United States Department of the Interior

Fish and Wildlife Service
Arizona Ecological Services Office
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In Reply refer to:

ECOSphere Project Number:
2023-0046708-S7-001

May 15, 2024

MEMORANDUM

To: Tasha Harden, Refuge Manager, San Bernardino National Wildlife Refuge

From: Heather Whitlaw, Project Leader, Arizona Ecological Services

Subject: Biological Opinion for Mesquite Grubbing Along Black Draw (Rio San Bernardino) on the San Bernardino National Wildlife Refuge

This document transmits our biological opinion based on our review of the effects of the proposed Mesquite Grubbing along Black Draw (Rio San Bernardino) on the San Bernardino National Wildlife Refuge on the threatened yellow-billed cuckoo (*Coccyzus americanus*) and its designated critical habitat as well as the threatened northern Mexican gartersnake (*Thamnophis eques megalops*), pursuant to section 7(a)(2) of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*). Your request for formal consultation, based on your determination that the proposed action as likely to adversely affect these species and yellow-billed cuckoo critical habitat, was received on July 13, 2023, and we initiated consultation at that time.

You also requested our concurrence on your determination that the proposed action was not likely to adversely affect the endangered jaguar (*Panthera onca*), endangered ocelot (*Leopardus pardalis*), threatened beautiful shiner (*Cyprinella formosa*) and its critical habitat, the endangered Yaqui chub (*Gila purpurea*) and its critical habitat, the endangered Yaqui topminnow (*Poeciliopsis sonoriensis*), the endangered Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*), and critical habitat for the threatened Yaqui catfish (*Ictalurus pricei*). Our concurrence with your determination appears in Appendix A.

You have further determined that the proposed action will have no effect on the threatened Mexican spotted owl (*Strix occidentalis lucida*), the non-essential population of the Northern aplomado falcon (*Falco femoralis septentrionalis*), the threatened Chiricahua leopard frog (*Rana chiricahuensis*), the threatened Yaqui catfish (*Ictalurus pricei*), the threatened San Bernardino springsnail (*Pyrgulopsis bernardina*) and its critical habitat, the endangered Cochise pincushion cactus (*Coryphantha robbinsorum*), the candidate species Monarch butterfly (*Danaus plexippus*), and the threatened Wright's Marsh Thistle (*Cirsium wrightii*). Species and critical habitats with "no effect" do not require review from the Act and are not addressed further.

This biological opinion is based on information provided in the July 13, 2023, biological assessment (BA), field investigations, and other sources of information. Literature cited in this opinion is not a complete bibliography of all literature available for the species, potential effects of the proposed action mesquite grubbing, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at Tucson Field Office.

CONSULTATION HISTORY

- January 12, 2023: You initiated the Intra-Service consultation process.
- February 10, 2023: You sent a draft Biological Evaluation.
- July 13, 2023: You submitted a final Biological Evaluation for Intra-Service consultation.
- September 15, 2023: We sent a draft Biological Opinion for your review.
- September 22, 2023: You submitted comments on the draft Biological Opinion.
- December 6, 2023: We sent a revised draft Biological Opinion for your review.
- January 3, 2024: You submitted comments on the revised draft Biological Opinion.
- February 23, 2024: We met with you to discuss details of the proposed project.
- March 15, 2024: We submitted questions to you about the project.
- April 15, 2024: You provided comments and other resources to us.
- May 8, 2024: We sent you a revised draft Biological Opinion for your review.
- May 9, 2024: We met with you to discuss details of the proposed project and Biological Opinion.
- May 9, 2024: You provided comments on the revised draft Biological Opinion.
- May 15, 2024: We sent a final Biological Opinion to you.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Regulations implementing the Act (50 CFR § 402.02) define "action" as "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies of the United States or upon the high seas."

The following is a summary of the proposed action, and a detailed description can be found in the project Biological Evaluation (BE).

Project Background

The San Bernardino Valley, location of the San Bernardino National Wildlife Refuge, was described by John Russell Bartlett (1854) as a level patch of green, resembling a luxuriant meadow, some eight or ten miles long. Bartlett continues describing the area with known historical features and states that after watering their animals and feeding them on the rich grass they resumed westerly where the road first entered a thick chaparral of mesquite (Bartlett 1854). Written accounts and photographs of early explorers and settles indicate that aquatic habitats in southeastern Arizona prior to the late 1800s were different from what they are today.

The San Bernardino Valley was a productive grassland dominated by native perennial grasses which were utilized for livestock production with the establishment of the Spanish missions (Presidio de San Bernardino 1776) (Bahre 1991) that brought livestock to the region and the subsequent Arizona cattle boom (1873–1893) (Sayre 1999). The establishment of large ranches, like the Rancho San Bernardino (now John Slaughter Ranch), for livestock production markedly changed the landscape (Bahre 1991). Such changes included the overgrazing of native perennial grasses that shifted the desert grassland ecosystem to one dominated by annual, often nonnative invasive grasses and woody plants. Further, ranching activities, grazing and livestock management, facilitated the encroachment of mesquite (generally velvet mesquite, *Prosopis velutina*, but also honey mesquite*, Prosopis glandulosa*) that were historically bounded to lower-lying areas (Polley et al. 1994; Sayre 2002).

Although it is unknown if groundwater makes a significant portion of a mesquite tree's yearly water intake (Scott 2000), mesquite encroachment has effects at both the local and landscape levels. At the landscape level, conversion from grassland to mesquite shrubland causes rates of evapotranspiration to increase and infiltration of water to decrease (Nie et al. 2012). At the local level, mesquite is known to readily outcompete grasses due to their extensive root systems (Tiedemann and Klemmedson 1977), and this process is especially accelerated as water becomes scarcer (Golubov et al. 2001) since perennial grass production is highly tied to the predictably and amount of precipitation (Cable 1975).

Mesquite bosques, associated with watered landscapes in the Southwest, were once the most common type of riparian vegetation (Brown 1982; Stromberg 1993a). These co-occur with cottonwood-willow forest galleries, but are located upbank in drier soils (Minckley and Clark 1984) or along terraces and incised channels (Stromberg 1993a). Mesquite bosque formation along stream beds can increase depth to water as well as alter channel morphology by stabilizing

bank soil for future up-bank sediment deposition and low-bank channel cutting (Minckley and Clark 1984).

Mesquite abundance in the San Bernardino Valley along Black Draw (Rio San Bernardino) was noted by E.A. Mearn (1907): "The San Bernardino River...is wooded with willow, cottonwood, boxelder, ash and mesquite; a few red junipers grow on adjacent hills; and creosote bush, mesquite, acacia and ocotillo occupy the stony mesas and arroyos which constitute the major portion of that region." Descriptions such as this attest to the past distribution of mesquite, which was limited to lower areas and drainages with little incursion upland.

The formation of arroyos and channel cutting in southern Arizona is largely attributed to vegetation alteration and removal during the cattle boom (Antevs 1952) and like many streams and drainages in Arizona, Black Draw has experienced channel morphology change likely from a shallow perennial flowing stream to a deeply incised ephemeral stream bed, likely occurring around the turn of the century (Francaviglia 1983). Once channels have become incised, woody vegetation can continue the process by stabilizing channel banks that would normally erode under high flow regimes (Pollen-Bankhead et al. 2009). As the channel becomes deeper, the water table drops (Neal 2009), affecting phreatophytic riparian vegetation (such as cottonwoods) that then become perched several meters above the stream bed which becomes increasingly more isolated where mortality can be high (Scott et al. 2000). The loss of connection to associated floodplains occurs as incised channels become deeper, increasing the groundwater gradient (toward the channel), due to disappearing groundwater recharge from overbank flooding (Hardison et al. 2009). Further, channel incision can result in increased depth to groundwater (Neal 2009) where exchange flow (between surface and ground water) in the hyporheic zone is reduced (Wondzell and Swanson 1999).

Mesquite bosques are particularly well suited to stabilizing and altering fluvial dynamics of stream banks as they are deeper rooted than cottonwoods and willows and can survive perched above deeply cut streams and still reach groundwater levels (Stromberg 1993b). Changes in hydrologic functioning (natural flow regimes, flood disturbance patterns, and fluvial dynamism) are one of the largest contributing factors to riparian vegetation loss and riparian restoration success depends on addressing these factors (Stromberg 2001). Removing root reinforcement provided by mesquite along incised channel banks allows erosionary forces to act on channel walls that promotes restoration by slowly widening and raising the stream bed as shown by Pollen-Bankhead et al. (2009) and Vincent (2009) after removing saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*).

In general, incised channels are streams and rivers that have lost the naturally co-occurring floodplain. Floodplains are essential for appropriate hydrological functioning as they divert water and spread water energy (Zeedyk and Clothier 2014). Incised channels have an imbalance between sediment transport capacity and sediment supply, which allows the force of moving water to act on the channel bottom, furthering the incision process (Harvey and Watson 1986). Currently, Black Draw is severely incised (in some places as much as 20 ft.) and the hydrology is significantly altered such that designated aquatic critical habitat for the Rio Yaqui Fishes is degraded and the riparian forest gallery shows little regeneration as the stand is dominated by large older trees and very few younger trees.

Project Description

The San Bernardino NWR proposes to conduct mesquite (*Prosopis* spp.) removal from areas along the incised Black Draw channel stabilized by this species. San Bernardino NWR will target mesquite removal on approximately 100 acres of the mesquite bosque over three years. Mesquite removal would occur by grubbing with heavy equipment (utilizing excavators and or backhoes to remove trees and as much of their root systems as possible to deter regrowth) and creating piles of mesquite for later disposal. Grubbing mesquite along the Black Draw channel directly contributes to ongoing overall watershed improvement efforts, which include riparian, wetland, and semi-desert grassland ecosystem restoration efforts, that San Bernardino NWR engages in. Grubbing mesquite is a routine annual action that has been conducted and maintained by refuge staff since the refuge was established in 1982; however, at times removal actions, such as this, may occur at a larger scale by contractors. Overall project objectives are to initiate processes that promote restoring natural fluvial processes.

Natural processes associated with flood events and subsequent bank sloughing are dependent on the appropriate environmental conditions which include amount, timing, and frequency of precipitation (Schumm and Parker 1973; Simon and Rinaldi 2006). If the necessary environmental conditions are present, they may enable passive, nature-based restoration actions such as bank erosion, raising of the channel bed through aggradation of material, and quasi-equilibrium through reestablishment of a functioning floodplain. Quasi-equilibrium implies that the system is not static, changes through time, but over a period of years the average condition is one of stability. The below channel evolution model by Schumm and Parker (1973) modified by Simon and Rinaldi (2006) depicts the natural process expected by removing the mesquite along the banks and destabilizing them.

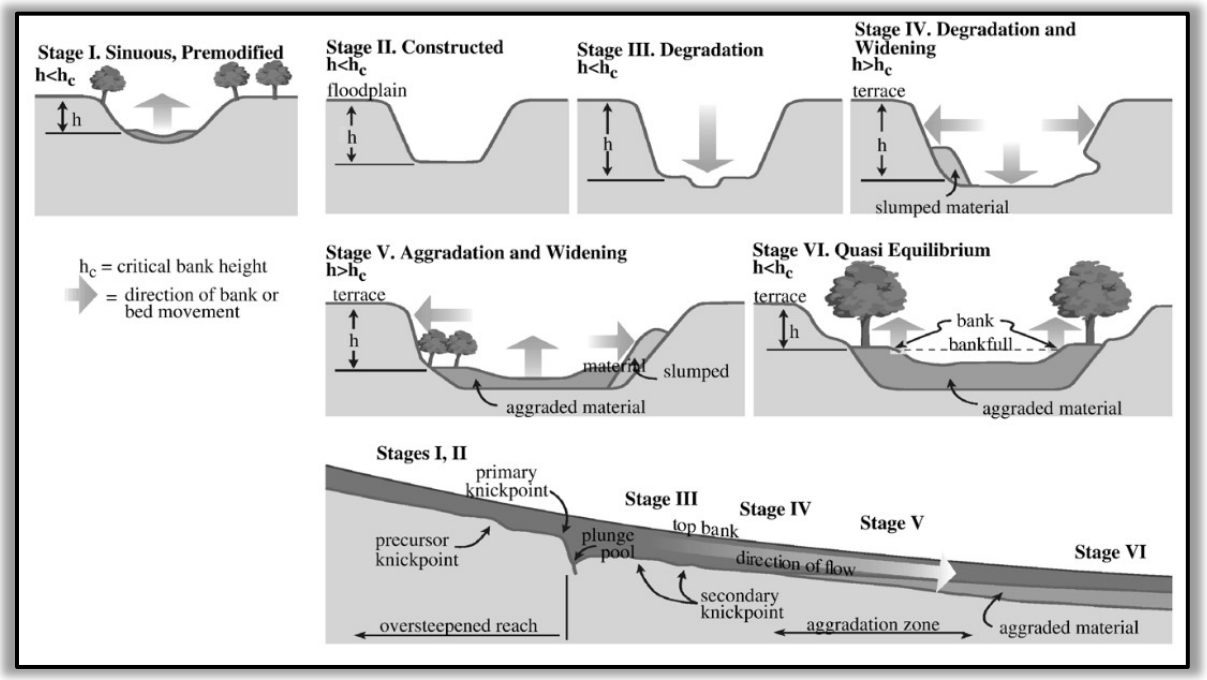

Figure 1. *Stages of channel evolution from* Simon and Rinaldi (2006 p.369).

As natural fluvial processes are restored, and if hydrologic conditions improve, long-term effects could potentially support the passive restoration of the cottonwood-willow riparian forest gallery. This forest type is one of the most diverse, as it supports high structural diversity that some riparian specialist species require (Stromberg 1993b).

The proposed project initiates three important restoration objectives: 1) provide a first step in restoring the natural hydrological functioning in Black Draw, 2) create conditions that initiate recruitment of the cottonwood-willow forest gallery, and 3) rehabilitate aquatic critical habitat for the Rio Yaqui fishes that inhabit the refuge. Post-project, long-term objectives for Black Draw restoration are the: 1) elevation of the groundwater table, 2) increase in perennial flow, and 3) expansion of Rio Yaqui Fish critical habitat physical biological features (PBFs).

Conservation Measures

The San Bernardino NWR will implement the following conservation measures with the intent to avoid and minimize the proposed action's adverse effects to proposed species:

Yellow-billed Cuckoo:

1. SBNWR will not conduct project activities during the yellow-billed cuckoo breeding season when individuals are present on refuge (May 25 – September 30); grubbing will be conducted October through March.

2. SBNWR will avoid removal or damage of riparian trees occurring along Black Draw, specifically willow and cottonwood trees with their associated understory vegetation.

3. SBNWR will not conduct grubbing during wet conditions, to the highest extent possible, to decrease ground disturbance effects.

4. SBNWR will stagger the mesquite removal over three years such that grubbing will be conducted in stages for the primary continuous thicket of mesquite (approximately 100 acres). Specifically, SBNWR will remove mesquite in smaller sections over at least 3 grubbing seasons where approximately 31 acres will be grubbed the first season, approximately 34 acres the second season, and approximately 30 acres the third season, see Figure 3.

Northern Mexican Gartersnake:

1. SBNWR will conduct project activities between October and March when the northern Mexican gartersnake is less active.
2. SBNWR will not conduct project activities in Black Draw proper, where the highest amount of suitable habitat and prey base exists for the northern Mexican gartersnake.
3. SBNWR will stage slash piles as far from aquatic resources as possible, to the extent possible to reduce northern Mexican gartersnake use.

Project and Action Area

The Project Area is approximately 100 acres, located along Black Draw in the center of the refuge, see Figure 2.

The action area is defined at (50 CFR § 402.02) as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The Service has determined that the action area for this project is a 561-foot buffer around the project footprint, which accounts for sound attenuation to an A-weighted decibel (meaning decibels adjusted to human hearing; dBA) of 69 dBA from the use of two excavators during project implementation. See Figure 2.

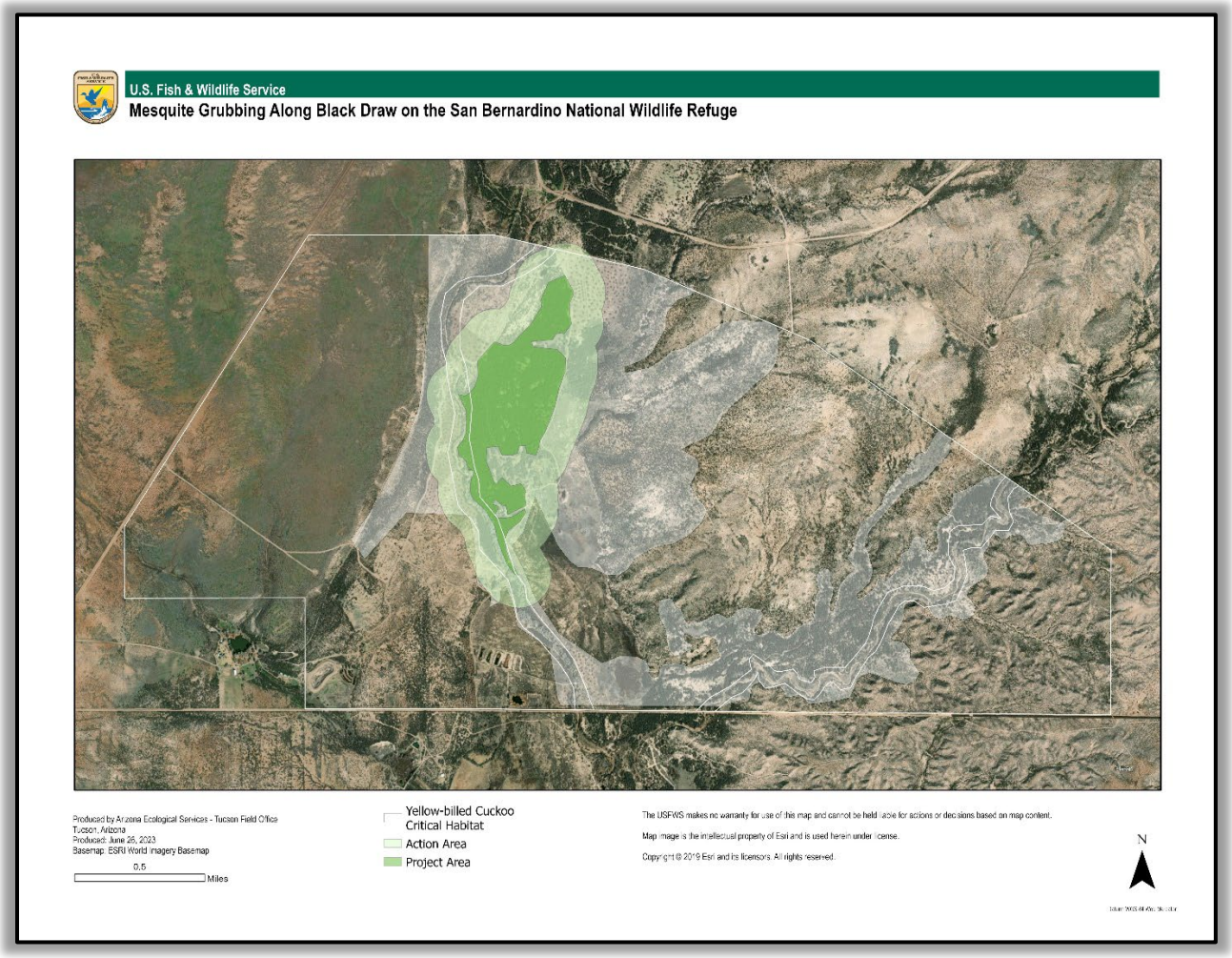

***Figure 2**. Project footprint (in dark green) where mesquite will be removed, project action area (in light green), and yellow-billed cuckoo critical habitat (in white).*

Project Timeline

Currently the refuge has Bipartisan Infrastructure Law (BIL) FY23 funds for mesquite removal in the grassland restoration unit. The FY23 funded contracted project could start in January 2024 at the earliest and be completed under 5 years. Initiation is dependent on contractor availability and may be extended to a later start date but will not exceed 3 consecutive years, see Figure 3.

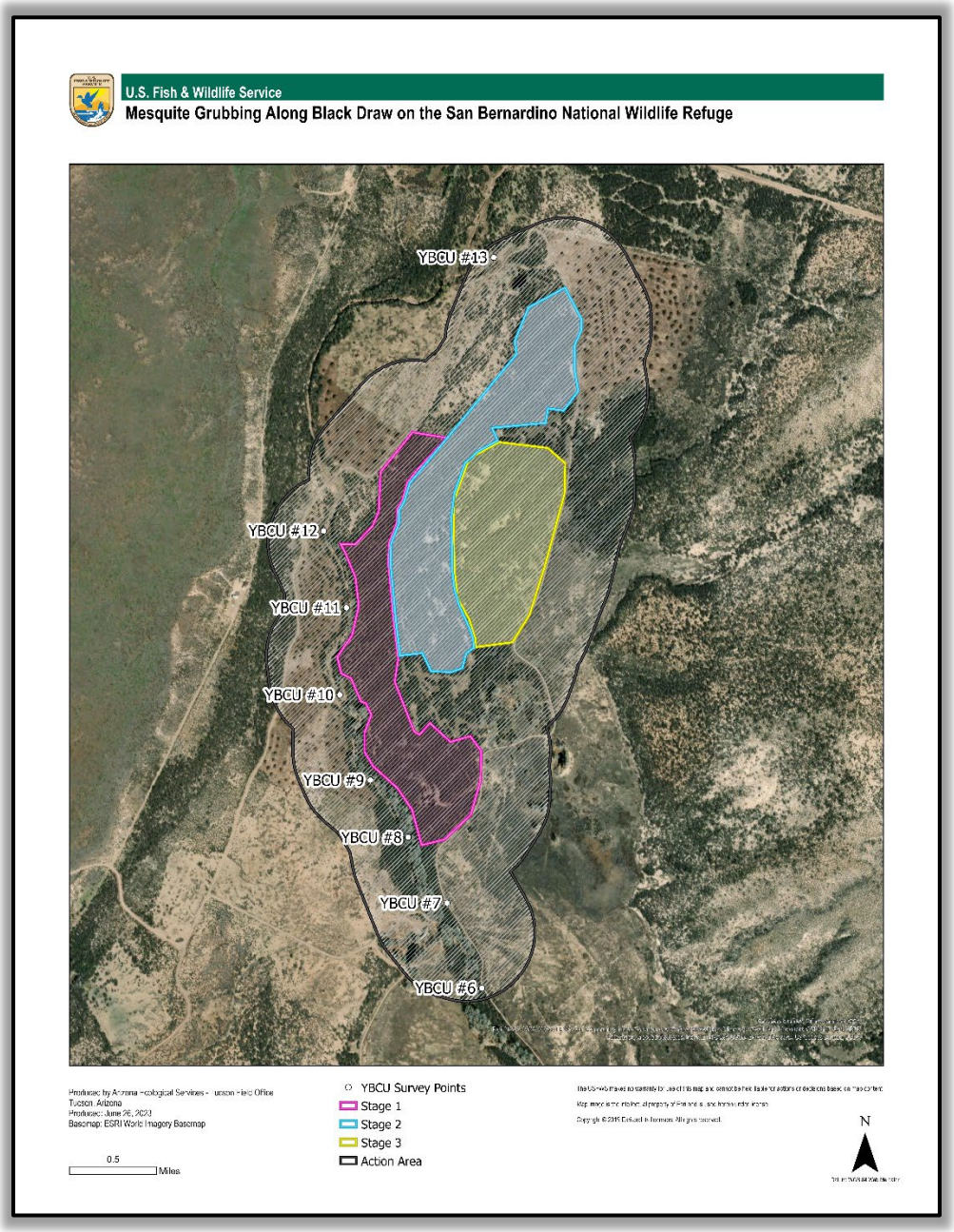

Figure 3. *Project footprint with implementation timeline in terms of Stage 1 (pink), Stage 2 (blue), and Stage 3 (yellow) with locations of yellow-billed cuckoo survey locations.*

STATUS OF THE SPECIES AND CRITICAL HABITAT

Yellow-billed Cuckoo

Legal Status and Taxonomy

This section summarizes best available data about the biology and condition of the western yellow-billed cuckoo (*Coccyzus americanus*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the western Distinct Population Segment (DPS) of the yellow-billed cuckoo as threatened on October 13, 2014 (USFWS 2014c). The Service issued a not warranted 12-month finding to a petition to delist the DPS of the western yellow-billed cuckoo on September 16, 2020 (USFWS 2020d). We have not yet developed a recovery plan for the cuckoo.

Description and Life History

Yellow-billed cuckoos are slender long-tailed passerines with a fairly stout and slightly down-curved bill. The plumage is grayish brown above and white below, with reddish primary flight feathers. The tail feathers are boldly patterned with black and white below. They are a medium-sized bird about 12 inches (in) (30 centimeters (cm)) in length, and about 2 ounces (oz) (60 grams (g)) in weight. The bill is blue-black with yellow on the basal half of the lower mandible. The legs are short and bluish gray. Males and females differ slightly but are indistinguishable in the field (Hughes 2015).

The yellow-billed cuckoo is a neotropical migrant bird that breeds in North America and winters in South America, east of the Andes, primarily south of the Amazon Basin in southern Brazil, Paraguay, Uruguay, eastern Bolivia, and northern Argentina (Sechrist et al. 2012; McNeil et al. 2015; Hughes 2015). Western yellow-billed cuckoos breed from late May through September, although most nesting occurs from late June through August. Timing of spring migration and arrival on the breeding grounds is likely related to climate, habitat, and food availability (Pulido et al. 2001; Cresswell et al. 2011). Both adults build loose platform nests composed of dry twigs. Nest height ranges from 1.3 - 17m (Halterman 2001; McNeil et al. 2013; Wohner et al. 2021b). Clutch size is variable, usually two or three (Halterman 2001; McNeil et al. 2013; Dillon and Moore 2020). Nestlings grow rapidly, with a period of 17 days from start of incubation to fledgling, which is among the shortest for most bird species (Hughes 2015).

Given that western yellow-billed cuckoos are larger birds with a short hatch-to-fledge time, they require access to abundant food sources to successfully rear their rapidly growing offspring (Laymon 1980). In portions of the southwestern United States, high densities of prey species may be seasonally present, often for brief periods of time, during the vegetation growing season. Food availability and foraging distance can vary greatly within and between years, drainages, and geographic area and is largely rainfall related. In areas that typically receive rains during the summer monsoon, an increase in humidity, soil moisture, and surface water flow are important triggers for insect reproduction and western yellow-billed cuckoo nesting (Wallace et al. 2013). In years of high insect abundance, western yellow-billed cuckoos lay larger clutches (three to five eggs rather than two), a larger percentage of eggs produce fledged young, and they breed

multiple times (two to three nesting attempts rather than one; Laymon et al. 1997a). On the upper San Pedro and lower Colorado Rivers, cuckoos renested following both successful and unsuccessful nesting attempts (Halterman 2009; McNeil et al. 2013). These subsequent nests are sometimes hundreds of meters away from previous nests.

