U.S. Fish & Wildlife Service

Recovery Outline for the Cactus Ferruginous Pygmy-Owl (*Glaucidium brasilianum cactorum*)

(Photo: George Andrejko, AZGFD)

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Subspecies Name: Latin - *Glaucidium brasilianum cactorum,* Common - *Cactus Ferruginous Pygmy-Owl*
Subspecies Range: Arizona and Texas, USA; Sonora, Sinaloa, Nayarit, Jalisco, Colima, Michoacán, Tamaulipas, and Nuevo Leon, Mexico
Recovery Priority Number: 12c (see information below)
Listing Status: Threatened, July 20, 2023 (88 FR 46910)
Lead Regional Office/Cooperating RO(s): Southwest Region
Lead Field Office/Cooperating FO(s): Arizona Ecological Services Field Office/ Texas Coastal and Central Plains Ecological Services Field Office
Lead Contact: Scott Richardson, Supervisory Fish and Wildlife Biologist

Background

The purpose of this recovery outline is to provide a preliminary strategy to guide the conservation and recovery of the cactus ferruginous pygmy-owl (pygmy-owl) until a final recovery plan is completed. Specifically, this recovery outline will guide (not require) pygmy-owl conservation and recovery actions by the U.S. Fish and Wildlife Service; other Federal, State and Tribal partners; local municipalities; non-governmental organizations; and other cooperators which will meaningfully address the threats and factors which led to the listing of the pygmy-owl under the Endangered Species Act (ESA). A recovery outline is part of the recovery planning process and carries equal weight as the ultimate recovery plan in outlining the U.S. Fish and Wildlife Service's (USFWS) intent for the recovery of a species. We intend that this recovery outline will facilitate the immediate implementation of actions which will start moving the cactus ferruginous pygmy-owl toward recovery such that progress is not delayed during the more lengthy process of developing a detailed and necessary recovery plan.

This section includes a summary of the biology, ecology, and life history of the pygmy-owl, in addition to information on threats to the species, and also identifies important information gaps. A comprehensive status review can be found in the Species Status Assessment Report for the cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*: pygmy-owl) (SSA) (USFWS 2023) (Species Profile for Cactus ferruginous pygmy-owl (Glaucidium brasilianum cactorum) (fws.gov)).

Type and Quality of Available Information to Date:
The most recent information we have on the demography, threats to, and conservation of the pygmy-owl was used to develop the pygmy-owl SSA and was the basis for this recovery outline. As outlined in the SSA, the following information is currently available to assess the status and needs of the pygmy-owl:

Arizona – The earliest work on pygmy-owls in Arizona was conducted by the Arizona Game and Fish Department (AZGFD) beginning in 1992. These efforts included survey activities to determine the extent of the occupied range in Arizona (Felly and Corman 1993; Collins and Corman 1994; Lesh and Corman 1995). As pygmy-owls began to be detected, monitoring was instituted to document nesting and reproduction; prey items; and seasonal use areas (Abbate et al. 1996, Wilcox et al. 2000). Later, radio-telemetry was used to gather data on home range use and dispersal patterns. All captured pygmy-owls were banded for individual identification (Abbate et al. 1999, Wilcox et al. 2000, Abbate et al. 2000). This work continued until the Arizona Distinct Population Segment of the pygmy-owl was delisted in 2006. Between 2006 and 2020, limited work continued and focused on monitoring of historical sites and establishing a captive breeding pilot program, which continues currently. Flesch (2023) completed a synthesis of much of the past monitoring data, including information from Arizona, and provides important information to consider for the conservation and recovery of the pygmy-owl. Additionally, Pima County, in compliance with their habitat conservation Plan (Pima County

Multi Species Conservation Plan) have been conducting pygmy-owls surveys and monitoring since 2017 (PCOSC 2021).

To provide the most current occupancy and distribution information in Arizona in order to inform the SSA, comprehensive pygmy-owl surveys were conducted in 2020 and 2021 (USFWS 2023, Section 4.1.1.1; AZGFD unpublished data). The Tohono O'odham Nation contributed to this survey effort and, in compliance with their information-sharing protocol, provided results at the level outlined in the protocol. Data on occupancy and distribution in Arizona considered in the SSA also included information from the Global Biodiversity Information Facility (GBIF) which includes information from such sources as eBird, iNaturalist, and museum specimens (GBIF 2020).

Texas – Studies of the pygmy-owl in Texas began in 1996 and consisted of projects evaluating the occupancy and distribution of pygmy-owls in south Texas, including information on habitat use, productivity, use of nest boxes, parasites, genetics, and some dispersal and home range data (Proudfoot 1996, Mays 1996, Proudfoot and Beasom 1997; Proudfoot et al. 2006a; Proudfoot et al. 2006b; Proudfoot et al. 2006c). Proudfoot continued gathering data on pygmy-owl nest box use until 2016 when monitoring ceased, but nest boxes were left in place. Since then, very little data has been gathered on the occupancy, distribution, and life history of pygmy-owls in Texas (TPWD 2019, TXNDD 2020). However, data on occupancy and distribution in Texas considered in the SSA also included information from the GBIF which includes information from such sources as eBird, iNaturalist, and museum specimens (GBIF 2020).

Northern Sonora – A significant long-term study of cactus ferruginous pygmy-owls in northern Sonora was conducted by Aaron Flesch from 2000 to 2021 (Flesch 2003, Flesch 2008, Flesch et al. 2017, Flesch 2021b). This study is significant because it tracked the long-term occupancy of pygmy-owls, and helped assess the influence of climatic variation, habitat resources, land-use and landcover change, intraspecific competition, and heterospecific enemies on pygmy-owl occupancy and productivity in a broad range of Sonoran Desert scrub, woodland, and semi-desert grassland environments (Flesch et al. 2017). Flesch's work also provided important information on pygmy-owl habitat relationships regarding nest site selection, productivity, occupancy, the relative influences of habitat area, quality, and connectivity on population dynamics, and of landscape structure, disturbance and landcover change, and local vegetation structure on movements and dispersal (Flesch and Steidl 2006; Flesch et al. 2010, Flesch 2014a, Flesch 2014b, Flesch et al. 2015, Flesch 2017), helping us understand the cyclical nature of pygmy-owl occupancy and productivity in specific areas of Sonoran Desert scrub habitats (Flesch et al. 2010, Flesch et al. 2017). Flesch's work also provided important information on pygmy-owl habitat relationships regarding prey, nest site selection, productivity, and occupancy (Flesch and Steidl 2006; Flesch 2014a, Flesch 2014b, Flesch et al. 2015). Data on occupancy and distribution in northern Sonora considered in the SSA also included information from the GBIF, which includes information from such sources as eBird, iNaturalist, and museum specimens (GBIF 2020).

Remaining areas in Mexico – Little study of pygmy-owls in the remaining areas of Mexico supporting suitable habitat and known occurrences of pygmy-owls has been completed.

However, some recent work does include pygmy-owl survey coverage and occupancy analysis that reports occupancy status in southern Sonora and Sinaloa (Cobbold et al. 2021, Cobbold et al. 2022a), adding to data on local occupancy patterns. In addition to this data, we also relied heavily on data related to occupancy and distribution in Mexico from the GBIF, which includes information from such sources as eBird, iNaturalist, and museum specimens (GBIF 2020).

The information available to date has been essential to our understanding of the species and its threats. Additional information, as described below, will be needed to improve our knowledge of the species and, importantly, to recover it.

