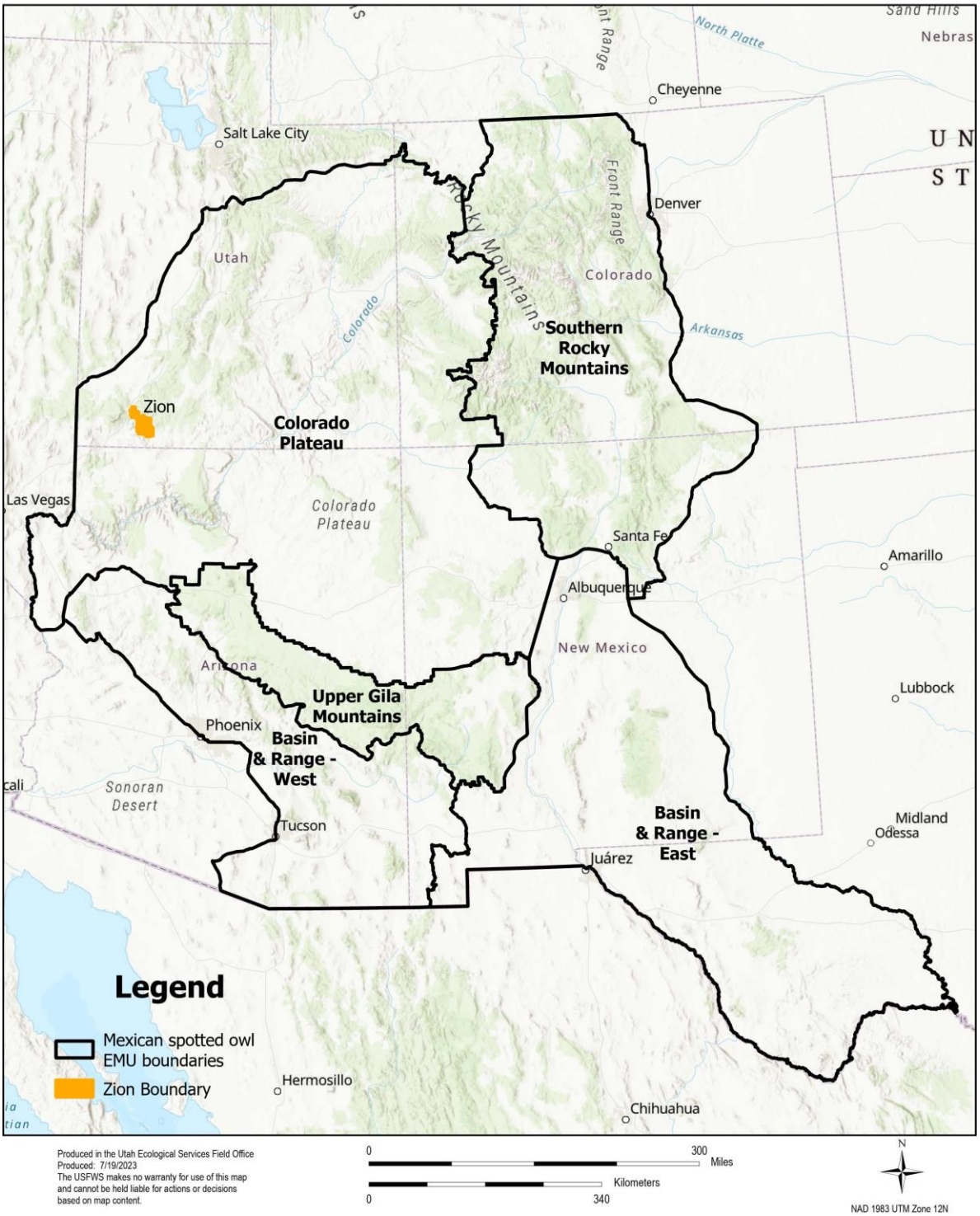

Figure 2. Zion National Park within the Mexican Spotted Owl Ecological Management Unit Boundaries in the United States. Five EMUs wholly within Mexico are not pictured.

The primary threats to the Mexican spotted owl at the time of listing were even-aged timber harvest and catastrophic wildfire (58 FR 14248, March 16, 1993). Grazing, recreation, and other

land uses were also mentioned as possible factors influencing the Mexican spotted owl population. Our most recent threat assessment in the revised Recovery Plan identified large, severe wildfires as the primary threat to the species (USFWS 2012). Historical and current anthropogenic uses of Mexican spotted owl habitat include domestic and wild ungulate grazing, recreation, fuels reduction treatments, resource extraction (e.g., timber, oil, gas), and development (USFWS 2012). These activities have the potential to reduce the quality of owl nesting, roosting, and foraging habitat, and may cause disturbance during the breeding season (USFWS 2012).

Overall, the status and distribution of the Mexican spotted owl has not changed significantly range-wide in the U.S. since the time of listing (which includes Utah, Colorado, Arizona, New Mexico, and extreme southwestern Texas).

Critical Habitat Description

We designated critical habitat for Mexican spotted owl on August 31, 2004 (69 FR 51382). Designated critical habitat includes approximately 8.6 million acres of forested mountain and canyon habitat on Federal lands in Arizona, Colorado, New Mexico, and Utah. Critical habitat continues to support the needs of the Mexican spotted owl throughout all EMUs located in the United States.

