An Evaluation of Threats to Federally Listed Avian Species in the Grand Canyon

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INTRODUCTION

The Colorado River runs 1,450 miles from its headwaters in the Rocky Mountains of Colorado, through the American Southwest, to the Gulf of California in Mexico. The Grand Canyon, the iconic centerpiece of Grand Canyon National Park (GCNP), is a stretch of the Colorado River that spans 277 miles across northwestern Arizona. Grand Canyon National Park is one of the United States' largest national parks, with over 1 million acres of public land (National Parks Service 2016). The park also has an enormous number of annual visitors. In 2019, GCNP had nearly 6 million visitors (National Parks Service 2019). Humans, however, are not the only park regulars.

GCNP has been recognized as a globally Important Bird Area for its role in protecting hundreds of bird species (National Parks Service 2017). This designation was granted by BirdLife International, a collection of conservation organizations with the shared mission of conserving birds around the world. 373 bird species are known to inhabit the park during some part of their life. In fact, the Grand Canyon remains a stronghold for some of the most endangered birds in the United States. This paper will examine current and historic threats to three prominent threatened and endangered bird species that inhabit Grand Canyon National Park. These species are: the California Condor (*Gymnogyps californianus*), the Mexican Spotted Owl (*Strix occidentalis lucida*), and the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). While there are numerous other threatened and endangered birds that live in GCNP, these three were chosen because they all have breeding populations in the Grand Canyon. Therefore, the Canyon is uniquely essential to the life history and success of each of these three species. To understand the full suite of threats to each, this analysis will also consider impacts throughout the Colorado River Basin. Lastly, this paper will also discuss management and policy tools to help support these species across their ranges.

SPECIES PROFILES

California Condor – *Federally Endangered*

Historic Range and Threats

The California Condor has been an inhabitant of North America since the Pleistocene Epoch, where it once fed on the carcasses of megafauna such a mammoths and giant sloths (Emslie 1987). At the close of the Pleistocene, the Condor's range was restricted to the west coast of California, where it subsisted for millennia on marine mammals that had washed ashore (Miller 1931). In fact, fossils from caves in the Grand Canyon support the theory of local extinction after the Pleistocene (Emslie 1987). The Condor is the largest bird in North America, with a wingspan of 9.2 feet (Snyder and Schmidt 2002). It uses these enormous wings to soar long distances in search of food, with a historic foraging range of up to 7,000 sq. kilometers (Meretsky and Snyder 1992). This species has a long natural life span paired with a low reproductive rate. Individuals don't breed until they reach at least six years of age and produce a maximum of 2 fledglings every three years (Meretsky 2000). In the Grand Canyon, Condors use cliffs and caves for roosting and nesting habitat.

In relatively recent years, the Condor became a conservation icon due to its dramatic road to recovery. The U.S. Fish and Wildlife Service (USFWS) listed it as endangered in 1967. By 1982, only 22 Condors were known to remain in the wild. Then in 1987 they became extinct in the wild when the last of the population was brought into captivity for a captive breeding program. Through the 1980s and 1990s the population steadily grew, and during this period, condors were even released into the wild at 8 locations (Fig. 1). The first attempts to nest in the wild were in 2001, and the first wild-hatched chick fledged in 2003. More detail on the Condor's conservation story can be found in Figure 2 (Walters et al. 2010). By 2018, the total world population of Condors was 488 individuals, including 312 free-flying in the wild and 176 in captivity (CDFW 2018).

Figure 1*: Map of California Condor release locations (numbered 1-8) and current range (shaded) in the Southwestern United States and Northwestern Mexico. Map taken from Rideout et al. 2012.*