Important information gaps:
Updated and long-term monitoring and research on pygmy-owl populations (western population includes Arizona, northern Sonora, and western Mexico, and eastern population includes Texas and northeastern Mexico) are needed. Monitoring is required to better understand current population status and track changes over time. It is vitally important to understand impacts from proposed or ongoing actions that have direct or indirect impacts on the species and/or its habitat. We lack current data on the numbers and distribution of pygmy-owls, especially in Mexico. We have some information related to pygmy-owl occupancy and distribution on the Tohono O'odham Nation (TON) in Arizona (USFWS 2023, section 4.1.1.1) thanks in large part to recent efforts by the TON and their Natural Resource Department to collaborate with FWS and other partners, and more comprehensive information of this kind will be helpful. The TON is willing to provide additional historical data, but these are not comprehensive or consistent in their methodology.

Across its range, more surveys are needed to identify potential new pygmy-owl population groups and to find and assess the status of all population groups. In Arizona, these areas include the TON, far western Arizona, Pinal County, and areas including and in proximity to Ironwood National Monument and Sonoran Desert National Monument. In Texas, priority areas include western portions of the pygmy-owl range and in proximity to the Rio Grande. In Mexico, areas immediately south of the international border are priority areas. There is ongoing debate related to the taxonomy of ferruginous pygmy-owls, and additional genetic studies are needed throughout the range of the species (*Glaucidium brasilianum*), particularly in Central and South America, to inform appropriate taxonomic classification at both the species and subspecies levels (USFWS 2023, section 2.1). There is also a need to assess potential management actions, such as ongoing propagation and introduction or augmentation efforts and survivability of reintroduced individuals, and habitat modeling and assessment to determine the location and extent of conservation areas where tools such as 10(j) areas, habitat conservation plans, conservation benefit agreements, conservation easements, conservation banks, etc. are appropriate.

Additional studies on threats, such as habitat fragmentation from development, agriculture, and wood harvesting; nonnative vegetation encroachment; altered disturbance and fire regimes; and drought and warming caused by climate change, will help us better understand how these current threats are impacting pygmy-owls and their habitats, as well as how natural resource managers can minimize and/or mitigate these threats. Continued research to identify the pygmy-owl demographic parameters contributing most to changes in population status and minimum

population size, such as a population viability analysis, as well as habitat modeling and suitability indices, will aid in the protection and enhancement of key areas for pygmy-owl core habitats for nesting, as well as key habitat connectivity areas. Such studies should include the TON and Mexico.

Treatment of uncertainties:
We have limited data on many aspects of the life history, threats, and conservation needs of the pygmy-owl. Due to limited data, there is some uncertainty associated with our analyses in the pygmy-owl SSA (USFWS 2023). Such uncertainties related to the pygmy-owl include genetic diversity and classification; impacts of climate change on the pygmy-owl, its prey, and its habitat; extent and impacts of threats; and the factors used in modeling in the SSA. We therefore make assumptions based on the best available information, which are explicitly defined in the SSA. Section 6.1 of the pygmy-owl SSA (USFWS 2023) specifically documents and explains the range of unknowns and assumptions under which we conducted our analyses in the SSA and these are carried forward in our development of this recovery outline.

Brief Life History:
Taxonomy - The cactus ferruginous pygmy-owl is a small, cavity-nesting owl in the order Strigiformes and the family Strigidae (ITIS 2020, Enríquez et al. *2*017; Proudfoot et al. *2*020). Currently, there are as many as fifteen subspecies of ferruginous pygmy-owl recognized over the entire range, with the cactus ferruginous pygmy-owl being the northernmost subspecies (Proudfoot et al. 2020). However, there is current debate and uncertainty regarding the genus, species, and subspecies classifications within the ferruginous pygmy-owl (USFWS 2023, section 2.1). Although there is genetic differentiation found at the far ends of the pygmy-owl's distribution represented by Arizona and Texas, there continues to be uncertainty in the southern portion of the range where the boundary between two species or subspecies is likely to exist (Proudfoot et al. 2006a, 2006b), which raises the question of whether there is adequate data to support a change in species classification and define the eastern and western distributions as separate subspecies (Proudfoot et al 2006a, 2006b, Cobbold et al. 2022b, Cobbold et al. in prep.). Other factors such as behavior, habitat preference, and morphology should also be considered. While future work and studies may clarify and resolve these issues, we adhere to current USFWS policy and procedures and we will continue to use the currently accepted distribution of *G. brasilianum cactorum* as described in the 1957 American Ornithological Union checklist and various other publications (Johnsgard 1988; Millsap and Johnson 1988; Oberholser 1974; Friedmann et al. *1*950).

Genetics - Genetic differences between pygmy-owls in Arizona-Sonora-Sinaloa, and southwestern Mexico (western population) and those in Texas and eastern Mexico (eastern population), combined with some differences in threats to pygmy-owls and their status in these regions, suggest that they be considered separately in assessing their status and in the development of management plans (Proudfoot et al. *2*006a; Proudfoot et al. *2*006b). Differences in management and protection of pygmy-owls across the international border with Mexico make it reasonable that pygmy-owl population groups in both Arizona and Texas also be considered separately when assessing the current and future condition of pygmy-owl populations and in the

development of conservation or management plans. It is also important to point out that, particularly in the northern portion of the geographic range including both Arizona and Texas, pygmy-owls function as metapopulations and are dependent upon exchange of individuals to provide genetic diversity and to "rescue" population groups that may decline or are extirpated due to various causes discussed later in this document.

Morphology - The cactus ferruginous pygmy-owl is a small bird, approximately 17 centimeters (cm) (6.75 inches (in)) long. Generally, male pygmy-owls average 58 grams (g) to 66 g (2.0 to 2.3 ounces (oz)) and females average 70 g to 75 g (2.4 to 2.6 oz) (AZGFD 2008; Proudfoot and Johnson 2000; Johnsgard 1988). The pygmy-owl is reddish brown overall, with a cream-colored belly streaked with reddish brown. Color may vary, with some individuals being more grayish brown (Proudfoot and Johnson 2000). The crown is lightly streaked, and a pair of dark brown or black spots outlined in white occurs on the nape, suggesting "eyes" (Oberholser 1974). The species lacks obvious ear tufts (Santillan, et al. 2008), and the eyes are yellow. The tail is relatively long for an owl and is reddish brown in color, with darker brown bars. Males have pale bands between the dark bars on the tail, while females have darker reddish bands between the dark bars.

Life History - The cactus ferruginous pygmy-owl is a diurnal, nonmigratory subspecies of ferruginous pygmy-owl *(Glaucidium brasilianum)* and is found from central Arizona south to Michoacán, Mexico, in the west and from south Texas to Tamaulipas and Nuevo Leon, Mexico, in the east. Pygmy-owls eat a variety of prey including birds, insects, lizards, and small mammals, with the relative importance of prey type varying throughout the year. Cactus ferruginous pygmy-owls are secondary cavity nesters, nesting in cavities of trees and columnar cacti, with nesting substrate varying throughout its range. Pygmy-owls can breed in their first year and typically mate for life, with both sexes breeding annually. Clutch size can vary from two to seven eggs with the female incubating the eggs for 28 days (Johnsgard 1988; Proudfoot and Johnson 2000). Fledging occurs 20 to 28 days after hatching (Proudfoot and Johnson 2000). Fledglings disperse from their natal sites about 8 weeks after they fledge (Flesch and Steidl 2007). Pygmy-owls live on average 3 to 5 years but have been documented to live 7 to 9 years in the wild (Glenn Proudfoot 2009, pers. comm.) and 10 years in captivity (Dennis Abbate 2009, pers. comm.). Pygmy-owls are found in a variety of vegetation communities, including Sonoran desertscrub and semidesert grasslands in Arizona and northern Sonora, thornscrub and tropical dry forests in southern Sonora south to Michoacán, Tamaulipan brushland in northeastern Mexico, and live oak forest in Texas. At a finer scale, the pygmy-owl inhabits habitat edges and semi-open areas of thorny scrub and woodlands in association with giant cacti and in scattered patches of woodlands in open landscapes, such as tropical dry forests and riparian communities along ephemeral, intermittent, and perennial drainages (König et al. 1999). It is often found at the edges of riparian and xeroriparian drainages and even habitat edges created by villages, towns, and cities (Abbate et al. 1999; Proudfoot and Johnson 2000).