Western yellow-billed cuckoos eat large insects (e.g., cicadas, caterpillars, katydids, grasshoppers, crickets, large beetles, dragonflies, and moth larvae) and small vertebrates (frogs and lizards) during nesting season (Laymon and Halterman 1985; Laymon et al. 1997; Halterman 2001, 2009; Griffin 2015a). Minor prey at that site and other sites includes beetles, dragonflies, praying mantis, flies, spiders, butterflies, caddis flies, crickets, and cicadas (Laymon et al. 1997; Hughes 2015). In Arizona, cicadas are an important food source (Halterman 2009).

Habitat Requirements and Distribution

Rangewide breeding habitat across the DPS exists primarily in riparian woodlands along low-gradient streams broad floodplains and open riverine valleys that provide wide floodplain conditions. The general habitat characteristics are areas that are often greater than 325 feet (ft) (100 meters (m)) wide, usually dominated by willow (*Salix* spp.) or cottonwood (*Populus* spp.) with above-average canopy closure (greater than 70 percent), and a cooler, more humid environment than the surrounding riparian and upland habitats. These areas contain the moist conditions that support riparian plant communities made up of overstory and understory components that provide breeding sites, shelter, cover, and food resources. In addition to cottonwood and willow, riparian vegetation may include tree species other than cottonwood and willow, including but not limited to boxelder (*Acer negundo*); ash (*Fraxinus* spp.); walnut (*Juglans* spp.); and sycamore (*Platanus* spp.) (Hamilton and Hamilton 1965; Gaines 1974; Laymon 1980; Gaines and Laymon 1984; Groschupf 1987; Corman and Magill 2000a; Dettling and Howell 2011).

In parts of the Southwestern United States and northwest Mexico, cuckoos breed along perennial, intermittent, and ephemeral drainages in montane canyons, foothills, desert floodplains, and arroyos below 6,000 ft elevation (1,829 m). Habitat often consists of narrow, patchy, and/or sparsely vegetated drainages surrounded by arid-adapted vegetation, with a greater proportion of xeroriparian and non-riparian tree species than elsewhere in the DPS.

Habitat may be less than 325 ft (100 m) wide due to narrow canyons or limited water availability and may be less than 200 ac (81 ha) or more in size, consisting of a series of smaller tree and large shrub patches separated by openings. Canopy closure is variable, and where trees are sparsely scattered, it may be dense only at the nest tree or small grove including the nest tree. The North American Monsoon brings high humidity and rainfall to some of these habitats especially in the ephemeral drainages in southeastern Arizona where winters are mild and warm, wet summers are associated with the monsoon and other tropical weather events (Wallace et al. 2013; Erfani and Mitchell 2014). Humidity associated with monsoon rainfall correlates with summer vegetation green-up and insect production. In addition to the riparian trees found across the species' range, the vegetation making up the Southwestern breeding habitat includes some other native and nonnative xeroriparian and non-riparian trees and large shrubs, such as, but not limited to: mesquite, hackberry (*Celtis reticulata* and *C. ehrenbergiana*), soapberry (*Sapindus*

saponaria), oak (*Quercus* spp.), acacia (*Acacia* spp., *Senegalia greggi*), mimosa (*Mimosa* spp.), greythorn (*Ziziphus obtusifolia*), desert willow (*Chilopsis linearis*), juniper (*Juniperus* spp.), pine (*Pinus* spp.), alder (*Alnus rhombifolia* and *A. oblongifolia*), wolfberry (*Lycium* spp.), Russian olive (*Elaeagnus angustifolia*), and tamarisk (*Tamarix* spp.)(Groschupf 1987; Corman and Magill 2000a; Villarreal et al. 2014; Griffin 2015b; MacFarland and Horst 2015, 2016, 2017, 2019; Corson 2018; Sferra et al. 2019).

Western yellow-billed cuckoos have placed nests in many species of trees and shrubs including Fremont cottonwood, Goodding's willow (*Salix gooddingii*), red willow (*Salix laevigata*), coyote willow (*Salix exigua*), yew-leaf willow (*Salix taxifolia*), Arizona sycamore, mesquite, tamarisk, hackberry, boxelder, soapberry, Arizona walnut, acacia, ash, alder, seep willow (*Baccharis salicifolia*), oak, juniper, tamarisk, and in non-native pecan (*Carya* sp.), English walnut (*Juglans regia*), prune (*Prunus domestica*), and almond (*Prunus dulcis*) (Laymon 1980, 1998; Groschupf 1987; Kingsley 1989; Corman and Magill 2000a; Halterman 2001, 2002; Corman and Wise-Gervais 2005; McNeil et al. 2013; MacFarland and Horst 2015; Hughes 2015; Sferra et al. 2019; Stanek et al. 2021).

Although tamarisk monocultures generally lack the structural diversity of native riparian habitat, western yellow-billed cuckoos may use these areas for foraging, dispersal, and breeding, especially if sites retain some native trees. Tamarisk contributes cover, nesting substrate, temperature amelioration, increased humidity, and insect production where native habitat regeneration and survivability has been compromised by altered hydrology (e.g., reduced flow or groundwater availability) and hydrologic processes (e.g., flooding and sediment deposition). Most occupied habitat with a tamarisk component is composed of at least 50 percent native habitat, but in parts of the western yellow-billed cuckoo's range, some tamarisk-dominated sites have been used for nesting and foraging, including parts of the Bill Williams, Verde, Gila, Salt, and Rio Grande Rivers (Groschupf 1987; Corman and Magill 2000a; Halterman 2001; Sogge et al. 2008; Dockens and Ashbeck 2011a, 2011b; Jarnevich et al. 2011; McNeil et al. 2013; Dillon et al. 2018; White et al. 2018; Parametrix, Inc. and Southern Sierra Research Station 2019). Thus, expansion of tamarisk defoliation by nonnative tamarisk leaf beetles (*Diorhabda* sp.) may lead to habitat degradation and may render areas unsuitable for occupancy by the western yellow-billed cuckoo (Sogge et al. 2008).

Home range size is highly variable and may depend on habitat quality and availability. Average 95% Kernal Density Home Range estimates are typically over 20 hectares, with individual estimates ranging from 1.5 to 216 ha (Laymon and Halterman 1985; Halterman 2009; McNeil et al. 2013; Sechrist et al. 2013; Dillon and Moore 2020). Cuckoos are also highly mobile, with estimates of movements from the Middle Rio Grande in New Mexico from 204 to 3357 m within a single day, and 365 to 5574 m within a season (Sechrist et al. 2013; Dillon and Moore 2020).

Rangewide Distribution

The species' rangewide territory estimates are near 1,300 (USFWS 2019a). Based on historical accounts, the cuckoo was formerly widespread and locally common in California and Arizona, more narrowly distributed but locally common in New Mexico, Oregon, and Washington, and uncommon along the western front of the Rocky Mountains north to British Columbia (American Ornithologists' Union 1998; Hughes 2015). The species may now be extirpated from

British Colombia, Washington, and Oregon (Hughes 2015; USFWS 2021b) and rare in scattered drainages in western Colorado, Idaho, Nevada, and Utah, with single, nonbreeding birds most likely to occur (USFWS 2014, 2020). The largest remaining core breeding populations occur in Arizona, along the Rio Grande in New Mexico, and in northwestern Mexico (USFWS 2020d, USFWS 2021b). Population declines continue to occur due to continuing and new threats to the western DPS (USFWS 2020).

Arizona Distribution

There are an estimated 450 Western yellow-billed cuckoo breeding territories across Arizona (USFWS 2019a). The species was a common resident chiefly in the lower Sonoran zones of southern, central, and western Arizona (Phillips et al. 1964; Groschupf 1987). The cuckoo now nests primarily in the central and southern parts of the state. In Arizona, the species was a common resident in the (chiefly lower) Sonoran zones of southern, central, and western Arizona (Phillips et al. 1964; Groschupf 1987). Populations in Arizona have declined in many perennial riparian areas from historical levels as well as over the past 35 years, with recent declines at some of the largest populations (e.g., Bill Williams River). The San Pedro River supports the largest population of cuckoos in Arizona in an unregulated riparian system and one of the largest in the DPS. The Gila River and lower Colorado River also contain large populations of western cuckoos in Arizona. Since listing, surveyors have documented western yellow-billed cuckoos breeding in ephemeral and intermittent drainages with a mix of xeroriparian and non-riparian trees, indicating a broader range of habitats and geographic areas than previously known. Fewer than 10 territories are present within most drainages, but combined they make up a large amount of occupied habitat across the landscape. The western yellow-billed cuckoo currently nests primarily in the central and southern parts of the state, as well as at revegetation sites along the lower Colorado River (Groschupf 1987; Corman and Magill 2000a; Halterman 2009; McNeil et al. 2013; Griffin 2015a; MacFarland and Horst 2015, 2016, 2017; Sferra et al. 2019).

Threats

Current yellow-billed cuckoo breeding populations are fragmented and geographically isolated. The primary threat to the species as the loss and degradation of its habitat from altered watercourse hydrology and natural stream processes, livestock overgrazing, encroachment from agriculture, and resulting conversion of native habitat to predominantly nonnative vegetation. Additional threats to the species include the effects of climate change, drought, pesticides, wildfire, and fragmentation of suitable habitat patches (USFWS 2014c). In addition, minerals mining projects adversely affect occupied habitat by reducing streamflow and habitat and increasing disturbance (USFWS 2020d). The tamarisk leaf beetle *(Diorhabda* spp.) may potentially adversely affect occupied habitat by defoliating tamarisk to the extent that it no longer provides protective cover, temperature amelioration, or food (USFWS 2020d). Mortality from collisions with towers and other tall structures and mortality from solar power facilities is an ongoing and serious threat that needs further evaluation (Longcore et al. 2005; Kagan et al. 2014).

Critical Habitat

USFWS designated critical habitat for the cuckoo on April 21, 2021 (USFWS 2021b) encompassing 298,845 acres (120,939 hectares) across the western United States. Critical habitat units do not include all known occupied habitat, or all reaches of occupied drainages.

Given the wide variety and extent of foraging habitat outside breeding habitat, and the large geographic areas in which western yellow-billed cuckoos search for food, we did not designate foraging habitat as critical habitat. Based on our current knowledge of the habitat characteristics required to sustain the species' life-history processes including breeding and dispersing, we have determined that the specific physical or biological features essential to the conservation of the western yellow-billed cuckoo consist of the following three components:

1. *Rangewide breeding habitat* - Riparian woodlands across the DPS; *Southwestern breeding habitat*, primarily in Arizona and New Mexico: Drainages with varying combinations of riparian, xeroriparian, and/or nonriparian trees and large shrubs. This physical or biological feature includes breeding habitat found throughout the DPS range as well as additional breeding habitat characteristics unique to the Southwest.

    a. *Rangewide breeding habitat (including areas in the Southwest)* - Rangewide breeding habitat is composed of riparian woodlands within floodplains or in upland areas or terraces often greater than 325 ft (100 m) in width and 200 ac (81 ha) or more in extent with an overstory and understory vegetation component in contiguous or nearly contiguous patches adjacent to intermittent or perennial watercourses. The slope of the watercourses is generally less than 3% but may be greater in some instances. Nesting sites within the habitat have an above-average canopy closure (greater than 70%), and have a cooler, more humid environment than the surrounding riparian and upland habitats. Rangewide breeding habitat is composed of varying combinations of riparian species including the following nest trees: cottonwood, willow, ash, sycamore, boxelder, alder, and walnut.

    b. *Southwestern breeding habitat* - Southwestern breeding habitat, found primarily in Arizona and New Mexico, is more variable than rangewide breeding habitat. Southwestern breeding habitat occurs within or along perennial, intermittent, and ephemeral drainages in montane canyons, foothills, desert floodplains, and arroyos. It may include woody side drainages, terraces, and hillsides immediately adjacent to the main drainage bottom. Drainages intersect a variety of habitat types including, but not limited to, desert scrub, desert grassland, and Madrean evergreen woodlands (presence of oak). Southwestern breeding habitat is composed of varying combinations of riparian, xeroriparian, and/or nonriparian tree and large shrub species including, but not limited to, the following nest trees: cottonwood, willow, mesquite, ash, hackberry, sycamore, walnut, desert willow, soapberry, tamarisk, Russian olive, juniper, acacia, and/or oak. In perennial and intermittent drainages, Southwestern riparian breeding habitat is often narrower, patchier, and/or sparser than rangewide riparian breeding habitat and may contain a greater proportion of xeroriparian trees and large shrub species. Although some

cottonwood and willow may be present in Southwestern riparian habitat, xeroriparian species may be more prevalent. Mesquite woodland may be present within the riparian floodplain, flanking the outer edges of wetter riparian habitat, or scattered on the adjacent hillsides. The more arid the drainage, the greater the likelihood that it will be dominated by xeroriparian and nonriparian nest tree species. Arid ephemeral drainages in southeastern Arizona receive summer humidity and rainfall from the North American Monsoon (PBF 3), with a pronounced green-up of grasses and forbs. These arid ephemeral drainages often contain xeroriparian species like hackberry or nonriparian species associated with the adjacent habitat type like oak, mesquite, acacia, mimosa, greythorn, and juniper. In southeastern Arizona mountains, breeding habitat is typically below pine woodlands (~6,000 ft (1,829 m)).

2. *Adequate prey base* - Presence of prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies, moth larvae, spiders), lizards, and frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas.

3. *Hydrologic processes* - The movement of water and sediment in natural or altered systems that maintains and regenerates breeding habitat. This physical or biological feature includes hydrologic processes found in rangewide breeding habitat as well as additional hydrologic processes unique to the Southwest in southwestern breeding habitat:

    a. Rangewide breeding habitat hydrologic processes (including the Southwest): Hydrologic processes (either natural or managed) in river and reservoir systems that encourage sediment movement and deposits and promote riparian tree seedling germination and plant growth, maintenance, health, and vigor (e.g., lower-gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). In some areas where habitat is being restored, such as on terraced slopes above the floodplain, this may include managed irrigated systems that may not naturally flood due to their elevation above the floodplain.

    b. Southwestern breeding habitat hydrologic processes: In southwestern breeding habitat, elevated summer humidity and runoff resulting from seasonal water management practices or weather patterns and precipitation (typically from North American Monsoon or other tropical weather events) provide suitable conditions for prey species production and vegetation regeneration and growth. Elevated humidity is especially important in southeastern Arizona, where western yellow-billed cuckoos breed in intermittent and ephemeral drainages.

Northern Mexican Gartersnake

Legal Status and Taxonomy

The *Federal Register* notice listing the northern Mexican gartersnake as threatened under the Act was published on July 8, 2014 (USFWS 2014b). Please refer to this rule for more in-depth information on the ecology and threats to the species, including references. Critical habitat was proposed on July 10, 2013 (USFWS 2013), and later revised and re-proposed on April 28, 2020 (USFWS 2020c) and designated as final on April 28, 2021 (USFWS 2021c). Details on critical habitat are provided below. The final listing and critical habitat rules are incorporated herein by reference.

Description and Life History

The northern Mexican gartersnake, which reaches up to 44 inches total length (112 cm), ranges in color from olive to olive-brown or olive-gray with three lighter-colored stripes that run the length of the body, the middle of which darkens towards the tail. It may occur with other native gartersnake species and can be difficult for people without specific expertise to identify because of its similarity of appearance to other native gartersnake species. The position of the lateral stripe in the anterior portion of the body is a key diagnostic feature. If this stripe invades the fourth scale row, it is conclusive as a northern Mexican gartersnake. Jones et al. (2020) provide a thorough species description.

Sexual maturity in northern Mexican gartersnakes occurs at two years of age in males and at two to three years of age in females (Rosen and Schwalbe 1988a). Northern Mexican gartersnakes are viviparous. Mating has been documented in April and May followed by the live birth of between 7 and 38 newborns from June through September (Rosen and Schwalbe 1988a; Degenhardt et al. 1996; Nowak and Boyarski 2012; Cobbold 2018). A staggered or biennial reproductive strategy is believed to be used by northern Mexican gartersnakes (Rosen and Schwalbe 1988a; Boyarski et al. 2019).

Periods of surface activity in northern Mexican gartersnakes depend on temperature which depends on elevation; stronger seasonality of surface activity in individuals is expected at higher elevations and vice versa at lower elevations. For example, if several weeks to months occur with consecutive nights below freezing, it is expected that northern Mexican gartersnakes would be inactive below ground during that time frame. However, in general and across its range, northern Mexican gartersnakes could be visible on the surface any day of the year if the preceding evening is above freezing (Emmons 2016). Cumulatively, these cold(er) season behaviors are better described as periods of inactivity or short-term torpor versus hibernation (Emmons and Nowak 2016). Longevity in the wild was estimated to be at least 10-11 years by Boyarski et al. (2019).

Foraging behavior of northern Mexican gartersnakes includes two different strategies 1) moving along vegetated shorelines, searching for prey in water, on land, and at the air-water interface (Drummond and Macias-Garcia 1989); and 2) implementing an underwater ambush strategy that appears to involve disguising themselves as inanimate objects while waiting for prey to move within striking range (Harrow et al. 2022). Primarily, its diet consists of aquatic or semi-aquatic

prey such as fishes, amphibians (metamorphosed and larval forms), and leeches followed secondarily by terrestrial prey items such as earthworms, lizards, or small rodents (Rosen and Schwalbe 1988a; Manjarrez et al. 2017). Some populations may specialize on seasonally available prey such as spadefoot toads (d'Orgeix et al. 2013) or Woodhouse's toads (Myrand et al. 2017). Manjarrez et al. (2017) sampled stomach contents from 262 Mexican gartersnakes across 23 discreet locations along the Mexican Plateau from 1980-1995. Fish (42.4 percent) were consumed most frequently followed by leeches (23.7 percent), earthworms (10.6 percent), frogs (10.2 percent) and tadpoles (9.8 percent); remaining prey items included slugs, axolotl, lizards, and mice) (Manjarrez et al. 2017). In situations where native prey species are rare or absent, the northern Mexican gartersnake's diet may include nonnative species, including larval and juvenile bullfrogs, western mosquitofish (Holycross et al. 2006; Emmons and Nowak 2013; Boyarski et al. 2019), or other nonnative fishes. In some cases where the aquatic community is nearly wholly nonnative, small size classes of predatory nonnative species (excluding crayfish) substitute native prey within the prey community (Emmons et al. 2016) until individuals grow out of these small size classes and can become highly predatory on northern Mexican gartersnakes themselves.

Habitat Requirements and Distribution

Considered a "terrestrial-aquatic generalist" by Drummond and Marcías-García (1989), the northern Mexican gartersnake is often found in riparian habitat, but also may spend time in terrestrial habitat removed from water (Emmons and Nowak 2016). Examples include grasslands up to a mile away from any surface water (Cogan 2015), several hundred yards from mainstem rivers (Ryan 2019), or even in highly disturbed, open, developed areas devoid of vegetation or associated lengthy, dry reaches along intermittent streams (Cobbold 2018). Species records suggest it may possess a more terrestrial ecology than previously considered (Jones 2017; Cobbold 2018), splitting habitat use patters seasonally between wetland areas and upland habitat (Jones et al. 2020), presumably forging on lizards, small mammals, and invertebrates possibly through periods of long(er)-distance dispersal. Terrestrial habitat serves three basic functions for northern Mexican gartersnakes: 1) thermoregulatory purposes; 2) as protective cover while surface active; and 3) for maintaining adequate terrestrial prey populations of small rodents, lizards, or invertebrates.

Aquatic habitat is used for prey acquisition and can be either lentic (stock tanks, ponds, cienegas, etc.) or lotic (low-gradient streams). In lotic habitat, Emmons and Nowak (Emmons and Nowak 2013) found this subspecies most commonly in protected backwaters, braided side channels and beaver ponds, isolated pools near the river mainstem, and edges of dense emergent vegetation that offered cover and foraging opportunities. Dense vegetation likely plays a key role in protecting northern Mexican gartersnakes when in the presence of predatory nonnative species (Boyarski et al. 2015) but is likely not critical in wholly native aquatic communities. Aquatic edge habitat is frequently used, followed by terrestrial habitat (for thermoregulatory purposes such as gestation and periods of dormancy) (Boyarski et al. 2015) and developed areas, with snakes documented using artificial, human-created objects as surface cover (Boyarski et al. 2015). Rocks and rock structures present excellent thermoregulatory conditions for a wide range of physiological needs and are frequently prioritized by gartersnakes over other types of

microhabitat (Huey 1991). Artificial cover is often preferred by snakes when available (Cox et al. 2009). Observations of northern Mexican gartersnakes in Mexico also found them using artificial cover such as tires, solid waste piles, discarded furniture, etc. (J. Servoss, U.S. Fish and Wildlife Service, pers. obs.). Other types of artificial microhabitat such as building foundations, construction debris, building foundations, gabion structures, etc. are used by North American colubrids for various purposes, suggesting such microhabitat would also be used by northern Mexican gartersnakes.

In the United States, the northern Mexican gartersnake is distributed from western, central, and southeastern Arizona, and southwestern New Mexico; presumed to occur along most large, perennial mainstem rivers and their larger tributaries (Jones et al. 2020). In Mexico, its range extends into Sonora and Chihuahua, and south along the Sierra Madre Occidental to the Transvolcanic Belt just south of Mexico City. Throughout its rangewide distribution, the northern Mexican gartersnake occurs at elevations from 140 to 8,497 ft (Rossman et al. 1996) within a wide variety of biotic communities including Sonoran Desertscrub through Semidesert Grassland, Interior Chaparral, Madrean Evergreen Woodland, into the lower reaches of Petran Montane Conifer Forest (Jones et al. 2020). In the United States, the highest known record occurs at 6,400 feet (Jones et al. 2020).

Occupancy, Surveys, and Detection

Of all vertebrates, snakes are one of the most elusive and difficult to detect using conventional biological survey protocols designed for their detection (Kéry 2002; Durso et al. 2011; Halstead et al. 2013, 2015; Oldham 2016; Ward et al. 2017; Boback et al. 2020; Tucker et al. 2021). Gartersnakes, like snakes in general, are notoriously difficult to detect due to their small size, secretive behavior, camouflage, rarity, inaccessibility of shelter sites (Kéry 2002), ability to occur in low densities, and are often unobservable due to their chosen habitats (Ward et al. 2017). Snakes, like most reptiles, have low energy demands, exhibit surface activity patterns that are unpredictable, and frequently forgo surface activity to avoid predation (Boback et al. 2020). For example, giant gartersnakes (*Thamnophis gigas*) exhibit extensive periods with little or no surface movement (Halstead et al. 2011). Habitat characteristics and preferences can affect detection using visual encounter surveys (Boback et al. 2020). Snakes can simply be unavailable for detection, whether underground, in vegetation, or underwater, which is considered availability bias. Whereas snakes that are available for detection but are not seen, result in perception bias. Both availability bias and perception bias are quite common in reptiles and amphibians and result in underestimation of distribution or abundance (Boback et al. 2020). Significant gaps in the history of records of the northern Mexican gartersnake displayed in Table 1 underscore how northern Mexican gartersnakes elude detection from surveys, within management subunits for decades at a time.

In particular, snakes that prefer lentic or lotic aquatic habitat are particularly problematic for detection. Durso et al. (2011) found that detection probabilities for seven species of North American aquatic snakes ranged from 3 - 46 percent. They found that even species considered common in the study area were difficult to detect, that sampling aquatic snake populations requires greater effort than other taxa, site occupancy was often, but not always, correlated with capture frequency, and that occupancy modeling may be useful for monitoring secretive aquatic snakes on a landscape-scale where traditional methods fail (Durso et al. 2011). Note that Durso

et al. (2011) studied aquatic snake populations using discreet wetlands within a terrestrial sample area, while northern Mexican gartersnakes can occur in riverine systems which may be hundreds of river miles long.

Table 1. *Record histories for the northern Mexican gartersnake showing significant gaps in time between records and before first detections.*

Northern Mexican Gartersnake				
Stream/Site	**Record**	**Subsequent Record**	**Gap in Years**	**First Record**
Gila River	1973	2002	29	
Duck Creek	1895	2018	123	
Colorado River	1904	2015	111	
Bill Williams River				2012
Big Sandy River				2010
Santa Maria River				2015
Agua Fria River	1985	2017 (released captives)	32	
Verde River	1884	1949	65	
Oak Creek	1975	2004	29	
Spring Creek	1986	2014	28	
Redrock Creek/Cott Drainage	1920	2008	88	
Sonoita Creek	1974	2013	39	
Parker Canyon Lake	1986	2017	31	
Arivaca Cienega	1970	2000	30	
Ft Huachuca	1892	1994	102	
Babocomari River	1985	2007	22	

Virtually all aquatic trapping surveys for gartersnakes in Arizona and New Mexico use unmodified Gee minnow traps. Despite much research in the herpetological community to evaluate and improve passive sampling techniques, detection and capture probabilities remain too low to reliably estimate demographic parameters (Halstead et al. 2013). Also, visual encounter surveys have shown low repeatability and high levels of observer bias, leading to very misleading inference about relative abundance (Halstead et al. 2013). However, certain types of data and effort can improve occupancy assessments when relationships are established. For example, survey date was not found to correlate with the detection probability of giant gartersnakes, whereas water temperature and the number of traps was correlated (Halstead et al. 2011); Oldham (2016) also found a positive correlation between detection probability and water temperature in northern watersnakes (*Nerodia sipedon*). Further complicating our assessment of occupancy is the limited accessibility to long stream reaches that flow through roadless or wilderness areas, presenting significant logistical challenges to surveying. Thus, most if not all survey locations occur in conjunction with access points (i.e. road crossings), but do not adequately represent the species' population status elsewhere along streams that are hundreds of river miles long and possess suitable habitat attributes along their course. Model simulations using trap data suggest the best way to decrease uncertainty in estimates of gartersnake occupancy is to increase the number of sampled sites within stream systems (Halstead et al. 2015).

Currently, we expect northern Mexican gartersnakes to generally occur as low-density subpopulations where habitat retains important characteristics. The history of records from 1980 to present (representing the most-surveyed period of time for this species) throughout all known occupied areas portrays the universe of potentially extant populations with imperfect resolution, which demonstrates the need to expand survey effort both in terms of the number of sites sampled within streams and the number and duration of traps and trapping effort across seasons and years.

Threats

Predatory Nonnative Species

The northern Mexican gartersnake evolved with native predators including birds, mammals, and other reptiles (in addition to the pikeminnow and occasional large chub) as their only natural predators, not the suite of nonnative predators from the Mississippi Basin which include fishes, bullfrogs, and crayfish that now dominate Southwestern aquatic habitat. The northern Mexican gartersnake is a recent example of a species affected by the ecologic ripple effect triggered by the introduction and persistence of predatory nonnative species – a trophic cascade which began with marked declines of several native fish species (Minckley and Marsh 2009), followed by subsequent declines in native amphibians (primarily native leopard frogs) (Clarkson and Rorabaugh 1989), and most recently, with the documented decline of a secondary predator within the aquatic community, the northern Mexican gartersnake (USFWS 2014b).