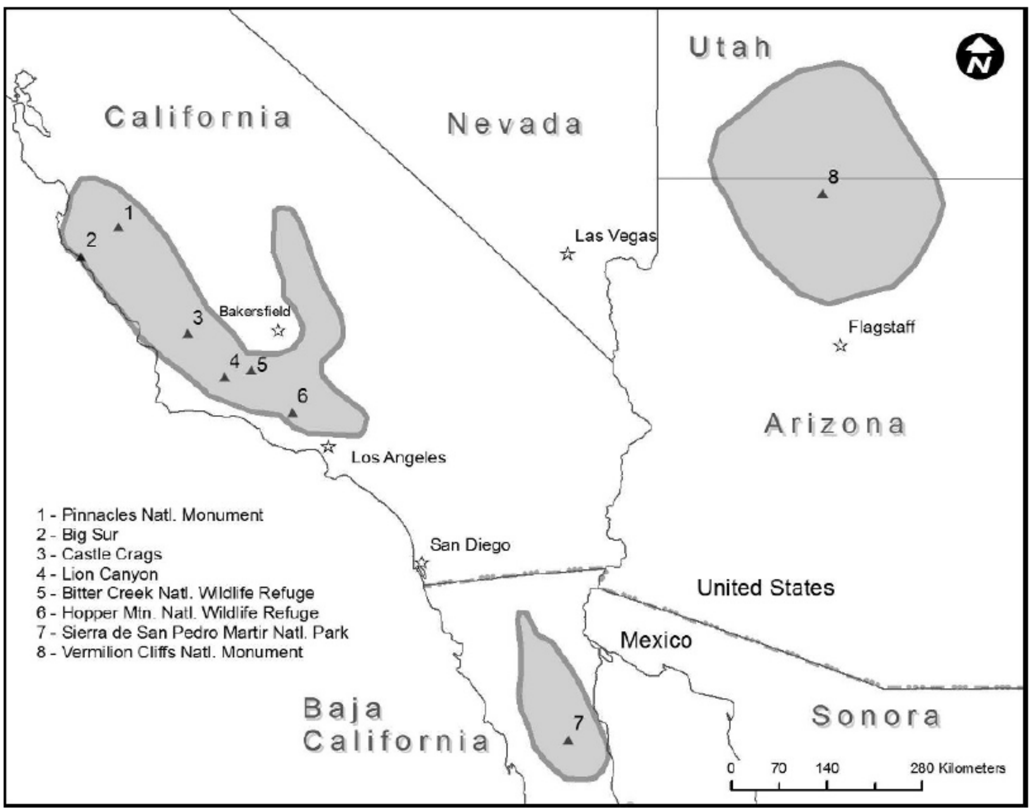
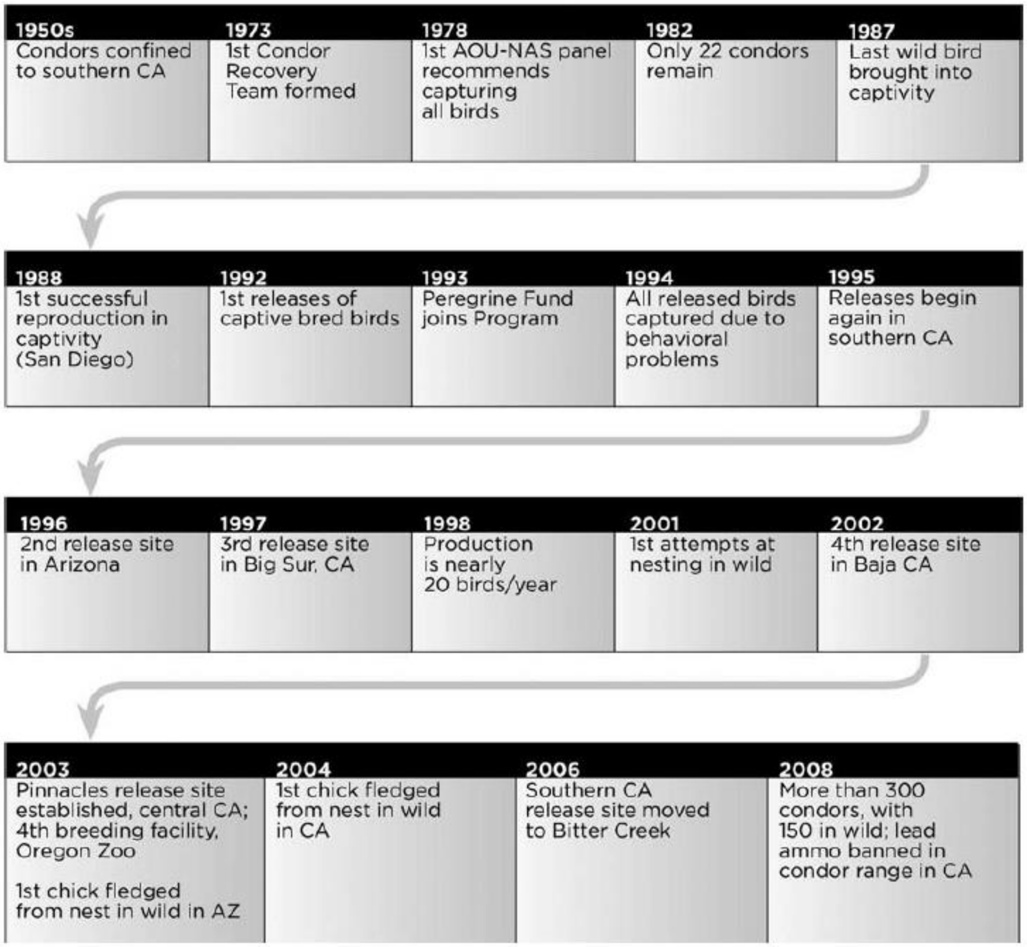