The physical and biological features relevant to Mexican spotted owl canyon habitat in the action area are:

- Canyon walls containing crevices, ledges, or caves;
- Presence of water (often providing cooler air temperature and often higher humidity than the surrounding areas);
- Clumps or stringers of mixed-conifer, pine-oak, pinyon-juniper, and/or riparian vegetation; and
- Woody debris to support prey populations.

In the Colorado Plateau EMU, designated critical habitat includes over 3.3 million acres of Federal lands. We designated five separate critical habitat units for Mexican spotted owl in Utah, totaling approximately 2,252,857 acres (69 FR 53182). Of that total, approximately 1,720,727 acres are located on lands administered by NPS (USFWS 2012).

For a more detailed description of Mexican spotted owl critical habitat, see the final listing and critical habitat rule (69 FR 53182).

2.2 Environmental Baseline

Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present effects of all Federal, state, or private actions and other human activities in the action area, the anticipated effects of all proposed Federal projects in the action that have already undergone formal or early section 7 consultation, and the effects of state or private actions that are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Zion National Park offers a diversity of recreation opportunities for scenic driving, OHV use, camping, and hiking (NPS 2023). Visitor use has grown steadily for many years, and recently the demand for public access has grown exponentially (NPS 2023). The action area has been highly disturbed by human activity and continues to be affected by human activity and exisiting facilitates. These currently include an existing Visitor Center with pedestrian entrance and kiosk, parking areas for visitors and employees, entrance roads, campgrounds, paved and unpaved trails, shuttle routes and facilities, vehicle and pedestrian bridges over the Virgin River, and numerous additional manmade structures. The NPS estimates median ambient noise levels in the action area are about 43 dBA (NPS 2023; NPS 2010 pg. 28).

2.2.1. Mexican Spotted Owl

Status of the Species within the Action Area

The Mexican spotted owl action area includes potential habitat that occurs within 0.5 mi of the proposed Project based on the potential for noise harassment. The entirety of the action area is approximately 1,990.7 acres. Using geospatial models (Willey and Spotskey 1997; Lewis 2014), we identified approximately 1,160 acres of potential habitat in the action area. Our action area and subsequent analysis differs slightly from that stated in the BA as we used a 0.5 mi buffer in our analysis, while NPS used a 1.0 mi buffer.

The action area occurs within the Utah portion of the Colorado Plateau EMU. Approximately 15 percent (206 owl sites) of all known owl sites recorded in the U.S. since 1989 occur in the Colorado Plateau EMU (USFWS 2012). Most owl sites within this EMU are on NPS administered lands (64 percent), followed by BLM administered lands (22 percent), and then Forest Service (FS) administered lands (13.5 percent; USFWS 2012, Appendix B, Table B.1). These numbers are best interpreted as minimum cumulative numbers of locations where at least one owl was recorded during at least one breeding season since 1989. We do not have information on how many of these sites within the Colorado Plateau EMU are currently occupied.

Steep-walled rocky canyon lands provide typical owl habitat in the Colorado Plateau EMU. Canyon habitat is used by owls for nesting, roosting, and foraging and includes landscapes dominated by vertical walled rocky cliffs within complex watersheds, including many tributary side canyons (USFWS 2012). Rock walls must include caves, ledges, and fracture zones that provide protection for nesting and roosting sites. Breeding sites are located below canyon rims; however, it is known that owls use areas outside of canyons (i.e., rims and mesa tops). Owl nests and roosts primarily on cliff faces using protected caves and ledges, and forage in canyon bottoms, on cliff faces and benches, and along canyon rims and adjacent lands. These areas frequently contain small clumps or stringers of mixed-conifer, ponderosa pine, pine-oak, pinyon-juniper, and or riparian vegetation (USFWS 2012). In Utah, owls have been documented using canyon bottoms and adjacent rims for foraging (Willey 1998). Mexican spotted owls typically occur in metapopulations (spatially separated populations; USFWS 2012), and most populations in Utah occupy large canyon complexes.

Mexican spotted owl habitat assessments and surveys within Zion were performed as early as 1987 and have continued regularly through 2021 (the last year of survey data available for the Project). Areas throughout the Zion that models (Willey 1997, Willey 2000, and Lewis 2014) indicate as potential habitat (approximately 69,554 acres) have had various levels of field

evaluations and surveys, as applicable to determine suitability for breeding, roosting, and foraging. Surveyors identify suitable habitat by ground-truthing modeled habitat through field visits to identify likely nesting or roosting habitat. Suitable habitat characteristics include deep, narrow, and long canyon complexes with exposed rocky cliffs or ledges that meets the species needs (USFWS 2012). This is standard practice since we and other species experts recognize that the habitat models over-estimates the amount of potential habitat (USFWS 2002a).

Zion has some of the highest densities of spotted owls known in Utah. As of 2021, there were 39 suspected or known Mexican spotted owl territories in Zion and NPS has delineated 31 PACs (NPS 2023, pg. 27).

There are no Mexican spotted owl PACs within the action area; however, there are three PACs within the vicinity: Oak Creek, Pine Creek, and Lady Mountain PACs. The Oak Creek PAC is closest to the action area, the edge of the PAC is about 0.25 mi from the action area. The edge of the Pine Creek PAC is about 0.8 mi from the action area and the edge of the Lady Mountain PAC is about 0.9 mi from the action area. Core areas for all three PACs are over 2 mi away from the action area. Surveys have identified that all three PACs are regularly occupied, and breeding pairs or individuals were detected in 2021.