Predatory nonnative species include fish in the families Centrarchidae and Ictaluridae. Specific examples of predatory nonnative fish that occur with northern Mexican gartersnakes and are managed by state wildlife agencies as sportfish include bass (*Micropterus* sp.), flathead catfish (*Pylodictis* sp.), channel catfish (*Ictalurus* sp.), Chihuahuan catfish (*Ictalurus chihuahua*), bullheads (*Ameiurus* sp.), sunfish (*Lepomis* sp.), and crappie (*Pomoxis* sp.). While not in the families Centrarchidae and Ictaluridae, brown trout (*Salmo trutta*) are considered the most aggressive and predatory of the trout species introduced and managed for sport fishing purposes in the Southwest but likely do not overlap frequently with northern Mexican gartersnakes due to differences in habitat preference. American bullfrogs (*Lithobates catesbeianus*) are widely recognized as predatory to native species where found outside their native distribution. All crayfish are nonnative to the western United States and are considered predatory to both aquatic communities and aquatic habitats. Northern (virile) crayfish (*Orconectes virilis*) and red swamp crayfish (*Procambarus clarkii*) are the most common species which occur within the distribution of the northern Mexican gartersnake. Collectively, and particularly in combination with the threat of diminishing water resources, this suite of predatory nonnative animals appears to be the most significant and pervasive reason for the decline of the northern Mexican gartersnake and its prey base.

Predatory nonnative species can directly threaten northern Mexican gartersnakes passively, such as through physical injury to northern Mexican gartersnakes from the dorsal or pectoral spines of predatory nonnative fish during ingestion (Emmons et al. 2016) or actively through direct predation of northern Mexican gartersnakes (Atkins 2012). Neonatal and juvenile gartersnakes are considered the most at risk from predation by predatory nonnative species but adult

gartersnakes could still be prey for predatory fish that reach large sizes and possess large gapes, such as largemouth bass and flathead catfish. Predatory nonnative fish are most likely to capture northern Mexican gartersnakes when they enter or swim across pool or run habitat within streams or lentic water bodies that support these fish. Crayfish are most likely to seize neonatal gartersnakes in the shallows or along the bottom of pools, slow runs, backwaters, or tanks resulting in the drowning of individual gartersnakes. Bullfrogs often reside at the edge of water bodies on land or in the water and are most likely seize gartersnakes as they forage along aquatic edge habitat.

Predatory nonnative species affect entire aquatic communities, resulting in an array of indirect effects to northern Mexican gartersnake populations. For many decades, entire aquatic communities that serve as the prey base for northern Mexican gartersnakes have been profoundly affected by predatory nonnative species. Native aquatic ecosystems are on the verge of collapse in the Southwest - documented by the listing of the majority of native fish species of the Southwestern United States and by a large and growing body of literature (Propst et al. 1986, 1988, 2008; Rosen and Schwalbe 1988a; Douglas et al. 1994; Fernandez and Rosen 1996; Inman et al. 1998; Rinne et al. 1998; Nowak and Santana-Bendix 2002; Bonar et al. 2004; Rinne 2004; Clarkson et al. 2005; Olden and Poff 2005; Fagan et al. 2005; Holycross et al. 2006; Brennan 2007; Turner and List 2007; Brennan and Rosen 2009; Minckley and Marsh 2009; Pilger et al. 2010; Stefferud et al. 2011). For example, in 2014, Timmons et al. (2015) conducted fish surveys at 65 different sites within the Gila River basin. They concluded that approximately 69 percent of the sites sampled, nonnative fish were a primary threat to the native fish community; often seconded by drought or crayfish. The scope and effect of these predatory nonnatives on the native aquatic community in the southwestern United States cannot be understated, and is a landscape-scale threat to biodiversity, particularly in the southwestern United States.

Competition pressure from predatory nonnatives for an increasingly diminished native prey base could ultimately result in degrees of starvation and reduced fitness. If predation rates are high enough within northern Mexican gartersnake populations, recruitment of gartersnakes can be affected which manifests itself through skewed age class representation favoring large adults with fewer juveniles or young adults represented within a population (Rosen and Schwalbe 1988a). These factors may cumulatively lead to population declines, deleterious genetic effects, and ultimately local and regional extirpations.

Diminishing Surface Water

Other threats are secondary to predatory nonnatives in terms of scope but can permanently alter large habitat areas rendering them completely unsuitable for northern Mexican gartersnakes by reducing or eliminating their ability to meet the biological needs of their prey base. Primary examples of these threats include activities that reduce or alter flows or dewater habitat, such as dams and diversions (Ligon et al. 1995; Turner and List 2007), flood-control projects, and groundwater pumping (Stromberg et al. 1996; Rinne et al. 1998; Voeltz 2002; Haney et al. 2009). Dewatering of habitat eliminates fish and amphibian populations which are integral to the persistence of northern Mexican gartersnake populations. If not dewatered, structures such as dams and diversions alter the timing, duration, intensity, and frequency of flood events which can not only can lead to declining base flow, but also hasten the shift of aquatic communities to favor predatory nonnative species (Rinne et al. 1998; Rinne 2004; Propst et al. 2008). Reservoirs

created behind dams are managed as sport fisheries which affect aquatic communities within, upstream, and downstream of their location (Paradzick et al. 2006).

Increasing Demand for Water

Human population growth in the southwest has been significant (Gammage et al. 2008) and is expected to increase. From 2010-2030, the human population of Arizona and New Mexico are expected to grow by 48 percent and 37 percent, respectively (Theobald et al. 2013). This projected population growth will intensify pressure on the region's water resources (Overpeck 2007), in particular larger perennial or near-perennial streams which are integral to the recovery of the northern Mexican gartersnake. The combination of greater human use of water and climate change-induced drought, could significantly limit surface water in the Southwest, exacerbate the ecological effect of predatory nonnative species, and therefore the recovery of northern Mexican gartersnakes on a rangewide scale. Human population growth is also expected to increase visitation to aquatic sites which may result in increases in adverse human interactions with snakes and potentially increases in gartersnake mortality due to the public's general fear and dislike of snakes (Fleharty 1967; Rosen and Schwalbe 1988a; Nowak and Santana-Bendix 2002; Hibbitts and Fitzgerald 2005).

Climate Change and Drought

The future of the northern Mexican gartersnake is also intrinsically linked to climate change. As discussed above, the northern Mexican gartersnake strongly depends on aquatic species as prey (Manjarrez et al. 2017). Projected climate change in the southwestern United States includes increasing temperatures, decreasing precipitation, decreasing snowpack, decreasing runoff and stream flow (Cayan et al. 2013). Specifically, projections suggest that by year 2100 1) average annual temperatures in the Southwest may increase by 2-9° F; 2) annual runoff could decrease by 10-40 percent; and 3) the severity and length of droughts and soil-moisture depletion could increase substantially (Fleishman et al. 2013). Increasing temperature increases the rate of evaporation and transpiration of surface water, further reducing the amount of water for gartersnake prey species. Cavazos and Arriaga (2010) found that average temperatures along the Mexican Plateau in Mexico could rise in the range of 1.8 °F (1 °C) to 9 °F (5 °C) and precipitation may decrease up to 12 percent over the next 20 years, with pronounced decreases in winter and spring precipitation, according to their models.

Climate change is expected to disproportionately affect the prey base of northern Mexican gartersnakes. Amphibians may be among the first vertebrates to exhibit broad-scale changes in response to climate change (Reaser and Blaustein 2005). Changes in temperature and water availability may cause amphibians to experience increased physiological stress and decreased immune system function, which could worsen the effect of disease on amphibian populations (Carey and Alexander 2003; Pounds et al. 2006). Bullfrogs, however, are expected to fare better under predicted climate change than are native leopard frogs (Coe et al. 2012). Rahel and Olden (2008) expect that increases in water temperatures in drier climates such as the southwestern United States will result in periods of prolonged low flows and stream drying.

Predatory nonnative fish such as largemouth bass are expected to benefit from prolonged periods of low flow (Propst et al. 2008; Rahel and Olden 2008). Other predatory nonnative species such as green sunfish, channel catfish, and bluegill, are expected to increase their distribution by 7.4

percent, 25.2 percent, and 33.3 percent, respectively (Eaton and Scheller 1996). Climate change is predicted to foster the expansion of predatory nonnative aquatic species into new areas, magnify the effects of existing aquatic nonnative species where they currently occur, increase predation rates from nonnative predators, and heighten the virulence of disease outbreaks in North America (Rahel et al. 2008). As annual precipitation amounts lower, base flows weaken, and pools decline in volume and persistence, aquatic vertebrate populations will be forced to occupy smaller aquatic spaces which will increase the frequency of interactions between predatory nonnative species and native species, thus increasing predation and hastening the decline of native aquatic species throughout the southwestern United States and Mexico.

Genetic Effects

Collectively, threats identified above have created isolated populations, which have reduced the genetic connectivity among extant northern Mexican gartersnake populations and resulted in genetic drift and subsequently, the potential for inbreeding and limited adaptive potential to address abiotic and biotic changes over time (Wood 2018). Genetic analyses performed by Wood et al. (2018) found that at the species level of taxonomy, the Mexican gartersnake occurs as four major lineages: lower Colorado River Basin lineage (U.S.), a northern Sierra Madre Occidental lineage (Mexico), a southern Sierra Madre Occidental lineage (Mexico), and a Transvolcanic Belt lineage (Mexico). Major clades within the lower Colorado River Basin lineage represent major drainage basins (Bill Williams, Verde, Salt, Santa Cruz, and Gila River Basins) and were spatially clustered accordingly (Wood et al. 2018). Genetic isolation of formerly connected populations within the United States is adversely affecting genetic diversity, with northern Mexican gartersnake populations in the Sierra Madre Occidental showing 1.4 to 2.4 times the genetic diversity as the United States populations (Wood et al. 2018). Estimates of effective population size for northern Mexican gartersnakes across sites resulted in values ranging from 15 to 204; all sampled populations had effective population sizes that were below the threshold ($\geq$ 100) to limit inbreeding depression, with the exception of the San Rafael Valley (Wood et al. 2018). Wood et al. (2018) also detected significant bottlenecks at seven of nine sites sampled suggesting a loss of genetic diversity has occurred within the last 2–4 generations in the United States.

When genetic connectivity among populations is disrupted, a series of deleterious and synergistic genetic effects can occur, including 1) levels and distribution of genetic diversity increasingly erode which can result in increased genetic differentiation between populations and small effective population sizes; 2) lower effective population sizes can create a feedback loop between genetic drift and inbreeding which can lead to decreased fitness of a population (or "inbreeding depression") and increased sensitivity to environmental stressors and demographic changes; and finally 4) these changes can cumulatively drive further population declines, increasing the risk for population extirpations (Wood et al. 2018).

Ralls et al. (2018) reiterate that small and genetically isolated populations can lose genetic diversity, becoming increasingly inbred with each generation. Wood et al. (2018) recommends considering assisted gene flow as a management tool for combatting genetic effects of isolation; specifically suggesting "… management using reciprocal translocations and multiple sources …" to alleviate concerns of further depleting low-density populations through removal of individuals

for this purpose. Tables 11 and 12 in Wood et al. (2018) list genetically vulnerable populations and potential source populations for use in assisted gene flow.

Synergistic Stressors

Many other factors have likely contributed to the decline of the northern Mexican gartersnake through synergistic mechanisms, including: development and recreation within riparian corridors (Briggs 1996; Ernst and Zug 1996; Wheeler et al. 2005; Paradzick et al. 2006); indirect effects from fisheries management activities (Dawson and Kolar 2003; Carpenter and Terrell 2005; Holycross et al. 2006; Finlayson et al. 2010); road construction, use, and maintenance (Klauber 1956; Waters 1995; Shine et al. 2004; Ouren et al. 2007; Breininger et al. 2012); environmental contaminants (Hopkins et al. 1999; Rainwater et al. 2005; Campbell et al. 2005; Wylie et al. 2009); and mortality from entanglement hazards such as erosion control products (Stuart et al. 2001; Barton and Kinkead 2005; Kapfer and Paloski 2011; Barragan-Ramirez and Ascencio-Arrayga 2013).

Critical Habitat

Revised critical habitat for the northern Mexican gartersnake was designated in nine units in portions of Arizona and New Mexico totaling 20,326 acres. Within these areas, the physical and biological features essential to northern Mexican gartersnake conservation are:

1) Perennial or spatially intermittent streams that provide both aquatic and terrestrial habitat that allows for immigration, emigration, and maintenance of population connectivity of northern Mexican gartersnakes and contain:
    i. Slow-moving water (walking speed) with in-stream pools, off-channel pools, and backwater habitat;
    ii. Organic and natural inorganic structural features (e.g., boulders, dense aquatic and wetland vegetation, leaf litter, logs, and debris jams) within the stream channel for thermoregulation, shelter, foraging opportunities, and protection from predators;
    iii. Terrestrial habitat adjacent to the stream channel that includes riparian vegetation, small mammal burrows, boulder fields, rock crevices, and downed woody debris for thermoregulation, shelter, foraging opportunities, brumation, and protection from predators; and
    iv. Water quality that meets or exceeds applicable State surface water quality standards.
2) Hydrologic processes that maintain aquatic and terrestrial habitat through:
    i. A natural flow regime that allows for periodic flooding, or if flows are modified or regulated, a flow regime that allows for the movement of water, sediment, nutrients, and debris through the stream network; and

ii. Physical hydrologic and geomorphic connection between a stream channel and its adjacent riparian areas.

3) A combination of amphibians, fishes, small mammals, lizards, and invertebrate prey species such that prey availability occurs across seasons and years.

4) An absence of nonnative fish species of the families Centrarchidae and Ictaluridae, American bullfrogs (*Lithobates catesbeianus*), and/or crayfish (*Orconectes virilis, Procambarus clarki,* etc.), or occurrence of these nonnative species at low enough levels such that recruitment of northern Mexican gartersnakes is not inhibited and maintenance of viable prey populations is still occurring.

5) Elevations from 130 to 8,497 feet (40 to 2,590 meters).

6) Lentic wetlands including off-channel springs, cienegas, and natural and constructed ponds (small earthen impoundment) with:

   i. Organic and natural inorganic structural features (e.g., boulders, dense aquatic and wetland vegetation, leaf litter, logs, and debris jams) within the ordinary high water mark for thermoregulation, shelter, foraging opportunities, brumation, and protection from predators;

   ii. Riparian habitat adjacent to ordinary high water mark that includes riparian vegetation, small mammal burrows, boulder fields, rock crevices, and downed woody debris for thermoregulation, shelter, foraging opportunities, and protection from predators; and

   iii. Water quality that meets or exceeds applicable State surface water quality standards.

Ephemeral channels that connect perennial or spatially intermittent perennial streams to lentic wetlands in southern Arizona where water resources are limited.

Previous Related Consultations

We maintain a complete list of all formal consultations affecting proposed and listed species. To find recent and accessible formal consultations that pertain to species considered in this consultation, please use the Biological Reporting feature of ECOSphere found here.

ENVIRONMENTAL BASELINE

Under 50 CFR § 402.02, the environmental baseline is "the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal projects in the action that have already undergone formal or early section 7 consultation; and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed

species or designated critical habitat from agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline."

Other than mostly ephemeral stream channels, the San Bernardino Ciénega was once the most extensive wetland in the region (associated with the highstand of the Holocene pluvial Lake Cochise) (Minckley and Brunelle 2007), beginning on what is now the San Bernardino NWR in the United States and extending into Sonora for > 2.5 miles (1.6 km) along Rio San Bernardino (Black Draw). Historical accounts of the wetted environment are found in Emory's description of the San Bernardino Valley such that he commented on the perpetual springs, abundance of water, and ciénega-like vegetation (Emory 1857); this description was echoed by both Frobel (1859) and Box (1869) in their narratives. More recent recollections place the cienega on the San Bernardino NWR still in existence at the beginning of the twentieth century (Francaviglia 1983).

The San Bernardino Valley Basin consists of a deep main groundwater aquifer and another shallower, perched, but connected aquifer. Water chemistry between the two aquifers differs as recharge for each is derived from different sources, specifically the deep aquifer recharge comes from snow melt and precipitation in the Chiricahua Mountains and the shallow aquifer is recharged through both precipitation in the valley and leakage from the deep aquifer (Earman et al. 2003). Annual mean recharge rates for the San Bernardino basin range from 6,030 to 14,280 ac-ft, with Arizona recharge on the order of 3,560-118,810 ac-ft (Davis 1997).

Within the San Bernardino aquifer on the Arizona side of the international border, 147 wells with pumps have been permitted by the Arizona Department of Water Resources (2023). Most wells in the area are deep aquifer wells measuring hundreds of feet deep and do not extract water from the perched shallow aquifer and thus do not directly reduce water availability for riparian vegetation. However, overutilization of the deep aquifer likely reduces leakage between the deep and shallow aquifers, which are likely important water sources for riparian vegetation during droughts and when precipitation recharge is lower than evapotranspiration. Further, south of the border in Sonora, approximately 748,795 hectares are irrigated for crops of which 417,509 hectares used groundwater (reported in 2007) (United Nations 2021). The total amount of groundwater used or the status of wells that support agricultural irrigation in Sonora is unknown. Ground water is integral to riparian health and appropriate hydrologic functioning, where past and continued extraction of groundwater from the San Bernardino aquifer could pose considerable effects to riparian vegetation within the area.

Past land-use practices such as livestock grazing, water diversion, and aquifer pumping drained the San Bernardino Cienega and incised the San Bernardino floodplain. Currently, however, even its degraded state, the San Bernardino NWR provides a mosaic of wet and dry habitats that allow for a diverse assemblage of vertebrates to live in a relatively small area. Many of the rare species that are present are listed as endangered or threatened both by Mexico and the United States. Wetland restoration (to restore the riparian and grassland habitats) in the San Bernardino Valley is a major objective on both sides of the international border. (Cuenca Los Ojos 2024 accessed 4/15/2024)

The San Bernardino NWR management objectives outlined in the 1995 draft Comprehensive Management Plan (CMP) address ten issues: 1) ecosystem sustainability; 2) biological diversity; 3) endangered species management; 4) water rights, water management, and wetlands protection;

5) compatibility and public use; 6) environmental education and public outreach; 7) cultural resources preservation and management; 8) interagency coordination; 9) land protection; and 10) staffing, funding, and coordination (USFWS 1995). Projects conducted on the San Bernardino NWR generally fall within these identified focus areas.

In Arizona, the San Bernardino NWR is completely surrounded by private and state trust lands that are within the Malpai Borderlands Area. The Malpai Borderlands Group currently operates ranching activities under a Habitat Conservation Plan (HCP) that minimizes effects to riparian species which includes the yellow-billed cuckoo and northern Mexican gartersnake (Malpai Borderlands Habitat Conservation Plan Technical Working Group and Lehman 2008; USFWS 2008).

Status of the Species and Critical Habitat within the Action Area

Yellow-Billed Cuckoo

In the Southwest, yellow-billed cuckoos are known to inhabit drier (intermittent or ephemeral) watersheds supporting Velvet Mesquite (*Prosopis velutina*), Arizona Ash (*Fraxinus velutina*), Net-leaf Hackberry (*Celtis reticulata*), and various oak species (*Quercus* spp.) in small narrow bands or clumps where obligate phreatophyte vegetation is significantly less abundant (Beauregard 2023). In many cases, small stands of cottonwood and willow are surrounded by the more xeric tree species mentioned above. The plasticity in habitat selection by cuckoos within the Southwest is described in the final critical habitat rule and defined as "Rangewide Habitat" to describe cottonwood/willow forests and "Southwestern Habitat" for drier xeric species dominated bosques (USFWS 2021b).

Yellow-billed cuckoo occurrences were classified as common on the San Bernardino Ranch before the establishment of the San Bernardino NWR (Lanning 1981). Since then, survey reporting in refuge annual narratives from 2013-2023 indicate potential breeding territories (as interpreted by guidance in the 2015 survey protocol by Halterman et al. (2015)) were detected every year since 2013. At a minimum, two yellow-billed cuckoo detections within 500 m and separated by at least 10 days between detections is considered a possible breeding territory (Halterman et al. 2015). Increased detections coupled with observed breeding behavior increase the likelihood from possible to probable breeding territory (Halterman et al. 2015). Beauregard (2023) demonstrated that the Halterman et al. (2015) survey protocol was strongly predictive of breeding locations (97% accurate). With the exception of the 2016-2018 refuge annual narratives where no maps were created, some proportion of the documented potential territories occur within the project and action areas, see Table 2.

The San Bernardino NWR intersects critical habitat Unit 21 (AZ-19 Black Draw) which is comprised of 1,595 ac (646 ha) where nearly 896 ac (362 ha) is in Federal ownership; 134 ac (54 ha) is in State ownership; and 570 ac (231 ha) is in other ownership. When designated in 2021, the unit was identified as providing the habitat component provided in physical or biological feature 1 (PBF 1) and the prey component in physical or biological feature 2 (PBF 2). Further, the final rule also indicated that within this unit, hydrologic processes, in natural or altered systems that provide for maintaining and regenerating breeding habitat as identified in physical

or biological feature 3 (PBF 3), occur but depend on river flows and flood timing. This unit is considered to have been occupied at the time of listing and is used by the western yellow-billed cuckoo during the breeding season (Corman and Magill 2000b; USFWS 2014a, USFWS 2015, USFWS 2016, USFWS 2017, USFWS 2018, USFWS 2019b, USFWS 2020a). The unit also provides a movement corridor and migratory stop-over habitat for western yellow-billed cuckoos. Occupied habitat is primarily cottonwood, Goodding's willow, and some mesquite. This unit is part of the core area as identified in the conservation strategy for designating critical habitat for the western yellow-billed cuckoo.

At least one documented occurrence of yellow-billed cuckoo nesting in mesquite exists in a vertebrate inventory of the San Bernardino Ranch prepared for the USFWS before acquisition of the property (Lanning 1981). The record is unclear where the nest was located (i.e., Black Draw, Hay Hollow, or elsewhere).

Table 2 *Number of reported territories for each breeding season survey between 2013-2023. Locations for yellow-billed cuckoo territories were reported in the proposed project area every year except for 2016-2018 when no maps were provided in the reporting.*

Survey Year	Breeding Territories Reported	In Project Area	Citation
2023	4	Y	(USFWS 2024 pp.47–48)
2022	1-4	Y	(USFWS 2023 pp.47–48)
2021	2	Y	(USFWS 2022 pp.27–28)
2020	1	Y	(USFWS 2021a pp.40–41)
2019	3	Y	(USFWS 2020a pp.40–41)
2018	1	---	(USFWS 2019b p.26)
2017	8	---	(USFWS 2018 p.20)
2016	7	---	(USFWS 2017 pp.41–42)
2015	5	Y	(USFWS 2016 pp.49–52)
2014	5	Y	(USFWS 2015 pp.43–44)
2013	5	Y	(USFWS 2014a pp.57–58)

Northern Mexican Gartersnake

Numerous historical records for the northern Mexican gartersnake on San Bernardino NWR suggest the refuge may have had a robust population (Rosen and Schwalbe 1988a; Rosen et al. 2001; Holycross et al. 2006). Major sampling events occurred on the SBNWR occurred from 1985-1989 and 1992-1999, with the last known record occurring in 2005 (USFWS 2012a). USFWS (2012a), an annual report compiled by the SBNWR, lists the northern Mexican gartersnake as a resident of the refuge. Approximately nine days (person-search hours not reported) were spent surveying the SBNWR in 1985 and 1986 (Rosen and Schwalbe 1988a) resulting the capture of 10 large adults. Gartersnakes in general were studied at the SBNWR from 1985–1986 and 1992–1999 in a survey effort that totaled 58,560 trap-hours, resulting in the detection of 148 northern Mexican gartersnakes, collectively between all years (Rosen et al. 2001). Although vast amounts of physically suitable northern Mexican gartersnake habitat exists within the SBNWR, bullfrog populations have remained dense from the 1980s through current times (Rosen and Schwalbe 1988b, 1995, 1996, 1997, 2002a, 2002b; Rosen et al. 1995; USFWS 2012a). However, the Rio Yaqui fishes that persist on the refuge and are likely important prey

for northern Mexican gartersnakes. There is also the possibility that northern Mexican gartersnakes may immigrate from Mexico, immediately adjacent to the SBNWR. Thus, it is reasonable that the northern Mexican gartersnake could be present in the project area.

No critical habitat for the northern Mexican gartersnake occurs within the action area.

Factors Affecting the Species and Critical Habitat Within the Action Area

The action area consists of National Wildlife Refuge System (NWRS) lands situated on the border between the United States and Mexico. Key factors that affect the yellow-billed cuckoo refuge-wide include actions by San Bernardino NWR to implement its draft CMP. Actions associated with implementing the draft CMP include vegetation management (mechanical, chemical, and fire), plant and wildlife monitoring, and refuge maintenance, which may affect the yellow-billed cuckoo and its designated critical habitat.

In 1995, the draft CMP states that mesquite bosque habitat comprised 508 ac of refuge lands and that management of this habitat type should be to enhance its biological value (USFWS 1995). Strategic clearing and thinning of the mesquite bosque are identified as management strategies, although the draft CMP emphasized that no mesquite clearing should occur along the arroyo (Black Draw) margins (USFWS 1995). However, the lack of recruitment in the cottonwood/willow forest gallery suggests that efforts to restore this vegetation community are needed before the habitat type is lost.

Yellow-Billed Cuckoo

Much of the nearly 900 acres of designated yellow-billed cuckoo habitat occurring on the San Bernardino NWR is unique from the critical habitat found off refuge because management actions supply perennial water into the two prominent riparian areas on the refuge, Black Draw and Hay Hollow, when other areas are dry outside of the monsoon season. This perennial water has supported the cottonwood/willow forest gallery that would likely not exist given current hydrology, as the riparian vegetation found along drier reaches off-refuge support mesquite bosque and other more xeric communities.

Previous grubbing efforts on the San Bernardino NWR have occurred to the east and west at the northern edge of the action area as well as a small portion near where Black Draw crosses into Mexico, which encompass approximately 80 acres of yellow-billed cuckoo critical habitat. Currently, there is approximately 10 acres of the riparian cottonwood/willow forest gallery habitat type occurs along the length of Black Draw within the San Bernardino NWR, which alone would not support a single yellow-billed cuckoo territory given that estimates of territory size across sexes and mating status in in cottonwood, willow, and mesquite habitat averaged 95.3 ac (38.6 ha) on the San Pedro River (Halterman 2009). Territories in more xeric environments are thought to be larger than territories exclusively in cottonwood/willow habitat types.

Northern Mexican Gartersnake

Previous grubbing efforts on the San Bernardino NWR have occurred to the east and west at the northern edge of the action area as well as a small portion near where Black Draw crosses into

Mexico, which encompasses approximately 80 acres. On these 80 acres, grubbed mesquite have been staged in piles for future burning. These piles could provide increased opportunity for northern Mexican gartersnakes occupancy in the action area. Like with other herpetofaunal species, northern Mexican gartersnakes and their prey species will utilize debris or brush piles. The increased numbers of brush/debris piles surrounding the action area could increase usage of the area by northern Mexican gartersnakes.