Figure 2: *California Condor Recovery Program Timeline, taken from Walters et al. 2010.*



Current Threats

Blood lead poisoning is the primary cause of mortality in California Condors. 67% of known causes of death in adults are due to lead poisoning (Rideout et al. 2010). A treatment is available to reduce the effects of lead poisoning, called *chelation therapy.* This treatment works by binding chelation agents to blood lead, which is then excreted through the kidneys. Unfortunately, this treatment is not 100% effective due to the body's capacity to hold lead in tissues and slowly release it back into the blood (Marcus 1985). In Arizona, as of 2007, condors exhibiting high blood lead levels had been chelated 124 times, with some individuals getting multiple treatments (Walters et al. 2010).

Lead-based ammunition is the source of elevated blood lead levels in Condors. Individuals with elevated blood lead levels matched the isotopic ratios of lead ($^{207}Pb/^{206}Pb$) in ammunition (Fig. 3) (Church et al. 2006). Scientists were even able to track an acute lead elevation signature (both concentration and lead isotope) through time by conducting an isotopic analysis along a feather (Fig. 4) (Church et al. 2006). The point of the feather that attaches to a bird is the "youngest" material (the newest growth). Feather growth gets progressively older further down the rachis (the main shaft of the feather), and the tip of the feather is the oldest material (Fig. 4) It is thought that Condors are likely exposed to lead ammunition by feeding on unretrieved carcasses or gut piles from hunting. Lead ammunition spreads widely through the tissues of hunted animals (Fig. 5), and is now outlawed throughout the Condor's range in California. However, it continues to be the greatest threat to adult Condors. To limit lead exposure and monitor wild birds, Condor populations receive supplemental food at feeding sites every 3 days (Walters et al. 2010).

Figure 3*: Lead concentrations vs. lead isotope ratios in condors with low blood lead levels (green) and high blood lead levels (yellow). Taken from Church et al. 2006.*

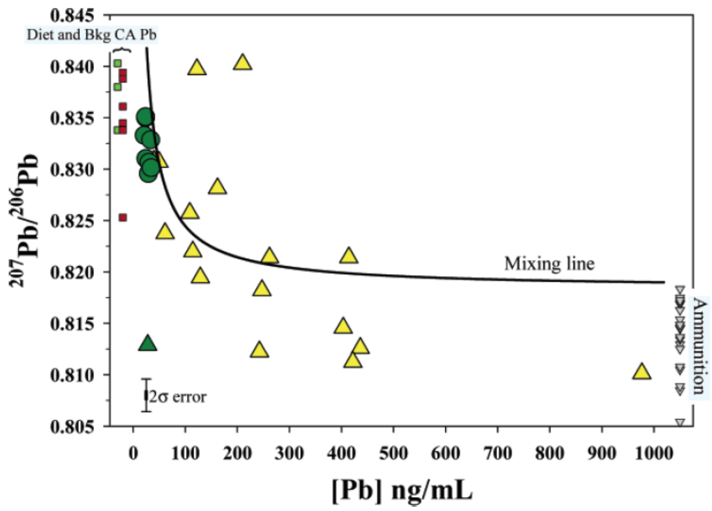
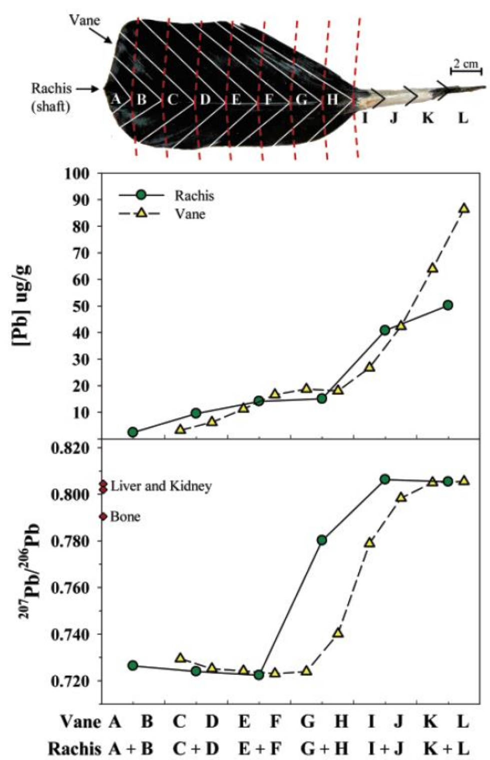