Suitable habitat within the action area contains Riparian Recovery Habitat found along Oak Creek and Virgin River. Riparian Recovery Habitat consists of riparian forests outside of PACs that could frequently be used by owls for foraging, roosting, daily movements, and potentially nesting (UWFWS 2012). This habitat type is important for owl recovery, as it can provide stepping stones for movement between population segments or be used by owls during the non-breeding season (USFWS 2012). Additionally, these areas may facilitate gene flow and the survival of owls during the winter (USFWS 2012).

There is the likelihood for spotted owls in PACs located outside of the action area to forage or use suitable habitat within the action area at various times during the year, although we have no documentation of this occurring. Available information suggests that Mexican spotted owls in Utah use relatively large home ranges and movement to peripheral areas in the nonbreeding season are typical (Willey 1998; Willey 2007; USFWS 2012). Suitable habitat within the action area may be used by PACs outside of the action area for foraging and juvenile dispersal; however, we would not expect more than occasional use of the action area by these owls as surveys have not identified any other breeding pairs and the baseline conditions of the action area are heavily disturbed. Annual surveys are needed to monitor the occupancy of the existing PACs and detect new owl sites in suitable habitat.

Status of Critical Habitat within the Action Area

The action area is within critical habitat unit CP-11 of the Colorado Plateau EMU, which covers Federal lands in three Utah counties (Washington, Kane, and Iron) and includes canyon and steep-sloped mixed conifer nesting habitat as well as additional foraging and dispersal habitat (69 FR 51382). The entirety of the action area (approximately 1,990.7 acres) is designated critical habitat for Mexican spotted owl. Furthermore, the entirety of Zion is designated as critical habitat for the species (approximately 148,733 acres). The action area represents approximately 1 percent of the CP-11 unit (260,105 acres) and less than one percent of the Colorado Plateau EMU (3.3 million acres) and the total designated critical habitat for the species (8.6 million acres).

Based on geospatial models (Willey and Spotskey 1997; Lewis 2014), there are approximately 1,160 acres of potential habitat within designated critical habitat in the action area. Of note, the riparian vegetation along Oak Creek and the Virgin River in the action area contain the physical and biological features to support roosting and foraging for spotted owls, but likely not nesting.

Not all acres of designated critical habitat contain the physical and biological features essential to the conservation of the species, such as cooler and often more humid conditions than the surrounding areas; steep canyon walls with crevices, ledges, or caves; high percent of ground litter and woody debris; and riparian or woody vegetation. Critical habitat was designated across large tracks of Federal land with known owl sites where canyon landscapes are common (69 FR 53183), resulting in large polygons that often include suitable and unsuitable habitat for the species, based on expert opinion species experts and more recent habitat models (Willey 1997). Best available information indicates that modeled habitat in conjunction with field assessments provides the best indication of potential occupancy and owl sites inside and outside of critical habitat.

Factors Affecting Species and Critical Habitat within the Action Area

Stressors to Mexican spotted owls and critical habitat in the action area include recreation; road use and development in canyons; and climate change (USFWS 2012). The extent to which these stressors are affecting Mexican spotted owls and critical habitat within the action area is presently unknown. Unlike in other portions of its range, fire is not a landscape-scale threat to Mexican spotted owl habitat in the action area and the Colorado Plateau EMU because the incidence and extent of stand-replacing fires in cliff and canyon habitat is very low (USFWS 2012). Additionally, because of the difficulty in harvesting trees in canyon habitat preferred by Mexican spotted owls in Utah and the lack of active timber harvest within the action area, we do not identify timber harvest as a threat.

Recreation and road use are likely the most important stressors affecting the species and critical habitat within the action area. Recreation ranks as a primary land use within the Colorado Plateau EMU because of high recreation pressure on public lands (USFWS 2012). Recreation intensity is high in this region of Utah, and visitation has increased exponentially in Zion in recent years (NPS 2023). The potential for recreation to affect owl presence and recovery is compounded by the terrain, with owls established in narrow canyons having less opportunity to move away from human activity. Activities such as hiking, camping, and OHV use occur in owl habitat within Zion and Colorado Plateau EMU (USFWS 2012). The action area experiences a high level of human use and human-caused noise (NPS 2023 pg. 44). Currently, noise and human activity in the action area occurs because of frequent automobile, bus and motorcycle traffic and visitor use of trails, parking areas, and visitor facilities. The NPS estimates median ambient noise levels in the Project area are about 43 dBA (NPS 2023; NPS 2010 pg. 28).

Both the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Global Climate Change Research Program (USGCRP) conclude that changes to climatic conditions, such as temperature and precipitation regimes, are occurring and are expected to continue in western North America over the next 100 years (Frankson et al 2017; Gonzalez et al. 2018; IPCC 2021; USGCRP 2017). The Southwestern United States (Southwest) is warmer (an average annual temperature increase of 1.6°F) since 1901, but there hasn't been much change to annual precipitation (Hoerling et al. 2013; Gonzalez et al. 2018). Since 1950, the Southwest was

warmer than any comparable period in the last 600 years; however, recent droughts (between 1901 to 2010) were not as severe or as long lasting as those experienced in the last 2,000 years (Hoerling et al. 2013).