Limiting Life History Characteristics:
In the pygmy-owl SSA, we assessed the best available information to identify the physical and biological needs to support individual fitness at all life stages for the pygmy-owl. For the purpose

of the SSA and this recovery outline, the limiting life history needs that were considered most significant include cavity availability (columnar cacti and trees large enough to support cavity excavation by woodpeckers and natural cavity formation), vegetation structural diversity (including over-story and mid-story layers for thermoregulation and predator avoidance), woodland tree canopy (provides thermoregulation and predator avoidance and adequate structure for movements), overall cover (contributes to thermoregulation, predator avoidance, movements, and habit for prey), prey availability (adequate availability for all seasons), adequate habitat patch size (habitat patch is large enough to support a breeding pair and offspring until dispersal); we use a conservative estimate that a home range is 200 acres (81 hectares) to insure adequate habitat over the wide range of habitat conditions found throughout the geographic range of the pygmy-owl), and habitat connectivity (adequate tree and shrub cover in an appropriate configuration to facilitate movements within home ranges and across the landscape during dispersal). From a demographic perspective, viability is limited by factors such as low numbers of pygmy-owls and population groups, inconsistent occupancy, and mortality resulting from predation and poor habitat conditions due to drought, development, and climate change. All of these factors are exacerbated by small population size in some of the analysis units (Arizona, Texas, and northern Sonora).

Primary Threats:

Both habitat and demographic factors affect the viability of pygmy-owl populations. Ultimately, viability is reduced due to low numbers of pygmy-owls and pygmy-owl population groups. The ability of an analysis unit to support greater numbers of pygmy-owls and population groups is dependent on adequate areas of pygmy-owl habitat, as well as habitat connectivity. As described in more detail in the SSA, the primary risk factors affecting the current and future status of the pygmy-owl are: (1) habitat loss and fragmentation (Listing Factor A), and (2) climate change and climate conditions (Listing Factor E). Habitat loss and fragmentation are primarily the result of residential and commercial development, infrastructure development (e.g. roadways), renewable energy development, agriculture, and wood cutting. Climate change and climate conditions affect vegetation health, structural diversity, prey availability, nest cavity availability, and presence of nonnative, invasive species. Increasing nonnative vegetation and changes in fire regimes can reduce woody vegetation and columnar cacti that are important nest substrates. We acknowledge, however, that all threats discussed in the SSA report can exacerbate or contribute to these two primary threats and that it is important to consider all of the known threats to pygmy-owl populations. These other threats include human activities and disturbance, disease and parasites, predation, small population size, and lack of adequate regulations. Successful protection or enhancement of core pygmy-owl nesting habitat and habitat connectivity must then be followed by efforts to increase the numbers and distribution of pygmy-owls at the analysis unit scale.

Current Biological Status of the Species:

Overview: The overall geographic range of the cactus ferruginous pygmy-owl is large, covering two states in the United States and eight states in Mexico. We determined that there are two populations of the pygmy-owl based on geographic location and genetic information (Proudfoot et al. 2006a, 2006b; Cobbold et al. 2022b, Cobbold et al. in prep.). There is a western population (Arizona and western Mexico) and an eastern population (Texas and northeastern Mexico).

Additionally, due to the large size of the range of the pygmy-owl, we divided the overall range into five analysis units in the SSA. This division into analysis units allowed us to consider the variability of various factors across the range of the pygmy-owl. There are two analysis units in the United States (Arizona and Texas) and three analysis units in Mexico (Northern Sonora, Western Mexico, and Northeastern Mexico). Within each of these analysis units, we examined various factors that would describe the current status of the pygmy-owl within each analysis unit and within each population (USFWS 2023, Table 4.2).

The available information suggests that pygmy-owls currently occupy all five analysis units, although likely at reduced numbers and distribution than occurred historically. However, the status and abundance vary considerably at a smaller scale, such as within an analysis unit, as in the case of Sonora. Flesch's work in Sonora indicates that pygmy-owl abundance and density vary among the northern, central, and southern parts of Sonora, as well as by vegetation communities (Flesch 2003). For example, pygmy-owl densities are similar in valley bottoms and lower bajada areas in Arizona desert scrub communities in norther Sonora as they are in tropical deciduous forests in southern Sonora (95% CI overlap). Pygmy-owl densities are much lower in the vegetation communities in central Sonora (AZGFD 2008, Flesch 2003). Similarly, pygmy-owls are more common currently in the oak motte habitats of Texas than they are along the Rio Grande. Additionally, pygmy-owls are more common in the southern, or Mexican, portion of the eastern population than they are in Texas, or northern portion of the eastern population. These specific variations are important to management and conservation of the pygmy-owl and must be considered as we work to recover the pygmy-owl. None of the analysis units or populations have formal population estimates for the pygmy-owl. Therefore, as described in the SSA report, we used a general relative scale of population size when analyzing each analysis unit, but management and conservation actions must also consider the variation within the analysis units.

Our analysis of each analysis unit was based on resiliency, redundancy, and representation (collectively, the 3R's), which is discussed in greater detail below. To assess the 3 R's, we looked at three demographic factors and three habitat factors and scored each factor within each analysis unit. The three demographic factors are abundance (overall numbers), occupancy of population group (persistence of occupancy over time), and evidence of reproduction (active nests, fledglings, or young-of-the-year pygmy-owls). The three habitat factors are vegetation intactness (an estimate of habitat connectivity), climate moisture deficit (an estimate of available moisture for vegetation growth and diversity), and vegetation health and cover (measure of change in Normalized Difference Vegetation Index (NDVI)). The evaluation of these six factors allowed us to score each analysis unit and determine the overall current condition categorized as low, moderate, or high condition (Figure 1).

The current condition was determined to be low for one analysis unit (Arizona). The current condition was determined to be moderate for three analysis units (northern Sonora, Texas, and Northeastern Mexico). Only one analysis unit was found to be in high current condition (Western Mexico). The overall determination to list the cactus ferruginous pygmy-owl was based on the cumulative condition across the range considering the current and future condition of each

analysis unit. Thus, recovery actions that can improve condition at the analysis unit scale can move the pygmy-owl towards recovery.

Figure 1. Current condition of the five analysis units for the cactus ferruginous pygmy-owl

The 3 R's

We define the cactus ferruginous pygmy-owl's viability as the ability of the subspecies to sustain populations in the wild over time. Using the SSA framework, we describe the species' viability in terms of the 3R's. The following provides a summary of our assessment of the 3R's relative to the current condition of the pygmy-owl from the SSA Report (USFWS, 2023).

- **Resiliency –** Overall, only one analysis unit is in high condition. This is a result of high pygmy-owl numbers and reduced effects of climate change. Thus, four out of five analysis units have a reduced resiliency, primarily due to the demographic factors for Arizona (low numbers of pygmy-owls and reduced occupancy) and habitat factors (reduced vegetation intactness, soil moisture, and vegetation health) for the remaining analysis units. The analysis unit in the best current condition is the Western Mexico analysis unit, which is rated as being in high condition (Figure 1). This analysis unit had both a demographic and a habitat factor rated as high. Three analysis units (Northern Sonora, Texas, and Northeastern Mexico) were classified as being in moderate condition (Figure 1). Northern Sonora was primarily classified as being in moderate condition for demographic and habitat factors, while Texas and Northeastern Mexico had high condition in certain factors tempered by other factors classified in low condition. Every

analysis unit, except for Western Mexico, had at least one condition factor that rated as low. Figure 1 shows a map of all analysis units depicting their current condition as determined by the analysis above.