Figure 4 (left): *Lead concentrations and lead isotope ratios of a feather shaft. Taken from Church et al. 2010.* ***Figure 5 (right):*** *Radiograph of lead fragments in a deer carcass. Photo courtesy of the Peregrine Fund.*



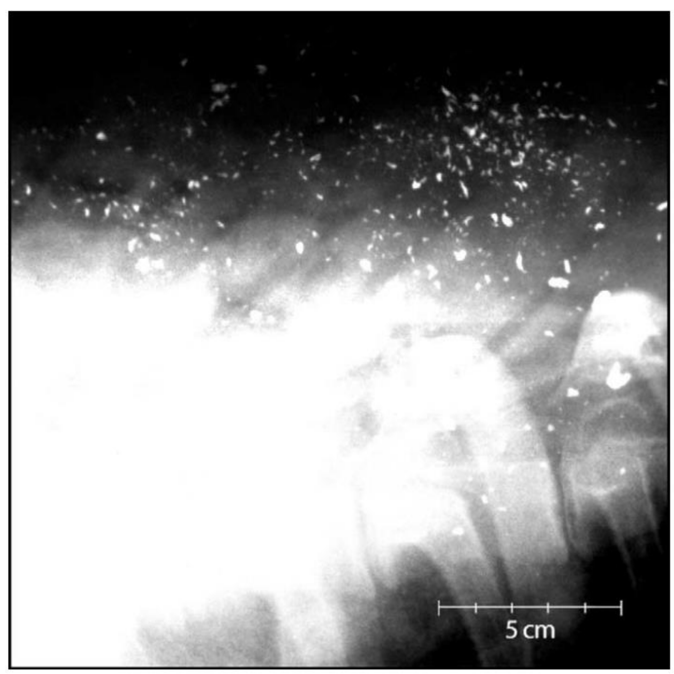


FIG. 5. Radiograph of lead fragment "snowstorm" in a deer carcass. (Photograph courtesy of The Peregrine Fund.)

Nesting adult Condors often bring trash to their nests to feed to their young. Trash ingestion is the greatest threat to Condor nestlings, accounting for 73% of nestling death (Rideout et al. 2010). It is thought that this behavior could be an attempt to provide a calcium source to their young, mistaking trash for bone shards and bits of mollusk shells (Mee et al. 2007). Parents also might mistake micro-trash (Figure 6) for small stones that could aid in digestion (Benson et al. 2004). Due to this erroneous behavior, it is likely that fledgling success would be nearly zero if chicks and nests weren't examined for micro-trash such as bolts, washers, rags, bottle caps, miscellaneous plastic bits, spent cartridges, and bits of wire (Mee et al. 2007).