American bullfrogs are documented in every aquatic habitat found on the San Bernardino NWR and surrounding locations. Eradication of this species within refuge waters is not possible due to the occupation status of waters in Sonora, Mexico. Until eradication efforts on lands surrounding the San Bernardino NWR are in effect, efforts to eradicate bullfrogs will continue to be unsuccessful.

EFFECTS OF THE ACTION

In accordance with 50 CFR § 402.02, effects of the action are "all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of all other activities that are caused by the proposed action but are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action."

Yellow-Billed Cuckoo

Effects to the Yellow-billed Cuckoo in the Action Area

Disturbance

Yellow-billed cuckoos are sensitive to noise disturbance (Goodwin and Shriver 2011) and can be affected by the noise from heavy equipment operation. Cuckoos vocalize at low frequencies that overlap with vehicular noise making them particularly sensitive. Mesquite grubbing activities within the action area are expected to produce noise within the range of 90 dBA at 50 ft., which will attenuate by 6 dBA (hard ground) for every doubling of distance (WDOT 2020). Local noise levels would reduce to 69 dBA (a threshold used for noise-sensitive species such as Mexican spotted owls (USFWS 2012b)) at 561 ft. from project activities. However, project activities will not occur during the cuckoo breeding season (May 25 – September 30) when individuals are present, unless vagrant individuals migrate earlier or later than usual. Thus, the project noise poses discountable direct effects to yellow-billed cuckoos.

Habitat Quality and Availability

While cuckoos have been documented using varying types of habitats, suitable riparian habitat requires vertical structural heterogeneity created by mixed-aged riparian forest galleries (Wohner et al. 2021a, 2021b), and surveys on the Coronado National Forest show that increased mesquite cover was correlated to sites associated with cuckoo pairs compared to sites not used by cuckoos (MacFarland and Horst 2017).

Mesquite bosques provide abundant resource constancy in arid and semi-arid regions, specifically all species of mesquite in the Southwest bloom in the spring before the rainy season when food availability can be lowest (Golubov et al. 2001). Potential prey species that rely in some part on mesquite bosque habitat are likely important components of the food web for foraging yellow-billed cuckoos. Further, yellow-billed cuckoos use of mesquite and other xeroriparian vegetation for nesting across southern Arizona (Beauregard 2023) as well on the San Bernardino NWR (Lanning 1981).

Given that mesquite bosque habitat is known foraging and breeding habitat, the proposed activity is likely to reduce both habitat quality (in prey availability) and quantity (for foraging and nesting) such that site occupancy within the project footprint will likely be reduced. This reduction in habitat quantity could reduce the number of breeding pairs that generally occupy Black Draw, for an extended period of time. Refuge survey efforts show that Black Draw supports cuckoos throughout the breeding season with identified potential territories varying across years. (USFWS 2014a, USFWS 2015, USFWS 2016, USFWS 2017, USFWS 2018, USFWS 2019b, USFWS 2020a, USFWS 2021a, USFWS 2022, USFWS 2023, USFWS 2024).

The reproductive output of this critical habitat unit is not known, so the contribution to the overall population is not understood. However, the project occurs in the upper portion of the Rio Yaqui watershed, which has a predicted mean occupancy probability in northern Mexico of approximately 0.4 to 0.7 (Macías-Duarte et al. 2015, 2023), suggesting that the area supports high numbers of cuckoos. Further evidence from Sonora suggests that both arroyo and riparian habitats support similar cuckoo densities (Macías-Duarte et al. 2023).

Effects to Yellow-billed Cuckoo Critical Habitat in the Action Area

Breeding Habitat (PBF 1)

Breeding habitat for the yellow-billed cuckoo in southeast Arizona encompasses both obligate phreatophyte riparian forests dominated by cottonwood and willow species as well as xeroriparian habitat; and yellow-billed cuckoos have been documented using mesquite bosque type habitat (nesting and foraging) for nearly 30 years (Groschupf 1987). Further, yellow-billed cuckoos in southern Arizona appear to show a preference for areas where these two forest components are present (likely due to limiting availability of cottonwood and willows), although patch sizes must be large and continuous (USGS 2009; USFWS 2020b). In the southwest, riparian vegetation is often more narrow given water limitation and often these riparian areas exhibit reduced regeneration, growth, and survival (USFWS 2020b). Project activities will remove approximately 100 acres of mesquite bosque forest, which is likely to alter a key feature of the area that create highly suitable breeding habitat as evidenced by the long occupation history of the site. While project activities will remove mesquite within the project footprint, passive restoration processes driven by rainy season conditions may initiate changes in channel morphology that can support cottonwood/willow forest restoration, although timing of restoration by these processes is unclear for monsoon dependent arid environments, particularly in the context of expected climate change.

Project effects to PBF 1, breeding habitat, are expected to be significant and potentially long-term as passive riparian restoration proceeds. However, project design will stagger mesquite

removal across three years to reduce effects to breeding, yellow-billed cuckoos. Although cottonwoods and willows are considered rapid recolonizers, restoration is only successful when the required hydrologic condyiond snf processes (such as normal flooding and appropriate depth to water) that support these species are present (Stromberg 1993b). Projects in other areas of the United States document channel connectivity to the floodplain (reversal of the incision process) restored passively within 11 years (Christensen et al. 2024). However, the full timeframe from mesquite removal to altered channel morphology, then connectivity between channel and floodplain, and finally restoration of obligate phreatophyte riparian forests to levels suitable for yellow-billed cuckoo foraging and breeding habitat is unclear, but unlikely to occur in the near future (less than 10-15 years).

Individual yellow-billed cuckoos are not known to show site fidelity and habitat use is highly variable both seasonally and annually (McNeil et al. 2013; Villarreal et al. 2014) such that they can utilize multiple habitat types in an area. However, suitable habitat is generally occupied in some capacity every year (see surveys on San Bernardino NWR). Outside the project footprint, but still within the critical habitat unit, mesquite bosque remnants still exist as well as another riparian corridor (Hay Hollow), that is often utilized by yellow-billed cuckoos (see San Bernardino NWR annual narrative reports). Whether nearby habitat is fully occupied with yellow-billed cuckoo territories every year is unknown, as is how territories could be restructured after the removal of 100 ac of suitable habitat. Cuckoos are known to travel up to 2.08 miles within a day (3.46 mi within a season) (Sechrist et al. 2013; Dillon and Moore 2020) and other breeding habitat opportunities may occur in the surrounding area (if not fully occupied). Mean occupancy in the upper Rio Yaqui watershed (0.4–.05) as predicted by (2023) suggests some habitats may not be fully saturated.

Adequate Prey Base (PBF 2)

Yellow-billed cuckoos take advantage of a diverse prey base that includes large invertebrates and small herpetofauna. Invertebrates are an integral link in riparian ecosystems as they bridge the aquatic and terrestrial food webs (Ramey and Richardson 2017). Ramey and Richardson (2017) describe five characteristics of riparian areas that enhance invertebrate diversity: 1) hydrologic disturbance (flooding and drought), 2) increased productivity, 3) increased microhabitat diversity, 4) increased microclimate heterogeneity, and 5) novel resources. Appropriate riparian functioning such as hydrologic processes and vegetation structure are critical for maintaining these characteristics.

Project activities will remove 100 acres of known foraging habitat that may be replaced, in the long-term, with structurally diverse, riparian forest habitat from nature-based passive restoration. Once the bank-stabilizing mesquite bosque is removed, channel restoration created by natural flooding events has the potential to change channel morphology such that successful regeneration (natural and induced) of the riparian vegetation is likely. Invertebrates and other riparian prey species are highly tied to riparian structure and show higher abundance in cottonwood/willow stands than mesquite bosque although, both native riparian vegetation types were preferred over non-native, (Bateman and Riddle 2020). Further Stromberg et al. (2012) document that riparian forest vegetation not only supports higher abundance of individuals and species but also unique community assemblages. Given this, long-term invertebrate abundance

available to yellow-billed cuckoos might be higher than present abundance if conditions promote growth of riparian vegetation.

Project effects to PBF 2 are likely to initially reduce prey abundance for yellow-billed cuckoos. This reduction in prey will occur over three years; however, new species of invertebrates and other prey items are likely to utilize the areas grubbed of mesquite by making use of woody debris piles. Although different groups of cuckoo prey base are likely to respond differently to disturbances, Perry and Herms (2019) indicate that ground-dwelling invertebrate biomass after logging was similar to pre-disturbance, suggesting larger numbers of smaller sized individuals occupied the area, and Russel et al. (2002) show that herpetofauna richness and abundance was not affected (approximately 1 year later) by logging in areas adjacent to riparian areas when woody debris was present. Changes in landcover for the 100-acre project footprint are unlikely to significantly reduce prey availability for cuckoos. In addition, San Bernardino NWR currently has approximately 20 ponds and another riparian area, Hay Hollow, that provide habitat for many of the prey species utilized by yellow-billed cuckoos. Further, habitat in Mexico remains unaltered and is easily accessed by any cuckoos occupying Black Draw.

Hydrological Processes (PBF 3)

Ephemeral and intermittent streams in arid environments perform similar functions as perennial streams, but the processes that support riparian functions (hydrology and sediment transport) are more variable (spatially and temporally) (Levick et al. 2008). While erosion is a natural part of riparian processes, local factors such as vegetation types can alter the erosion process in ways that degrade riparian hydrologic processes (Rutherford 2007). Given the incised nature of Black Draw's channel, removal of the mesquite stabilizing that channel may restore appropriate channel characteristics that will support more appropriate hydrological regimes, such as lower velocity high flows and overbank flooding that upholds the alluvial floodplain that bolsters and prolongs base flow after flood events (Zeedyk and Clothier 2014). Ephemeral channels, like Black Draw, are generally more erodible and exhibit less sinuosity than perennial reaches due to vegetation characteristics (Zeedyk and Clothier 2014). After the removal of mesquite along Black Draw, the subsequent sloughing of channel banks, and presumed reestablishment of connectivity to the floodplain, passive cottonwood and willow restoration is anticipated. The restoration of the riparian forest gallery is crucial to maintaining the appropriate channel conditions that support optimal hydrology. For example, willows, particularly younger individuals, are especially supple and during high velocity flows provide a buffer to erosionary forces that sturdier woody species cannot provide (Zeedyk and Clothier 2014).

Project effects to PBF 3 are unlikely to negatively alter the local hydrology, as it is already significantly altered. As described above, PBF 3 requires that critical habitat contain hydrologic processes that encourage sediment movement and deposits and promote riparian tree seedling germination and plant growth, maintenance, health, and vigor (e.g., lower-gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial streams). In addition, southwestern breeding habitat requires increased humidity in drainages utilized by yellow-billed cuckoos. Currently, water outflow from several ponds maintained on the refuge provides perennial water in several locations along the length of Black Draw. The restoration of the Black Draw channel, which is initiated by removing 100 acres of mesquite bosque, is intended to address and improve all aspects of PBF 3.

Benefits

Initially, project implementation is likely to significantly and negatively alter but not adversely modify components of yellow-billed cuckoo critical habitat, such as breeding habitat and adequate prey base. However, the riparian forest remaining after project completion and surrounding areas will provide these features for returning cuckoos to the area, although in lower quantity. Over time, as hydrological processes recover, this area will continue to support yellow-billed cuckoo critical habitat and breeding cuckoos. Riparian forest vertical structure is shown to play an active role in yellow-billed cuckoo habitat (Wohner et al. 2021b). The complexity of this structure is related to patterns of recruitment in these riparian forests as structural diversity is increased with increased numbers of age classes. If left unrestored, it is likely that over time, the cottonwood-willow forest gallery will likely disappear, as recruitment of riparian forests is tied to hydrology (Boland 2014). Given apparent low recruitment of the forest gallery at Black Draw, near-term restoration of the channel is needed to maintain this riparian corridor.

Northern Mexican Gartersnake

Effects to the Northern Mexican Gartersnake in the Action Area

Mortality and Injury from Crushing

Northern Mexican gartersnakes have not been detected on the San Bernardino NWR since 2005 and high bullfrog density suggests that their occurrence on the refuge may be rare. However, northern Mexican gartersnakes are known to travel up to a mile away from aquatic habitats and are not tightly bound to wetland areas. Thus, the species could occur in the project footprint since project activities will occur adjacent to the Black Draw channel. Given this, Northern Mexican gartersnake individuals could experience mortality or injury from crushing. The use of heavy equipment between October and March suggests that gartersnakes could be crushed either on the surface or as they overwinter underground near aquatic sites. However, grubbing will occur when northern Mexican gartersnakes are less active, reducing potential crushing of snakes that could be surface active.

When debris that has been scattered and left to cure prior to piling and burning, it may become a source of cover for resident gartersnakes. Northern Mexican gartersnakes may then be disturbed and forced to flee during the process of collecting and piling debris after it has cured. Occupation of temporary slash piles could negatively affect gartersnakes when these piles are removed by burning. To deter use of these piles by northern Mexican gartersnake, San Bernardino will stage slash piles away from aquatic resources, such as pools in Black Draw, to the extent possible.

Habitat Alteration

Northern Mexican gartersnakes could be indirectly affected by habitat alteration from activities associated with the proposed project. Specifically, the removal of the mesquite bosque adjacent to Black Draw could alter habitat structure utilized by northern Mexican gartersnakes. Terrestrial habitat structure used by the species encompasses small mammal burrows, boulder fields, rock crevices, and downed woody debris; characteristics that likely currently exist. These features could be altered by heavy equipment and the actual process of grubbing large mesquite trees

from the ground. However, the grubbing of mesquite inevitably alters surface characteristics that create new structure that is often quickly colonized by mammals, herpetofauna, and invertebrates. Thus, Northern Mexican gartersnakes may find suitable structure post grubbing.

As Northern Mexican gartersnakes are dependent upon an aquatic prey base, actions that cause decreases in aquatic species could potentially negatively affect the species. Such effects include reduction in aquatic habitat, decreases in aquatic invertebrate base, and increased sedimentation. However, project activities will not eliminate or greatly diminish aquatic prey species (such the Rio Yaqui fishes) as these species are well established in ponds that outflow into Black Draw. Thus, the populations in Black Draw are constantly augmented with new individuals. Further, ponds on San Bernardino are well within the traveling distance of northern Mexican gartersnakes suggesting that the species would not have to alter foraging behavior to find prey.

As grubbing activities will occur over three years, northern Mexican gartersnakes will have the opportunity to disperse from altered habitat during warmer seasons. In addition, grubbing will only occur along approximately 37% of the length of Black Draw, such that suitable habitat will remain available outside the project footprint.

Benefits

Initially, project implementation is likely to negatively affect northern Mexican gartersnakes, however project objectives are to restore natural hydrologic processes that will increase the value of the area to the species. Increased hydrologic functioning provides decreased channel incision, increased riparian vegetation recruitment, as well as prolonged flow and pooling, all of which increase potential habitat and prey abundance for northern Mexican gartersnakes. If left unrestored, it is likely that overtime, the cottonwood-willow forest gallery will likely disappear as recruitment of riparian forests is tied to hydrology (Boland 2014), and current recruitment rates are believed to be near zero. The long-term potential benefit of Black Draw to northern Mexican gartersnakes is limited due to the high density of bullfrogs.

Effects to the Northern Mexican Gartersnake in the Action Area

No critical habitat exists within the action area.

CUMULATIVE EFFECTS

Cumulative effects are those "effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area" considered in this Opinion (50 CFR § 402.02).

Directly to the south, San Bernardino NWR adjoins ranchlands in Sonora that support a variety of activities related to livestock grazing that could have some adverse effects on both the yellow-billed cuckoo and northern Mexican gartersnake in the action area. Livestock grazing within riparian areas has been shown to decrease diversity of some riparian bird communities (Tewksbury et al. 2002) by altering aspects of riparian habitat (Krueper 1996). These activities are expected to occur into the future such that reduced habitat suitability in Sonora, could increase competition for available suitable habitat within the action and project areas.

Arizona State Trust lands make up the majority of lands within the area surrounding the San Bernardino NWR within the U.S. and if these lands are sold at auction, development may occur on these lands. Since 2017, over 80,500 acres (ranging from 0.021 to 16,670 acres per transaction) of State Trust land was outright sold or development rights sold across the state (AZSLD 2023a). Permitted development on State Trust Lands include commercial and recreational land use, agriculture and grazing, as well as mineral and geothermal development (AZSLD 2023b). Significant alteration of land use could reduce the amount of suitable habitat available to both species outside of the project and action areas. This reduction of suitable habitat could increase the effects of the proposed action on individuals within the project and action areas as suitable habitat that would not occur elsewhere.

Additionally, cross-border activities along the U.S./Mexico border continue to increase and impacts to the action area may include increases in human traffic, deposition of trash, new trails from human traffic, soil compaction and erosion, fire risk from human traffic, water depletion and contamination, introduction and spread of disease, and interference of survey, monitoring and research. Since 2020, with the construction of the border wall and associated flood gates, human traffic within Black Draw has increased including trash and trail creation within and along Black Draw.

JEOPARDY AND ADVERSE MODIFICATION ANALYSIS

Section 7(a)(2) of the ESA requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

Jeopardy Analysis Framework

Our jeopardy analysis relies on the following:

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). The following analysis relies on four components:

(1) Status of the Species, which evaluates the range-wide condition of the listed species addressed, the factors responsible for that condition, and the species' survival and recovery needs;

(2) Environmental Baseline, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species;

(3) Effects of the Action (including those from conservation measures), which determines the direct and indirect effects of the proposed federal action and the effects of any interrelated or interdependent activities on the species; and,

(4) Cumulative Effects, which evaluates the effects of future, non-federal activities in the

action area on the species.

The jeopardy analysis in this biological opinion emphasizes the range-wide survival and recovery needs of the listed species and the role of the action area in providing for those needs. We evaluate the significance of the proposed Federal action within this context, taken together with cumulative effects, for making the jeopardy determination.

Destruction/Adverse Modification Analysis Framework

The final rule revising the regulatory definition of "destruction or adverse modification of critical habitat" became effective on March 14, 2016 (USFWS 2016). The revised definition states: "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features."

Similar to our jeopardy analysis, our adverse modification analysis of critical habitat relies on the following four components:

(1) the Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat in terms of PCEs, the factors responsible for that condition, and the intended recovery function of the critical habitat overall;

(2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area;

(3) the Effects of the Action, which determine the direct and indirect effects of the proposed federal action and the effects of any interrelated or interdependent activities on the PCEs and how they will influence the recovery role of affected critical habitat units; and,

(4) Cumulative Effects, which evaluates the effects of future, non-federal activities in the action area on the species.

CONCLUSION

Yellow-Billed Cuckoo

After reviewing the current status of the yellow-billed cuckoo and its critical habitat, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the yellow-billed cuckoo and is not likely to destroy or adversely modify designated critical habitat for the yellow-billed cuckoo.

We base this conclusion on the following:

1. Project activities will occur outside the time when yellow-billed cuckoos are likely to be present within the action area. Thus, we do not expect direct effects to yellow-billed

cuckoos because they will not abandon nests or fledglings as a result of disturbance from project activities.

2. Yellow-billed cuckoos are likely to be negatively affected by habitat modification and removal as a consequence of project implementation. The project will remove 100 acres of mesquite bosque known to be utilized by yellow-billed cuckoos during some part of the breeding season. The suitable habitat lost is expected to be temporary, but long term (greater than 10-15 years) as the riparian forest gallery of native willow and cottonwood is passively restored. Of the resources that are most likely to decrease in response to project implementation, nesting sites are the one attribute that will take the longest to recover. While the removal of the mesquite bosque is likely to shift the prey species available to yellow-billed cuckoos and may initially show decreases in abundance, this decrease will be short lived as new species colonized the area and utilize the piles created by grubbing mesquite. However, cuckoo nesting sites are generally characterized by some component of dense canopy cover near the nest and project activities will alter this. Given published rates of riparian restoration (Carothers et al. 1989; Taylor and McDaniel 1998), the decrease in nesting sites is not expected to last more than 5-10 years (after restoration of appropriate hydrological conditions) as multiple age classes of willow and cottonwood trees are added to the already large older trees located within and along Black Draw. Past mesquite removal projects on the refuge are not helpful in narrowing down passive restoration timelines, as these did not fully remove mesquite stabilizing the bank and they occurred in areas where cottonwoods and willows are not present. Further, the removal of mesquite will only occur on approximately 37% of the length of Black Draw on the San Bernardino NWR. Of the four permanent water sources (outflows) in Black Draw, the project footprint only encompasses one. As higher humidity is needed for breeding in more arid regions such as southeast Arizona, other areas along Black Draw, as well as Hay Hollow, exist for yellow-billed cuckoos in the interim (if suitable habitat is not fully occupied) as restoration progresses.

3. The 100 acres of designated critical habitat represents 5.6% of the entire AZ 19 Black Draw Unit but 10% of the critical habitat on refuge, and all three PBFs of yellow-billed cuckoo critical habitat will be affected by project activities. PBFs 1 and 2 will show initial decreases, however PBF 3 is limited within Black Draw on San Bernardino NWR. The alteration of PBF 1 may be appreciably diminished in the near-term, but this alteration is temporary and does not inhibit survival and recovery of the yellow-billed cuckoo at the species level. Project activities will not appreciably diminish the value of PBF 2 or 3 within the project area and will not impede recovery and survival of the yellow-billed cuckoo.

4. Long-term project objectives align with recovery of the yellow-billed cuckoo and will increase the value of critical habitat within San Bernardino NWR. In general, mesquite bosques, while supporting a high diversity of birds, do not support the diversity of the cottonwood-willow riparian forests (Ohmart et al. 1988; Rosenberg et al. 1991). In addition, compared to mesquite bosque sites, cottonwood-willow forest galleries offer more mesic microclimates that can support nearly 5.5 times the amount of arthropod biomass (Allen 2016) and higher abundances of lizards, especially arboreal species

foraged by cuckoos. With the long-term trend of continued channel incision and near zero cottonwood and willow recruitment, the prognosis of survival and recovery of the yellow-billed cuckoo on San Bernardino NWR is poor without restoration of channel or riparian forest gallery.

Northern Mexican Gartersnake

After reviewing the current status of the northern Mexican gartersnake, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the yellow-billed cuckoo and as no designated critical habitat occurs in the project or action areas, it will not be affected.

1. The lack of recent occurrence data from surveys in 2020 in addition to the high population density of American bullfrogs suggests that if northern Mexican gartersnakes do occur on San Bernardino NWR, they occur at very low densities. Thus, the probability is low that they will occur in the project footprint during project activities. In addition, they are seasonally less active when heavy equipment will be utilized (October – March).
2. Habitat alteration is unlikely to be significantly modified such that it becomes unusable by northern Mexican gartersnake. In rare circumstance that this does occur, other suitable habitat is available nearby. Prey species occur in multiple locations within traveling distance of the project footprint, such that reduced prey availability will not be a consequence for northern Mexican gartersnakes.

The conclusions of this biological opinion are based on full implementation of the project as described in the Description of the Proposed Action section of this document, including any conservation measures that were incorporated into the project design.

TIPPING POINT ANALYSIS

In *Wild Fish Conservancy v. Salazar*, 628 F.3d 513 (9th Cir.2010), the Ninth Circuit held that the FWS must identify when a species will likely pass the tipping point for recovery and determine whether the proposed action will cause the species to reach that tipping point. That case, and subsequent cases addressing "tipping point," involved challenges to biological opinions that analyzed the effects of project-specific Federal actions.

Yellow-billed Cuckoo

The tipping point at which the ability to recover the yellow-billed cuckoo (i.e., delist from its threatened status) is difficult to definitively determine in the absence of a recovery plan. The cuckoo, however, is a relatively widespread and somewhat plastic (in terms of habitat selection) species at both the range-wide scale (see Status of the Species, above) and in the action area (see Environmental Baseline above). As the action area encompasses the average yellow-billed cuckoo territory in xeroriparian habitat, the temporary reduction in nesting habitat from project activities is unlikely to reduce the species' potential for recovery by reaching the tipping point that precludes recovery.

Northern Mexican Gartersnake

The tipping point at which the ability to recover the northern Mexican gartersnake (i.e. delist from its threatened status) is difficult to definitively determine in the absence of a recovery plan. However, given that predatory nonnative aquatic species have been identified as the most serious threat to this gartersnake, recovery planning will focus on measures to mitigate this threat. This project has no bearing on predatory nonnative aquatic species and thus does not influence recovery potential. The gartersnake, while dependent upon aquatic resources is relatively flexible in its use of aquatic and terrestrial habitat. As the project area encompasses a small portion of Black Draw, as well as other available habitat, the temporary effects from project activities are unlikely to reduce the species' potential for recovery by reaching the tipping point that precludes recovery.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined (50 CFR § 17.3) as significant habitat modification or degradation that kills or injures listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" means intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR § 17.3).

"Incidental take" is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), the Act does not prohibit incidental take, provided that such take complies with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary and must be undertaken by the San Bernardino NWR as appropriate, for the exemption in section 7(o)(2) to apply. The San Bernardino NWR has a continuing duty to regulate the activity covered by this incidental take statement. If the San Bernardino NWR (1) fails to assume and implement the terms and conditions or (2) fails to require grantees/contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, then the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the San Bernardino NWR must report the progress of the action and its impact on the species as specified in the incidental take statement [50 CFR § 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Yellow-billed Cuckoo

The Service anticipates that the proposed action will result in take of yellow-billed cuckoos. The incidental take is expected to be in the form of harm through the temporary reduction in approximately 100 acres of nesting and/or foraging habitat in the action area from effects associated with mesquite grubbing along Black Draw.

50 CFR 402.14(i)(1)(i) states that an opinion may use surrogates to express the amount or extent of anticipated take, provided that the opinion or incidental take statement: (1) describes the causal link between the surrogate and take of the listed species, (2) explains why it is not practical to express the amount or extent of anticipated take or to monitor take-related impacts in terms of individuals of the listed species, and (3) sets a clear standard for determining when the level of anticipated take has been exceeded.

The Service anticipates incidental take of yellow-billed cuckoos will be difficult to detect for the following reason(s): (1) the uncertainties associated with counting individual cuckoos; (2) the complexities of positively identifying nesting; and (3) most importantly because of the determination in the 2014 Final Rule listing the taxon that territories are the most valid measure of yellow-billed cuckoo abundance (USFWS 2014c). However, the level of take of this species can be anticipated by loss of yellow-billed territories because the loss of a territory precludes reproductive output at that site whereas effects to individual yellow-billed cuckoos cannot be definitively linked to the presence of the species in a given area (for the reasons identified above).

Therefore, the following amounts of incidental take are authorized:

Incidental take of yellow-billed cuckoos in the action area for the proposed project is one territory (and its associated potential reproductive output) comprised of xeroriparian habitat that is subject to long-term (more than 10-15 years) harm via modification and removal. Project activities that are expected to result in take include the grubbing of the mesquite bosque habitat.

Take will be exceeded if more than 100 acres of suitable xeroriparian habitat is removed or if any obligate phreatophyte riparian forest habitat (dominated by cottonwood and willow species) is removed.