Down-scaled climate projections for the Colorado Plateau predict a 10 °F increase in mean annual temperature by 2100 (Munson et al. 2011). A consensus of 22 models predicts annual temperatures to exceed the 1950 to 1999 range of variability by the 2030s, with spring precipitation declining by 11 to 45 percent by the end of the century (Krause 2015). These changes are likely to increase drought frequency, and severe droughts in the Colorado Plateau in the future could exceed any recently experienced (Seager et al. 2007).

These climatic changes are expected to adversely affect ESA-listed species and their habitats, including Mexican spotted owl (Gonzalez et al. 2018; 78 FR 61622, October 3, 2013). Climate change is likely to reduce owl distribution rangewide by increasing the prevalence of high-intensity wildland fire and through changes like increased temperature, changes in timing and amounts of precipitation, and related changes in vegetation community over time that reduce the ability of owls to persists in some areas (Wan et al. 2019; Salazar-Borunda et al. 2022). Studies have shown that high emission scenarios will result in the gradual and continuous loss of suitable bioclimatic space for owls in the Colorado Plateau EMU starting in 2030 (Salazar-Borunda et al. 2022).

3. Effects of the Action on Mexican Spotted Owl and Designated Critical Habitat

Based on geospatial models (Willey and Spotskey 1997; Lewis 2014), there are approximately 1,160 acres of potential habitat within the action area, which contains the project footprint plus a 0.5 mi buffer. The entirety of the action area (1,990.6 acres) is designated critical habitat for the species, although not all acres may contain the physical or biological features. The NPS has not delineated any PACs within the action area; however, there are 3 PACs within 2 mi of the action area (see Section 2.2.1., *Status of the Species in the Action Area*). The riparian vegetation along Oak Creek and the Virgin River in the action area contain the physical and biological features to support roosting and foraging for spotted owls, but likely not nesting.

The Project may adversely affect Mexican spotted owls and critical habitat through a range of mechanisms related to human presence, noise, surface disturbances, and vegetation removal or alteration. We anticipate that the primary effects of the Project to Mexican spotted owls would occur to foraging or roosting Mexican spotted owls. An increase in noise disturbance may affect owls from the three PACs in the vicinity of the Project and owls may experience localized disturbance of foraging and roosting habitat within the action area during construction. Additionally, there may be a reduction in prey availability during and in the period following construction until the action area revegetates.

Noise, like that produced by construction equipment, can mask biologically important sounds, such as mating call behavior and predator and prey sounds. Disturbance duration can vary from abrupt and brief (e.g., a single vehicle passing by) to extended disturbance (e.g., high traffic volumes on a busy holiday, or dispersed camping taking place within foraging habitat, etc.). Accordingly, species' response durations may also range from brief, immediate behavioral responses, such as alerting, to long-term responses, such as abandoning preferred habitat. When these stressors result in territory displacement, failure to initiate nesting, or increased

physiological stress, they negatively affect reproductive success of individuals and populations (Steven et al. 2011).

Disturbances associated with human presence and noise could also result in sub-lethal effects including elevated stress levels and reduced foraging time (Larson et al. 2016). If persistent, noise harassment and human presence could result in territory abandonment, thereby reducing reproductive success. Many animal species respond to human presence in the same ways they respond to predators (Suraci et al. 2019). These responses include increased stress and expenditures of time and energy towards vigilance and avoidance behaviors, and consequently decreased expenditures of time and energy towards beneficial activities like foraging, roosting, or caring for young (Steven et al. 2011; Ortega 2012; Shannon et al. 2016).

Infrequent, noise-producing activities are generally assumed to have relatively little long-term effect on Mexican spotted owls (USFWS 2012). However, owls will react to noise disturbances by changing behavior, such as flushing from their perches (Delaney et al. 1999a; Swarthout and Steidl 2001, 2003). The following studies show that noise has the potential to negatively affect Mexican spotted owls depending on noise levels and seasonal use:

- Delaney et al. (1999a) determined that the proportion of owls flushing was negatively related to distance and positively related to noise level.
- Pater et al. (2009) quantified the abovementioned and determined noises greater than 69 dBA had a higher probability of causing an owl to flush.
- Studies of Mexican spotted owl tolerance (resilience) to mechanical human disturbance and noise found that owls were fairly resilient to short-duration disturbance caused by overflight of helicopters and fixed-wing aircraft (Delaney et al. 1999b; Johnson and Reynolds 2002) and chainsaw operation more than 197 ft. from roosts (Delaney et al. 1999b). Closer chainsaw operations caused most owls to flush from their perches. This indicates some level of resilience of the species to human disturbance until close distance.
- The largest known populations of Mexican spotted owls in the Colorado Plateau EMU occur within National Parks (132 owl sites), where some PACs, including in Zion, support regular breeding pairs despite being in close proximity to heavily used hiking trails.

Due to the distance from core PAC areas to the action area, we anticipate direct noise disturbance is unlikely to affect breeding or nesting individuals. If owls were to utilize the action area for roosting, foraging, or dispersal it is possible individuals could be displaced from the Project area by the anticipated increased noise and human activity resulting from construction as well as reduced prey availability. For a more detailed review of noise effects to owls, see the Mexican Spotted Owl Recovery Plan (USFWS 2012).