Figure 6*: Microtrash taken from a Condor nest in Southern California. Photo courtesy of USFWS.*

Management and Policy Recommendations

Scott et al. (2005) defines a conservation-reliant species as, "species that are at risk from threats so persistent that they require continuous management intervention to maintain population levels above those that would trigger listing as threatened or endangered." Currently, the California Condor exists in the wild only through massive conservation efforts. As discussed, these include a captive breeding program, food subsidies, chelation therapy, nest inspections, and vaccinations. It is the epitome of a conservation-reliant species, however, that doesn't mean it has no hope for recovery. Condor recovery is possible if exposure to lead from ingestion of ammunition is eliminated (Walters et al. 2010). State and federal agencies should lead the way in tightening up restrictions on lead ammunition. The USFWS is the lead agency responsible for Condor recovery, although it has no statutory authority to regulate lead ammunition. State wildlife agencies do, however, have authority to regulate hunting activities. Lead ammunition has already been eliminated from waterfowl hunting through a gradual transition (Friend et al. 2009). To achieve Condor recovery, lead ammunition should be eliminated in the American

West. A gradual regulatory approach should be taken to alleviate hardships imposed on hunters, agencies who administer regulations, and the ammunition industry (Thomas et al. 2009). Any efforts toward Condor recovery will be in vain until the exposure to lead ammunition is addressed.

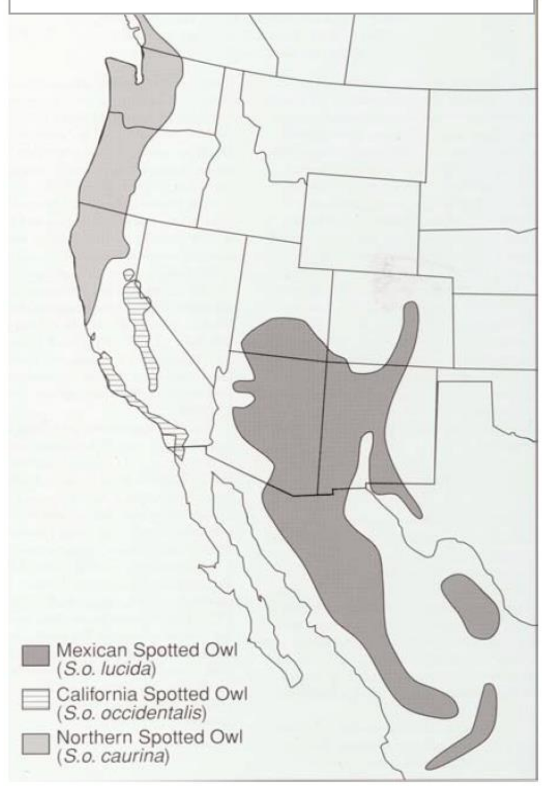
Mexican Spotted Owl – *Federally Threatened*

Biology, Range, and Threats

The Mexican Spotted Owl, one of three subspecies of the Spotted Owl, was listed as threatened by the USFWS in 1993. Historically, the main threats to this species were the timber industry coupled with forest management plans that were hostile to wildlife. The greatest threat currently is the increasing likeliness of stand-replacing wildfire (USFWS 2012). This owl is distributed broadly across montane and rocky canyonland ecosystems in the United States (Figure 7) (Willey et al. 2003). The Mexican Spotted Owl has two main habitats: old growth forests and canyons. In old growth forests, the owls need a diversity of tree species and age classes, with 30-45% of the trees having a minimum trunk diameter of 12 inches. The owls also need at least 40% canopy cover to buffer temperatures, and plenty of large trees (known as snags) littered across the forest floor, which provides foraging habitat (USFWS 2012). Patterns of habitat use in canyons differs considerably from old growth forests. In canyon habitat, owls need the presence of water to create a microclimate of milder temperatures, and cliffs and caves throughout the canyon to provide nesting and roosting habitat. For adequate foraging habitat, they need ample woody ground litter interspersed with mixed-conifer, pinyon-juniper, or riparian vegetation (USFWS 2012).

The Mexican Spotted Owl does not build nests, but instead relies primarily on tree cavities in old growth forests across most of its range. However, in the Grand Canyon, the owl preferentially nests in caves in the upper reaches of large tributary canyons (Willey et al. 2003). Due to access to rather pristine and undisturbed habitat in the canyons, Mexican Spotted Owls have higher fecundity (reproduction rate) in Grand Canyon National Park (0.84) than any other local population. The population of owls in the Coconino Forest of Northern Arizona had the next highest fecundity (0.494), although only about half as successful (Bowden et al. 2008). It is possible that Grand Canyon fecundity estimates were unusually high due to a short study period and environmental stochasticity. However, other research also supports the idea that the Grand Canyon population of Mexican Spotted Owls is uniquely successful. A study in 2003 found that the Grand Canyon population could be as large as 200 individuals, which would make it the largest population in the Colorado high plateaus and a likely source population for the entire region (Willey and Ward 2003).