Northern Mexican Gartersnake

The Service anticipates that the proposed action will result in take of northern Mexican gartersnakes. The incidental take is expected to be in the form of harm, direct mortality, disturbance, or displacement from effects associated with mesquite grubbing along Black Draw.

50 CFR 402.14(i)(1)(i) states that an opinion may use surrogates to express the amount or extent of anticipated take, provided that the opinion or incidental take statement: (1) describes the causal link between the surrogate and take of the listed species, (2) explains why it is not practical to express the amount or extent of anticipated take or to monitor take-related impacts in terms of individuals of the listed species, and (3) sets a clear standard for determining when the level of anticipated take has been exceeded.

The Service anticipates incidental take of northern Mexican gartersakes will be difficult to detect for the following reason(s): (1) effects that result in dead or impaired individuals are unlikely to be detected because this species is relatively small, well camouflaged, fossorial, and may occur in water of varying clarity; (2) thought to occur in low densities in the action area; and (3) seasonal fluctuations in environmental conditions, population factors, and habitat conditions over time further mask detection. However, the following level of take of this species can be anticipated by loss of foraging habitat or prey base because not only are these effects measurable in terms of their effect to primary prey species of the gartersnake, but also because of the tight correlation between occupancy of northern Mexican gartersnakes and an available, functioning, and reliable prey base.

The following amounts of incidental take are authorized:

Incidental take of northern Mexican gartersnakes in the action area for the proposed project is a 50% reduction in aquatic habitat utilized by the Rio Yaqui fishes or a 50% reduction in the abundance of Rio Yaqui fishes in the project area. Project activities that are expected to result in take include less pond outflow into Black Draw due to the proposed action or decreases in Rio Yaqui fish abundance on annual surveys associated with project activities or passive restoration.

Take will be exceeded if aquatic habitat in the action area is reduced by more than 50% or abundance of Rio Yaqui fishes in the action area decreases by more than 50% due to project activities or passive restoration. Conservation measures for the Rio Yaqui Fishes (Yaqui topminnow, Yaqui chub, and Yaqui beautiful shiner), delineated in Appendix A, require SBNWR to annually monitor these species and their aquatic habitat.

EFFECT OF THE TAKE

In this biological opinion, we have determined that the level of anticipated take is not likely to result in jeopardy to the yellow-billed cuckoo or northern Mexican gartersnake. Although we anticipate some incidental take to occur, the implementation of the proposed conservation measures would ultimately result in avoidance and minimization of adverse effects.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

Reasonable and Prudent Measures

Reasonable and prudent measures refer to “those actions the Director considers necessary or appropriate to minimize the impacts of the incidental take on the species” (50 CFR § 402.02). Reasonable and prudent measures, along with the terms and conditions that implement them, cannot alter the basic design, location, scope, duration, or timing of the action, and may involve only minor changes. Reasonable and prudent measures may include measures implemented inside or outside of the action area that avoid, reduce, or offset the impact of incidental take (50 CFR § 402.14 (i)(2)).

Yellow-billed Cuckoo

The Service considers the following reasonable and prudent measure is necessary and appropriate to minimize the impacts of incidental take on the yellow-billed cuckoo:

1. The San Bernardino NWR shall pursue and work to secure funding for restoration activities to occur on San Bernardino NWR's reach of Black Draw.

Northern Mexican Gartersnake

The Service considers the following reasonable and prudent measure is necessary and appropriate to minimize the impacts of incidental take on the northern Mexican gartersnake:

1. The San Bernardino NWR will provide any information on incidental take.

Terms and Conditions

Terms and conditions are actions designed to implement the reasonable and prudent measures. To be exempt from the prohibitions of section 9 of the Act, the San Bernardino NWR must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline the reporting and monitoring requirements. These terms and conditions are non-discretionary.

Yellow-billed Cuckoo

The following Terms and Conditions implement Reasonable and Prudent Measure 1.

1. San Bernardino NWR will secure resources to fund active restoration activities that will explicitly promote the regeneration of the cottonwood/willow forest along the Refuge's reach of Black Draw.
2. San Bernardino NWR will consult with Arizona Ecological Services on active restoration projects and their effects to listed, proposed, and candidate species.
3. San Bernardino NWR will develop a long-term monitoring plan and associated success targets for active restoration projects(s) before project implementation to track restoration progress, effects to listed species, and incidental take.

Northern Mexican Gartersnake

1. San Bernardino NWR will report on the yearly status of aquatic habitat and prey species within the action area.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species, initial notification must be made to the Service's Law Enforcement Office within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a

photograph if possible, and any other pertinent information. The notification must be sent to the Law Enforcement Office with a copy to this office. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve the biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

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

Yellow-billed Cuckoo

(1) We recommend that San Bernardino NWR update and finalize the 1995 Comprehensive Management Plan that reflect the Refuge's current management objectives and goals for listed, proposed, and candidate species as well as their habitats.

(2) We recommend that San Bernardino NWR consult with Arizona Ecological Services on the effects of the Comprehensive Management Plan to listed, proposed, and candidate species as well as designated and proposed critical habitat.

(3) We recommend that San Bernardino NWR continue to conduct annual yellow-billed cuckoo surveys by persons trained and permitted by the USFWS to follow the Halterman et al. (2015) survey protocol.

Northern Mexican Gartersnake

(1) We recommend that San Bernardino continue to address nonnative species removal on the Refuge that will benefit recovery of northern Mexican gartersnakes.

(2) We recommend that San Bernardino adopt the Nowak (2013) protocol for regular surveys and monitoring of northern Mexican gartersnakes on the refuge.

For Ecological Services to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, Ecological Services requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the Mesquite Grubbing Along Black Draw (Rio San Bernardino) on the San Bernardino National Wildlife Refuge project. As provided in 50 CFR § 402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this

opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion or written concurrence; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Please refer to the consultation number, 2023-0046708-S7-001 in future correspondence concerning this project. If you require further assistance or have any questions, please contact Cassondra Walker (cassondra_walker@fws.gov) or Julie McIntyre (julie_mcintyre@fws.gov).

Approved:

HEATHER WHITLAW Digitally signed by HEATHER WHITLAW Date: 2024.05.15 08:26:08 -07'00'

May 15, 2024

Heather Whitlaw, Field Supervisor — Date

Arizona Ecological Services

Concur:

Division Chief, Division of Environmental Review — Date

Region 2

LITERATURE CITED

Allen D.C. 2016. Microclimate Modification by Riparian Vegetation Affects the Structure and Resource Limitation of Arthropod Communities. Ecosphere 7(2):e01200.

American Ornithologists' Union. 1998. The A.O.U. Checklist of North American Birds. 7th ed. American Ornithologists' Union, Washington, D.C.

Antevs E. 1952. Arroyo-Cutting and Filling. The Journal of Geology 60(4):375–385. The University of Chicago Press.

Arizona Department of Water Resources. 2023. Wells Data | Arizona Department of Water Resources. Available from https://www.azwater.gov/permitting-wells/wells-data (accessed October 2, 2023).

Arizona State Land Department. 2023a. Reports & Notices | Arizona State Land Department. Available from https://land.az.gov/reports-notices (accessed October 2, 2023).

Arizona State Land Department. 2023b. Applications & Permits | Arizona State Land Department. Available from https://land.az.gov/applications-permits (accessed October 2, 2023).

Atkins C. 2012, June 22. E-mail correspondence from Christina Akins (Arizona Game and Fish Department).

Bahre C.J. 1991. A Legacy of Change: Historic Human Impact on Vegetation in the Arizona Borderlands. University of Arizona Press, Tucson, Arizona, United States.

Barragan-Ramirez J.L., and Ascencio-Arrayga J.J. 2013. *Thamnophis eques* (Mexican gartersnake). Mortality. Herpetological Review 44(1):158.

Bartlett J.R. 1854. Personal Narrative of Explorations and Incidents in Texas, New Mexico, California, Sonora, and Chihuahua Connected with the United States and Mexican Boundary Commission, During the Years 1850, '51, '52, and '53. Volume 1. D. Appleton & Company, New York, United States and London, Britain.

Barton C., and Kinkead K. 2005. Do Erosion Control and Snakes Mesh? Journal of Soil and Water conservation 60(2):33A-35A.

Bateman H.L., and Riddle S.B. 2020. Reptile Community Responses to Native and Non-Native Riparian Forests and Disturbance Along Two Rivers in Arizona. River Research and Applications 36(3):492–502.

Beauregard N. 2023. Identification and Evaluation of Yellow-Billed Cuckoo Habitat Using Acoustic Monitoring and Species Distribution Model Methods. Doctoral Dissertation. Northern Arizona University, Flagstaff, Arizona, United States.

Boback S.M., Nafus M.G., Yackel Adams A.A., and Reed R.N. 2020. Use of Visual Surveys and Radiotelemetry Reveals Sources of Detection Bias for a Cryptic Snake at Low Densities. Ecosphere 11(1):1–19.

Boland J.M. 2014. Factors Determining the Establishment of Plant Zonation in A Southern Californian Riparian Woodland. Madroño 61(1):48–63.

Bonar S.A., Leslie L.L., and Velez C.E. 2004. Influence of Species, Size Class, Environment, and Season on Introduced Fish Predation on Native Fishes in the Verde River System, Arizona. Pages 1–108. Research Report Number: 04–01. Arizona Cooperative Fish and Wildlife Research Unit, Tucson, Arizona, United States.

Box J. 1869. Adventures and Explorations in New and Old Mexico. James Miller Publisher, New York, New York, United States.

Boyarski V., Ryan M., and Cotten T. 2019. Population Ecology of Northern Mexican Gartersnakes (*Thamnophis eques megalops*) at Bubbling Ponds Hatchery Complex. Pages 1–44. Technical Report Number: 317. Terrestrial Wildlife Branch, Wildlife Management Division, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Boyarski V., Young M., and Cotton T. 2015. Home Range and Habitat Use of Northern Mexican Gartersnakes (*Thamnophis eques megalops*) in a Highly Modified Habitat. Pages 1–27. Unpublished Technical Report Number: 291. Nongame Wildlife Branch, Wildlife Management Division, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Breininger D.R., Mazerolle M.J., Bolt M.R., Legare M.L., Drese J.H., and Hines J.E. 2012. Habitat Fragmentation Effects on Annual Survival of the Federally Protected Eastern Indigo Snake Protected Eastern Indigo Snake. Animal Conservation 15:361–368.

Brennan T.C. 2007. Collecting Narrow-Headed Gartersnakes (*Thamnophis rufipunctatus*) at the Black River, Arizona. Pages 1–12. Arizona Game and Fish Department, Phoenix, Arizona, United States.

Brennan T.C., and Rosen P.C. 2009. Report on Narrow-Headed Gartersnake (*Thamnophis rufipunctatus*) Surveys at Oak Creek and the Black River, Arizona. Pages 1–23. Arizona Game and Fish Department, Phoenix, Arizona, United States.

Briggs M.K. 1996. Riparian Ecosystem Recovery in Arid Lands: Strategies and References. University of Arizona Press, Tucson, Arizona, United States.

Brown D.E. 1982. Biotic Communities of the American Southwest- United States and Mexico. Desert Plants 4(1–4):1–342.

Cable D.R. 1975. Influence of Precipitation on Perennial Grass Production in the Semidesert Southwest. Ecology 56(4):981–986.

Campbell K.R., Campbell T.S., and Burger J. 2005. Heavy Metal Concentrations in Northern Water Snakes (*Nerodia sipedon*) from East Fork Poplar Creek and the Little River, East Tennessee, USA. Archives of Environmental Contamination and Toxicology 49(2):239–248.

Carey C., and Alexander M.A. 2003. Climate Change and Amphibian Declines: Is There a Link? Diversity and Distributions 9(2):111–121.

Carothers S.W., Mills G.S., and Johnson R.R. 1989. The Creation and Restoration of Riparian Habitat in Southwestern Arid and Semi-Arid Regions. Pages 359–371 *In* Kusler JA and Kentula ME, editors. Wetland Creation and Restoration: The Status of the Science. Corvallis Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Corvallis, Oregon, United States.

Carpenter J., and Terrell J.W. 2005. Effectiveness of Fish Barriers and Renovations for Maintaining and Enhancing Populations of Native Southwestern Fishes. Pages 1–111. Unpublished Final Report Number: 201814N756. U.S. Geologic Survey, Fort Collins, Colorado, United States.

Cavazos T., and Arriaga S. 2010. Documentation of Regional Climate Scenarios. Available from http://peac-bc.cicese.mx/escenariosdoc.htm (accessed December 18, 2012).

Cayan D. et al. 2013. Future Climate: Projected Average. Pages 101–125 *In* Garfin G, Jardine A, Merideth R, Black M, and LeRoy S, editors. Assessment of Climate Change in the Southwest United States: A Report By the Southwest Climate Alliance. Island Press, Washington, D.C., United States.

Christensen N., Prior E., Czuba J., and Hession C. 2024. Stream Restoration that Allows for Self-Adjustment Can Increase Channel-Floodplain Connectivity. Journal of Ecological Engineering Design:1–15.

Clarkson R.W., Marsh P.C., Stefferud S.E., and Stefferud J.A. 2005. Conflicts Between Native Fish and Nonnative Sport Fish Management in the Southwestern United States. Fisheries 30(9):20–27.

Clarkson R.W., and Rorabaugh J.C. 1989. Status of Leopard Frogs (*Rana pipiens* Complex: Ranidae) in Arizona and Southeastern California. The Southwestern Naturalist 34(4):531–538.

Cobbold S. 2018, June 12. Observation of a Northern Mexican Gartersnake in a Parking Lot in Punkin Center, Arizona.

Coe S.J., Finch D.M., and Friggens M.M. 2012. An Assessment of Climate Change and the Vulnerability of Wildlife in the Sky Islands of the Southwest. Pages 1–208. General Technical Report Number: RMRS-GTR-273. Rocky Mountain Forest and Range Experimental Station, U.S. Forest Service, Fort Collins, Colorado, United States.

Cogan R. 2015, April 7. E-mail Correspondence from Roger Cogan, Conservation Coordinator at Appleton-Whittell Research Ranch, National Audubon Society.

Corman T.E., and Magill R.T. 2000a. Western Yellow-billed Cuckoo in Arizona: 1998 and 1999 Survey Report. Pages 1–49. Technical Report Number: 150. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Corman T.E., and Magill R.T. 2000b. Western Yellow-billed Cuckoo in Arizona: 1998 and 1999 Survey Report. Page 55. Nongame and Endangered Wildlife Program Technical Report Number: 150. Arizona Game and Fish Department, Phoenix, AZ.

Corman T.E., and Wise-Gervais C., Editors. 2005. Arizona Breeding Bird Atlas. University of New Mexico Press, Albuquerque, New Mexico, United States.

Corson C. 2018. Yellow-billed Cuckoo Survey at Buenos Aires National Wildlife Refuge, Arizona, 2018. Pages 1–20. Draft Report. Buenos Aires National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Sasabe, Arizona, United States.

Cox C.L., Farrar E.S., Hey J.D., and Morrill M.C. 2009. Cover Object Usage Among an Assemblage of Iowa Snakes. Herpetological Conservation and Biology 40(1):80–84.

Cresswell K.A., Satterthwaite W.H., and Sword G.A. 2011. Understanding the Evolution of Migration Through Empirical Examples. Pages 7–16 *In* Milner-Gulland EJ, Fryxell JM, and Sinclair ARE, editors. Animal Migration: A Synthesis. Oxford University Press, Oxford, United Kingdom.

Cuenca Los Ojos. 2024. Cuenca Los Ojos Website. Available from https://www.cuencalosojos.org.

d'Orgeix C., Mathies T., Ellison B., Johnson K., Monagan I., and Young T. 2013. Northern Mexican Gartersnakes, *Thamnophis eques megalops*, Feeding on *Spea multiplicata* in an Ephemeral Pond. Herpetological Review 44(2):213–215.

Davis L.A. 1997. Ground-Water Flow and Interaction with Surface Water in San Bernardino Valley, Cochise County, Arizona, and Sonora, Mexico. Master's Thesis. University of Arizona, Tucson, Arizona, United States.

Dawson V.K., and Kolar C.S. 2003. Integrated Management Techniques to Control Nonnative Fishes. Pages 1–310. Final Report Number: 01-AA-32–0040. U.S. Geological Survey, La Crosse, Wisconsin, United States.

Degenhardt W.G., Painter C.W., and Price A.H. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico, United States.

Dettling M.D., and Howell C.A. 2011. Status of the Yellow-billed Cuckoo along the Sacramento River in 2010. Pages 1–47. PRBO Contribution Number: 1794. PRBO Conservation Science, Petaluma, California, United States.

Dillon K.G., Ahlers D., and Moore D. 2018. Yellow-billed Cuckoo Study Results – 2017 Middle Rio Grande from Los Lunas to Elephant Butte Reservoir, New Mexico. Pages 1–66. Reclamation-Managing Water in the West. Technical Service Center, Bureau of Reclamation, Denver, Colorado, United States.

Dillon K.G., and Moore D. 2020. Yellow-billed Cuckoo Breeding Habitat Use: Radio Telemetry on the Middle Rio Grande, New Mexico 2019. Pages 1–46. Final Report Number: ENV-2020-016. Technical Service Center, Bureau of Reclamation, Denver, Colorado, United States.

Dockens P.E.T., and Ashbeck T.C. 2011a. Southwestern Willow Flycatcher and Yellow-billed Cuckoo Surveys on the Horseshoe Reservoir Study Area, Arizona, 2011. Pages 1–20. Summary Report Number: 09–281004. EcoPlan Associates, Inc., Mesa, Arizona, United States.

Dockens P.E.T., and Ashbeck T.C. 2011b. Southwestern Willow Flycatcher and Yellow-billed Cuckoo Surveys at the SRP-Managed Properties Along the San Pedro River, Pinal County, Arizona. Pages 1–39. Summary Report Number: 09–281003. EcoPlan Associates, Inc., Mesa, Arizona, United States.

Douglas M.E., Marsh P.C., and Minckley W.L. 1994. Indigenous Fishes of Western North America and the Hypothesis of Competitive Displacement: *Meda fulgida* (Cyprinidae) as a Case Study. Copeia 1994(1):9–19.

Drummond H., and Macias-Garcia C. 1989. Limitations of a Generalist: A Field Comparison of Foraging Snakes. Behaviour 108(1/2):23–43. Brill.

Durso A.M., Willson J.D., and Winne C.T. 2011. Needles in Haystacks: Estimating Detection Probability and Occupancy of Rare and Cryptic Snakes. Biological Conservation 144(5):1508–1515.

Earman S., McPherson B.J., Phillips F.M., Ralser S., and Herrin J.M. 2003. An Investigation of the Properties of the San Bernardino Groundwater Basin, Arizona and Sonora, Mexico. Pages 1–283. Final Report. Hydrology Program, New Mexico Institute Mining and Technology, Socorro, New Mexico, United States.

Eaton J., and Scheller R. 1996. Effects of Climate Warming on Fish Thermal Habitat in Streams of the United States. Limnology and Oceanography 41(5):1109–1115.

Emmons I. 2016, February 1. E-mail Correspondence from Iain Emmons (Graduate Student at Northern Arizona University).

Emmons I., and Nowak E. 2013. Northern Mexican Gartersnake Surveys 2012: Interim Report. Pages 1–20. Interim Report. Colorado Plateau Research Station, Northern Arizona University, Flagstaff, Arizona, United States.

Emmons I., and Nowak E. 2016. Northern Mexican Gartersnake (*Thamnophis eques megalops*) Habitat Use and Ecology: Monitoring Surveys and Radiotelemetry in the Verde Valley, Arizona. Pages 1–73. Final Report Number: Grant # I12028. Heritage Fund, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Emmons I.D., Nowak E.M., and Lauger K.K. 2016. Prey Availability and Foraging Events of the Northern Mexican Gartersnake (*Thamnophis eques megalops*) in North-central Arizona. Herpetological Review 47(4):555–561.

Emory W.H. 1857. Report on the United States and Mexican Boundary Survey. Volume 1 Part 2. A.O.P Nicholson, Printer, Washington D. C., United States.

Erfani E., and Mitchell D. 2014. A Partial Mechanistic Understanding of the North American Monsoon. Journal of Geophysical Research 119:13096–13115.

Ernst C.H., and Zug G.R. 1996. Snakes In Question. Smithsonian Institution Press, Washington D.C., United States.

Fagan W.F., Aumann C., Kennedy C.M., and Unmack P.J. 2005. Rarity, Fragmentation, and the Scale Dependence of Extinction Risk in Desert Fishes. Ecology 86(1):34–41.

Fernandez P.J., and Rosen P.C. 1996. Effects of the Introduced Crayfish *Orconectes virilis* on Native Aquatic Herpetofauna in Arizona. Pages 1–82. Final Report Number: IIPAM Project No. I94054, Prepared for the Heritage Program, Arizona Game and Fish Department. Department of Biology, Grand Canyon University, Phoenix, Arizona, United States.

Finlayson B., Schnick R., Skaar D., Anderson J., Demong L., Duffield D., Horton W., and Steinkjer J. 2010. Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management—Rotenone SOP Manual. Pages 1–128. American Fisheries Society, Bethesda, Maryland, United States.

Fleharty E.D. 1967. Comparative Ecology of *Thamnophis elegans*, *T. cyrtopsis*, and *T. rufipunctatus* in New Mexico. The Southwestern Naturalist 12(3):207–229. Southwestern Association of Naturalists.

Fleishman E. et al. 2013. Natural Ecosystems. Pages 148–167 *In* Garfin G, Jardine A, Merideth R, Black M, and LeRoy S, editors. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. Island Press, Washington D. C., United States.

Francaviglia R.V. 1983. Tall Grass and Flowing Water: An Oral-Environmental History of Texas John Slaughter's San Bernardino Ranch. Pages 1–30. Final Report. Geo-Graphic Designs, Bisbee, Arizona, United States.

Frobel J. 1859. Seven Year's Travel in Central America, Northern Mexico, and the Far West of the United States. Richard Bentley, London, United Kingdom.

Gaines D. 1974. Distribution, Density and Habitat Requirements of the California Yellow-billed Cuckoo in the Sacramento Valley: 1972-73. Pages 1–21. Number: W-54-R6. University of California, Davis, California, United States.

Gaines D., and Laymon S.A. 1984. Decline, Status and Preservation of the Yellow-billed Cuckoo in California. Western Birds 15(2):49–80.

Gammage G.J., Hall J.S., Lang R.E., Melnick R., Welch N., and Crow M.M. 2008. Megapolitan: Arizona's Sun Corridor. Pages 1–52. Morrison Institute for Public Policy, School of Public Affairs, College of Public Programs, Arizona State University.

Golubov J., Mandujano M.C., and Eguiarte L.E. 2001. The Paradox of Mesquites (*Prosopis* spp.): Invading Species or Biodiversity Enhancers? Boletín de la Sociedad Botánica de México 69:23–30.

Goodwin S.E., and Shriver W.G. 2011. Effects of Traffic Noise on Occupancy Patterns of Forest Birds: Birds and Traffic Noise. Conservation Biology 25(2):406–411.

Griffin D.J. 2015a. Surveys for Yellow-billed Cuckoos at Buenos Aires National Wildlife Refuge, Pima County, Arizona. Pages 1–41. Final Report. Griffin Biological Services, Sahuarita, Arizona, United States.

Griffin D.J. 2015b. Surveys for Yellow-billed Cuckoos at Buenos Aires National Wildlife Refuge, Pima County, Arizona. Prepared for Buenos Aires National Wildlife Refuge, U.S. Fish and Wildlife Service. Griffin Biological Services, Sasabe, AZ.

Groschupf K. 1987. Status of the Yellow-billed Cuckoo (*Coccyzus americanus occidentallis*) in Arizona and West Texas. Number: 20181-86–00731. Tempe, Arizona, United States.

Halstead B., Wylie G., Coates P., and Casazza M. 2011. Bayesian Adaptive Survey Protocols for Resource Management. The Journal of Wildlife Management 75(2):450–457.

Halstead B.J., Skalos S.M., Casazza M.L., and Wylie G.D. 2015. Realized Detection and Capture Probabilities for Giant Gartersnakes (*Thamnophis gigas*) Using Modified Floating Aquatic Funnel Traps. Pages 1–44. Open-File Report Number: 2015–1200. U.S. Geological Survey, Reston, Virginia, United States.

Halstead B.J., Wylie G.D., and Casazza M.L. 2013. Efficacy of Trap Modifications for Increasing Capture Rates of Aquatic Snakes in Floating Aquatic Funnel Traps.

Halterman M.D. 2001. Population Status of the Yellow-billed Cuckoo at the Bill Williams River NWR and Alamo Dam, Arizona, and Southern Nevada: Summer 2000. Pages 1–46. Final Report. Southern Sierra Research Station, Weldon, California, United States.

Halterman M.D. 2002. Surveys and Life History Studies of the Yellow-billed Cuckoo: Summer 2001. Pages 1–37. Final Report. Southern Sierra Research Station, Weldon, California, United States.

Halterman M.D., Johnson M.J., Holmes J.A., and Laymon S.A. 2015. A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo. Pages 1–46. Draft Report. U.S. Fish and Wildlife Techniques and Methods, Sacramento, California, United States.

Halterman M.M. 2009. Sexual Dimorphism, Detection Probability, Home Range, and Parental Care in the Yellow-billed Cuckoo. PhD Dissertation. University of Nevada, Reno, Nevada, United States.

Hamilton W.J. III, and Hamilton M.E. 1965. Breeding Characteristics of Yellow-Billed Cuckoos in Arizona. Proceedings of the California Academy of Sciences 32(14):405–432.

Haney J., Robles M., Majka D., and Marshall R. 2009. Sustaining River Flows in the Face of Growing Water Demands in Arizona. Page 11. Unpublished Report. The Nature Conservancy Center for Science and Public Policy.

Hardison E.C., O'Driscoll M.A., DeLoatch J.P., Howard R.J., and Brinson M.M. 2009. Urban Land Use, Channel Incision, and Water Table Decline Along Coastal Plain Streams, North Carolina1. Journal of the American Water Resources Association 45(4):1032–1046.

Harrow R.L., Durran-Granillo A., and Ryan M.J. 2022. *Thamnophis eques* (Mexican Gartersnake). Foraging Behavior. Herpetological Review 53(4):702–703.

Harvey M.D., and Watson C.C. 1986. Fluvial Processes and Morphological Thresholds in Incised Channel Restoration1. Journal of the American Water Resources Association 22(3):359–368.

Hibbitts T.J., and Fitzgerald L.A. 2005. Morphological and Ecological Convergence in Two Natricine Snakes. Biological Journal of the Linnean Society 85(3):363–371.

Holycross A.T., Burger W.P., Nigro E.J., and Brennan T.C. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* along the Mogollon Rim and New Mexico. Pages 1–94. Arizona Game and Fish Department, Phoenix, Arizona, United States.