Disturbance from the proposed action will occur on 23.13 acres of land, however not all of these acres contain the physical and biological features of Mexican spotted owl critical habitat. Of these acres, 10.42 acres will be temporarily disturbed and 12.7 acres will be permanently lost. The South Campground within the action area contains the most riparian vegetation and has the largest portion of tree removal. In total, about 147 trees (about 16 percent of trees in the campground area) will be removed. An additional 120 trees will be removed for road improvements (not in the riparian area). About 300 trees will be replanted in the South

Campground. As a result, this project will create a temporary loss of 267 trees until they reach maturity. No habitat within PACs will be altered. The net loss of foraging and roosting habitat will be about 12.7 acres. This is less than 1 percent of the available habitat at Zion for the species.

Components of the proposed action such as tree removal, soil compaction, paving, and heavy equipment operation will likely kill prey species of Mexican spotted owl (including woodrats, insects, etc.) and temporarily degrade prey habitat. This would reduce pretty availability, thus reducing owl feeding success. Prey populations are likely to return to preconstruction levels over several years after construction completion.

4. Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Cumulative effects to the ESA listed species under the Project would include, but are not limited to, the following broad types of effects:

- Increased recreational and economic use of non-federal lands within Zion as a result of travel access;
- Changes in land use patterns or practices that adversely affect a species' potential, occupied, or critical habitat, including encroachment of human use and/or development into those habitats; and
- Management actions by some, or all, of the following groups, on lands adjoining or upstream of NPS administered lands:
    - Tribal Nations
    - State of Utah
    - County governments in Utah
    - Local governments in Utah
    - Private landholders in Utah

Zion National Park contains private inholdings and is surrounded by a checkerboard pattern of land ownership including Federal, Tribal, State, and private landowners, where activities such as livestock grazing, human population expansion and associated infrastructure (increased trails, roads, and utilities) development, research, and recreation activities are expected to continue within the ranges of ESA-listed species (for more information, see the Zion National Park General Management Plan (NPS, 2001)). We expect many of these activities will continue on private lands and could contribute to cumulative effects to the species within the action area.

Across the entire Park, there is approximately 69,554 acres of potential habitat and 147,698 acres of critical habitat for Mexican spotted owl. Potential habitat in the Park occurs on Federal and private lands whereas critical habitat is only found on Federal lands. Activities associated with these cumulative effects have the potential to affect productivity with disturbances to breeding, nesting, and foraging behaviors and further fragmenting habitat of prey populations.

Other reasonably foreseeable activities occurring on State and private lands include land development, fire management, irrigation, and recreational activities. Implementation of these

activities will likely affect the environment through several mechanisms including water quality, water rights, and wildlife resources.

5. Conclusions

After reviewing the proposed action, the current status of species and its critical habitat, the environmental baseline within the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Mexican spotted owl or likely to result in the adverse modification of critical habitat for Mexican spotted owl. We base these conclusions on the following:

a. PACs include foraging and roosting habitat as well as core nesting habitat. Owls in Utah are believed to have large home ranges and may utilize the action area outside of nearby PACs for foraging, roosting, or juvenile dispersal. If owls were to utilize the action area for these purposes, it is possible individuals could be displaced from the action area by the anticipated increased noise and human activity resulting from construction as well as reduced prey availability.
b. Because baseline conditions within the action area are already heavily disturbed by human activity and existing facilities, particularly during the breeding season, it is unlikely that Mexican spotted owl utilize the area frequently.
c. The action area does not overlap with PACs, the edges of the three closest PACs are located 0.25 mi, 0.8 mi, and 0.9 mi, respectively, from the action area. Core nesting areas within PACs are over 2 mi from the action area. Due to the distance from core PAC areas to the action area, we anticipate direct noise disturbance is unlikely to affect breeding or nesting individuals.
d. Models indicate approximately 69,554 acres of potential habitat for the species in Zion, the action area contains approximately 1.6 percent of this potential habitat.
e. The applicant committed conservation measures stated in the BA, including timing restrictions on tree removal, would reduce the potential effects on Mexican spotted owl. If monitoring of Mexican spotted owl occupied habitat indicates that disturbance is occurring due to the proposed action, the NPS will implement appropriate corrective actions as identified in the BA.

We conclude, based on the reasons listed above, the sub-lethal effects of the action are not likely to significantly impair essential behavioral patterns to the point where it kills or injures owls, and that the Project may adversely affect the species, but does not rise to the level of take and that the action will not result in jeopardy to the species.

Mexican Spotted Owl Critical Habitat

a. The entirety of the action area (1,990.6 acres) is designated critical habitat. This represents 1.3 percent of critical habitat within Zion National Park (147,698 acres), and less than one percent of designated critical habitat within the CP-11 (260,105 acres), Colorado Plateau EMU (3.3 million acres) and of the total designated critical habitat for the species (8.6 million acres).
b. The Project will disturb approximately 23.13 acres of designated critical habitat, and 12.7 acres will be permanently converted to pavement and sidewalks; however, not all acres contain the physical and biological features of designated critical habitat. This loss accounts for less than 1 percent of critical habitat available for the species within Zion National Park and less than 0.01 percent of critical habitat within CP-11.

c. The Project will result in a temporary loss of 267 trees until replanted trees reach maturity. Approximately 147 trees within the South Campground area (which contains physical and biological feature of riparian habitat) will be removed during Project actions.
d. NPS will implement applicant-committed conservation measures as identified in the BA to reduce the effects on Mexican spotted owl designated critical habitat, including leaving larger woody debris on the ground and replanting about 300 trees to replace riparian vegetation lost during construction.
e. Over the long term, the proposed action will have beneficial effects on critical habitat by reducing the number of dead or dying trees, reducing nonnative plants that are prone to fire, and increasing woody debris and ground litter.
f. Best available information indicates that Mexican spotted owl critical habitat continues to support the needs of the species in Zion and across the range. The Project would temporarily affect prey base and riparian habitat through noise disturbance and the removal of trees and woody debris.