***Figure 7**: A map of the range of each Spotted Owl subspecies. Taken from USFWS 2012.*



Management and Policy Recommendations

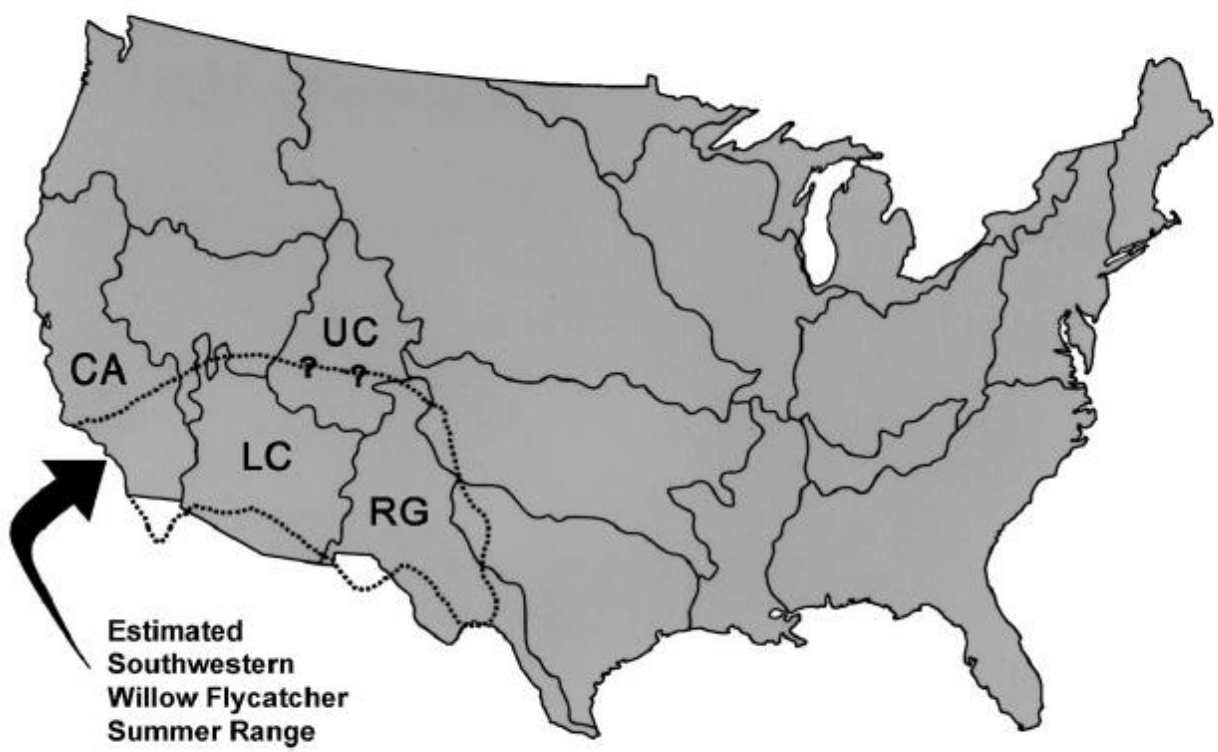
Due to the relative success of the Grand Canyon population of Mexican Spotted Owl, this population should be carefully monitored and protected. Nesting and foraging habitat in the upper reaches of tributary canyons should be protected from the rim to the canyon floor. Not only do these areas provide habitat directly for the owls, but also ample habitat for owl prey species. These areas are likely already well isolated from most human activity in the park, but efforts should be made to limit any trail construction that would encourage recreation in the owl's core canyon habitat. If these recommendations are followed, owls and their habitat in GCNP will be protected from direct anthropogenic disturbance. Ideally, this population will remain a source population to Mexican Spotted Owls in other areas of their range.