Hopkins W.A., Rowe C.L., and Congdon J.D. 1999. Elevated Trace Element Concentrations and Standard Metabolic Rate in Banded Water Snakes (*Nerodia fasciata*) Exposed to Coal Combustion Wastes. Environmental Toxicology and Chemistry 18(6):1258–1263.

Huey R.B. 1991. Physiological Consequences of Habitat Selection. The American Naturalist 137(Supplement):S91–S115.

Hughes J.M. 2015. Yellow-billed Cuckoo (*Coccyzus americanus*). Pages 1–99 *In* Rodewald PG, editor. The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York, United States.

Inman T.C., Marsh P.C., Bagley B.E., and Pacey C.A. 1998. Survey of Crayfishes of the Gila River Basin, Arizona and New Mexico, with Notes on Occurrences in Other Arizona Drainages and Adjoining States. U.S. Bureau of Reclamation, Phoenix, Arizona, United States.

Jarnevich C.S., Evangelista P., Stohlgren T.J., and Morisette J. 2011. Improving National-Scale Invasion Maps: Tamarisk in the Western United States. Western North American Naturalist 71(2):164–175.

Jones T.R. 2017, August 2. E-mail Correspondence from Thomas R. Jones, Amphibians and Reptiles Program Manager, Arizona Game and Fish Department.

Jones T.R., Ryan M.J., Cotten T.B., and Servoss J.M. 2020. (*Thamnophis eques*) Mexican Gartersnake. Pages 418–432 *In* Holycross AT and Mitchell JC, editors. Snakes of Arizona. ECO Publishing, Rodeo, New Mexico, United States.

Kagan R.A., Viner T.C., Trail P.W., and Espinoza E.O. 2014. Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis. Pages 1–28. Preliminary Report. National Fish and Wildlife Forensics Laboratory, Ashland, Oregon, United States.

Kapfer J., and Paloski R. 2011. On the Threat to Snakes of Mesh Deployed for Erosion Control and Wildlife Exclusion. Herpetological Conservation and Biology 6(1):1–9.

Kéry M. 2002. Inferring the Absence of a Species: A Case Study of Snakes. Journal of Wildlife Management 66(2):330–338.

Kingsley K.J. 1989. Biological and Social Repercussions of Irrigated Pecan Agriculture. Pages 131–152 *In* Schmidt JO, editor. Special Biotic Relationships in the Arid Southwest. University of New Mexico Press, Albuquerque, New Mexico, United States.

Klauber L.M. 1956. Rattlesnakes: Their Habitats, Life Histories, and Influence on Mankind. University of California Press, Berkeley, California, United States.

Krueper D.J. 1996. Effects of Livestock Management on Southwestern Riparian Ecosystems. Pages 281–301. Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colorado, United States.

Lanning D.V. 1981. The Vertebrates of San Bernardino Ranch Cochise County, Arizona. Final Report Number: 14-16- 0002-81–213, Prepared for The Nature Conservancy and the U.S. Fish and Wildlife Service. Arizona Natural Heritage Program, Tucson, Arizona, United States.

Laymon S.A. 1980. Feeding and Nesting Behavior of the Yellow-billed Cuckoo in the Sacramento Valley. Pages 1–29. Final Report Number: 80–2. State of California Department of Fish and Game, Sacramento, California, United States.

Laymon S.A. 1998. Yellow-billed Cuckoo (*Coccyzus americanus*). Pages 1–21 The Riparian Bird Conservation Plan: A Strategy for Reversing the Decline of Riparian-associated Birds in California. California Partners in Flight. Available from http://www.prbo.org/calpif/htmldocs/riparian_v-2.html.

Laymon S.A., and Halterman M.D. 1985. Yellow-billed Cuckoos in the Kern River Valley: 1985 Population, Habitat Use, and Management Recommendations. Pages 1–59. Kern River Preserve, The Nature Conservancy, Weldon, California, United States.

Laymon S.A., Williams P.L., and Halterman M.D. 1997. Breeding Status of the Yellow-billed Cuckoo on the South Fork Kern River Valley, Kern County, California: Summary Report 1985-1997. Pages 1–40. Final Report Number: 92-5–13. Kern River Research Center, Weldon, California, United States.

Levick L.R. et al. 2008. The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest. Pages 1–102. Research and Development Number: EPA/600/R-08/134, ARS/233046. Office of Research and Development, U.S. Environmental Protection Agency, Washington D.C., United States.

Ligon F.K., Dietrich W.E., and Trush W.J. 1995. Downstream Ecological Effects of Dams: A Geomorphic Perspective. BioScience 45(3):183–192.

Longcore T., Rich C., and Gauthreaux S.A.Jr. 2005. Scientific Basis to Establish Policy Regulating Communications Towers to Protect Migratory Birds: Response to Avatar Environmental, LLC., Report Regarding Migratory Bird Collisions with Communications Towers, WT Docket No. 03–187. Federal Communications Commission Notice of Inquiry. Page 34. Land Protection Partners, Los Angeles, California, United States.

MacFarland J., and Horst J. 2015. Yellow-billed Cuckoo Surveys on the Coronado National Forest within Eight Sky Island Mountain Ranges in Southeast Arizona. Pages 1–234. Final Report. Tucson Audubon Society, Tucson, Arizona, United States.

MacFarland J., and Horst J. 2016. Yellow-billed Cuckoo Surveys on the Coronado National Forest within Five Sky Island Mountain Ranges in Southeast Arizona in 2016. Pages 1–103. Final Report. Tucson Audubon Society, Tucson, Arizona, United States.

MacFarland J., and Horst J. 2017. Yellow-billed Cuckoo Surveys on the Coronado National Forest within Five Sky Island Mountain Ranges in Southeast Arizona in 2017. Pages 1–145. Final Report. Tucson Audubon Society, Tucson, Arizona, United States.

MacFarland J., and Horst J. 2019. Yellow-billed Cuckoo Surveys on the Coronado National Forest within Three Sky Island Mountain Ranges in Southeast Arizona in 2018. Pages 1–64. Final Report. Tucson Audubon Society, Tucson, Arizona, United States.

Macías-Duarte A., Alvarado-Castro J.A., Ortega Rosas C.I., Gutiérrez-Ruacho O.G., Villarruel-Sahagún L., and Sánchez-Murrieta E. 2015. Assess Status and Habitat Use of Yellow-Billed Cuckoo Populations in Sonora, Mexico. Pages 1–25. Technical Report Number: UES-PIE-15-UAH-LE-03. Sonora State University, Hermosillo, Sonora, Mexico.

Macías-Duarte A., Juárez E., Murrieta E.S., Perales-Hoeffer E.L., and Rosas C.I.O. 2023. Abundance and Occupancy of the Western Yellow-Billed Cuckoo (*Coccyzus americanus*) in Sonora, Mexico. Canadian Journal of Zoology 00:1–11.

Malpai Borderlands Habitat Conservation Plan Technical Working Group, and Lehman W. 2008. Malpai Borderlands Habitat Conservation Plan for Privately Owned and State Trust Rangelands in the Malpai Borderlands of Southern Arizona and New Mexico. Pages 1–248. Habitat Conservation Plan Number: AESO/SE 22410-2006-F-0408. Malpai Borderlands Group, Douglas, Arizona, United States.

Manjarrez J., Pacheco-Tinoco M., and Venegas-Barrera C.S. 2017. Intraspecific Variation in the Diet of the Mexican Garter Snake *Thamnophis eques*. PeerJ 5:e4036. PeerJ Inc.

McNeil S.E., Tracy D., and Capello C.D. 2015. Loop Migration by a Western Yellow-Billed Cuckoo Wintering in the Gran Chaco. Western Birds 46:24–215.

McNeil S.E., Tracy D., Stanek J.R., and Stanek J.E. 2013. Yellow-billed Cuckoo Distribution, Abundance, and Habitat Use on the Lower Colorado River and Tributaries 2008-2012 Summary Report. Pages 1–331. Southern Sierra Research Station, Weldon, California, United States.

Mearns E.A. 1907. Mammals of the Mexican Boundary of the United States. Government Printing Office, Washington D. C., United States.

Minckley T.A., and Brunelle A. 2007. Paleohydrology and Growth of a Desert Ciénega. Journal of Arid Environments 69(3):420–431.

Minckley W.L., and Clark T.O. 1984. Formation and Destruction of a Gila River Mesquite Bosque Community. Desert Plants 6(1):23–30.

Minckley W.L., and Marsh P.C. 2009. Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota. University of Arizona Press, Tucson, Arizona, United States.

Myrand J., Nowak E., Bergamini R., and Emmons I. 2017. 2016 Surveys and Telemetry of Northern Mexican Gartersnakes of Lower Tonto Creek: Report to the Salt River Project. Pages 1–36. Unpublished Report. USGS Colorado Plateau Research Station, Northern Arizona University, Flagstaff, Arizona, United States.

Neal E.G. 2009. Channel Incision and Water-Table Decline Along a Recently Formed Proglacial Stream, Mendenhall Valley, Southeastern Alaska. Pages 1–15. Professional Paper Number: 1790- E. U.S. Geological Survey, Reston, Virginia, United States. Available from https://pubs.usgs.gov/pp/1760/e/ (accessed November 27, 2023).

Nie W., Yuan Y., Kepner W., Erickson C., and Jackson M. 2012. Hydrological Impacts of Mesquite Encroachment in the Upper San Pedro Watershed. Journal of Arid Environments 82:147–155.

Nowak E.M. 2013. Protocol for Surveys and Monitoring - Narrow-headed Gartersnakes (*Thamnophis rufipunctatus*) Northern Mexican Gartersnakes (*T. eques megalops*). Prepared for Arizona Game and Fish Department. Colorado Plateau Research Station, Northern Arizona University, Flagstaff, Arizona, United States.

Nowak E.M., and Boyarski V.L. 2012. *Thamnophis eques megalops* (Northern Mexican Gartersnake). Reproduction: Litter size. Herpetological Review 43(2):351–352.

Nowak E.M., and Santana-Bendix M.A. 2002. Status, Distribution, and Management Recommendations for the Narrow-Headed Garter Snake (*Thamnophis rufipunctatus*) in Oak Creek, Arizona. Pages 1–57. Final Report. Arizona Game and Fish Department, Phoenix, Arizona, United States.

Ohmart R.D., Anderson B.W., and Hunter W.C. 1988. The Ecology of the Lower Colorado River from Davis Dam to the Mexico-United States International Boundary. Pages 1–296. Biological Report Number: 85 (7.19). Research and Development, U.S. Fish and Wildlife Service, Washington D.C., United States.

Olden J.D., and Poff N.L. 2005. Long-Term Trends of Native and Non-Native Fish Faunas in the American Southwest. Animal Biodiversity and Conservation 28(1):75–89.

Oldham C. 2016, January 1. Investigations in Cryptic Species: Considerations and Applications for Estimating Detection, Occupancy, and Abundance of Semi-Aquatic Snakes. Master's Thesis. University of Kentucky, Lexington, Kentucky, United States.

Ouren D.H., Haas C., Melcher C.P., Stewart S.C., Ponds P.D., Sexton N.R., Burris L., Fancher T., and Bowen Z.H. 2007. Environmental Effects of Off-Highway Vehicles on Bureau of Land Management Lands: A Literature Synthesis, Annotated Bibliographies, Extensive Bibliographies, and Internet Resources. Pages 1–225. Open-File Report Number: 2007–1353. U.S. Geological Survey, Reston, Virginia, United States.

Overpeck J. 2007, October 22. Climate Change in the Southwestern US: Mechanisms, Evidence and Projections. Albuquerque, New Mexico, United States.

Paradzick C., Valencia R., Beane R., Bills D., Servoss J., Werner B., and Weedman D. 2006. Fish and Watershed Committee Report in Support of the Issuance of an Incidental Take Permit Under Section 10(a)(1)(b) of the Endangered Species Act: Horseshoe and Bartlett Reservoirs, Verde River, Arizona. Pages 1–186.

Parametrix, Inc., and Southern Sierra Research Station. 2019. Yellow-billed Cuckoo Surveys on the Lower Colorado River and Tributaries, 2014 to 2018 Summary Report. Page 238. Summary Report Number: R14PD0004. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada, United Stats.

Perry K.I., and Herms D.A. 2019. Dynamic Responses of Ground-Dwelling Invertebrate Communities to Disturbance in Forest Ecosystems. Insects 10(61):1–19.

Phillips A., Marshall J., and Monson G. 1964. The Birds of Arizona. First Edition. University of Arizona Press, Tucson, Arizona, United States.

Pilger T.J., Gido K.B., and Propst D.L. 2010. Diet and Trophic Niche Overlap of Native and Nonnative Fishes in the Gila River, USA: Implications for Native Fish Conservation. Ecology of Freshwater Fish 19(2):300–321.

Pollen-Bankhead N., Simon A., Jaeger K., and Wohl E. 2009. Destabilization of Streambanks by Removal of Invasive Species in Canyon de Chelly National Monument, Arizona. Geomorphology 103(3):363–374.

Polley H.W., Johnson H.B., and Mayeux H.S. 1994. Increasing CO2: Comparative Responses of the C4 Grass Schizachyrium and Grassland Invader Prosopis. Ecology 75(4):976–988.

Pounds J.A. et al. 2006. Widespread Amphibian Extinctions from Epidemic Disease Driven by Global Warming. Nature 439(7073):161–167.

Propst D.L., Bestgen K.R., and Painter C.W. 1986. Distribution, Status, Biology, and Conservation of the Spikedace (*Meda fulgida*) in New Mexico. Pages 1–93. Endangered Species Report Number: 15. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

Propst D.L., Bestgen K.R., and Painter C.W. 1988. Distribution, Status, Biology, and Conservation of the Loach Minnow (*Tiaroga cobitis*) in New Mexico. Pages 1–75. Final Report Number: 17. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

Propst D.L., Gido K.B., and Stefferud J.A. 2008. Natural Flow Regimes, Nonnative Fishes, and Native Fish Persistence in Arid-Land River Systems. Ecological Applications 18(5):1236–1252. Wiley Online Library.

Pulido F., Coppack T., and Berthold P. 2001. Genetic Variation and Phenotypic Plasticity May Explain Adaptive Changes in the Timing of Autumn Migration. The Ring 23(1–2):149–158.

Rahel F.J., Bierwagen B., and Taniguchi Y. 2008. Managing Aquatic Species of Conservation Concern in the Face of Climate Change and Invasive Species. Conservation Biology 22(3):551–561.

Rahel F.J., and Olden J.D. 2008. Assessing the Effects of Climate Change on Aquatic Invasive Species. Conservation Biology 22(3):521–533.

Rainwater T.R., Reynolds K.D., Cañas J.E., Cobb G.P., Anderson T.A., McMurry S.T., and Smith P.N. 2005. Organochlorine Pesticides and Mercury in Cottonmouths (*Agkistrodon piscivorus*) from Northeastern Texas, USA. Environmental Toxicology and Chemistry 24(3):665–673.

Ralls K., Ballou J.D., Dudash M.R., Eldridge M.D.B., Fenster C.B., Lacy R.C., Sunnucks P., and Frankham R. 2018. Call for a Paradigm Shift in the Genetic Management of Fragmented Populations. Conservation Letters 11(2):1–6.

Ramey T.L., and Richardson J.S. 2017. Terrestrial Invertebrates in the Riparian Zone: Mechanisms Underlying Their Unique Diversity. BioScience 67(9):808–819.

Reaser J.K., and Blaustein A. 2005. Repercussions of Global Change. Pages 60–63 *In* Lannoo M, editor. Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley, California, United States.

Rinne J.N. 2004. Native and Introduced Fishes: Their Status, Threats and Conservation. Pages 193–213 *In* Baker MB, Ffolliott PF, DeBano LF, and Neary DG, editors. Riparian areas of the southwestern United States. Lewis Publishers, Boca Raton, Florida, United States.

Rinne J.N., Stefferud J.A., Clark D.A., and Sponholtz P.J. 1998. Fish Community Structure in the Verde River, Arizona, 1974-1997. Hydrology and Water Resources in Arizona and the Southwest 28:75–80.

Rosen P.C., and Schwalbe C.R. 1988a. Status of the Mexican and Narrow-Headed Garter Snakes (*Thamnophis eques megalops* and *Thamnophis rufipunctatus rufipunctatus*) in Arizona. Pages 1–50. Unpublished Report. Arizona Game and Fish Department, Phoenix, Arizona, United States.

Rosen P.C., and Schwalbe C.R. 1988b. Status of the Mexican and Narrow-Headed Garter Snakes (*Thamnophis eques megalops* and *Thamnophis rufipunctatus rufipunctatus*) in Arizona. Pages 1–50. Unpublished Report. Nongame Branch, Wildlife Management Division, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Rosen P.C., and Schwalbe C.R. 1995. Bullfrogs: Introduced Predators in Southwestern Wetlands. Pages 452–454. Final Report, Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. National Biological Service, U.S. Department of the Interior, Washington D.C., United States.

Rosen P.C., and Schwalbe C.R. 1996. A Critical Interim Evaluation of the Effectiveness of Bullfrog Removal Methods at San Bernardino National Wildlife Refuge. Pages 1–21. Final Draft Report. Heritage Fund IIAPM Program, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Rosen P.C., and Schwalbe C.R. 1997. Status of Native and Introduced Species of Aquatic Herpetofauna at San Bernadino National Wildlife Refuge. Pages 1–20. Final Report Number: I05045. University of Arizona, Tucson, Arizona, United States.

Rosen P.C., and Schwalbe C.R. 2002a. Widespread Effects of Introduced Species on Reptiles and Amphibians in the Sonoran Desert Region. Pages 220–240 *In* Tellman B, editor. Invasive Exotic Species in the Sonoran Region. University of Arizona Press, Tucson, Arizona, United States.

Rosen P.C., and Schwalbe C.R. 2002b. Conservation of Wetland Herpetofauna in Southeastern Arizona. Pages 1–160. Final Report Number: I99016. University of Arizona, Tucson, Arizona, United States.

Rosen P.C., Schwalbe C.R., Parizek D.A., Hom P.A., and Lowe C.H. 1995. Introduced Aquatic Vertebrates in the Chiricahua Region: Effects on Declining Native Ranid Frogs. Pages 251–261 *In* DeBano LF, Ffolliott PF, Ortega-Rubio A, Gottfried GJ, and Edminster CB, editors. Biodiversity and Management of Madrean Archipelago: The Sky Islands of the Southwestern United States and Northwest Mexico, RM-GTR-264. Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colorado, United States.

Rosen P.C., Wallace J.E., and Schwalbe C.R. 2001. Resurvey of the Mexican Gartersnake (*Thamnophis eques*) in Southeastern Arizona. Pages 1–64. Final Report. University of Arizona, Tucson, Arizona, United States.

Rosenberg K.V., Ohmart R.D., Hunter W.C., and Anderson B.W. 1991. Birds of the Lower Colorado River Valley. University of Arizona Press, Tucson, Arizona, United States.

Rossman D.A., Ford N.B., and Seigel R.A. 1996. The Garter Snakes. University of Oklahoma Press, Norman, Oklahoma, United States.

Russell K.R., Hanlin H.G., Wigley T.B., and Guynn D.C. 2002. Responses of Isolated Wetland Herpetofauna to Upland Forest Management. The Journal of Wildlife Management 66(3):603–617.

Rutherford I. 2007. The Influence of Riparian Management on Stream Erosion. Pages 85–116 *In* Lovett S and Price P, editors. Principles for Riparian Lands Management. Land & Water Australia, Canberra, Australia.

Ryan M.J. 2019. Communication Record with Private Landowner Re: Observation of Northern Mexican Gartersnakes Along the Verde River, Downstream of the Interstate 17 Crossing.

Sayre N.F. 1999. The Cattle Boom in Southern Arizona: Towards a Critical Political Ecology. Journal of the Southwest 41(2):239–271.

Sayre N.F. 2002. Ranching, Endangered Species, and Urbanization in the Southwest: Species of Capital. University of Arizona Press, Tucson, Arizona, United States.

Schumm S.A., and Parker R.S. 1973. Implications of Complex Response of Drainage Systems for Quaternary Alluvial Stratigraphy. Nature Physical Science 243(128):99–100.

Scott M.L., Lines G.C., and Auble G.T. 2000. Channel Incision and Patterns of Cottonwood Stress and Mortality Along the Mojave River, California. Journal of Arid Environments 44(4):399–414.

Scott R. 2000. The Water Use of Two Dominant Vegetation Communities in a Semiarid Riparian Ecosystem. Agricultural and Forest Meteorology 105(1–3):241–256.

Sechrist J., Ahlers D.D., Zehfuss K.P., Doster R.H., Paxton E.H., and Ryan V.M. 2013. Home Range and Use of Habitat of Western Yellow-billed Cuckoos On the Middle Rio Grande, New Mexico. The Southwestern Naturalist 58(4):411–419.

Sechrist J.D., Paxton E.H., Ahlers D.D., Doster R.H., and Ryan V.M. 2012. One Year of Migration Data for a Western Yellow-Billed Cuckoo. Western Birds 43(1):12.

Sferra S., Drost C., Theimer T.C., and Beauregard N. 2019. Investigating Western Yellow-billed Cuckoo Breeding Status in the Mountains of Southeastern Arizona; Implications for Recovery. Annual Report 2018. Pages 1–16. Annual Report. Northern Arizona University, Flagstaff, Arizona, United States.

Shine R., Lemaster M., Wall M., Langkilde T., and Mason R. 2004. Why Did the Snake Cross the Road? Effects of Roads on Movement and Location of Mates by Garter Snakes (*Thamnophis sirtalis parietalis*). Ecology and Society 9(1):9. The Resilience Alliance.

Simon A., and Rinaldi M. 2006. Disturbance, Stream Incision, and Channel Evolution: The Roles of Excess Transport Capacity and Boundary Materials in Controlling Channel Response. Geomorphology 79(3):361–383.

Sogge M.K., Sferra S.J., and Paxton E.H. 2008. Tamarix as Habitat for Birds: Implications for Riparian Restoration in the Southwestern United States. Restoration Ecology 16(1):146–154.

Soykan C.U., Brand L.A., Ries L., Stromberg J.C., Hass C., Jr D.A.S., Patterson W.J.D., and Sabo J.L. 2012. Multitaxonomic Diversity Patterns Along a Desert Riparian–Upland Gradient. PLoS ONE 7(1):e28235.

Stanek J.E., Mcneil S.E., Tracy D., Stanek J.R., Manning J.A., and Halterman M.D. 2021. Western Yellow-billed Cuckoo Nest-Site Selection and Success in Restored and Natural Riparian Forests. The Journal of Wildlife Management 85(4):782–793.

Stefferud J.A., Gido K.B., and Propst D.L. 2011. Spatially Variable Response of Native Fish Assemblages to Discharge, Predators and Habitat Characteristics in an Arid-Land River. Freshwater Biology 56(7):1403–1416.

Stromberg J.C. 1993a. Riparian Mesquite Forests: A Review of Their Ecology, Threats, and Recovery Potential. Journal of the Arizona-Nevada Academy of Science 27(1):111–124.

Stromberg J.C. 1993b. Frémont Cottonwood-Goodding Willow Riparian Forests: A Review of Their Ecology, Threats, and Recovery Potential. Journal of the Arizona-Nevada Academy of Science 27(1):97–110.

Stromberg J.C. 2001. Restoration of Riparian Vegetation in the South-Western United States: Importance of Flow Regimes and Fluvial Dynamism. Journal of Arid Environments 49(1):17–34.

Stromberg J.C., Tiller R., and Richter B. 1996. Effects of Groundwater Decline on Riparian Vegetation of Semiarid Regions: The San Pedro, Arizona. Ecological Applications 6(1):113–131.

Stuart J., Watson M.L., Brown T.L., and Eustice C. 2001. Plastic Netting: An Entanglement Hazard to Snakes and Other Wildlife. Herpetological Review 32(3):162–164.

Taylor J.P., and McDaniel K.C. 1998. Restoration of Saltcedar (*Tamarix* sp.)-Infested Floodplains on the Bosque del Apache National Wildlife Refuge. Weed Technology 12(2):345–352.

Tewksbury J.J., Black A.E., Nur N., Saab V.A., Logan B.D., and Dobkin D.S. 2002. Effects of Anthropogenic Fragmentation and Livestock Grazing on Western Riparian Bird Communities. Studies in Avian Biology(25):158–202.

Theobald D.M., Travis W.R., Drummond M.A., and Gordon E.S. 2013. The Changing Southwest. Pages 37–55 *In* Garfin G, Jardine A, Merideth R, Black M, and LeRoy S, editors. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. Island Press, Washington D. C., United States.

Tiedemann A.R., and Klemmedson J.O. 1977. Effect of Mesquite Trees on Vegetation and Soils in the Desert Grassland. Journal of Range Management 30(5):361.

Timmons R.J., Paulus S.A., and Upton L.J. 2015. Fish Monitoring of Selected Streams Within the Gila River Basin, 2014 Annual Report. Pages 1–51. Annual Report Number: R12PC32007. Arizona Game and Fish Department, Nongame Branch, Phoenix, Arizona, United States.

Tucker A.M., McGowan C.P., Mulero Oliveras E.S., Angeli N.F., and Zegarra J.P. 2021. A Demographic Projection Model to Support Conservation Decision Making for an Endangered Snake with Limited Monitoring Data. Animal Conservation 24(2):291–301.

Turner D.S., and List M.D. 2007. Habitat Mapping and Conservation Analysis to Identify Critical Streams for Arizona's Native Fish. Aquatic Conservation: Marine and Freshwater Ecosystems 17(7):737–748.

United Nations. 2021. AQUASTAT - FAO's Global Information System on Water and Agriculture. Available from https://www.fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/irrigation-by-country/country/MEX.

U.S. Fish and Wildlife Service. 1995. San Bernardino and Leslie Canyon National Wildlife Refuges Comprehensive Management Plan 1995-2015. Draft Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

U.S. Fish and Wildlife Service. 2008. Malpai Borderlands Habitat Conservation Plan. Pages 1–135. Biological Opinion Number: 22410-2006- F- 0408. Arizona Ecological Services, Region 2 (Southwest), U.S. Fish and Wildlife Service, Phoenix, Arizona, United States.

U.S. Fish and Wildlife Service. 2012a. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2011. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2012b. Mexican Spotted Owl Recovery Plan, First Revision (*Strix occidentalis lucida*). Pages 14248–14270. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Proposed Rule. Federal Register 78(132):41550–41608.

U.S. Fish and Wildlife Service. 2014a. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2013. Pages 1–163. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2014b. Endangered and Threatened Wildlife and Plants; Threatened Status for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Final Rule. Federal Register 79(130):38678–38746.

U.S. Fish and Wildlife Service. 2014c. Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*). Final rule. Federal Register 79(192):59992–60038.

U.S. Fish and Wildlife Service. 2015. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2014. Pages 1–155. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2016. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2015. Pages 1–161. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2017. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2016. Pages 1–158. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2018. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2017. Pages 1–93. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2019a. Historical and Current Status of the Western Yellow-Billed Cuckoo (YBCU) Excerpted from October 2013 Proposed Listing Rule and Updated by the YBCU Core Team. Pages 1–40. Region 2 (Southwest), U.S. Fish and Wildlife Service, Phoenix, Arizona, United States.