We conclude, based on the reasons listed above, specifically the relatively small proportion of critical habitat within the action area and the temporary effects to the physical and biological features within the action area that the proposed action would not appreciably diminish the value of the critical habitat for the conservation of Mexican spotted owl.

6. Reporting Requirements

Upon locating a dead or injured Mexican spotted owl or other ESA-listed species, initial notification must be made within one business day to our Office of Law Enforcement in West Valley City, Utah at telephone (435) 303-0490, our Ecological Services Office at telephone (801) 975-3330, and the Southeastern Regional office of the Utah Division of Wildlife Resources at telephone (435) 613-3700. This reporting requirement will allow our field office or the UDWR to collect and process dead individual if necessary to determine cause of death. Instructions for proper handling and disposition of such specimens will be issued by our Division of Law Enforcement consistent with the provisions of the Incidental Take Statement.

7. Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the Act, NPS must ensure that any activities associated with the proposed action comply with the NPS-committed conservation measures and species-specific NPS committed conservation measures described in the BA (NPS, 2023). No additional terms and conditions are necessary for this consultation.

8. Recommended Conservation Measures

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend incorporating the following recommendations into actions occurring at Zion National Park to assist with management, protection, and recovery of listed species and their habitats at the landscape and site-specific levels. Available recovery plans, conservation agreements and strategies, scientific literature, and other available information should

consistently be applied to occupied, suitable, and potentially suitable habitats of listed species. The following recommendations should be used in conjunction with available species-specific plans and literature and appropriately applied at the landscape and site-specific planning levels in a manner that ensures conservation and recovery of listed and sensitive species. In general, these guidelines should apply to listed and sensitive species habitats in areas of known and likely occurrence, particularly where recovery and conservation objectives have been identified by available species-specific plans.

The following recommended conservation measures have been provided to minimize the effects of recreation and noise disturbances to Mexican spotted owls. These conservation measures were identified in our 2012 Recovery Plan (USFWS 2012) and we recommend that the NPS implement them to the extent feasible:

1. Recreation Disturbance:
    a. The following guidelines apply to PACs during the breeding season, (1 Mar - 31 Aug). If non-breeding is inferred or confirmed that year per the accepted survey protocol, restrictions on noise disturbances can be relaxed depending on the nature and extent of the proposed disturbance (Swarthout and Steidl 2001, 2003).
    b. No construction of new facilities (e.g., trailheads, OHV trails) or expansion of existing facilities should take place in PACs during the breeding season. Any construction within PACs should be considered on a case-specific basis.
    c. Managers should, on a case-specific basis, assess the presence and intensity of currently allowed (permitted and non-permitted) recreational activities. The assessment should include distance, frequency, duration, and source of the disturbance. If recreation is determined to be a problem (e.g., increased OHV or hiking use), limit human activities during the breeding season in areas occupied by owls (timing may vary depending on local nest chronology). Disturbance here is defined as the presence of 1 to 12 people; group sizes exceeding 12 people should not be allowed. In areas where nest and roost sites are not identified, human disturbance should be limited to ≤ 2 disturbances per hour (averaged over a 24-hour period) throughout the PAC. Where nest and roost sites are known, disturbance should be limited to ≤ 2 disturbances per hour (averaged over a 24-hour period) within line of sight of the nest/roost sites. In some cases, disturbances may be avoided by routing trails and recreational uses (e.g., OHV use) outside of PACs through signing in order to designate zones free from human disturbances during critical periods.
    d. Seasonal closures of specifically designated recreational activities (e.g., OHV use, rock climbing, or biking) should be considered where disturbance to breeding owls seems likely.
    e. Conduct education through signing, interpretation events, access permitting, or other information sources to inform the public of proper and legal behaviors when encountering owls.

2. Noise Disturbance:
    a. The following guideline applies to areas within PACs during the breeding season (1 March to 31 August).

i. Managers should, on a case-specific basis, assess the potential for noise disturbance to nesting owls.
ii. Breeding-season restrictions should be considered if noise levels are estimated to exceed 69 dBA consistently (i.e., >twice/hour) or for an extended period of time (>1 hr) within 165 ft of nesting sites (if known) or within entire PAC if nesting sites are not known.

9. Re-initiation Statement

This concludes formal consultation on your Project. As provided in 50 CFR §402.16, re-initiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

1. If the amount or extent of taking specified in the incidental take statement is exceeded;
2. If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
3. If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or
4. If a new species is listed or critical habitat designated that may be affected by the identified action.

If any of the four re-initiation clauses occur, any activities causing such take must cease immediately pending re-initiation. To re-initiate section 7 consultation, NPS should immediately notify our office by phone or email.

We appreciate your commitment in the conservation of endangered and threatened species. If you require further assistance or have any questions, please contact Danielle Costantini at Danielle_costantini@fws.gov.

Literature Cited

Aitchison, S.W. 1977. Some effects of a campground on breeding birds in Arizona. Pages 175-182 in Importance, preservation, and management of riparian habitat: A symposium. 9 July 1977, Tucson, Arizona. USDA Forest Service Gen. Tech. Rep. RM-43.