- **Redundancy** - Given that pygmy-owls occur in all five analysis units, redundancy currently occurs at the range-wide scale for pygmy-owls. Each analysis unit within the geographic range of the subspecies maintains a network of population groups that are connected both within and between analysis units. These population groups have the potential to recolonize areas where other population groups are lost to catastrophic events. As a result, pygmy-owl population groups provide redundancy to withstand catastrophic events were they to occur in any given part of the pygmy-owl's overall range. However, maintaining the redundancy can be affected by reduced numbers of population groups within a given analysis unit, loss of habitat connectivity among population groups or analysis units such that the potential for demographic support (rescue effect) is eliminated or reduced significantly, or resiliency within analysis units declines. Conversely, if land management improves habitat connectivity and conservation actions improve demographic factors, redundancy within and among analysis units will improve. Currently, these types of factors are affecting a number of the analysis units. For example, population groups within the Arizona analysis unit have likely become extirpated based on the lack of detections over multiple consecutive years. Habitat connectivity between the Arizona and Northwest Mexico analysis units, as well as between the Texas and Northeastern Mexico analysis units may be affected by the construction of border walls and associated effects like vegetation clearing, lighting, patrols, and border enforcement activities (Flesch et al. 2010; USFWS 2023, section 7.2). However, limited telemetry data has shown that pygmy-owls are able to cross into Mexico, at least in one area of Arizona (Arizona Game and Fish Department, unpublished data). The redundancy of all analysis units is being reduced through ongoing habitat loss and fragmentation. Despite existing habitat fragmentation, research and monitoring have documented that exchange of individual pygmy-owls between population groups and between some analysis units is still occurring (Arizona/Northern Sonora and Texas/Northeastern Mexico). Maintaining habitat connectivity will be important for preserving this redundancy throughout the subspecies' range. So, while redundancy currently exists across the range of the pygmy-owl, continued redundancy is not certain when considering the factors affecting redundancy within analysis units.

- **Representation** - We consider the pygmy-owl to currently have representation across its range in the form of genetic diversity (see Section 2.2 of SSA) and ecological diversity (see Sections 2.5 and 3.3 of the SSA). This primarily occurs as a result of the large geographic area covered by the range of the pygmy-owl, resulting in genetic isolation by distance and its occurrence in a wide variety of habitat types ranging from southern Arizona, through western Mexico, and in northeastern Mexico to southern Texas (Proudfoot et al. 2006a, 2006b; Cobbold et al. 2022b). Vegetation communities where the pygmy-owl is found range from Sonoran desert scrub to thornscrub and tropical deciduous forests in the west, and oak-mesquite woodlands and riparian communities to Tamaulipan thornscrub and secondary forests in the east. The overall range of the pygmy-owl is also characterized by two genetically distinct populations: the eastern and western populations. Within both the eastern and western populations of the pygmy-owl, genetic

variation among the various analysis units also occurs (Proudfoot 2006a; Proudfoot 2006b).

Representation occurs on two scales. First, at the population scale, representation is needed within both the eastern and western populations of the pygmy-owl. Representation at this scale currently occurs because pygmy-owl population groups are documented throughout both the eastern and western populations. These populations are defined based on geographic separation and genetic differences. The second scale is at the analysis unit scale. Representation within the analysis units contributes to overall representation within the two populations. Representation at the analysis unit scale occurs due to either genetic differences or ecological variation among analysis units. In summary, pygmy-owls occupy a diversity of habitat types throughout the geographic range of the subspecies and maintain substantial genetic diversity. It is possible that representation boundaries could be adjusted in the future after further investigation of the genetic and ecological diversity of the subspecies.

Conservation Actions to Date

Surveys and Monitoring – The AZGFD initiated surveys to determine the extent of pygmy-owl occurrence in Arizona in 1992. Additional surveys were conducted in other areas from 1993 through 1995, primarily in response to a petition to list the pygmy-owls under the Endangered Species Act (Felly and Corman 1993; Collins and Corman 1994; Lesh and Corman 1995). From 1996 to 2006, AZGFD increased its monitoring and research efforts focusing on Pima and Pinal counties to document the more recent distributions. Partly in response to the Federal listing of the pygmy-owl as endangered in 1997, this work attempted to answer basic questions on the ecology of this subspecies in Arizona to help guide potential management decisions. Efforts to assess population distribution at that time were complemented by surveys of historical locations outside of the greater Tucson area (Harris Environmental Group, Inc. 1998; 1999), and also benefited from numerous project clearance surveys. During this period a standardized survey protocol was updated and refined from earlier survey methods and jointly approved by the USFWS and AZGFD after a public comment period (USFWS 2000). Survey requirements under section 7 of the ESA resulted in a number of private consultants conducting surveys in numerous areas on private, public, State, and Tribal lands which helped to confirm previous estimates of low numbers, limited distribution and the apparent occurrence of pygmy-owls in small disjunct populations (USFWS unpublished data; Flesch 1999; Harris Environmental Group, Inc. 1998; 1999; and others). Field efforts at the time focused on population surveys in areas of previous pygmy-owl activity as well as new locations with appropriate habitat characteristics. Researchers also monitored breeding areas, documented observations of behavior and movements, and conducted diet and habitat studies (AZGFD 2000, unpublished data; Abbate et al. 1996; 1999; 2000). Despite funding limitations and prohibited access to some areas, this effort detected localized population fluctuations and raised concerns about further population decline. In addition, municipalities and other agencies conducted their own monitoring and clearance surveys associated with a variety of development projects providing additional records indicating the limited distribution of pygmy-owls in the state.

In 2020, a comprehensive survey effort was coordinated to provide a better idea of the current numbers and distribution of the pygmy-owl to inform the development of the SSA report. Specifically, this effort included surveys to document distribution, territory occupancy monitoring, and some nest searches. Biologists from AZGFD, USFWS, TON, Phoenix Zoo, Pima County, University of Arizona SNRE, Tucson Audubon, and BLM conducted perhaps the most exhaustive assessment of the wild pygmy-owl population in Arizona, covering in one breeding season the largest area of potential habitat and the greatest number of historical activity areas ever completed in the state during one breeding season.

Additionally, Pima County's MSCP monitoring and habitat modeling in and near the Altar Valley continue to provide information related to pygmy-owls in this area. This effort has been extensive, systematic, repeated and documented population trends, the influence of important habitat elements on occupancy, and ~30 new territories unknown prior to 2017. It has also successfully demonstrated the application of a habitat model based on demographic attributes to locate owls and select survey areas in the wild that should also be useful for identifying places for various recovery actions such as nest boxes, which the most recent report does (Flesch 2018 2021a, 2024).

Extensive surveys and monitoring in Texas were primarily accomplished in the mid-1990's through work done by Proudfoot (1996) and Mays (1996). Since then, very little data has been gathered on the occupancy, distribution, and life history of pygmy-owls in Texas (TPWD 2019, TXNDD 2020).

Regular and consistent survey and monitoring in Mexico has been accomplished in northern Sonora as a result of the long-term study in this area by Flesch (Flesch 2003, Flesch 2008, Flesch et al. 2010, Flesch 2014a, Flesch 2014b, Flesch et al. 2015, Flesch and Steidl 2006). Additionally, AZGFD and CEDES cooperated and conducted some recent survey and occupancy work in southern Sonora and northern Sinaloa in Mexico (Cobbold et al. 2021, Cobbold et al. 2022a).