U.S. Fish and Wildlife Service. 2019b. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2018. Pages 1–119. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2020a. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2019. Pages 1–197. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2020b. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo. Proposed Rule. Federal Register 85(39):11458–11594.

U.S. Fish and Wildlife Service. 2020c. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Revised Proposed Rule. Federal Register 85(82):23608–23668.

U.S. Fish and Wildlife Service. 2020d. Endangered and Threatened Wildlife and Plants: Findings on a Petition to Delist the Distinct Population Segment of the Yellow-billed Cuckoo. Notification of Findings. Federal Register 65(33):8104–8107.

U.S. Fish and Wildlife Service. 2021a. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2020. Pages 1–207. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2021b. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Population Segment of the YellowBilled Cuckoo. Final Rule. Federal Register 86(75):20798–21005.

U.S. Fish and Wildlife Service. 2021c. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake. Final Rule. Federal Register 86(80):22518–22580.

U.S. Fish and Wildlife Service. 2022. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2021. Pages 1–125. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2023. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2022. Pages 1–197. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 2024. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 2023. Pages 1–197. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service (USFWS). 2020. Endangered and Threatened Wildlife and Plants: Findings on a Petition to Delist the Distinct Population Segment of the Yellow-billed Cuckoo; Notification of Findings. Federal Register 65(33):8104–8107.

U.S. Geological Survey. 2009. Understanding the Habitat Needs of the Declining Western Yellow-Billed Cuckoo. Pages 1–2. Fact Sheet Number: 2009–3091, Fact Sheet. Southwest Biological Center, Colorado Plateau Research Station, U.S. Geological Survey, Flagstaff, Arizona, United States.

Villarreal M.L., van Riper C., and Petrakis R.E. 2014. Conflation and Aggregation of Spatial Data Improve Predictive Models for Species with Limited Habitats: A Case of the Threatened Yellow-Billed Cuckoo in Arizona, USA. Applied Geography 47:57–69.

Vincent K.R., Friedman J.M., and Griffin E.R. 2009. Erosional Consequence of Saltcedar Control. Environmental Management 44(2):218–227.

Voeltz J.B. 2002. Roundtail Chub (*Gila robusta*) Status Survey of the Lower Colorado River Basin. Pages 1–228. Technical Report Number: 186. Nongame Branch, Wildlife Management Division, Arizona Game and Fish Department, Phoenix, Arizona, United States.

Wallace C.S.A., Villarreal M.L., and van Riper III C. 2013. Influence of Monsoon-Related Riparian Phenology on Yellow-billed Cuckoo Habitat Selection in Arizona. Journal of Biogeography 40(11):2094–2107.

Ward R.J., Griffiths R.A., Wilkinson J.W., and Cornish N. 2017. Optimising Monitoring Efforts for Secretive Snakes: A Comparison of Occupancy and N-Mixture Models for Assessment of Population Status. Scientific Reports 2017(7):18074.

Washington State Department of Transportation. 2020. Construction Noise Impact Assessment. Pages 1–95. Number: Chapter 7, Biological Assessment Preparation for Transportation Projects - Advanced Training Manual. Washington State Department of Transportation, Olympia, Washington, United States.

Waters T.F. 1995. Sediment in Streams - Sources, Biological Effects and Control. American Fisheries Society, Bethesda, Maryland, United States.

Wheeler A.P., Angermeier P.L., and Rosenberger A.E. 2005. Impacts of New Highways and Subsequent Landscape Urbanization on Stream Habitat and Biota. Reviews in Fisheries Science 13(3):141–164.

White M.C., Dillon K.G., and Moore D. 2018. Lower Rio Grande Yellow-billed Cuckoo Survey Results - 2017: Selected Sites Within the Lower Rio Grande Basin from Elephant Butte Dam, NM to El Paso, TX. Pages 1–41. Final Report, Reclamation-Managing Water in the West. Technical Service Center, Bureau of Reclamation, Denver, Colorado, United States.

Wohner P.J., Laymon S.A., Stanek J.E., King S.L., and Cooper R.J. 2021a. Challenging Our Understanding of Western Yellow-Billed Cuckoo Habitat Needs and Accepted Management Practices. Restoration Ecology 29(3):1–12.

Wohner P.J., Laymon S.A., Stanek J.E., King S.L., and Cooper R.J. 2021b. Early Successional Riparian Vegetation Is Important for Western Yellow-billed Cuckoo Nesting Habitat. Restoration Ecology 29(5):1–13.

Wondzell S.M., and Swanson F.J. 1999. Floods, Channel Change, and the Hyporheic Zone. Water Resources Research 35(2):555–567.

Wood D. 2018, January 31. Genome-Wide SNPS Reveal Low Genetic Diversity in Threatened Gartersnakes. Flagstaff, Arizona, United States.

Wood D.A., Emmons I.D., Nowak E.M., Christman B.L., Holycross A.T., and Vandergast A.G. 2018. Conservation Genomics of the Mogollon Narrow-Headed Gartersnake (*Thamnophis rufipunctatus*) and Northern Mexican Gartersnake (*Thamnophis eques megalops*). Pages 1–47. Open-File Report Number: 2018–1141. U.S. Geological Survey, Reston, Virginia, United States.

Wylie G.D., Hothem R.L., Bergen D.R., Martin L.L., Taylor R.J., and Brussee B.E. 2009. Metals and Trace Elements in Giant Garter Snakes (*Thamnophis gigas*) from the Sacramento Valley, California, USA. Archives of Environmental Contamination and Toxicology 56(3):577–587.

Zeedyk B., and Clothier V. 2014. Let the Water Do the Work: Induced Meandering, an Evolving Method for Restoring Incised Channels. Chelsea Green Publishing, White River Junction, Vermont, United States.

APPENDIX A

This appendix contains our concurrences with your "may affect, not likely to adversely affect" determinations for the endangered jaguar (*Panthera onca*), endangered ocelot (*Leopardus pardalis*), Yaqui beautiful shiner (*Cyprinella formosa*) and its critical habitat, the endangered Yaqui chub (*Gila purpurea*) and its critical habitat, the endangered Yaqui topminnow (*Poeciliopsis sonoriensis*), the endangered Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*), and critical habitat for the threatened Yaqui catfish (*Ictalurus pricei*).

JAGUAR

While jaguars have not been documented on SBNWR, the U.S. Fish and Wildlife Service has documented seven, possibly nine individuals in the U.S. between 1996-2022 (USFWS 2014a accessed 11/9/2023, USFWS 2014b). These occurrences, as confirmed by camera sightings in southern Arizona, are all males suggesting no breeding currently occurs in Arizona as the last documented female dates to 1963 (Hatten et al. 2005). Although breeding does not occur in Arizona, some of these adult male jaguars have been resident individuals (McCain and Childs 2008; Culver 2016). Jaguars have been documented using a variety of vegetation communities; in the northernmost part of their range (northwest Mexico and southwest U.S.) they have been recorded in thorn scrub, desert scrub, chapparal, semidesert grassland, Madrean evergreen woodland, deciduous forest, and conifer forest (Boydston and Lopez-Gonzalez 2005; USFWS 2018). Although rare in the U.S., jaguars can occur within the multiple mountain ranges in southern Arizona.

Recent construction of the border wall and associated seasonal openings of flood gates allow for the potential occurrence of jaguars on SBNWR. Jaguars have not been documented on refuge, but a male jaguar has been documented in the Chiricahua Mountains (~20 miles N/E of SBNWR) and is believed to have traveled north from Mexico. Jaguars are known to have large territories and could potentially be documented utilizing resources on SBNWR. There has been and continues to be trail camera monitoring on SBNWR with no documentation of a jaguar. However, there is a very low likelihood that jaguars could occur in the proposed action area given both the proximity to and habitat connectivity of known locations of jaguars and their travel routes in relation to the proposed site. If a jaguar were present during project activities, it could be affected. Potential effects include habitat alteration, reduced prey base, and anthropogenic disturbance (increased vehicular traffic and increased noise levels). Because occurrences of jaguars in Arizona are rare in any one specific location or footprint, the probability of jaguar presence during project implementation is unlikely. Given this, we concur that project activities may affect, but are not likely to adversely affect, the species.

Conservation Measures

1. SBNWR will not conduct project activities during nighttime, when jaguars are most active.
2. SBNWR will impose a 25-mph speed limit, for all vehicles to reduce potential effects to jaguars.

Concurrence

Our concurrence is based on the following:

- Traveling jaguars will utilize cover, when possible (USFWS 2018), and mesquite grubbing will remove 100 acres of canopy cover. However, Hay Hollow (adjacent wash approximately 1.5 mi east) and remaining sections of Black Draw riparian areas, documented wildlife movement corridors, will still provide cover for jaguars should they occur in the action area, in addition to the remaining mesquite woodlands that will be left on refuge. Further, habitat alteration around Black Draw may reduce prey opportunities for jaguars, but wildlife avoidance of the area is temporary (only during project implementation) and water in Black Draw will continue to bring prey species to the locality for jaguars that may be in the area. Therefore, effects to jaguars from habitat alteration are insignificant.

- Jaguars in the area may be disturbed by project activities, such as increased noise and human presence. The noise level created by project implementation is expected to be 90 dBA at 50ft (WDOT 2020). Without topographic or other environmental factors, noise will attenuate with distance by 6 dBA (for hard ground) for every doubling of distance (WDOT 2020). Therefore, noise levels will be at ambient levels (45.4 dBA average for Pusch Ridge Wilderness, Santa Catalina Mountains, Arizona (Schoenecker and Krausman 2002)) 1.60 miles from project activities. Should jaguars occur in the action area, we anticipate effects from human disturbance will be insignificant because project activities are temporary (no more than 3 years), seasonal (only between October and March), and will occur during daylight hours when jaguars are least active.

- Increased vehicular traffic in the project area could affect jaguars through fatality or injury due to vehicular collisions; however, SBNWR will ensure vehicular travel at a speed of no more than 25 mph within the project area to reduce effects to jaguars, thereby making effects from vehicle strikes discountable.

References

Boydston E.E., and Lopez-Gonzalez C.A. 2005. Sexual Differentiation in the Distribution Potential of Northern Jaguars (*Panthera onca*). Pages 51–56 *In* Gottfried GJ, Gebow BS, Eskew L, and Edminster CB, editors. Connecting Mountain Islands and Desert Seas: Biodiversity and Management of the Madrean Archipelago II. Proceedings RMRS-P-36. Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colorado, United States.

Culver M. 2016. Jaguar Surveying and Monitoring in the United States. Pages 1–246. Open-File Report Number: 2016–1095, Version 1.1, Open-File Report. U.S. Geologic Survey, Reston, Virginia, United States.

Hatten J.R., Averill-Murray A., and van Pelt W.E. 2005. A Spatial Model of Potential Jaguar Habitat in Arizona. Journal of Wildlife Management 69(3):1024–1033.

McCain E.B., and Childs J.L. 2008. Evidence of Resident Jaguars (*Panthera onca*) in the Southwestern United States and the Implications for Conservation. Journal of Mammalogy 89(1):1–10.

Schoenecker K.A., and Krausman P.R. 2002. Human Disturbance in Bighorn Sheep Habitat, Pusch Ridge Wilderness, Arizona. Journal of the Arizona-Nevada Academy of Science 34(1):63–68.

U.S. Fish and Wildlife Service. 2014a. Online Jaguar Observation Database. Available from https://jaguardata.info/. Accessed 11/9/2023.

U.S. Fish and Wildlife Service. 2014b. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Jaguar. Final Rule. Federal Register 79(43):12572–12654.

U.S. Fish and Wildlife Service. 2018. Jaguar Recovery Plan. Pages 1–273. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

Washington State Department of Transportation. 2020. Construction Noise Impact Assessment. Pages 1–95. Number: Chapter 7, Biological Assessment Preparation Manual. Washington State Department of Transportation, Olympia, Washington, United States.

OCELOT

Since 2009, reported detections of ocelots in southeast Arizona have increased (USFWS 2016) resulting in the identification of six individual males occupying primarily the Huachuca, Santa Rita, and Patagonia Mountains. The last known detection was reported in 2023, in the Huachuca Mountains. Researchers documented an individual traveling between the Huachuca and Patagonia Mountains (84 km round trip) (Culver 2016), confirming that ocelots move across suitable habitat in Arizona. Ocelots are found in many vegetated habitat types; however, Arizona ocelots appear to be associated with Madrean evergreen woodland (Avila-Villegas and Lamberton-Moreno 2013; Culver 2016), semidesert grassland, and Great Basin grassland biotic communities (Culver 2016). The proposed project area contains potential ocelot habitat, so ocelots could be affected by project activities should they occur near the site.

Recent construction of the border wall and associated seasonal openings of flood gates allow for the potential occurrence of ocelots on SBNWR. Ocelots are known to have large territories and could potentially be documented utilizing resources on SBNWR. There has been and continues to be trail camera monitoring on SBNWR with no documentation of an ocelot. However, there is a very low likelihood that an ocelot could occur in the proposed action area given both the proximity to and habitat connectivity of known locations of ocelots and their travel routes in relation to the proposed site. If an ocelot was present during project activities, it could be

affected. Potential effects include habitat alteration, reduced prey base, and anthropogenic disturbance (increased vehicular traffic and increase noise levels). Because occurrences of ocelots in Arizona are rare in any one specific location, however, the probability of ocelot presence during project implementation is unlikely. Given this, we concur that project activities may affect, but are not likely to adversely affect ocelots.

Conservation Measures

1. SBNWR will not conduct project activities during nighttime, when ocelots are most active.
2. SBNWR will impose a 25-mph speed limit, for all vehicles to reduce potential effects to ocelots.

Concurrence

Our concurrence is based on the following:

- Primarily, we anticipate the effects of the proposed action to ocelot will be discountable because ocelots have never been documented in this portion of Arizona. However, if ocelots are documented in the action area during the implementation of the action, anticipated effects would be insignificant or discountable as explained herein.

- Traveling ocelots will utilize cover, when possible (USFWS 2016), and mesquite grubbing will remove 100 acres of canopy cover. However, Hay Hollow (adjacent wash approximately 1.5 mi east) and remaining sections of Black Draw riparian areas, documented wildlife movement corridors, will still provide cover for ocelots should they occur in the action area, in addition to the remaining mesquite woodlands that will be left on refuge. Further, habitat alteration around Black Draw may reduce prey opportunities for ocelots, but wildlife avoidance of the area is temporary (only during project implementation) and water in Black Draw will continue to bring prey species to the area for ocelots that may be in the area. Therefore, effects to ocelot from habitat alteration are insignificant.

- Ocelots in the area may disturbed by project activities, such as increased noise and human presence. The noise level created by project implementation is expected to be 90 dBA at 50ft (WDOT 2020). Without topographic or other environmental factors, noise will attenuate with distance by 6 dBA (for hard ground) for every doubling of distance (WDOT 2020). Therefore, noise levels will be at ambient levels (45.4 dBA average for Pusch Ridge Wilderness, Santa Catalina Mountains, Arizona (Schoenecker and Krausman 2002)) 1.60 miles from project activities. Should ocelots occur in the action area, we anticipate effects from human disturbance will be insignificant because project activities are temporary (no more than 3 years), seasonal (only between October and March), and will occur during daylight hours when ocelots are least active.

- Increased vehicular traffic in the project area could affect ocelots through fatality or

injury due to vehicular collisions (as this has been documented in the past (Avila-Villegas 2013); however, SBNWR will ensure vehicular travel at a speed of no more than 25 mph within the project area to reduce effects to ocelots, thereby making effects from vehicle strikes discountable.

References

Avila-Villegas S. 2013, March 15. E. Fernandez Email Exchange with Sky Island Alliance; Vehicular Mortality of Ocelots.

Avila-Villegas S., and Lamberton-Moreno J. 2013. Wildlife Survey and Monitoring in the Sky Island Region with an Emphasis on Neotropical Felids. Pages 441–447 *In* Gottfried GJ, Ffolliott PF, Gebow BS, Eskew L, and Collins LC, editors. Merging Science and Management in a Rapidly Changing World: Biodiversity and Management of the Madrean Archipelago III. Proceedings RMRS-P-67. Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colorado, United States.

Culver M. 2016. Jaguar Surveying and Monitoring in the United States. Pages 1–246. Open-File Report Number: 2016–1095, Version 1.1, Open-File Report. U.S. Geologic Survey, Reston, Virginia, United States.

Schoenecker K.A., and Krausman P.R. 2002. Human Disturbance in Bighorn Sheep Habitat, Pusch Ridge Wilderness, Arizona. Journal of the Arizona-Nevada Academy of Science 34(1):63–68.

U.S. Fish and Wildlife Service. 2016. Recovery Plan for the Ocelot (*Leopardus pardalis*), First Revision. Pages 1–273. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

YAQUI BEAUTIFUL SHINER

The beautiful shiner (*Cyprinella formosa*) is one of eight species of fish known as the Rió Yaqui Fishes (USFWS 1995) and was described from the San Bernardino Creek (Rió San Bernardino, or Black Draw) just south of the Arizona-Sonora border (Girard 1856; Rutter 1896). The beautiful shiner inhabits small streams and ponds in the Rió Yaqui drainage of Arizona and Mexico. The beautiful shiner consists of two forms: the Yaqui form (inhabiting the Yaqui basin) and the Guzman form (inhabiting the Guzman basin). Historically, the Yaqui beautiful shiner was found in the Riós Yaqui, Casas Grandes, Santa Maria, and Santa Clara drainages in Sonora and Chihuahua, Mexico; the Rió Yaqui (San Bernardino Creek/Black Draw) in Arizona; and the Mimbres River in New Mexico (USFWS 1995).

The Yaqui beautiful shiner was reintroduced to the San Bernardino NWR in 1990 (USFWS 1991) after collections in Mexico from the Rió Montezuma in 1989 (USFWS 1990). Currently, the Yaqui form of the beautiful shiner in the United States reside in San Bernardino Creek and several artificial ponds on San Bernardino National Wildlife Refuge and in Leslie Creek on

Leslie Canyon National Wildlife Refuge and are dependent on well water and management actions for continued persistence.

Critical habitat was designated in 1984 and includes all aquatic habitats on the San Bernardino NWR (USFWS 1984), including Black Draw in the project area.

Within the project area, the species occurs within several refuge-managed ponds and in small perennial pools in Black Draw: specifically North Pond outflow, Minckley Ponds outflow, Twin outflow, and Hackberry Ponds outflow. The Yaqui beautiful shiner does occur within the project footprint and is likely to be affected by project activities, although not adversely, and will likely ultimately benefit from the project. Potential effects to beautiful shiner include crushing injury or mortality from debris spilled into pools in Black Draw, temporary habitat degradation from sedimentation, and overall habitat modification. Given this, we concur that the project is likely to affect, but not adversely affect the Yaqui beautiful shiner.

Conservation Measures

1. SBNWR will not conduct mesquite grubbing activities within Black Draw proper where Yaqui beautiful shiner occur.

2. SBNWR will monitor known permeant water locations in Black Draw both during project implementation and post-project to document restoration actions on occupied sites in Black Draw. Specifically, SBNWR will monitor availability of aquatic habitat and potential impacts to aquatic habitat from bank sloughing. SBNWR will salvage and translocate fish if deemed necessary.

3. SBNWR will continue annual monitoring of Yaqui beautiful shiner in all aquatic habitats including sites within the project area.

4. SBNWR will continue to monitor stream geomorphology and chemistry during annual surveys.

Concurrence

Our concurrence is based on the following:

- San Bernardino NWR will ensure that no project activities occur in the Black Draw channel and will monitor the permanent pools in Black Draw throughout project implementation. Given that activities will be restricted from beautiful shiner locations and these locations will be monitored makes the potential effects to beautiful shiner from crushing both insignificant and discountable.

- Beautiful shiner could also experience habitat degradation related to sedimentation and turbidity from project activities and future events resulting from project activities such as the sloughing of material from the Black Draw channel banks. Sedimentation negatively affects fish in multiple ways to include direct health effects and reproductive effects

(Bruton 1985; Berkman and Rabeni 1987) as well as indirect effects from water clarity (turbidity) (Remington 2008). Arid land adapted fishes have often evolved high tolerance to sedimentation and turbidity as desert aquatic systems experience seasonal monsoon and flooding events that increase both sedimentation and turbidity in natural streams and drainages (Holden 1973; Miller 2005). Barkalow and Bonar (2015) found that Yaqui chub (a Yaqui drainage sympatric species) exhibited high sediment tolerance in short term exposures, specifically embryos and fry. Increased sedimentation and turbidity directly caused by project activities are unlikely, as no actions will be conducted within the stream channel, and temporary, as no activities will be conducted during monsoon season when higher flow pulse events could further increase turbidity, making direct effects to shiner both insignificant and discountable. Future events of increased sedimentation and turbidity are likely to be associated with pulse events perpetuated by monsoonal rains and flooding. Given this, the exposure to these effects is temporary (usually minutes to hours (Levick et al. 2007)), and as a regionally adapted fish native to Black Draw, the effects to beautiful shiner are insignificant.

- Yaqui beautiful shiner could experience potential effects from habitat modification by project activities. Such effects could be alteration of perennial pool depth, width, underwater structure, as well as other components of water quality. Direct effects from project activities are unlikely as project implementation will not occur in the channel of Black Draw making these effects discountable. However, habitat modification is likely in the future as a result of project actions. Seasonal monsoon and flooding events often modify stream channels such that multiple significant changes can occur within a channel in a single monsoon season depending on precipitation and drainage features (Levick et al. 2007). However, the sloughing of the Black Draw channel, the anticipated future events from project activities, will create a wider, less incised channel that more closely resembles the historical structure and functioning of aquatic habitat that beautiful shiner evolved in. Beautiful shiner, while documented in various habitats, show high affiliation with small stream riffles (USFWS 1984). The arroyo cutting of Black Draw has resulted in near total loss of naturally occurring habitat for beautiful shiner in Black Draw. As the species is dependent upon management actions to provide artificial flow into Black Draw from deep aquifer wells, the potential future benefits of habitat restoration from project activities will outweigh the temporary impacts of project activities, thus, the potential effects to Yaqui beautiful shiner are insignificant.

- The USFWS designated critical habitat in 1984 (USFWS 1984) which includes all aquatic habitats of the San Bernardino NWR, and defines the constituent elements for the Rio Yaqui Fishes as: 1) clean, small, permanent streams and springs without any exotic fishes, 2) deep pool areas separated by riffles and flowing areas with moderate current, and 3) backwater areas of stream and springs with overgrown cut banks and accumulations of detritus necessary for feeding and shelter. Currently, Black Draw does not possess all three of these constituent elements. While clean, small, permanent stream reaches devoid of exotic fishes and deep pool areas do exist within the Black Draw reach on the refuge, small riffles and backwaters with undercut banks are generally lacking due to severe channel incision. The proposed project will remove mesquite trees that increase

bank stability and contribute to arroyo formation and cutting. The proposed project activities themselves will not adversely modify Rió Yaqui fish critical habitat. Rather, future benefits are expected as Black Draw is restored and critical habitat on San Bernardino NWR is enhanced. Therefore, potential effects to the constituent elements of beautiful shiner critical habitat from project activities are insignificant.

References

Barkalow S., and Bonar S.A. 2015. Effects of Suspended Sediment on Early-Life Stage Survival of Yaqui Chub. Transactions of the American Fisheries Society 144:345–351.

Berkman H.E., and Rabeni C.F. 1987. Effect of Siltation on Stream Fish Communities. Environmental Biology of Fishes 18(4):285–294.

Bruton M.N. 1985. The Effects of Suspensoids on Fish. Pages 221–241 *In* Davies BR and Walmsley RD, editors. Perspectives in Southern Hemisphere Limnology. Springer Netherlands, Dordrecht, Netherlands.

Girard C. 1856. Researches Upon the Cyprinoid Fishes Inhabiting the Fresh Waters of the United States of America, West of the Mississippi Valley, from Specimens in the Museum of the Smithsonian Institution. Proceedings of the Academy of Natural Sciences Philadelphia 8:165–213.

Holden P.B. 1973. Distribution, Abundance and Life History of the Fishes of the Upper Colorado River Basin. Doctoral Dissertation. Utah State University, Logan, Utah, United States.

Levick L.R., Goodrich D.C., Hernandez M., Semmens D., Stromberg J., Leidy R., Apodaca M., Guertin D.P., Tluczek M., and Kepner W. 2007. Hydrology and Ecology of Intermittent Stream and Dry Wash Ecosystems. Pages E35–E47 Proceedings from the Southwest Region Threatened, Endangered, and At-Risk Species Workshop. HydroGeoLogic, Inc., Reston, Virginia, United States. Available from https://apps.dtic.mil/sti/pdfs/ADA606999.pdf#page=139 (accessed February 17, 2023).

Miller R.R. 2005. Freshwater Fishes of Mexico. The University of Chicago Press, Chicago, Illinois, United States.

Remington R.K. 2008. Ecology and Evolution of Turbid Water Adaptations in Fishes. Doctoral Dissertation. University of Oklahoma, Norman, Oklahoma, United States. Available from https://www.proquest.com/openview/94d520c490b77840048273b8b5805d46/1?pq-origsite=gscholar&cbl=18750 (accessed February 17, 2023).

Rutter C. 1896. Notes on Freshwater Fishes of the Pacific Slope of North America. Leland Stanford Jr. University, Palo Alto, California, United States.

U.S. Fish and Wildlife. 1984. Endangered and Threatened Wildlife and Plants; Final Rule to Determine the Yaqui Chub to Be an Endangered Species with Critical Habitat, and to Determine the Beautiful Shiner and the Yaqui Catfish to Be Threatened Species with Critical Habitat. Final Rule. Federal Register 49(171):34490–34497.

U.S. Fish and Wildlife. 1995. Yaqui Fishes Recovery Plan. Pages 1–56. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

U.S. Fish and Wildlife Service. 1990. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 1989. Pages 1–28. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

U.S. Fish and Wildlife Service. 1991. San Bernardino National Wildlife Refuge Annual Narrative Report for Calendar Year 1990. Pages 1–35. Annual Narrative Report. San Bernardino National Wildlife Refuge, Region 2 (Southwest), U.S. Fish and Wildlife Service, Douglas, Arizona, United States.

YAQUI CHUB

The Yaqui chub (*Gila purpurea*) is one of several species of fish known as the Rió Yaqui Fishes (USFWS 1995) and was described from the Rió San Bernardino (Black Draw) just south of the Arizona-Sonora border (Girard 1856). This species often inhabits pools and undercut banks in permanent streams, particularly where vegetative structure is adequate. Yaqui chub are restricted to within about 3 km south of the international border in Sonora (Miller 2005). Once thought wider ranging, in 1991 the Yaqui chub was found to include a cryptic species, the desert chub (*Gila eremica*), and is now known to be restricted to the San Bernardino basin (DeMarais 1991).

Critical habitat was designated in 1984 and includes all aquatic habitats on the San Bernardino NWR (USFWS 1984), including Black Draw in the project area.