American Ornithologists Union (AOU). 1957. Check-list of North American birds. Fifth edition. American Ornithologists Union, Baltimore, Maryland, USA.

Blakesley, J.A. and K.P. Reese. 1988. Avian use of campground and noncampground sites in riparian zones. J. Wildl. Manage. 52 (3):399-402.

Boyce, M.S. 1986. Bet hedging in avian life histories. Pp. 2131-2139 in H.O. Ouellet, (ed.), Acta XIX Congressus Internationalis Ornithologici. National Museum of Natural Science, Ottawa, Canada.

Bryce, S.A., J.R. Strittholt, B.C. Ward, D.M. Bachelet, K. Ford. 2012. Colorado Plateau Rapid Ecoregional Assessment Report. Bureau of Land Management, Denver, Colorado. 221 pp. + Appendices.

Delaney, D.K., T.G. Grubb, and P. Beier. 1999a. Activity patterns of nesting Mexican spotted owls. Condor 101:42-49.

Delaney, D.K., Grubb, T.G., Beier, P., Pater, L.L. and Reiser, M.H., 1999b. Effects of helicopter noise on Mexican spotted owls. The Journal of Wildlife Management, pp.60-76.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs No. 87. 64 p.

Francis C. D., C. P. Ortega, A. Cruz. 2011a. Vocal frequency change reflects different responses to anthropogenic noise in two suboscine tyrant flycatchers. Proc Biol Sci. 278(1714):2025-31.

Francis, C.D., Paritsis, J., Ortega C.P., & A. Cruz. 2011b. Landscape patterns of avian habitat use and nest success are affected by chronic gas well compressor noise. Landscape Ecology. 26(9), pp. 1296-1280.

Franklin, A.B., D.R. Anderson, R.J. Gutíerrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70:539-590.

Frankson, R., K. Kunkel, L. Stevens and D. Easterling, 2017: Utah State Climate Summary. NOAA Technical Report NESDIS 149-UT, September 2019 Revision, 4 pp.

Ganey, J.L. 1988. Distribution and habitat ecology of the Mexican spotted owls in Arizona. M.S. Thesis Northern Arizona Univ., Flagstaff. 229 p. 35.

Gonzalez, P. G.M. Garfin, D.D., Breshears, K.M., Brooks, H.E., Brown, E.H., Elias, A. Gunasekara, N., Huntly, J.K., Maldonado, N.J., Mantua, H.G. Margolis, S. McAfee, B.R. Middleton, and B.H. Udall. 2018. Southwest *In* Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds)]. U.S. Global Change Research Program, Washington D.C. USA, pp. 1101 – 1184. Available online: https://nca2018.globalchange.gov/chapter/southwest

Hashino, E., and Okanoya, K. 1 989. Auditory sensitivity in the zebra finch (*Poephila guttata castanotis*). J. Acoust. Soc. Jpn. 10, 1-2.

Hashino, E., Sokabe, M., and Miyamoto, K. 1988. Frequency specific susceptibility to acoustic trauma in the budgerigar. J. Acoust. Soc. Am. 83, 2450-2452.

Hashino, E., and Sokabe, M. 1989. Hearing loss in the budgerigar (*Melopsittacus undulatus*). J. Acoust. Soc. Am. 85, 289-294.

Hayward, L. S., A. E. Bowles, J. C. Ha, and S. K. Wasser. 2011. Impacts of acute and long-term vehicle exposure on physiology and reproductive success on the northern spotted owl. Ecosphere 2(6):art65. Doi: 10.1890/ES10-00199.1

Hockenbary, C.E. 2011. Exploring relationships among recreation, habitat type, and Mexican spotted owls on the Colorado Plateau in southern Utah. M.S. Thesis. Montana State University, Bozeman, Montana. 76 p.

Hoerling, M. P., M. Dettinger, K. Wolter, J. Lukas, J. Eischeid, R. Nemani, B. Liebmann, and K. E. Kunkel. 2013. "Present Weather and Climate: Evolving Conditions." In Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 74–100. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

Intergovernmental Panel on Climate Change (IPCC). 2021. Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group 1 to the Sixth Assessment Reprot of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Pean, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock. T. Waterfield, O. Yelekci, R. Yu, and B. Zhou (eds.)]. In Press. 40 pp.

Johnsgard, P.A. 1988. North American owls: biology and natural history. Smithsonian Inst. Press, Washington, D.C. 295 pp.

Johnson, C.L. and R.T. Reynolds. 2002. Responses of Mexican spotted owls to low-flying military jet aircraft. USDA Forest Service, Research Note, RMRS-RN-12, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

Krause, C.M., Cobb, N.S. and Pennington, D.D. 2015. Range Shifts Under Future Scenarios of Climate Change: Dispersal Ability Matters for Colorado Plateau Endemic Plants. Natural Areas Journal, 35(3), pp.428-438.

Larson, C. L., Reed, S. E., Merenlender, A. M., & Crooks, K. R. (2016). Effects of recreation on animals revealed as widespread through a global systematic review. *PloS one*, *11*(12), e0167259.

Lewis, L. R. (2014). Habitat characteristics of Mexican Spotted Owls (Strix occidentalis lucida) in the canyonlands of southern Utah. Utah State University.