Renewed territory monitoring and survey efforts are not only considered essential for current assessment of conservation needs but would be integral to determining abundance and distribution of pygmy-owls to inform management actions and progress towards recovery.

Nest Box Trials – Research in Texas had demonstrated successful use of artificial nest structures by pygmy-owls (Proudfoot *et al.* 1999). In October 1992, 40 nest boxes were established in areas of the Wild Horse Desert known to be occupied by pygmy-owls. Nest boxes of varying configurations were set up in eight groups of five, in order to determine if pygmy-owls would use artificial nest structures and evaluate their possible preferences for different nest box configurations. In this initial study, pygmy-owls used 37% (3 boxes/8 groups) of the nest boxes, suggesting that nest boxes may be a viable management tool. Based on these findings, the study was expanded. Additionally, 33 pygmy-owl nests in natural cavities were located and information on entrance orientation, height above ground, depth of cavity, and surrounding habitat composition was obtained, all of which proved beneficial in the nest box studies. Application of these findings resulted in the use of 50 nest boxes by pygmy-owls since 1994.

Results from Proudfoot et al. (1999) suggest pygmy-owls will accept wide variations in orientation (North, South, East, West) of nest box entrances and placement height (6 to 40 feet). They found that tree age class did not affect nest box usage; pygmy-owls used nest boxes in young and old growth stands. However, the amount of understory in proximity to the nest site appeared to be important in nest site selection as most nest sites were in areas with 50 to 100% understory cover. When they established nest boxes in groups of 3 (within a 30-yard radius) to provide a selective opportunity, usage increased by more than 100% over single nest box placement.

Pygmy-owl researchers in Arizona suspected that nest cavity availability and interspecific competition for cavities might be some of the factors influencing pygmy-owl abundance and distribution in Arizona. In response to concerns about cavity availability, two nest box trials were conducted in Arizona. In 1998, a preliminary nest box trial was conducted when 15 nest boxes divided among five sites were installed on native deciduous trees along three segments of the Cienega Creek Preserve and in Catalina State Park where mature riparian vegetation offered cover and plentiful prey. These locations represent historical pygmy-owl habitat, however there were no recent records of pygmy-owl activity in either area. No pygmy-owls were detected during nest box inspections over the 1998 and 1999 breeding seasons and the trial was terminated. While no pygmy-owls used these nest boxes, a high percentage were occupied by other species indicating cavities were likely limited in these areas.

In 2006, an expanded nest box pilot study was initiated with the identification of 20 sites and the installation of 60 nest boxes (three boxes per site) on the Buenos Aires National Wildlife Refuge (BANWR) in the Altar Valley, Pima County. Sites were selected based on where pygmy-owl activity was documented in recent years, but where cavities were known to be limited (Richardson 2007). The launch of this project was a cooperative effort by the USFWS Arizona Ecological Services Office and research biologist Dr. Glenn Proudfoot. The project was funded by AZGFD's Arizona Bird Conservation Initiative Grant. Field assistance during installation and monitoring was provided by the University of Arizona student chapter of the Wildlife Society, BANWR volunteers and the Phoenix Zoo. Nest boxes were installed near historical pygmy-owl activity areas, near saguaros or in areas with larger trees and more extensive canopy cover. After monitoring over three breeding seasons (2007–2009), no evidence of nest box use by pygmy-owls was found. Although some of the boxes were occupied by Africanized bees, more than 50 percent were used for nesting by several bird species including western screech-owls (*Megascops kennecottii,*), suggesting natural cavity availability for small owls and other birds in this area was limited. Since screech-owls are well-known competitors of pygmy-owls (Flesch et al. 2015), some boxes were later modified to exclude them. Even so, use of these boxes by a small owl is instructive regarding size, design, and protective cover within semi-desert grassland habitat where pygmy-owls are known to occur. Though pygmy-owl use of nest boxes was not detected during this trial, it should be noted that nest box placements were limited to a relatively small area (southern portion of Altar Valley only) and not within an area currently known to be occupied by pygmy-owls. The expansion of artificial nest structures over a larger portion of the Altar Valley remains a potential conservation tool, especially where there are few nest saguaros or where vegetative structure is optimal, but cavities suitable for nesting are limited; a recent

study evaluated potential areas across for such management across various jurisdictions in the Altar Valley (Flesch 2024). This strategy may be a way to increase nesting pairs in the valley and adjacent canyons where pygmy-owl nesting has been documented in recent years but may be at risk due to loss of mature saguaros or other landscape changes. Additionally, installation of nest boxes near new release sites for captive-bred individuals that are learning how to navigate their environment will also provide nesting substrate and predator escape cover where cavity availability is restricted. Monitoring of released, captive-bred pygmy-owls in southern Altar Valley documented the use of nest boxes placed in proximity to release sites (AZGFD unpublished data).

Captive Breeding and Population Augmentation – A cactus ferruginous pygmy-owl captive breeding pilot program was established in 2006. The goal of this managed breeding program for cactus ferruginous pygmy-owls is to provide individuals to augment existing population groups or establish new population groups in areas where pygmy-owl habitat exists (AZGFD 2015, entire). To date, these efforts have demonstrated: a) successful capture and transport of wild cactus ferruginous pygmy-owls, b) safe, healthfull, and stress-free captive facilities, c) the development of appropriate care, feeding and maintenance protocols, d) successful breeding, and e) appropriate care and development of young-of-the-year birds. Five pilot releases of captive-bred pygmy-owls have been implemented since the inception of this program. This effort establishes the first formal captive-breeding for the species and provides the groundwork for evaluation of this strategy in wild cactus ferruginous pygmy-owl population augmentation (AZGFD 2024).

Releases of captive-bred pygmy-owls occurred in Arizona in 2016, 2020, 2021, 2022, and 2023. These releases were generally in the Altar and Avra Valleys, west of Interstate 10. While there is no evidence that any of the released pygmy-owls have survived and successfully nested, the releases have helped us learn about the appropriate selection of release sites, improvements in the design of hack boxes, and that movements by pygmy-owls across the international border fence are possible.

Conservation Planning - Several municipalities located in the vicinity of current or historical pygmy-owl activity areas have explored or implemented Habitat Conservation Plans (HCP) under the ESA as an approach to address potential conflicts between development projects and requirements of the ESA.

The HCP plans included the Sonoran Desert Conservation Plan (Multi-Species Conservation Plan) developed by Pima County (Pima County 2016), the Town of Marana Habitat Conservation Plan and the City of Tucson's Avra Valley and Southlands Habitat Conservation Plans. Each of these four HCP efforts identified the pygmy-owl as one of the covered species under their prospective plans. The planning areas for three of the four plans include locations where pygmy-owls are currently active or were historically documented during surveys and monitoring since 1993. Since the initiation of these planning efforts, Pima County has completed their Multi-Species Conservation plan and was issued a USFWS permit in 2016. Implementation is ongoing and includes conservation measures for the pygmy-owls such as ongoing survey and monitoring and habitat acquisition and protection. These actions occur throughout Pima County

and significantly contribute to the conservation of the pygmy-owl, especially in the Altar Valley which is one of the last strongholds for breeding pygmy-owls in Arizona. The City of Tucson has focused conservation planning for the Avra Valley and this HCP remains in progress and should be finalized soon. Progress on the Southlands HCP has been put on hold, as has the Town of Marana HCP. Currently, substantial habitat for pygmy-owls remains within the City of Tucson and Town of Marana jurisdictions and together with TON lands and federally-managed natural preserves in adjacent areas such as Saguaro National Park and Ironwood Forest National Monument, may present further opportunities for pygmy-owl conservation associated with augmentation, should these municipalities offer cooperation on actions within their jurisdictions.