Within the project area, the species occurs within several refuge-managed ponds and in small perennial pools in Black Draw. Since the Yaqui chub does occur within the project footprint and is likely to be affected by project activities, although not adversely; Yaqui chub and will likely ultimately benefit from the project. Potential effects to the Yaqui chub include crushing injury or mortality from debris spilled into pools in Black Draw, temporary habitat degradation from sedimentation, and overall habitat modification. Given this we concur that the project is likely to affect, but not adversely affect Yaqui chub.

Conservation Measures:

1. SBNWR will not conduct mesquite grubbing activities within Black Draw proper where Yaqui chub occur.

2. SBNWR will monitor known permeant water locations in Black Draw both during project implementation and post-project to document restoration actions on occupied sites

in Black Draw. Specifically, SBNWR will monitor availability of aquatic habitat and potential impacts to aquatic habitat from bank sloughing. SBNWR will salvage and translocate fish if deemed necessary.

3. SBNWR will continue annual monitoring of Yaqui chub in all aquatic habitats including sites within the project area.

4. SBNWR will continue to monitor stream geomorphology and chemistry during annual surveys.

Concurrence

Our concurrence is based on the following:

- San Bernardino NWR will ensure that no project activities occur in the Black Draw channel and will monitor the permanent pools in Black Draw throughout project implementation. Given that activities will be restricted from Yaqui chub locations and these locations will be monitored makes the potential effects to this species from crushing both insignificant and discountable.

- Yaqui chub could also experience habitat degradation related to sedimentation and turbidity from project activities and future events resulting from project activities such as the sloughing of material from the Black Draw channel banks. Sedimentation negatively affects fish in multiple ways to include direct health effects and reproductive effects (Bruton 1985; Berkman and Rabeni 1987) as well as indirect effects from water clarity (turbidity) (Remington 2008). Arid land adapted fishes have often evolved high tolerance to sedimentation and turbidity as desert aquatic systems experience seasonal monsoon and flooding events that increase both sedimentation and turbidity in natural streams and drainages (Holden 1973; Miller 2005). Barkalow and Bonar (2015) found that Yaqui chub exhibited high sediment tolerance in short term exposures, specifically embryos and fry. Increased sedimentation and turbidity directly caused by project activities are unlikely, as no actions will be conducted within the stream channel, and temporary as no activities will be conducted during monsoon season when higher flow pulse events could further increase turbidity, making direct effects to Yaqui chub both insignificant and discountable. Future events of increased sedimentation and turbidity are likely to be associated with pulse events perpetuated by monsoonal rains and flooding. Given this, the exposure to these effects is temporary (usually minutes to hours (Levick et al. 2007)), and as a regionally adapted fish native to Black Draw, the effects to Yaqui chub are insignificant.

- Yaqui chub could experience potential effects from habitat modification by project activities. Such effects could be alteration of perennial pool depth, width, underwater structure, as well as other components of water quality. Direct effects from project activities are unlikely as project implementation will not occur in the channel of Black Draw making these effects discountable. However, habitat modification is likely in the

future as a result of project actions. Seasonal monsoon and flooding events often modify stream channels such that multiple significant changes can occur within a channel in a single monsoon season depending on precipitation and drainage features (Levick et al. 2007). However, the sloughing of the Black Draw channel, the anticipated future events from project activities, will create a wider, less incised channel that more closely resembles the historical structure and functioning of aquatic habitat that Yaqui chub evolved in. Such habitat is documented as pools and undercut banks in perennial streams (USFWS 1984), the arroyo cutting of Black Draw has resulted in near total loss of naturally occurring habitat for Yaqui chub in Black Draw. As the species is dependent upon management actions to provide artificial flow into Black Draw from deep aquifer wells, the potential future benefits of habitat restoration from project activities will outweigh the temporary impacts of project activities, thus, the potential effects to Yaqui chub are insignificant.

- The USFWS designated critical habitat in 1984 (USFWS 1984) which includes all aquatic habitats of the San Bernardino NWR, and defines the constituent elements for the Rió Yaqui Fishes as: 1) clean, small, permanent streams and springs without any exotic fishes, 2) deep pool areas separated by riffles and flowing areas with moderate current, and 3) backwater areas of stream and springs with overgrown cut banks and accumulations of detritus necessary for feeding and shelter. Currently, Black Draw does not possess all three of these constituent elements. While clean, small, permanent stream reaches devoid of exotic fishes and deep pool areas do exist within the Black Draw reach on the refuge, small riffles and backwaters with undercut banks are generally lacking due to severe channel incision. The proposed project will remove mesquite trees that increase bank stability and contribute to arroyo formation and cutting. The proposed project activities themselves will not adversely modify Rió Yaqui fish critical habitat. Rather, future benefits are expected as Black Draw is restored and critical habitat on San Bernardino NWR is enhanced. Therefore, potential effects to the constituent elements of Yaqui chub critical habitat from project activities are insignificant.

References

Barkalow S., and Bonar S.A. 2015. Effects of Suspended Sediment on Early-Life Stage Survival of Yaqui Chub. Transactions of the American Fisheries Society 144:345–351.

Berkman H.E., and Rabeni C.F. 1987. Effect of Siltation on Stream Fish Communities. Environmental Biology of Fishes 18(4):285–294.

Bruton M.N. 1985. The Effects of Suspensoids on Fish. Pages 221–241 *In* Davies BR and Walmsley RD, editors. Perspectives in Southern Hemisphere Limnology. Springer Netherlands, Dordrecht, Netherlands.

DeMarais B.D. 1991. *Gila eremica*, A New Cyprinid Fish from Northwestern Sonora, México. Copeia 1991(1):179–189.

Girard C. 1856. Researches Upon the Cyprinoid Fishes Inhabiting the Fresh Waters of the United States of America, West of the Mississippi Valley, from Specimens in the Museum of the Smithsonian Institution. Proceedings of the Academy of Natural Sciences Philadelphia 8:165–213.

Holden P.B. 1973. Distribution, Abundance and Life History of the Fishes of the Upper Colorado River Basin. Doctoral Dissertation. Utah State University, Logan, Utah, United States.

Levick L.R., Goodrich D.C., Hernandez M., Semmens D., Stromberg J., Leidy R., Apodaca M., Guertin D.P., Tluczek M., and Kepner W. 2007. Hydrology and Ecology of Intermittent Stream and Dry Wash Ecosystems. Pages E35–E47 Proceedings from the Southwest Region Threatened, Endangered, and At-Risk Species Workshop. HydroGeoLogic, Inc., Reston, Virginia, United States. Available from https://apps.dtic.mil/sti/pdfs/ADA606999.pdf#page=139 (accessed February 17, 2023).

Miller R.R. 2005. Freshwater Fishes of Mexico. The University of Chicago Press, Chicago, Illinois, United States.

Remington R.K. 2008. Ecology and Evolution of Turbid Water Adaptations in Fishes. Doctoral Dissertation. University of Oklahoma, Norman, Oklahoma, United States. Available from https://www.proquest.com/openview/94d520c490b77840048273b8b5805d46/1?pq-origsite=gscholar&cbl=18750 (accessed February 17, 2023).

U.S. Fish and Wildlife. 1984. Endangered and Threatened Wildlife and Plants; Final Rule to Determine the Yaqui Chub to Be an Endangered Species with Critical Habitat, and to Determine the Beautiful Shiner and the Yaqui Catfish to Be Threatened Species with Critical Habitat. Final Rule. Federal Register 49(171):34490–34497.

U.S. Fish and Wildlife. 1995. Yaqui Fishes Recovery Plan. Pages 1–56. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

YAQUI TOPMINNNOW

Both the Yaqui (*Poeciliopsis occidentalis sonoriensis*) and Gila (*Poeciliopsis occidentalis occidentalis*) topminnow were listed as endangered in 1967 under the binomial, *Poeciliopsis occidentalis*, (USFWS 1967). The Gila and Yaqui topminnow can be distinguished morphologically by the Yaqui form's relatively longer snout, shorter female lateral band, and superior mouth orientation (compared to Gila topminnow's sub-superior) (USFWS 1984). The Yaqui form of the species was described as a full species in 1859 (Girard 1859) and both forms were recognized as separate subspecies by Minckley (1969), who gave their distinguishing traits. The Yaqui topminnow was originally abundant throughout the Rió Yaqui drainage (Hendrickson et al. 1980). In the United States, the headwater area of the Rió Yaqui held Yaqui topminnow in Whitewater and Black Draws and their associated springs and ciénegas, presumably in abundant numbers (USFWS 1984).

Habitat loss and predation by introduced mosquitofish were listed factors in the decline of the Yaqui topminnow and in 1984, the species was known to persist in only five locations. Currently, self-sustaining populations of the Yaqui topminnow in occur in multiple on- and off-refuge locations.

Within the project area, the species occurs within several refuge-managed ponds and in small perennial pools in Black Draw. The Yaqui topminnow does occur within the project footprint and is likely to be affected by project activities, although not adversely Yaqui topminnow will likely ultimately benefit from the project. Potential effects to the Yaqui topminnow include crushing injury or mortality from debris spilled into pools in Black Draw, temporary habitat degradation from sedimentation, and overall habitat modification. We concur that project activities are likely to affect, but not adversely affect Yaqui topminnow.

Conservation Measures

1. SBNWR will not conduct mesquite grubbing activities within Black Draw proper where Yaqui topminnow occur.

2. SBNWR will monitor known permeant water locations in Black Draw both during project implementation and post-project to document restoration actions on occupied sites in Black Draw. Specifically, SBNWR will monitor availability of aquatic habitat and potential impacts to aquatic habitat from bank sloughing. SBNWR will salvage and translocate fish if deemed necessary.

3. SBNWR will continue annual monitoring of Yaqui topminnow in all aquatic habitats including sites within the project area.

4. SBNWR will continue to monitor stream geomorphology and chemistry during annual surveys.

Concurrence

Our concurrence is based on the following:

- San Bernardino NWR will ensure that no project activities occur in the Black Draw channel and will monitor the permanent pools in Black Draw throughout project implementation. Given that activities will be restricted from Yaqui topminnow locations and these locations will be monitored makes the potential effects to this species from crushing both insignificant and discountable.

- Yaqui topminnow could also experience habitat degradation related to sedimentation and turbidity from project activities and future events resulting from project activities such as the sloughing of material from the Black Draw channel banks. Sedimentation negatively affects fish in multiple ways to include direct health effects and reproductive effects (Bruton 1985; Berkman and Rabeni 1987) as well as indirect effects from water clarity (turbidity) (Remington 2008). Arid land adapted fishes have often evolved high tolerance

to sedimentation and turbidity as desert aquatic systems experience seasonal monsoon and flooding events that increase both sedimentation and turbidity in natural streams and drainages (Holden 1973; Miller 2005). Barkalow and Bonar (2015) found that Yaqui chub (a Rió Yaqui drainage sympatric species) exhibited high sediment tolerance in short term exposures, specifically embryos and fry. Increased sedimentation and turbidity directly caused by project activities are unlikely, as no actions will be conducted within the stream channel, and temporary as no activities will be conducted during monsoon season when higher flow pulse events could further increase turbidity, making direct effects to Yaqui topminnow both insignificant and discountable. Future events of increased sedimentation and turbidity are likely to be associated with pulse events perpetuated by monsoonal rains and flooding. Given this, the exposure to these effects is temporary (usually minutes to hours (Levick et al. 2007)), and as a regionally adapted fish native to Black Draw, the effects to Yaqui topminnow are insignificant.

- Yaqui topminnow could experience potential effects from habitat modification by project activities. Such effects could be alteration of perennial pool depth, width, underwater structure, as well as other components of water quality, such as water temperature. Direct effects from project activities are unlikely as project implementation will not occur in the channel of Black Draw making these effects discountable. However, habitat modification is likely in the future as a result of project actions. Seasonal monsoon and flooding events often modify stream channels such that multiple significant changes can occur within a channel in a single monsoon season depending on precipitation and drainage features (Levick et al. 2007). However, the sloughing of the Black Draw channel, the anticipated future events from project activities, will create a wider, less incised channel that more closely resembles the historic structure and functioning of aquatic habitat that Yaqui topminnow evolved in. Such habitat is documented as shallow, warm, quiet waters with occasional flow (USFWS 1995), the arroyo cutting of Black Draw has resulted in near total loss of naturally occurring habitat for Yaqui topminnow in Black Draw. As the species is dependent upon management actions to provide artificial flow into Black Draw from deep aquifer wells, the potential future benefits of habitat restoration from project activities will outweigh the temporary impacts of project activities, thus, the potential effects to Yaqui topminnow are insignificant.

References:

Barkalow S., and Bonar S.A. 2015. Effects of Suspended Sediment on Early-Life Stage Survival of Yaqui Chub. Transactions of the American Fisheries Society 144:345–351.

Berkman H.E., and Rabeni C.F. 1987. Effect of Siltation on Stream Fish Communities. Environmental Biology of Fishes 18(4):285–294.

Bruton M.N. 1985. The Effects of Suspensoids on Fish. Pages 221–241 *In* Davies BR and Walmsley RD, editors. Perspectives in Southern Hemisphere Limnology. Springer Netherlands, Dordrecht, Netherlands.

Girard C. 1859. Ichthyological Notices. Proceedings of the Academy of Natural Sciences of Philadelphia XLI(LXI):56–58.

Hendrickson D.A., Minckley W.R., Siebart D.J., and Minckley P.H. 1980. Fishes of the Río Yaqui Basin, México and United States. Journal of the Arizona-Nevada Academy of Sciences 15(3):65–106.

Holden P.B. 1973. Distribution, Abundance and Life History of the Fishes of the Upper Colorado River Basin. Doctoral Dissertation. Utah State University, Logan, Utah, United States.

Levick L.R., Goodrich D.C., Hernandez M., Semmens D., Stromberg J., Leidy R., Apodaca M., Guertin D.P., Tluczek M., and Kepner W. 2007. Hydrology and Ecology of Intermittent Stream and Dry Wash Ecosystems. Pages E35–E47 Proceedings from the Southwest Region Threatened, Endangered, and At-Risk Species Workshop. HydroGeoLogic, Inc., Reston, Virginia, United States.

Miller R.R. 2005. Freshwater Fishes of Mexico. The University of Chicago Press, Chicago, Illinois, United States.

Minckley W.L. 1969. Native Arizona Fishes: Part I - Livebearers. Wildlife Views, Arizona Game and Fish Department 16(3):6–8.

Remington R.K. 2008. Ecology and Evolution of Turbid Water Adaptations in Fishes. Doctoral Dissertation. University of Oklahoma, Norman, Oklahoma, United States.

U.S. Fish and Wildlife. 1995. Yaqui Fishes Recovery Plan. Pages 1–56. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

U.S. Fish and Wildlife Service. 1967. Office of the Secretary; Native Fish and Wildlife; Endangered Species. Federal Register 32(48):4001.

U.S. Fish and Wildlife Service. 1984. Gila and Yaqui Topminnow Recovery Plan. Pages 1–56. Recovery Plan. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

YAQUI CATFISH CRITICAL HABITAT

The Yaqui catfish (*Ictalurus pricei*) was listed with critical habitat in 1984 (USFWS 1984) and was once widely distributed across northwest Mexico and parts of Arizona. The Yaqui catfish is a bottom-dwelling omnivore, and the only known native *Ictalurus* spp. (catfish) west of the U.S. continental divide (USFWS 2019). The Yaqui catfish exhibits a narrow-elongated body that is blueish grey above (dorsally) and lighter-white below (ventrally) with spots or speckles on the body (Meek 1904) and can range in size up to 19 inches (500 mm) in length (Rutter 1896; Minckley and Gilbert 1980).

Habitat preferences of Yaqui catfish described by Hendrickson et al. (1980) indicate that the species is most abundant in larger rivers with medium to slow water flow, characterized by sandy or rocky bottoms at lower elevations. At higher elevations, Yaqui catfish were frequently found in clear, still pools containing aquatic plants, with gravely or sandy bottoms (Hendrickson et al. 1980). Critical habitat includes all aquatic habitats on the San Bernardino NWR, including Black Draw in the project area (USFWS 1984).

The most pressing threats to the Yaqui catfish throughout its range in both magnitude and extent include the presence of channel catfish and the construction of large water impoundment structures (dams). Further, these two stressors interact to perpetuate threats to the Yaqui catfish.

Government programs introduced channel catfish throughout Mexico to promote sport and commercial fishing (Ruíz-Compos et al. 2014) and evidence shows that the species can interbreed with Yaqui catfish, forming hybrids that potentially backcross with parent species and other hybrids (Gutiérrez-Barragán et al. 2021). Across the range of the Yaqui catfish, the construction of impoundments has led to the alteration of aquatic habitat and promotion of channel catfish stocking across the range. Yaqui catfish do not appear to exhibit reservoir habitat adaptability, likely due to lack of suitable habitat. In addition, the high abundance of channel catfish stocked in reservoirs increases direct competition and hybridization potential with Yaqui catfish, and since large reservoirs create source populations of channel catfish, the species is able to infiltrate nearly all available aquatic habitats across the Yaqui catfish range.

In the United States, Yaqui catfish were extirpated in the 1960s, coinciding with collapsing water flows in Arizona's upper San Bernardino River (McNatt 1974). Genetically pure Yaqui catfish are known to now remain within the Yaqui and the Fuerte river basins of Sonora, Mexico (Gutiérrez-Barragán et al. 2021; Pérez-Rodríguez 2022)**.**

Conservation Measures:

1. SBNWR will continue to monitor stream geomorphology and chemistry during annual surveys.

Concurrence

Our concurrence is based on the following:

- Since the Yaqui catfish is extirpated from habitats in the United States, direct threats to the Yaqui catfish are discountable. In addition, appropriate habitat for the species does not currently exist within the United States but project objectives may create opportunities for new habitat creation in the future.

- The USFWS designated critical habitat in 1984 (USFWS 1984) which includes all aquatic habitats of the San Bernardino NWR, and defines the constituent elements for the Rió Yaqui Fishes as: 1) clean, small, permanent streams and springs without any exotic fishes, 2) deep pool areas separated by riffles and flowing areas with moderate current, and 3) backwater areas of stream and springs with overgrown cut banks and accumulations of detritus necessary for feeding and shelter. Currently, Black Draw does not possess all three of these constituent elements. While clean, small, permanent stream reaches devoid of exotic fishes and deep pool areas do exist within the Black Draw reach on the refuge, small riffles and backwaters with undercut banks are generally lacking due to severe channel incision. The proposed project will remove mesquite trees that increase bank stability and contribute to arroyo formation and cutting. The proposed project activities themselves will not adversely modify Rió Yaqui fish critical habitat. Rather,

future benefits are expected as Black Draw is restored and critical habitat on San Bernardino NWR is enhanced. Therefore, potential effects to the constituent elements of Yaqui catfish critical habitat from project activities are insignificant.

References:

Gutiérrez-Barragán A., García-De León F.J., Varela-Romero A., Ballesteros-Córdova C.A., Grijalva-Chon J.M., and De la Re-Vega E. 2021. Evidence of Hybridization Between Yaqui Catfish *Ictalurus pricei* (Rutter, 1896) and Channel Catfish *Ictalurus punctatus* (Rafinesque, 1818) in North-West México Revealed by Analysis of Mitochondrial and Nuclear Genes. Aquatic Conservation: Marine and Freshwater Ecosystems 31(11):3334–3341.

Hendrickson D.A., Minckley W.R., Siebart D.J., and Minckley P.H. 1980. Fishes of the Río Yaqui Basin, México and United States. Journal of the Arizona-Nevada Academy of Sciences 15(3):65–106.

McNatt R.M. 1974. Re-Evaluation of the Native Fishes of the Rio Yaqui in the United States. Pages 273–279 Proceedings of the Annual Conference Western Association of State Game and Fish Commissions. Albuquerque, New Mexico, United States.

Meek S.E. 1904. The Fresh-Water Fishes of Mexico North of the Isthmus of Tehuantepec. Field Columbian Museum, Chicago, Illinois, United States.

Minckley W.R., and Gilbert C.R. 1980. *Ictalurus pricei* (Rutter) Yaqui Catfish. Page 445 *In* Lee DS, Gilbert CR, Hocutt CH, Jenkins RE, McAllister DE, and Stauffer Jr. JR, editors. Atlas of North American Freshwater Fishes. North Carolina Biological Survey, Raleigh, North Carolina, United States.

Pérez-Rodríguez R., Domínguez-Domínguez, Pedraza-Lara C., Rosas-Valdez R., Pérez-Ponce de León G., García-Andrade A.B., and Doadrio I. 2022. Multi-Locus Phylogeny and Species Delimitation in the Catfish Genus *Ictalurus* Rafinesque, 1820 (Actinopterygii, Siluriformes). Research Square.

Rutter C. 1896. Notes on Freshwater Fishes of the Pacific Slope of North America. Leland Standford Jr. University, Palo Alto, California, United States.

Ruíz-Campos G., Varela-Romero A., Sánchez-Gonzales S., Camarena-Rosales F., Maeda-Martínez A., González-Acosta A., Andreu-Soler A., Campos-González E., and Delgadillo-Rodríguez J. 2014. Peces Invasores en el Noroeste De México. Pages 375–527 *In* Mendoza-Alfaro R and Koleff-Osorio P, editors. Especies Acuáticas Invasoras En México. Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad, Parques del Pedregal, Tlalpan, México.

U.S. Fish and Wildlife Service. 1984. Endangered and Threatened Wildlife and Plants; Final Rule to Determine the Yaqui Chub to be an Endangered Species with Critical Habitat, and to Determine the Beautiful Shiner and the Yaqui Catfish to be Threatened Species with Critical Habitat. Final Rule. Federal Register 49(171):34490–34497.

U.S. Fish and Wildlife. 2019. Yaqui Catfish (*Ictalurus pricei*) Five-Year Review: Summary and Evaluation. Pages 1–18. Five-Year Review. Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.

HUACHUCA WATER UMBEL

The Huachuca water umbel is a semi-aquatic to fully aquatic herbaceous (non-woody) perennial (having a life cycle of more than two years). The root system is comprised of both long horizontal rhizomes (underground stem that has shoots and roots growing from it) and connected shorter vertical rhizomes. Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, the USFWS is aware of 17 locations supporting extant occurrences of Huachuca water umbel, 8 locations where Huachuca water umbel occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years (USFWS 2017). Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting Huachuca water umbel occurrences, though most of these locations have not been revisited in recent years (USFWS 2017).

The Huachuca water umbel inhabits ciénegas (marshes), rivers, streams, and springs. It generally occurs in perennial, shallow, and slow-flowing or quiet waters or in active stream channels containing refugial sites where most plants can escape the effect of scouring floods (USFWS 1997, USFWS 1999). Historically, drainages in southeastern Arizona consisted of broad, shallow waterways in valley bottoms that gradually collected overland flow from large watersheds. The San Pedro River, for example was reported to be a meandering marshy creek before channel incision (Stromberg and Tellman 2009). Huachuca water umbel appears to be adapted to this type of hydrological regime and resulting conditions. During larger flood events, small, weakly-rooted clumps of the plant may tear off, float downstream, and are deposited elsewhere in the drainage. Some of these clumps survive if appropriate habitat conditions are present.

Huachuca water umbel competes poorly with other wetland plant species, making intermediate levels of disturbance from flooding, fire, grazing, or other sources necessary to reduce competition and promote dispersal and the preservation of genetic diversity (USFWS 1997). As Huachuca water umbel possesses weak and shallow roots, the need to be able to compete for sunlight, water, and nutrients must be balanced with some unknown extent of companion plants that enable bank stability along riparian channels.

Currently, Huachuca water umbel is propagated and reintroduced into suitable locations on the San Bernardino and Leslie Canyon NWRs by refuge staff. At least one, possibly two, extant populations of the species occur within the project area within the Black Draw channel. The populations persist due to their intentional placement near pond outflow pipes that provide perennial flow and bank-like habitat where disturbance is less likely than along the stream channel proper. Given this, Huachuca water umbel could be affected by project activities, specifically potential crushing from debris or personnel and habitat modification from channel sloughing of the Black Draw channel. We concur that project activities are likely to affect, but not adversely affect the Huachuca water umbel.

Conservation Measures

1. SBNWR will conduct Huachuca water umbel surveys before initiation of project activities and will monitor identified sites throughout the duration of the project.

2. SBWWR will continue to monitor Huachuca water umbel sites post project to assess effects to the species.

3. SBNWR will transplant new patches of Huachuca water umbel within the project area if any locations are scoured due to project activities.

4. SBNWR will continue to help enact the Recovery Plan for the Huachuca water umbel through continued efforts to conserve historical, existing, newly discovered, and newly established Huachuca water umbel occurrences and their seedbanks by augmenting existing occurrences and establishing new occurrences in appropriate habitat on SBNWR.

5. SBNWR will maintain a source population of Huachuca water umbel for transplant activities.

Concurrence

Our concurrence is based on the following:

- San Bernardino NWR will ensure that no project activities occur within the Black Draw channel and will monitor all known occupied sites throughout project implementation. Given that activities will be restricted from known Huachuca water umbel locations, and these will be monitored for effects, the potential effects from crushing are discountable.

- Huachuca water umbel could experience habitat modification from channel bank sloughing as mesquite trees (that stabilized the incised channel) are removed and flashy hydrology is used to raise the channel bed by relocating soils from the steep banks. This soil relocation could dislodge patches of Huachuca water umbel, or increased turbidity from higher sediment loads could increase scouring of occupied sites. These types of events are part of the life history of the species as hydrochory is the is main dispersal mechanism and Huachuca water umbel demonstrates functional traits that suggest adaptation to this environment. Specifically, Huachuca water umbel is able to reestablish at sites from seedbanks, employs buoyant fruit for water dispersal, and can reproduce asexually to produce clonal patches (USFWS 2017). Thus, effects from project activities will not adversely affect the species. Further, conservation measures will ameliorate these effects as the refuge currently monitors and actively transplants Huachuca water umbel to create new patches within Black Draw. In addition, the long-term effects of the project are likely to be beneficial for Huachuca water umbel as hydrology is restored to resemble historical conditions more closely with lower energy water flow through the stream channel. Given this, the potential effects to Huachuca water umber from habitat modification are insignificant.

References:

Stromberg J.C., and Tellman B., Editors. 2009. Ecology and Conservation of the San Pedro River. University of Arizona Press, Tucson, Arizona, United States.

U.S. Fish and Wildlife Service. 1997. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for Three Wetland Species Found in Southern Arizona and Northern Sonora, Mexico. Final Rule. Federal Register 62(3):665–689.

U.S. Fish and Wildlife Service. 1999. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Huachuca Water Umbel, a Plant. Final Rule. Federal Register 64(132):37441–37453.

U.S. Fish and Wildlife Service. 2017. Recovery Plan for *Lilaeopsis schaffneriana* ssp. *recurva* (Huachuca water umbel). Pages 1–108. Final Recovery Plan. Arizona Ecological Services, Region 2 (Southwest), U.S. Fish and Wildlife Service, Albuquerque, New Mexico, United States.