Munson, S.M, J. Belnap, C.D. Schelz, M. Maron, and T.W. Carolin. 2011. On the brink of change: Plant responses to climate on the Colorado Plateau. Ecosphere 2(6): Article 68.

National Park Service (NPS). 2001. Zion National Park General Management Plan. Denver, Colorado.

National Park Service (NPS). 2010. Zion National Park Soundscape Management Plan. 42pp.

National Park Service (NPS). 2011. Bryce Canyon National Park: Acoustic monitoring report 2009-2010. Natural Resource Technical Report NPS/BRCA NRTR—2011/421. National Park Service, Fort Collins, Colorado.

National Park Service (NPS). 2023. Biological Assessment for the proposed Zion Canyon South Entrance Area Redesign Project. Zion National Park, Springdale, Utah.

Ortega, C.P. 2012. Chapter 2: Effects of noise pollution on birds: A brief review of our knowledge. Ornithological monographs, 74(1), pp.6-22.

Pater, L. L., T. G. Grubb, and D. K. Delaney. 2009. Recommendations for improved assessment of noise Impacts on wildlife. Journal of Wildlife Management 73(5):788-795.

Salazar-Borunda, M. A., Pereda-Solís, M. E., López-Serrano, P. M., Chávez-Simental, J. A., Martínez-Guerrero, J. H., & Tarango-Arámbula, L. A. (2022). Climate change will affect the distribution of the Mexican Spotted Owl (Strix occidentalis lucida Nelson 1903) El cambio climático afectará la distribución del búho manchado mexicano (Strix occidentalis lucida Nelson 1903). *Revista Chapingo Serie Ciencias Forestales y del Ambiente*, *28*(2).

Shannon, G., M.F. McKenna, LM. Angeloni, K.R. Crooks, K.M Kristrup, E. Brown, K.A. Warner, M.D. Nelson, C. White, C. Briggs, S. McFarland, and G. Wittemyer. 2016. A synthesis of two decades of research documenting the effects of noise on wildlife. Biological Reviews 91:982-1005.

Steven, R., Pickering, C., & Castley, J. G. (2011). A review of the impacts of nature based recreation on birds. *Journal of environmental management*, *92*(10), 2287-2294.

Swarthout, E.C. and Steidl, R.J. 2001. Flush responses of Mexican spotted owls to recreationists. The Journal of wildlife management, pp.312-317.

Swarthout, E.C. and Steidl, R.J. 2003. Experimental effects of hiking on breeding Mexican spotted owls. Conservation Biology, 17(1), pp.307-315.

Suraci, J. P., Clinchy, M., Zanette, L. Y., & Wilmers, C. C. (2019). Fear of humans as apex predators has landscape-scale impacts from mountain lions to mice. *Ecology letters*, *22*(10), 1578-1586.

Tarango, L.A., R. Valdez, F. Clemente and G. Mendoza. 2001. Roost-site characteristics of Mexican spotted owls in Sierra Fria, Aguascalientes, Mexico. Journal of Raptor Research 35:165-168.

U.S. Department of Transportation, Federal Highway Administration (FHWA). 2011. FHWA Highway Traffic Noise: Analysis and Abatement Guidance.

U.S. Fish and Wildlife Service (USFWS). 1995. Recovery Plan for the Mexican Spotted Owl. Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (USFWS). 2012. Final Recovery Plan for the Mexican Spotted Owl (*Strix occidentalis lucida*), First Revision. U.S. Fish and Wildlife Service. Albuquerque, New Mexico, USA. 413 p.

U.S. Fish and Wildlife Service (USFWS). 2013. Mexican Spotted Owl (*Strix occidentalis lucida*), 5-year review Short Form Summery. U.S. Fish and Wildlife Service. Pheonix, Arizona, USA.

U.S. Global Change Research Program (USGCRP). 2017. Climate Science Special Report: Fourth National Climate Assessment, Volume 1 [Wuebbels, D.J., D.W. Fahey, K.A. Hibbard, D.F. Dokken, B.C. Stewart, and T.K. Maycock (eds)]. Washington, D.C., USA. 470 pp.

Wan, H. Y., Cushman, S. A., & Ganey, J. L. (2019). Recent and projected future wildfire trends across the ranges of three spotted owl subspecies under climate change. *Frontiers in Ecology and Evolution*, *7*, 37.

Ward, J.P., Jr., and W.M. Block. 1995. Chapter 5: Mexican spotted owl prey ecology. Pp. 1-48 in Recovery plan for the Mexican spotted owl (*Strix occidentalis lucida*), volume II. USDI Fish and Wildlife Service Albuquerque, New Mexico, USA. Available from: http://mso.fws.gov/recovery-plan.htm.

Willey, D.W. 1998. Movements and habitat utilization by Mexican spotted owls within the canyon lands of Utah. PhD Thesis. Northern Arizona University. 87 p.

Willey, D.W. and H.C. Willey. 2010. Ecology of small mammals within spotted owl nest areas in Grand Staircase-Escalante National Monument. Pp. 463-480 *in* Learning from the land: Grand Staircase-Escalante National Monument science symposium proceedings. USDI Bureau of Land Management, Grand Staircase-Escalante National Monument, Kanab, Utah. 36 p.

Willey, D. W. (2007). Home range characteristics of Mexican spotted owls in the canyonlands of Utah. *Journal of Raptor Research*, *41*(1), 10-15.