Another conservation planning effort that is ongoing and has the potential to support pygmy-owl conservation in the Altar Valley of southern Arizona is the Altar Valley Watershed Management Plan developed by the Altar Valley Conservation Alliance with numerous partners and participants. The plan describes stewardship practices and tools and a series of high-priority projects that maximize positive impacts on the land and in the community. Projects will address two major themes: 1) Hydrology issues including channel incision of the Altar Wash main stem and upland tributaries; and 2) Vegetation issues related to nonnative species and brush encroachment from mesquite and other woody species (outside of natural, xeroriparian woodlands).

In Mexico there are federal, state, or municipal Protected Natural Areas. These areas, and the implementation of the protections therein, can work well as conservation strategies for the pygmy-owl. There is now a new option for protected areas called Voluntary Conservation Areas (Áreas Destinadas Voluntariamente a la Conservación; ADVA) which are areas for conservation and can be a good conservation strategy (https://www.gob.mx/conanp/documentos/areas-naturales-protegidas-278226) (Enríquez 2021, pers. comm.).

On the TON, including historic TON lands in Mexico, the Nation is working on listed species recovery, the Sonoyta mud turtle for example, and could potentially offer the same for pygmy-owl conservation and recovery. TON biological staff have provided input on the FWS pygmy-owl SSA and are conducting some pygmy-owl survey and monitoring work.

Preliminary Recovery Program

Recovery Priority Number: 12C

The cactus ferruginous pygmy-owl is assigned a recovery priority number of 12c, indicating that this is a subspecies that faces a moderate degree of threat and has a low recovery potential; there is a potential conflict with commercial and residential development, renewable energy, agriculture, and wood cutting in all analysis units (see 48 FR 43098 for USFWS Recovery Priority Guidelines).

The threats to the pygmy-owl are moderate because it is listed as threatened. Recovery potential is low because although the threats to the pygmy-owl have been identified and are relatively well understood, recovery actions will likely require intensive management with an uncertain probability of success and unknown techniques or techniques that are experimental. Recovery is likely to take intense management and protection of habitat to provide core nesting areas and

habitat connectivity. From a demographic perspective, actions needed to increase the overall numbers and distribution of the pygmy-owl have been initiated and need to be improved through adaptive management, but ultimate outcomes are uncertain. However, with sufficient funding and commitment to continue increasing population viability, reducing habitat fragmentation, controlling nonnative invasive vegetation, augmenting existing populations, establishing new populations, and monitoring and incorporating results into adaptive management, the species can be recovered. We fully recognize that recovery will take partnerships and must involve cooperation and coordination with Mexico, Federal, State, private, and Tribal landowners and managers, as well as NGOs and other conservation organizations.

Preliminary Recovery Strategy

The overall recovery strategy for the cactus ferruginous pygmy-owl is to improve population resiliency, redundancy, and representation, beginning at the analysis unit scale, such that the following are met:

- **Resiliency**: There are sufficient numbers of individuals within each analysis unit to support recovery from demographic stochasticity (e.g., random fluctuations in reproductive rates and survivorship) and environmental stochasticity (e.g., normal variation in rainfall and temperature and small-scale fire).

- **Redundancy**: There are multiple population groups of pygmy-owls within each analysis unit of sufficient number and distribution to guard against catastrophic events (e.g., catastrophic fire, flooding, prolonged exceptional drought, and disease) which could lead to extirpation of portions of the species' current range within individual analysis units or, cumulatively, lead to extinction of the species as a whole.

- **Representation**: Population groups are distributed across suitable habitat within individual analysis units sufficient to maintain or enhance genetic and ecological diversity within individual analysis units, but which cumulatively contribute to conserving the subspecies' ability to adapt to future changes in its physical (e.g., habitat and climate) and biological (e.g., small populations, predators, competitors, and diseases) environment.

This strategy will require 1) the protection of currently occupied habitats and habitat connectivity among occupied core habitats, 2) enhancement or protection of suitable habitat areas to provide for the expansion of the number of pygmy-owls and pygmy-owl population groups and enhance connectivity for the movement of pygmy-owls across the landscape, 3) implementation of strategies that increase the number of pygmy-owls and population groups on the landscape, and 4) the development of partnerships to apply conservation and management in appropriate areas of pygmy-owl habitat to address climate change, changing fire regimes, control and reduction of nonnative invasive vegetation, and protection and enhancement of woodland habitats and nest cavity substrates. Threats to the species must be addressed and reduced to a point such that viable populations of cactus ferruginous pygmy-owls can be maintained through the maintenance and expansion of population groups within each population. Implementation of this strategy will involve working with local, County, State, and Federal agencies, Tribes, private landowners, and local communities and businesses in the United States (U.S.) and Mexico to address stressors to the species that will restore and protect habitat and enable augmentation, reintroduction, and

introduction, as well as the natural expansion of the subspecies to increase abundance and the number of resilient population groups in all analysis units.

Preliminary Action Plan (Actions not prioritized):
1) Protect extant population groups of cactus ferruginous pygmy-owls by minimizing adverse effects to pygmy-owl habitat and pygmy-owl individuals and population groups:

a) Work with partners to identify occupied core pygmy-owl nesting habitat and areas of habitat connectivity among core nesting habitat areas. Where possible, identify and curtail future potential activities that would reduce suitable pygmy-owl habitat and areas of pygmy-owl habitat connectivity. Implement efforts to avoid or minimize alterations to existing pygmy-owl habitat to prevent habitat loss and fragmentation. Focus on areas, including the TON and Mexico, where connectivity is intact and not affected by development or other barriers.

b) Work with partners to adapt land management practices such as brush control, fire management, livestock production, invasive species control and development activities in such a manner as to protect and enhance pygmy-owl habitat and reduce disturbance of resident pygmy-owls. Encourage partners to utilize the existing 4(d) rule to reduce regulatory requirements of actions while accomplishing pygmy-owl conservation and recovery.

c) Work with partners to avoid and minimize actions that contribute to the degradation of pygmy-owl habitat. Develop plans to maintain and support healthy watersheds and their associated woodland habitats and cavity-bearing substrates occupied by pygmy-owls.

d) Develop a landscape approach with partners to increase pygmy-owl habitat and habitat connectivity and reduce impacts from invasive nonnative vegetation and changing fire regimes.

e) Investigate actions that can improve the potential for pygmy-owl movements across the international border with Mexico. Such movements help to maintain the viability of existing pygmy-owl population groups on both sides of the international border.

2) Survey for the cactus ferruginous pygmy-owl and monitor persistence and productivity:

a) It is unknown where all the areas are that currently support pygmy-owls. Surveys need to be conducted in order to document, protect, and expand currently occupied habitats to implement action #1 above.

b) For occupied areas, work with partners to develop long-term monitoring plans, study sites, and field methodology to be implemented across the species' current and historical range. Work with partners, including Mexico and the TON, to ensure that long-term monitoring data are comparable among and across all study sites. USFWS needs to work with partners to finalize a revised cactus ferruginous pygmy-owl survey protocol and develop training materials so that surveys and data from surveys are consistent across the range of the pygmy-owl.

c) The same effort is needed for monitoring approaches and protocols. Efforts should be consistent and provide comparable data to facilitate the development of a population viability analysis (PVA) to guide conservation and recovery efforts. The information needed for a PVA

needs to be identified and efforts to gather such information need to be conducted in a consistent, clear, and useable format.

c) Work with willing landowners, partners, and cooperators to develop appropriate access agreements and permitting to facilitate more widespread access to suitable pygmy-owls habitat to implement this recovery action. It is important that we gather occupancy data across all areas of the pygmy-owl's range, especially areas of suitable habitat that have not been historically surveyed.

d) Develop a streamlined process for issuing survey and monitoring permits where needed. The permitting applications and requirements need to be clear, understandable, and consistent.