Southwestern Willow Flycatcher – *Federally Endangered*

Biology, Range, and Threats

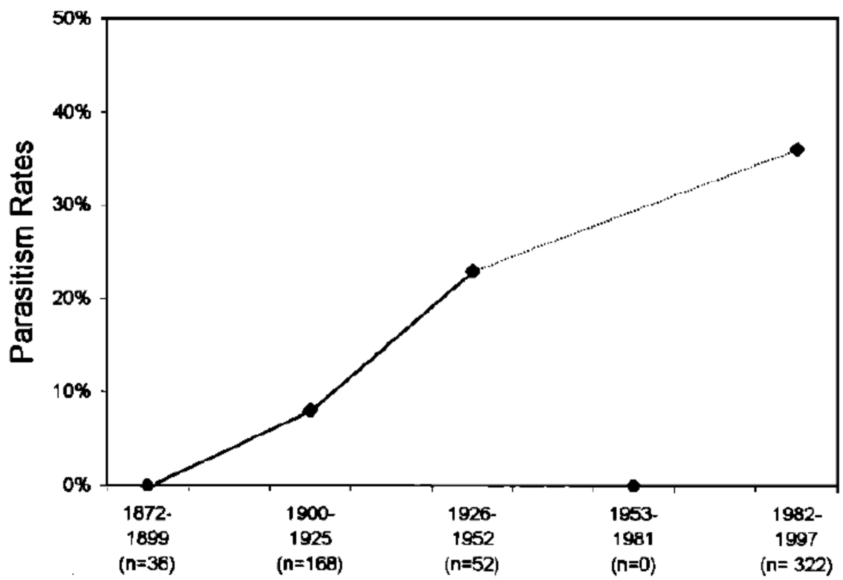
The Southwestern Willow Flycatcher is a tiny, insectivorous, riparian bird that migrates between Central America and the Southwest for wintering habitat and breeding habitat, respectively (Fig. 8). It is one of four subspecies of the Willow Flycatcher, and it requires dense riparian forest adjacent to slow moving water for habitat. These birds once flourished in lowland riparian habitat throughout the Southwest, but it's been estimated that only 5% of this habitat type remains (Johnson and Haight 1984). This has been regarded as the major cause of decline for this species (Unitt 1987), however other threats continue to depress the ability of this species' recovery. Currently, the Grand Canyon population is the largest known population of this bird (Unitt 1987), and it is one of the last places it is known to breed in the wild.

Figure 8: Estimated Southwestern Willow Flycatcher Summer Habitat



Nest parasitism is extremely detrimental to nesting success for flycatchers. Nest parasitism is a behavior in which a bird (the parasite) lays eggs in another bird's nest (the host), and the host presumably raises the orphaned offspring. The Brown-headed Cowbird is a ubiquitous and problematic nest parasite of the Southwestern Willow Flycatcher, and have been detected at all known flycatcher breeding locations. Most parasitized flycatcher nests fail (no chicks survive to fledge). In fact, the average hatch rate for parasitized nests is only 20% while unparasitized nests have a hatch rate of 61% (Whitfield and Sogge 1999). In the Grand Canyon, parasitism has been measured to be 48-100% (Brown 1988; Whitfield & Sogge 1999). High rates of parasitism between these two species likely developed over the last century, evidenced by historical records dating back to the late 1800s (Figure 9) (nest record collection of University of Arizona). Although Cowbird parasitism certainly retards the population size of the flycatcher, it is a symptom of a greater problem. The greatest impact to the flycatcher is loss of riparian habitat due to regulation of river systems in the Southwest.

Figure 9*: Historical cowbird parasitism rates of Southwestern Willow Flycatchers in Arizona and California 1872-1977 (no data available 1953-1981). Taken from Whitfield and Sogge 1999.*



Dams alter the natural hydrology of a river system through careful control of discharge and timing of water. This regulation causes lower overall flow amplitude, which in turn simplifies channel morphology and causes the loss of functions such as aquifer recharge, sediment mobilization and deposition, and seed bank renewal. These processes create the physical environment that is an essential foundation for healthy riparian habitat (Graf et al. 2002). Historic flows through the Grand Canyon caused dynamic changes in channel morphology that supported riparian habitat, floodplains, and unique features such as oxbow lakes which add habitat diversity for flycatchers and species. Infrequent, yet severe flooding served to reset the successional clock of riparian habitats and allowed large riparian forests to be rejuvenated Graf et al. 2002). However, under current conditions, experimental floods and environmental flows intended for sediment transport and support of riparian plants can have negative impacts on the Southwestern Willow Flycatcher. An experimental flood conducted by the U.S. Bureau of Reclamation on the Colorado River in 1996 eroded foraging habitat. In some locations, up to 72% of this habitat was lost and half of the marshes didn’t recover until the next year (Stevens et al. 2001).