3) Identify unoccupied areas of suitable pygmy-owl habitat as potential areas where we can increase the number and distribution of pygmy-owl population groups and, where feasible, enhance existing low-quality habitat to promote population size, reproductive output and survival. Investigate actions that can be undertaken to protect and enhance those areas. Encourage partners to take advantage of the existing 4(d) rule to reduce regulatory requirements to accomplish pygmy-owl habitat protection and enhancement.

a) Evaluate formerly occupied watersheds across the historical range to determine whether physical habitat parameters (e.g., woody vegetation, nest cavity substrates, vegetation structural diversity, prey availability, habitat connectivity) exist to increase resiliency, redundancy, and representation in areas that are currently in low and moderate condition and to facilitate population connectivity within or between analysis units.

b) Explore conservation mechanisms or agreements to facilitate the protection and enhancement of unoccupied suitable pygmy-owl habitats that will provide areas of suitable pygmy-owl habitat able to support an increase in the numbers of pygmy-owls and pygmy-owl population groups, while providing regulatory assurances to landowners.

c) Coordinate and cooperate with the State Land Departments, State Forestry and Fire Departments, and Tribes (including range conservationists, biologists, and natural resource managers) to identify State or Tribal lands with suitable pygmy-owl habitat where management actions can be implemented that accomplish the mission of these entities while also achieving pygmy-owl conservation. With regard to tribes specifically, tribes such as the Tohono O'odham Nation are sovereign entities, and any actions proposed involving them should emphasize and respect that. Acknowledge the value of what their existing management and survey work contributes to recovery and conservation of this species. In the case of the pygmy-owl, this contribution can be significant. This action should include finding out what these entities need in order to move forward with such management actions, providing resources and technical support, developing a plan for information protection, developing management plans, streamlining development while considering pygmy-owl conservation, and providing support and technical assistance related to regulations.

d) Work to increase the overall number of pygmy-owls in each analysis unit to a minimum of the "high hundreds" category in Table 4.2 of the SSA. Currently, the Arizona Analysis Unit does not meet this criterion. Alternatively, if a PVA is completed and a minimum population size is

identified, work to increase the overall number of pygmy-owls to the minimum population size identified in the PVA. The numbers identified and the focus areas for pygmy-owl habitat protection and enhancement should also focus on the broader spatial context and population structure linked to connectivity among them and the benefits of having multiple population groups that can persist (possibly with little movement between them).

e) Work to increase the number of population groups in each analysis unit to a minimum of five population groups. Currently, the Arizona and Texas Analysis Units do not likely meet this criterion. It is unknown whether the analysis units in Mexico meet this criterion, but it is likely that at least the Western Mexico Analysis Unit does meet the criterion. We anticipate that increasing the number of populations groups to at least five will result in pygmy-owl population groups being well distributed across available pygmy-owl habitat within analysis units improving resiliency, redundancy, and representation.

4) In both occupied and unoccupied areas of pygmy-owl habitat, manage vegetation to provide habitat elements that will contribute to the long-term viability of pygmy-owl population groups. Restore and enhance habitat focusing on criterial limiting resources (e.g., cavities, woodland structure) and implementation of actions in spatially targeted ways that increase population size, better connect newly restored and existing habitat, and create new population groups in formally occupied areas. These efforts should include: 1) actions to promote new population groups in the northern and eastern portions of the historical Arizona range and in the borderlands areas of Arizona, Texas, and Mexico, where owls are now extirpated, and 2) bolstering population size in areas that are still occupied to increase their likelihood of long-term persistence and provide surplus individuals available to recolonize, either naturally or with facilitation, newly restored habitat elsewhere. :

a) Protect nest cavity substrates, including saguaros and large trees, especially in areas where age structure of existing saguaros is dominated by older individuals and reproduction and survival of young individuals has been limited.

I. Investigate methodology and management to protect these substrates from fire and invasive nonnative vegetation.
II. Determine if and what nonnative trees can provide suitable cavities for nesting.
III. Investigate feasibility of saguaro salvage and partner with Departments of Transportation, developers, municipalities, non-profit organizations, etc. where applicable.
IV. Investigate feasibility of propagating saguaros and partner with native plant nurseries, municipalities, botanical gardens, etc.
V. Study transplanting protocols and investigate the effects of climate change, soils, precipitation, nurse plants, etc. on transplant survival
VI. Manage for saguaros, riparian trees, and any other trees in older age classes and oak motte habitat (preferred by pygmy-owls for nests) and for their long-term presence on the landscape in the face of climate change. Investigate how we can keep cavity substrates viable on the landscape.
VII. Manage for cavity availability and for cavity excavators such as Gila woodpeckers, flickers, and golden fronted woodpeckers.
VII. Investigate the feasibility of using nest boxes as a short-term solution to limitations in natural cavity availability, including appropriate design and placement of nest boxes.

b) Promote appropriate woody vegetation and woodland community management to provide core pygmy-owl nesting habitat and habitat connectivity especially in large once-wooded bottomlands along major valley bottom drainages and their main tributaries.

I. Cooperate with partners to balance the control of mesquites with the conservation and enhancement of pygmy-owl habitat. Investigate how we can potentially accomplish this by focusing on drainages and oak motte habitat for protection of mesquites and other large trees. Identify areas where it is good to keep mesquites and where it can be managed (controlled) for overall land use goals and ecosystem health.

II. Manage for vertical cover – large trees and midstory. Promote tree canopy cover in appropriate areas.

III. Manage for woodlands in proximity to saguaros.

c) Investigate how to adapt management to focus on overall vegetation management in the face of climate change and development

I. Identify and maintain large enough areas of suitable habitat for core pygmy-owl nesting habitat areas in the appropriate locations to support population groups.

II. Maintain and create pygmy-owl habitat connectivity for rescue/metapopulation viability.

III. Conduct surveys to describe occupied pygmy-owl habitat and develop models to identify where we have viable areas of pygmy-owl habitat and then model to manage for the long-term viability of these areas.

IV. Incorporate resiliency and mitigation for impacts to habitat from increased frequency of tropical storms, hurricanes, and severe drought.

5) Investigate, test, and apply tools for augmenting or establishing pygmy-owl population groups in areas and contexts that are best suited for each technique and in ways that address key limiting factors such as habitat connectivity, habitat amount, and habitat quality:

a) Using adaptive management, continue to investigate best practices to improve the success of captive breeding and release of pygmy-owls to augment existing pygmy-owl population groups and to establish new pygmy-owl population groups. This should include things like live-prey provisioning, predator avoidance training, and improved flight capabilities, as well as testing different soft release techniques/spaces and improved monitoring techniques. Additionally, if feasible, some sort of genetic management plan would be useful to best inform some of the actions proposed below, like translocation and cross-fostering. Improve the analysis of release site suitability/feasibility, to help prioritize potential release site(s) to be used in this and the activities outlined below.

b) Investigate the feasibility of translocation of wild, experienced pygmy-owls to accomplish augmentation of existing pygmy-owl population groups or to establish new pygmy-owl population groups. Pygmy-owls in this activity will come from locations where there are surplus pygmy-owls so they do not harm local populations and be subject to rapid disease screening.

c) Investigate the feasibility of cross-fostering captive-bred pygmy-owl nestlings into wild pygmy-owl nests if resources on the landscape are adequate for wild pygmy-owl pairs to successfully provision and fledge multiple offspring.