Tamarisk (*Tamarix, salt cedar*) is an extremely invasive species in riparian habitats throughout the Southwest, but provides suitable and reliable habitat for these birds in the Grand Canyon. Brown (1988) found that 100% of Southwestern Willow Flycatcher nests in the Canyon were placed in Tamarisk (Brown 1988). In fact, Tamarisk completely dominates 75% of nesting sites, while a native willow (*Salix spp.*) only dominated 25% of nesting sites (Brown 1988). Breeding success is not negatively affected when Southwestern Willow Flycatchers breed in Tamarisk. Therefore, in systems lacking native riparian vegetation, Tamarisk is a valuable nesting resource for flycatchers. The structure of vegetation communities, rather than species composition, might be the most important factor for habitat choice in birds (Hausner et al 2002). Therefore, Tamarisk control could reduce local or regional populations of many bird species, including the Southwestern Willow Flycatcher, if riparian restoration doesn’t replace the functional value of Tamarisk stands (Sogge et al. 2008).

Management and Policy Recommendations

Three main factors affect population viability of the Southwestern Willow Flycatcher. First and foremost, the alteration of natural flow regimes by dam operations affects the hydrologic processes that build suitable habitat for this species. These processes are the foundation of riparian systems. Dams and flow regulation have had the greatest impact on this population, and has likely caused more susceptibility to other threats. Environmental flows in the Canyon should be closely planned to mitigate negative effects on the flycatcher as much as possible. Experimental flows that mimic *some* hydrologic processes but not all have the potential to create conflict between different species’ needs. Second, parasitic pressure from Cowbirds has limited the Flycatcher’s population growth across its range. In some places, Cowbird removal has alleviated this pressure and allowed for population growth, but it should be noted that this conservation measure should be secondary to restoration of riparian habitat and natural river processes (Whitfield and Sogge 1999). Lastly, control of exotic Tamarisk should continue, but cautiously. With the lack of native riparian habitat, Tamarisk is now an essential habitat component for the Flycatcher (Sogge et al. 2008). Tamarisk removal plans should consider costs and benefits to all native species and incorporate actions to foster native riparian vegetation communities.

FUTURE OF THREATENED AND ENDANGERED BIRDS IN THE GRAND CANYON

Although not without management challenges, the Grand Canyon remains a sanctuary of crucial habitat for wildlife. Its untrammeled and remote backcountry is the perfect refuge for endangered species to thrive. Evidence of this truth is unearthed by the story of the three listed birds that nest in the canyon. These are resources worth protecting. Although their listing statuses likely will not change soon, the light at the end of the tunnel is the management and policy opportunities that will afford these species better protection and longevity. For the California Condor, banning lead ammunition is the most valuable effort to assist species recovery. To support the GCNP population of Mexican Spotted Owls, park managers should continue to limit recreation in their core areas, especially during breeding season. Lastly, to support the Southwestern Willow Flycatcher, flow regimes and experimental flows should be carefully planned to limit habitat disturbance. Additionally, cost and benefits for all native species should be weighed when considering Tamarix control measures. In the face of climate change, these species should be given every opportunity to thrive and adapt.

Although no major common threads exist between best management practices for each of these threatened and endangered bird species, management and policy efforts to benefit them do not exist in a vacuum. These efforts will have a positive impact on many other bird species and other wildlife species in the park by improving the overall quality of wildlife management. In fact, any effort to restore habitat or physical processes in the Canyon will benefit other threatened and endangered species, including the Humpback chub, Razorback sucker, Kanab ambersnail, and the Desert tortoise. These species are the most impacted by anthropogenic changes, and thus will likely receive the most benefit from restoration activity. Conserving native species will increase the overall intrinsic value of the park, encouraging visitor support for years to come.

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