6) Improve our understanding of cactus ferruginous pygmy-owl geography, ecology, biology, population viability, genetics, threats, compatible land uses, and habitat restoration, through scientific research, thereby enabling better management of pygmy-owls and pygmy-owl habitat.

a) Develop long-term partnerships. There is value and understanding in long-term studies. We need to work with the TON, landowners/managers, agriculture, energy, commercial and residential developers, real estate folks, NGOs, universities, conservation organizations, etc. as partners and cooperators in better understanding the needs of pygmy-owls and to develop mutually beneficial solutions to conservation. Specifically, we need to investigate partnerships with universities, state wildlife agencies, tribal entities, landowners, and conservation groups who can facilitate research both to provide information on immediate needs, but also to provide continuity for long-term research questions. Many of these entities have experience and background in the conservation and recovery of listed species.

b) Identify pygmy-owl research needs and conduct scientific studies on the geography, ecology, biology, productivity, dispersal, viability, and genetics of the species and share results among land managers and researchers. Develop a cactus ferruginous pygmy-owl PVA to inform a conservation plan. Develop a centralized database to backup data from individual land managers and researchers, as well as to provide and make accessible a centralized source of information for various conservation activities. Analysis of data, with informed findings and recommendations, should be provided to pygmy-owl conservation partners for on-the-ground application and monitoring subject to an adaptive management approach.

c) Identify pygmy-owl research needs and conduct scientific studies on threats, compatible land uses, and habitat restoration, and share results among land managers and researchers.

7) Coordinate with and involve Mexico and the TON in cactus ferruginous pygmy-owl conservation and recovery, especially habitat protection and enhancement efforts focused on large areas of habitat and a significant population of owls within 50-100 km of Arizona:

a) Continue to seek support and approval from The Canada/Mexico/US Trilateral Committee for Wildlife and Ecosystem Conservation and Management for ongoing and new coordinated pygmy-owl work involving Mexico and the United States, including maintain or enhancing habitat connectivity and potential translocations of pygmy-owls.

b) Increase awareness of ongoing safety issues limiting pygmy-owl conservation activities in Mexico.

c) Provide resources to develop capacity for additional pygmy-owl conservation work in Mexico and the TON. Coordinate with our colleagues in Mexico and the TON to identify appropriate conservation actions.

d) Reach out to professors at universities and other researchers in Mexico to utilize resources such as interns and graduate students and to build off of existing research.

e) Work with the Sonoran Joint Venture and other Joint Ventures to share the final pygmy-owl survey protocol and training materials with Mexican and TON biologists, especially in Sonora and Nuevo Leon/Tamaulipas. This would provide consistency in methodology beyond the international border if any surveys are conducted by Mexican and TON biologists, and increase awareness on the need for pygmy-owl surveys in Mexico.

f) Initially, focus monitoring, management, and scientific studies on Sonora and Nuevo Leon and Tamaulipas to enhance connectivity of population groups along the border.

8) Increase public knowledge, education, and support for the cactus ferruginous pygmy-owl:

a) Develop programs and materials to inform the public of the need and benefits of restoring and protecting the cactus ferruginous pygmy-owl and overall landscape health. Coordinate with partners to host workshops and outreach events and produce social media outreach content.

b) Work with partners to develop new Conservation Benefit Agreements or Habitat Conservation Plans and educate landowners on the benefits of participation.

c) It is important to increase public knowledge and education in Mexico. Reaching out to local groups/agencies that could educate the Mexican public on pygmy-owl conservation issues, especially in the border states (Sonora, Nuevo Leon, Tamaulipas) where the owl populations tend to be relatively scattered and vulnerable, yet contribute to the AZ owl populations through dispersal. The pygmy-owl and the challenges it faces and will be facing are unlikely to be known by the public in Sonora for example. Our Mexican colleagues would probably know who to reach out to. Also reach out to NGOs that do work in Mexico (e.g. the Sonoran Joint Venture, local NGOs in Mexico).

c) Where possible, work with private landowners and others to ensure landscape activities (e.g., agricultural, land clearing, pesticide/herbicide application) are conducted using methodology to avoid or minimize harmful effects to pygmy-owls and pygmy-owl habitats.

d) Work with partners to educate the public, with an emphasis on birders and photographers, regarding the potential negative effects of disturbance on pygmy-owls and to promote appropriate birding ethics in areas occupied by pygmy-owls.

Table 1. Preliminary Recovery Actions (not prioritized)

Recovery Action	Threats Addressed	Contributions to Recovery
1) Protect extant population groups of cactus ferruginous pygmy-owls.	Loss of resiliency, redundancy, and representation; effects of climate change	Increase demographic factors of abundance, persistence, and productivity.
2) Survey for the cactus ferruginous pygmy-owl and monitor for persistence and productivity.	Loss of resiliency, redundancy, and representation; effects of climate change	Increase demographic factors of abundance, persistence, and productivity.

3) Identify, protect, and enhance unoccupied areas of suitable pygmy-owl habitat as potential areas where we can increase the number and distribution of pygmy-owl population groups.	Loss of resiliency, redundancy, and representation; loss of habitat and increased habitat fragmentation; effects of climate change	Identify areas of suitable pygmy-owl habitat where we can increase pygmy-owl numbers and the number and distribution of population groups.
4) Manage vegetation to provide habitat elements that will contribute to the long-term viability of pygmy-owl population groups.	Loss of resiliency, redundancy, and representation; loss of habitat and increased habitat fragmentation; effects of climate change	Improve habitat factors of habitat connectivity, vegetation health, and cover and prey availability.
5) Investigate, test, and apply tools for augmenting or establishing pygmy-owl population groups.	Loss of resiliency, redundancy, and representation; effects of climate change	Increase demographic factors of abundance, persistence, and productivity.
6) Improve our understanding of cactus ferruginous pygmy-owl geography, ecology, biology, viability, genetics, threats, compatible land uses, and habitat restoration, through scientific research.	Loss of resiliency, redundancy, and representation; loss of habitat and increased habitat fragmentation; effects of climate change	Increase demographic factors of abundance, persistence, and productivity and Improve habitat factors of habitat connectivity, vegetation health, and cover and prey availability.
7) Coordinate with and involve Mexico and TON in cactus ferruginous pygmy-owl conservation and recovery.	Loss of resiliency, redundancy, and representation; loss of habitat and increased habitat fragmentation; effects of climate change	Increase demographic factors of abundance, persistence, and productivity and Improve habitat factors of habitat connectivity, vegetation health, and cover and prey availability.
8) Increase public knowledge, education, and support for the cactus ferruginous pygmy-owl.	Loss of resiliency, redundancy, and representation; loss of habitat and increased habitat fragmentation; effects of climate change	Increase demographic factors of abundance, persistence, and productivity and Improve habitat factors of habitat connectivity, vegetation health, and cover and prey availability.

Preliminary Steps for Recovery Planning

Will a Recovery Plan be Developed? Yes

Type of Recovery Plan: Single species

Who will Develop the Recovery Plan: The Arizona Ecological Services Field Office Species Lead in cooperation with biologists from Texas Coastal and Central Plains Ecological Services Field Office and Lower Rio Grande Valley National Wildlife Refuge. We anticipate forming a recovery team with appropriate representation from Arizona, Texas, and Mexico.

Plan for Stakeholder Role/Involvement*:* Multiple stakeholders will be involved during the recovery planning process for Arizona and Texas. These will include County, State, and Federal agencies, universities, and conservation organizations, as well as private landowners and managers within Arizona and Texas in the U.S. and Sonora and Nuevo Leon and Tamaulipas in Mexico. In accordance with the requirements of the ESA, we will solicit independent peer review of the draft recovery plan from qualified individuals.

Recovery Planning Milestones: We anticipate forming a recovery team in 2025 and beginning work on a draft recovery plan that same year. We anticipate completing a draft recovery plan in 2026 and a final recovery plan in 2027. These dates may change depending upon available resources and regional priorities.

JONNA POLK Digitally signed by JONNA POLK
Date: 2024.11.06 08:45:56 -06'00' Date:_____

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